Agnes R. Stogicza
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Peter S. Staats
Editors

Interventional Pain

A Step-by-Step Guide for the FIPP Exam

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ISBN 978-3-030-31740-9 ISBN 978-3-030-31741-6 (eBook)
https://doi.org/10.1007/978-3-030-31741-6

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Foreword

It is integral to the profession, and to our patients, to provide interventional pain procedures with the highest levels of procedural safety. The learning available through WIP, leading to the FIPP exam, provides the physician with the tools needed for excellent care with maximum safety. Although today there are many minimally invasive pain procedures available, the examined 20 procedures in the FIPP exam are representative of the overall interventional pain management field.

This book provides a timely and much needed standardized approach to the 20 procedures tested at the FIPP exam. It is an excellent resource for both examinees and examiners and will ultimately enhance excellence of care and the highest standards of safety.

The idea for WIP and a standardized exam first started 25 years ago, when the five WIP founders (late Prithvi Raj, late David Niv, Serdar Erdine, Ricardo Ruiz-Lopez, and Gabor B Racz) realized the worldwide unfilled need for effective interventional chronic pain management. Today, there are 1,229 FIPP physicians providing excellent interventional pain management to tens of thousands of patients globally.

Complications can arise, and our obligation is to do everything to avoid them. For example, the use of blunt needles has been shown to decrease bleeding; the use of 22G needles is easier to steer and control than the 25G, which has been implicated as the source of the most common medicolegal cases: pneumothoraxes; 10 years ago we did not know that numbness, paresis, and paraplegia can arise from loculation, the lack of runoff at the epidural space, and can be solved with exercises (neuroflossing) that open up the neuroforamina.

Safety is paramount. The best way to ensure safety is to continuously train ourselves, to set standards in knowledge, and to share that knowledge. This is the ultimate goal of WIP. In this sense, the FIPP exam is only the beginning of a path of lifelong learning in these interventional pain procedures. When you have your name added to the list of FIPPs, the process does not stop. You must keep learning and passing your information to your colleagues and all those who will benefit from the information. WIP provides you with a global network of colleagues with whom to collaborate, to share your knowledge, and to extend your abilities.

The evolution of this practical book has taken over 20 years. One of the early fellows of Edit Racz was Agnes Stogicza. Dr. Stogicza has now become an outstanding, enthusiastic, and dedicated physician. She is committed to her patients and committed to passing on her extensive knowledge in interventional pain management. She has been widely involved with the WIP activities, not only in Budapest but around the world. I congratulate her and her coauthors, André M. Mansano, Andrea Trescot, and Peter Staats on this excellent and timely book.

Gabor B. Racz, MD, DABA, ABIPP, FIPP
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Preface

This book *Interventional Pain: A Step-by-Step Guide for the FIPP Exam* provides a concise standardized approach to each procedure examined during the World Institute of Pain's (WIP) Fellow of Interventional Pain (FIPP) examination, providing guidance for both the examiner and the examinee. Each chapter contains the relevant C-arm and needle positions that are expected to be demonstrated during the FIPP exam. High-resolution native and edited images help to clarify anatomy and injection targets, as well as safe and unsafe zones. Where there are multiple acceptable approaches for the exam, these are included in this *Guide*.

This *Guide* outlines the most common reasons for "unacceptable procedures performance" and "potentially unsafe procedures performance" to help the examinees understand and avoid the most common pitfalls.

The authors understand that the targets will have other approaches. The goal of this *Guide* is to demonstrate commonly accepted, safe approaches. Pain doctors in their practices, however, may differ from the approaches given in this *Guide*, since the profession itself is constantly evolving as we learn from our experiences and the experiences of others.

The injectate used by pain doctors varies largely, depending on the goal of the actual procedure. Generally, diagnostic injections use small volumes, whereas therapeutic injections may use much larger volumes. In this *Guide*, we offer suggestions on the injectate only where it is generally accepted as standard.

The available evidence has been summarized at the end each chapter by two main groups, the WIP Benelux Chapter and the American Society of Interventional Pain Physicians, in order to help the practicing physician integrate various views of the available literature.

This book was written by 20 FIPPs, and each chapter has been reviewed by at least 5 FIPPS, involving a total of 21 countries from around the world in order to achieve a consensus guideline.

It is our hope that all candidates will pass the FIPP exam, practice and teach safe injection procedures, help the many patients in pain around the world, and strengthen our international interventional pain physician group at WIP. We thank all the participants who were involved in the creation of this *Guide*.

Budapest, Hungary — Agnes R. Stogicza, MD, FIPP, CIPS, ASRA-PMUC

Acknowledgments

The idea for this book first came about when I observed the complexities of the different approaches to pain procedures during the FIPP exams, and also the opportunity to show simple ways to teach and learn them. However, this book would never have made it to print without the kind support and expert guidance of a great many people across the world.

I remain indebted to my three outstanding physician friends and contributors: Dr. Andrea Trescot, past Chair of the WIP Education Committee, my mentor, and, more importantly, my friend for 15 years; Dr. André M. Mansano for editing and for his most thorough review of the literature; and Dr. Peter Staats, past Chair of the Examination Board and President Elect of the WIP for his support of this project.

My sincerest thanks:

To the WIP Education Committee, which embraced this project, and to Dr. Craig Hartrick, WIP Past President, for his support and suggestions.

To the contributors from over 19 countries and to the many reviewers from 13 countries, who came together to help ensure this book provided consensus work in a complex field. They include: Dr. Mert Akbas, Dr. Charles Amaral, Dr. Alan Berkman, Dr. Jianguo Cheng, Dr. Miles Day, Dr. Javier De Andrés Ares, Dr. Fabricio Dias Assis, Dr. Sudhir Diwan, Dr. Serdar Erdine, Dr. Charles Gauci, Dr. Amitabh Gulati, Dr. Standiford Helm, Dr. Frank Huygen, Dr. Rafael Justiz, Dr. Steven Litman, Dr. Pierluigi Manchiaro, Dr. Andre Masano, Dr. TCT Novy, Dr. Einar Ottestad, Dr. Ricardo Plancarte, Dr. Gabor Racz, Dr. Olav Rohof, Dr. Matthew Rupert, Dr. Micha Sommer, Dr. Peter Staats, Dr. Agnes Stogicza, Dr. Milan Stojanovic, Dr. Andrea Trescot, Dr. Sandra van den Heuvel, Dr. Maarten van Kleef, Dr. Jan van Zundert, Dr. Massimo Barbieri, Dr. Athmaja Thottungal and Dr. Raja Reddy.

To Dr. Milan Stojanovic, Current Chair of the WIP Education Committee, for critically reviewing all the chapters and providing expert and timely feedback.

To Dr. Gabor Racz, Dr. Edit Racz, and Dr. Andrea Trescot who have helped me over my entire career. Their continuing pursuit of knowledge has been instrumental in inspiring my academic growth.

To the Benelux team (Dr. Jan van Zundert, Dr. Frank Huygen, Dr. Jan W Kallewaard, Dr. Kris Vissers, Dr. Koen van Boxem, Dr. Maarten van Kleef, Dr. Maurits van Tulder) for creating an extract of the recently published evidence review.

To the American Society of Interventional Pain Physicians, and Dr. Laxmaiah Manchikanti for offering another view on the current evidence of the procedures, with different inclusion criteria and evaluation of the available literature. The work of these two groups greatly helps the reader navigate the vast literature available on the topics.

To 3D4Medical Limited for their beautiful anatomy images that help clarify fluoro-anatomy.

To countless colleagues across the world who share a belief that all of society benefit from physicians becoming more adept at pain management techniques, as we are able to treat both acute and chronic pain more effectively.

To my family, who put up with my late nights and deadlines, offering support and logistics along the way.

And last, but certainly not least, to our patients, who put their faith in us and will hopefully go on to lead happy, healthy, and fruitful lives.

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Part I

Head and Neck Procedures

Interlaminar Cervical Epidural Injection

1

Alan Berkman

Equipment and Monitoring

- Standard ASA monitoring
- Fluoroscopy
- Sterile prep, and drape
- Skin local anesthesia prior to any needle larger than 25G (unless sedation is used)
- Coaxial view is always used to advance needle, unless otherwise specified
- CPR equipment and medications available
- 18 - 22G, 3.5 inch (90 mm) epidural Tuohy/coude needle
- LOR (loss of resistance) syringe
- Low volume extension tubing
- Preservative-free saline
- Preservative-free local anesthetic
- Nonionic contrast material
- Particulate or nonparticulate steroid

Anatomy

- LF (ligamentum flavum) is discontinuous in the cervical region, leading to high rates of false LOR
- LF to dura distance at C7 is only 1.5–2 mm. Neck flexion increases this distance
- All CESI (cervical epidural steroid injection) procedures are recommended to be performed at C7-T1, but not higher than C6–C7 level, alternatively at the T1–T2 cervical/thoracic level
- Imaging studies (MRI or CT) should be reviewed prior to the procedure, preferably reviewing the actual sagittal and axial images in order to confirm that there is adequate epidural space for needle placement at the target level and to determine the optimal spinal entry level (look for epidural fat in T1 sagittal sequence)

Structures to Keep in Mind and Possible Complications

- Dural puncture → spinal headache
- Dural puncture and intrathecal medication administration → sudden onset motor block, cardiac/respiratory arrest, death
- Subdural puncture → spinal cord compression, or medication related sudden onset motor block, cardiac/respiratory arrest, death
- Epidural blood vessels → bleeding/spinal cord compression and epidural hematoma formation, possible onset even after procedure completed
- Direct spinal cord damage/injection → loss of bladder/bowel function, various paresthesias, motor loss, depending on injected amount, syrinx formation, quadriplegia, death
- Epidural infection → abscess
- Exiting nerve roots → nerve injury
- Procedure should not be performed while patient is taking certain anticoagulants
- Heavy sedation should be avoided for routine CESI
- Infection
- Bleeding
- Postprocedure pain
- Vasovagal reaction
- Allergic reaction

Fluoroscopy Technique, Target Localization

CESI should be performed only with use of both anteroposterior (AP) and lateral and/or contralateral oblique (CLO) views

- Patient prone, neck flexed using pillow under chest

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A. R. Stogicza et al. (eds.), *Interventional Pain*, https://doi.org/10.1007/978-3-030-31741-6_1

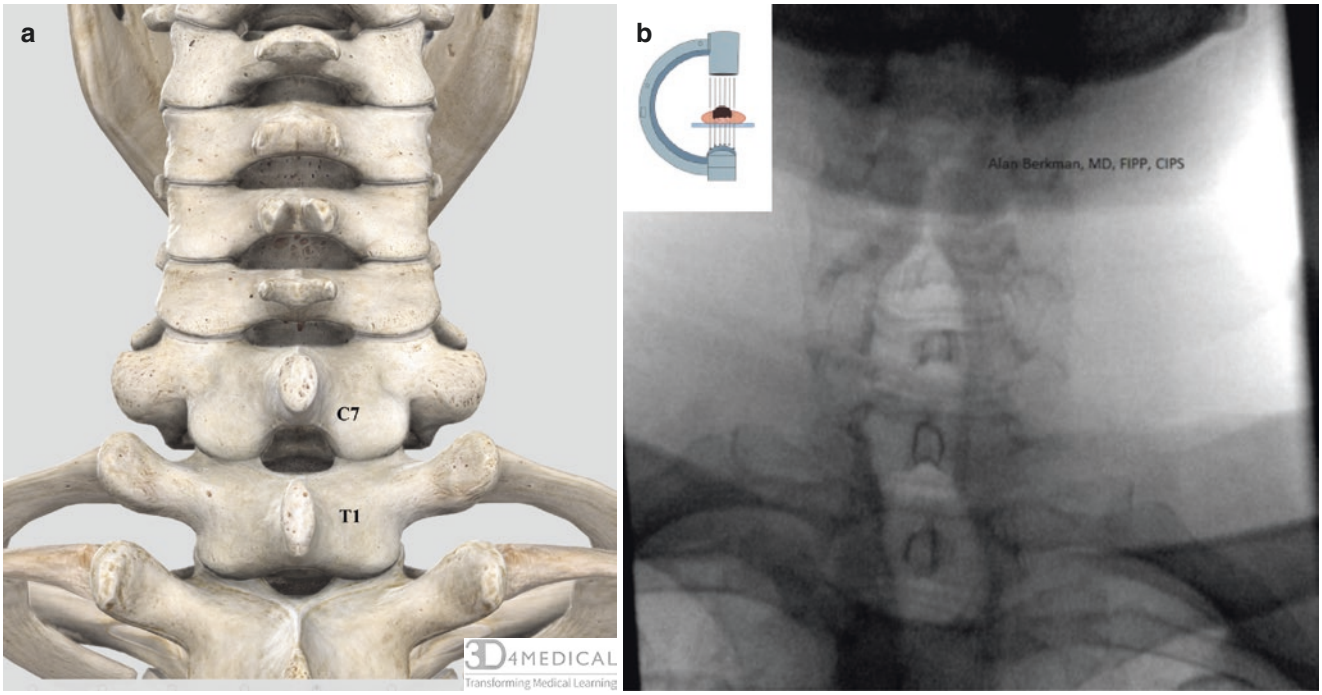

Fig. 1.1 Cervical spine AP view (with slight cephalo-caudad tilt to optimize the interlaminar opening). Complete Anatomy image (**a**) and fluoroscopy image (**b**)

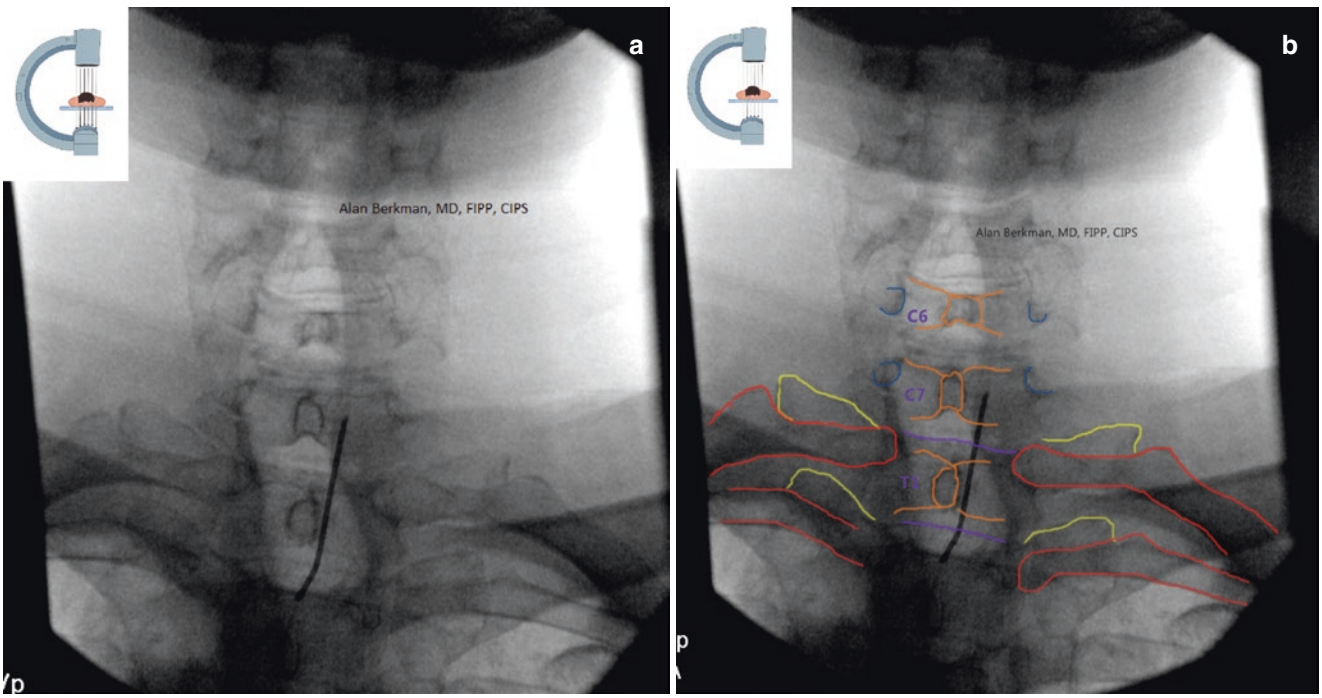

Fig. 1.2 AP view of cervical spine. Needle pointing at skin entry point, lateral to C7 spinous process, posterior to the lamina (right paramedian approach). Orange = spinous processes and laminae; yellow = transverse processes; blue = pedicles; purple = vertebral body endplates; red = ribs. Native (**a**) and edited (**b**) fluoroscopy image

- AP image
- Occasionally, C-arm angulation in a cephalo-caudad tilt is needed to best view target area (however, most often not needed) (Fig. 1.1a, b)
- Identify C7-T1 or C6-7 (alternatively T1–T2)
- Skin entry point should be below the target space posterior to the lamina (zone 2-see below (Fig. 1.4a, b)) via a paramedian approach (Fig. 1.2a, b) or at the interspace for midline approach

Procedure Steps – Paramedian Approach, AP and Lateral Fluoroscopy Views

- Skin entry paramedian, just lateral to spinous process (zone 2) of C7 or T1 (or T2)
- Advance needle to touch the cephalad edge of the lamina (Fig. 1.3).This will lead to a needle placement almost, but not completely, in coaxial view
- Walk the needle off the lamina cephalad to the interspace (Fig. 1.4a, b)
- View the lateral image to determine the depth of the needle (which may be very difficult to view due to superimposed shoulders) (Fig. 1.5a–c)

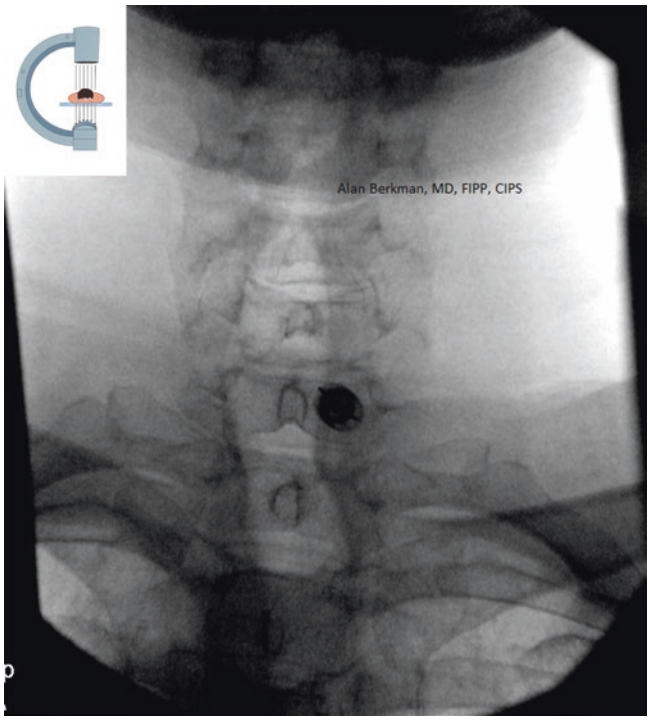

Fig. 1.3 Needle advanced to the cephalad edge of the C7 lamina (right paramedian approach) Native fluoroscopy image

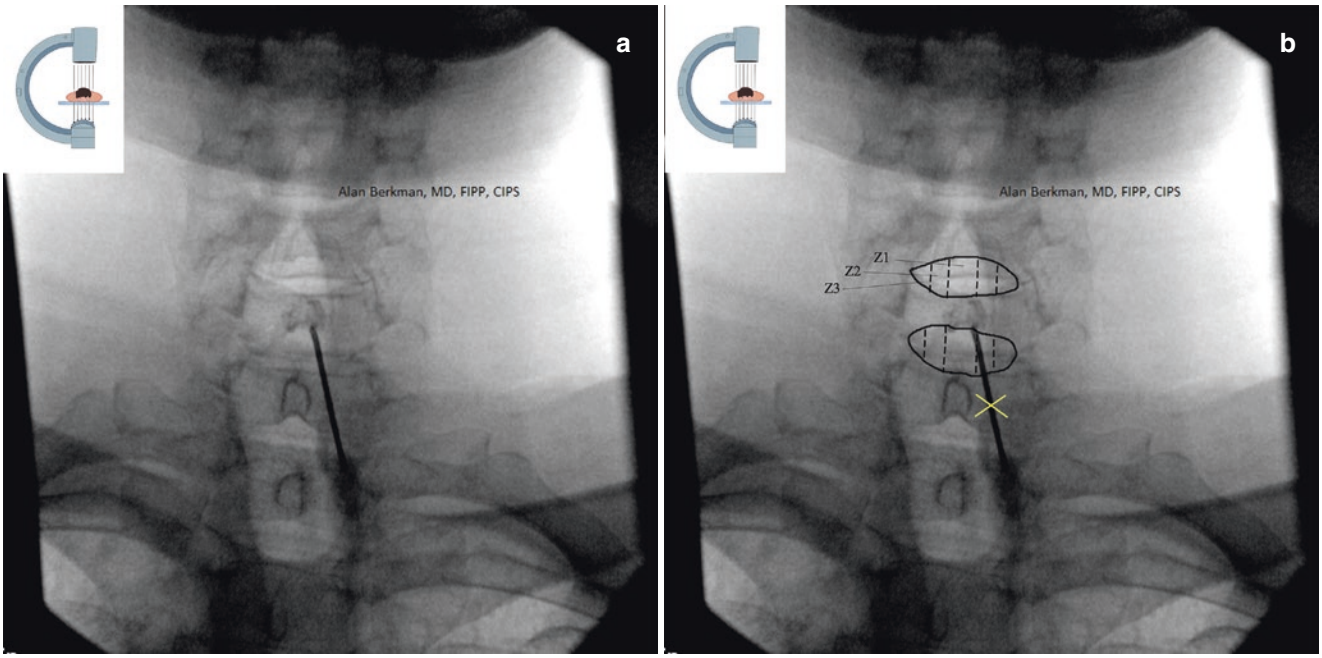

Fig. 1.4 Needle advanced to the epidural space with loss of resistance technique (right paramedian approach). X marks the skin entry site. The anteroposterior (AP) view was divided into three zones: Zone 1 (Z1) extends from lateral margin of spinous process on the left to the right side. The area from the lateral margin of the spinous process to the very lateral margin of the interlaminar opening measured at its maximum width was subdivided into two equal zones. Zone 2 (Z2) is medial and Zone 3 (Z3) is lateral. The needle tip is in Zone 1. Native (**a**) and edited (**b**) fluoroscopy image

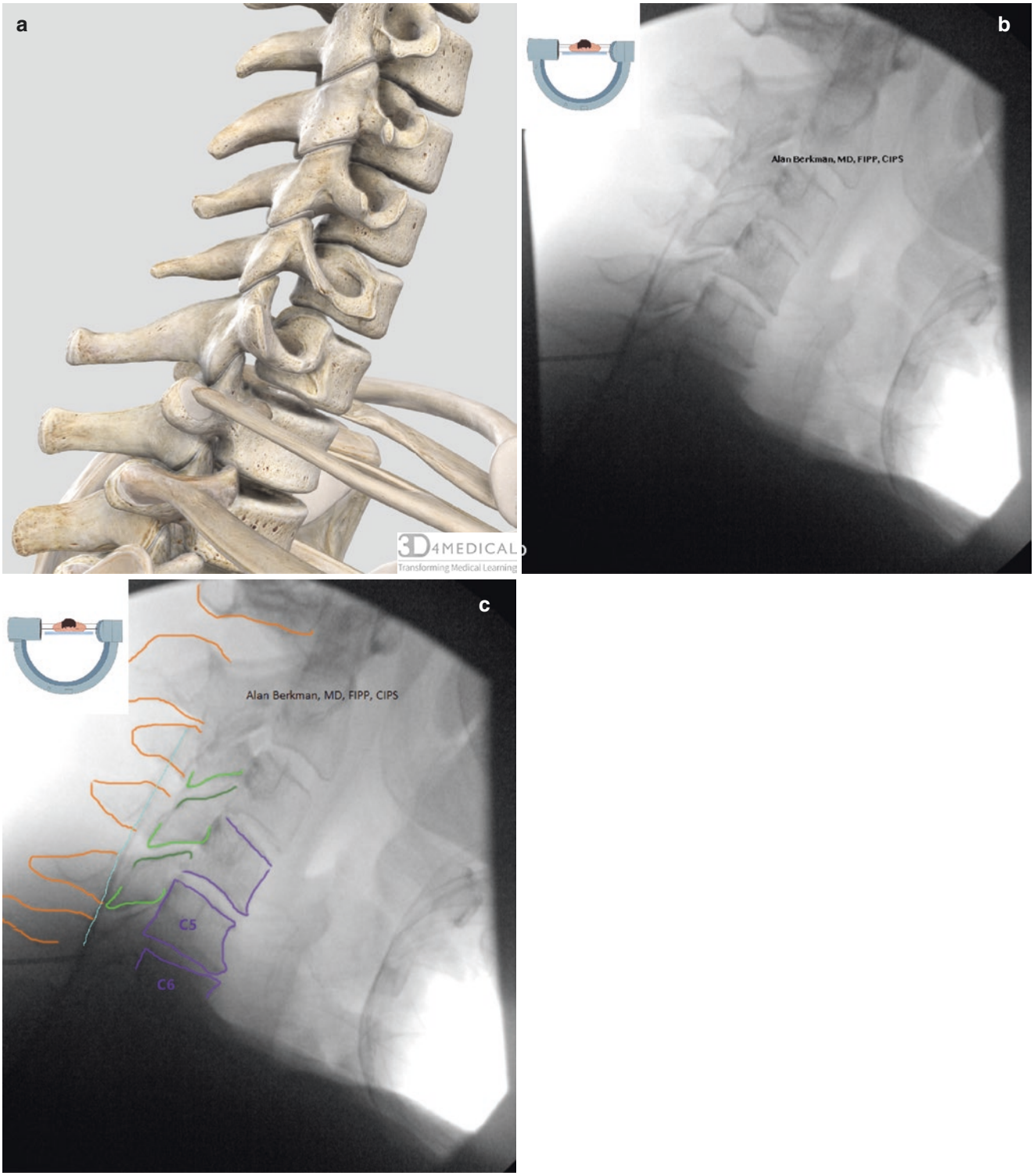

Fig. 1.5 Lateral view of the cervical spine confirms appropriate needle position and epidural spread of contrast material (right paramedian approach). Orange = spinous processes and laminae; light green = inferior articular processes; dark green = superior articular processes; light blue = spino-laminar line; purple = vertebral bodies. Complete Anatomy image (**a**), native (**b**) and edited fluoroscopy images (**c**)

- Do NOT advance the needle tip beyond the spino-laminar line without LOR technique
- Advance the needle slowly with continuous LOR technique until LOR is encountered
- If any doubts, check the AP, lateral and CLO views (see below)

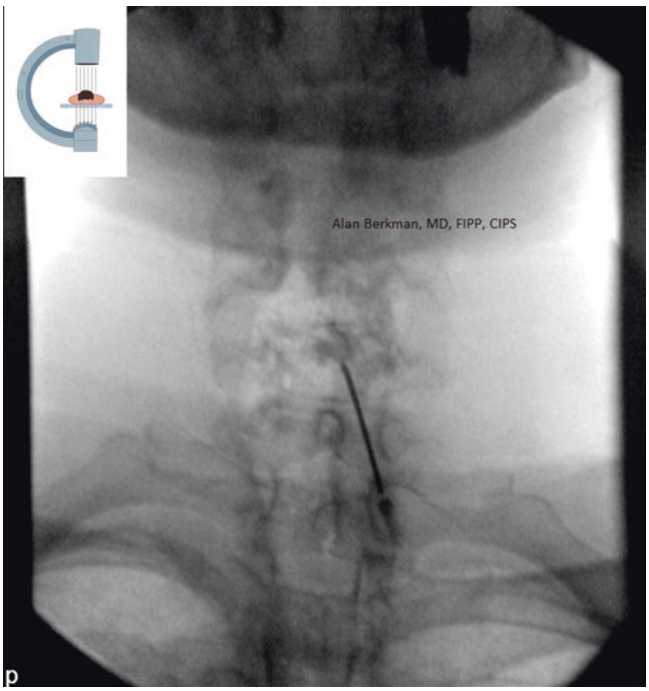

Fig. 1.6 AP view of the cervical spine, which confirms appropriate epidural contrast spread, patchy, mostly right sided spread. The contrast outlines the right C7 and T1 pedicles. Native fluoroscopy image

- Confirm access to epidural space with injection of 1–2 ml contrast medium using extension tubing and intermittent or live fluoroscopy
- Contrast should flow along the spino-laminar line, creating a thin dorsal line of spread (Fig. 1.5a–c)
- Verify epidural spread on an AP view (Figs. 1.6 and 1.9)
- Consider using Digital Subtraction Angiography (DSA)
- Abandon procedure if subarachnoid, subdural spread suspected
- Reposition needle if venous blood contacted

Procedure Steps – Paramedian Approach, AP and Contralateral Oblique Fluoroscopy Views

- Touhy/Coude needle entry should be paramedian, just lateral to spinous process of C7 or T1 (or T2) (Fig. 1.7a) *(Identical step to the procedure above.)*
- Touch bone on the cephalad edge of the lamina, then walk off lamina and advance slowly a few millimeters until needle is engaged in the ligamentum flavum (Fig. 1.7a, b) *(Identical step to the procedure above.)*
- View contralateral (CLO) view at about 50° opposite to the needle entry side (Fig. 1.8a). Advance the needle to the Ventral Interlaminar Line (VILL)
- Advance the needle slowly with continuous LOR technique until LOR is encountered. If any doubts, check the AP, lateral, and CLO views (Figs. 1.7 and 1.8)

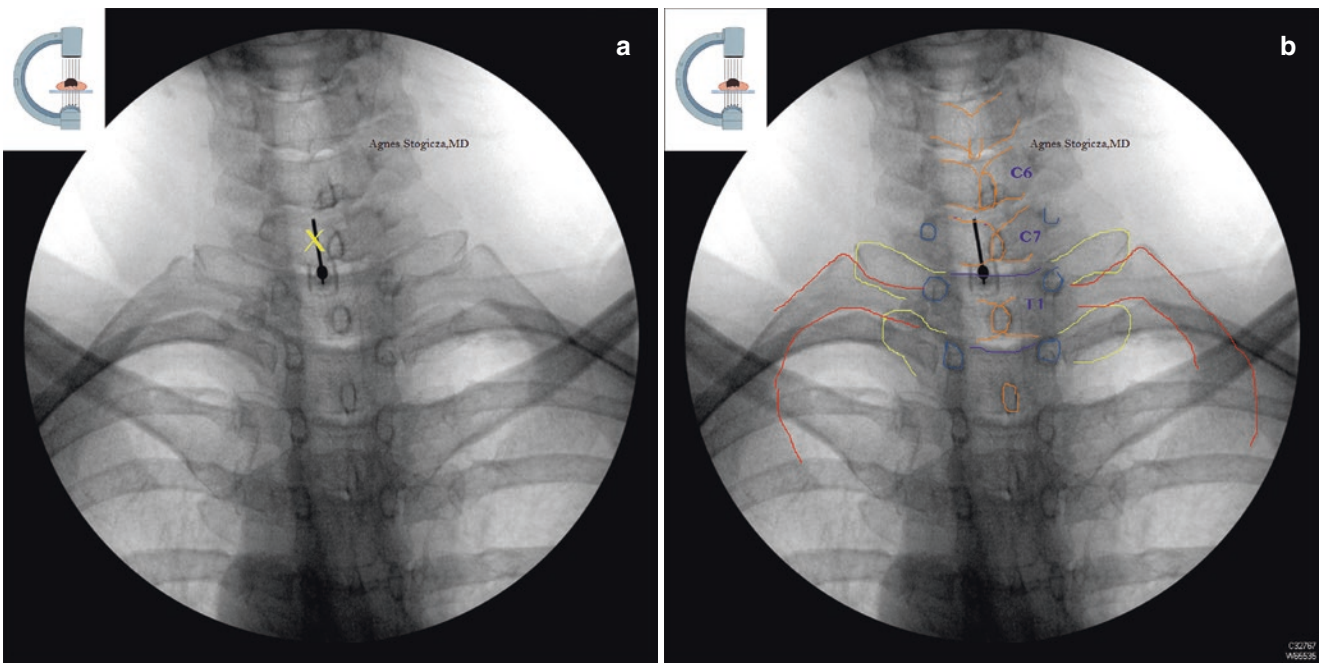

Fig. 1.7 Cervical epidural, paramedian approach. Needle in epidural space, after loss of resistance, before contrast injection. X marks the skin entry point just lateral to C7 spinous process. Orange = spinous process and lamina; yellow = transverse process; red = ribs; purple = vertebral body. Native (**a**) and edited (**b**) fluoroscopy image

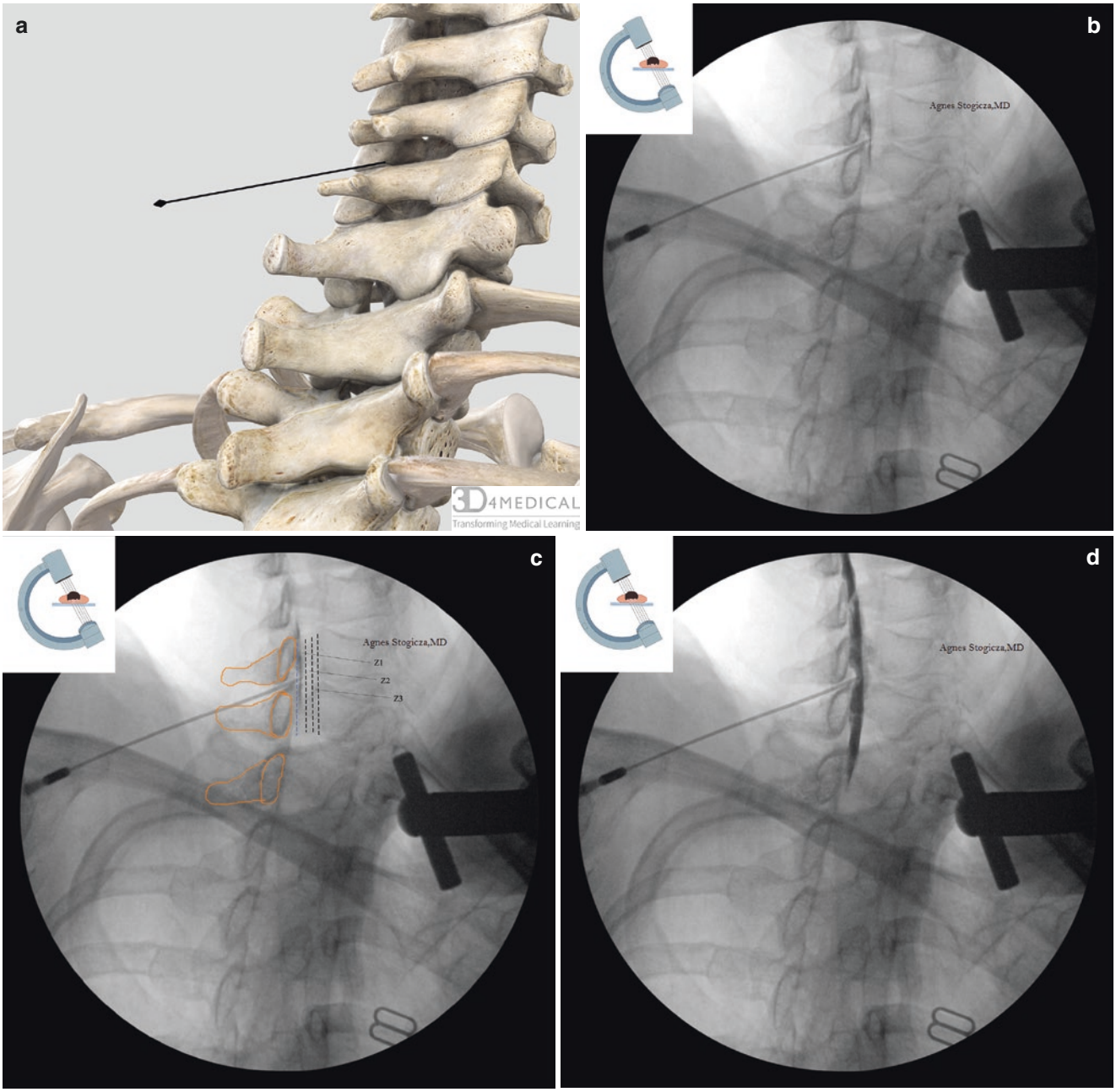

Fig. 1.8 Cervical spine, contralateral oblique view. Needle position marked on Complete Anatomy image (**a**). The area anterior to the ventral interlaminar line (VILL = blue dashed line) and posterior to the line joining the uncinate processes (along the ventral margin of foramen) was equally divided into three zones posterior to anterior (black dashed lines), with Zone 2 being posterior. The needle tip is in Zone 1. Orange = spinous process and lamina. Native (**b**) and edited (**c**) fluoroscopy image with 0.2 ml contrast in the posterior epidural space. Then, 2 ml contrast is injected in the posterior epidural space (**d**)

- Confirm access to epidural space with injection of small dose of contrast medium using extension tubing – intermittent or live fluoroscopy (Fig. 1.8a–d)
- Contrast should flow anterior to the VILL in zone 1 or rarely in zone 2 (depending on thickness of ligamentum flavum), creating a thin dorsal line of spread in CLO view
- Verify epidural spread on an AP view (Fig. 1.9a, b)

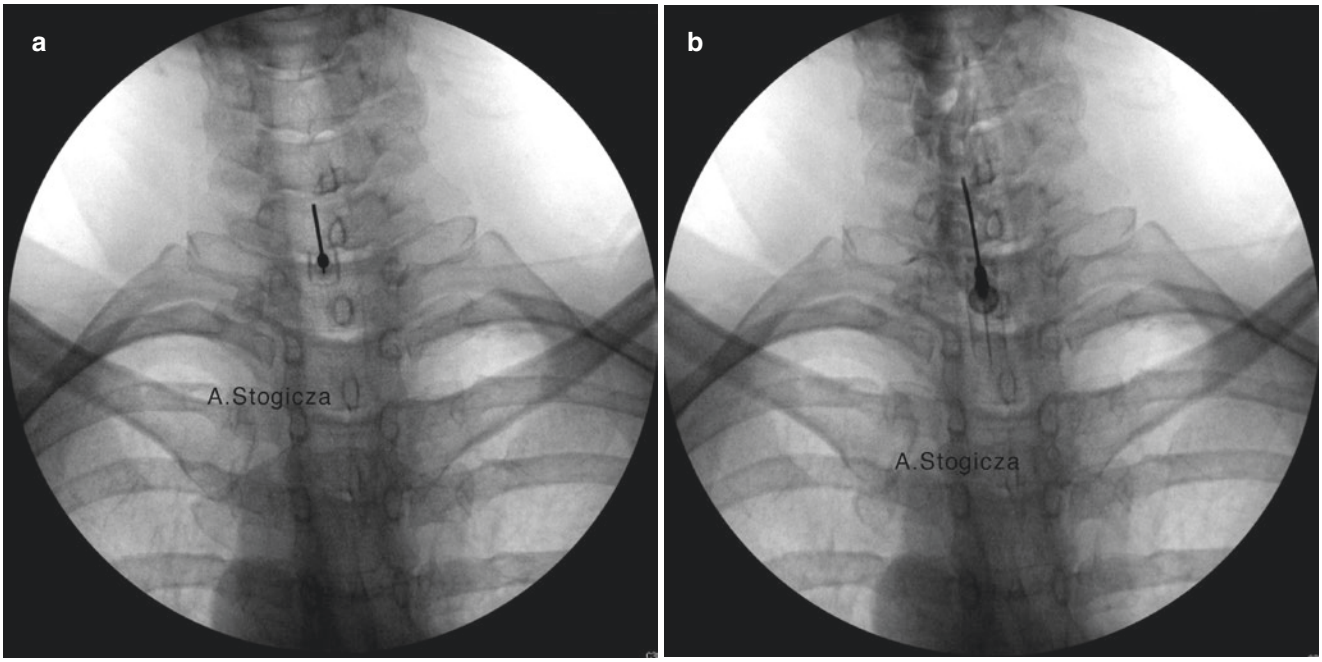

Fig. 1.9 Cervical epidural, paramedian approach AP view. Fluoroscopy image without (**a**) and with contrast in the epidural space (**b**)

Clinical Pearls

- When using midline approach, one must remember the common gap in LF at the cervical level
- Beware of false loss of resistance between interspinous ligament and LF
- Precise entry point identification is very important for easy procedural performance
- On a lateral view, when a patient has large shoulders, it can be difficult to visualize the tip of the needle. In this setting use CLO view, pull downward on the upper arms, or adjust the C-arm angle
- Use of an extension tubing helps keep ones hands out of the course of the beam of radiation when live fluoroscopy is used
- Do NOT advance the needle tip beyond the VILL without the use of LOR technique
- Consider using DSA if available
- Abandon procedure if subarachnoid, subdural spread suspected
- Pay attention to patient feedback. Any shooting pains, new numbness, weakness need to be carefully evaluated
- Reposition needle if venous blood contacted
- Inject local anesthetic and steroid of choice, remove needles and observe patient for 30 minutes

Unacceptable, Potentially Harmful Needle Placement on Exam

- Rough needle manipulation close to the epidural space potentially resulting in spinal cord compromise
- Advancing needle too anterior at any time which could potentially result in injury to the spinal cord
- Not checking either lateral or CLO view to assess depth of the needle (multiple planes)
- Any proof of lack of understanding of cervical spine anatomy, for example, the needle positioned far posterior between spinous processes while indicating to the examiner that it is in the correct and final position

Unacceptable, But Not Harmful Needle Placement on Exam

- The procedure was abandoned after unsuccessful attempts, but it was clear that the examinee was cognizant of the safety aspects of the procedure, the needle did not compromise vital structures.

Evidence

Table 1.1 Level of evidence and recommendations by the Benelux section of the World Institute of Pain
These recommendations are based on both a review of the literature in 2015 by an independent third party (Kleijnen Systematic Reviews LTD) and the previous published guidelines published in Pain Practice. The recent literature, the potential risk for complications, and the grade of invasiveness were considered when deciding to upgrade or downgrade the recommendation.

Indication	Procedure	Recommen-dation 2009[1]	Grade 2015[2]	Recommen-dation 2018[3,4]
Cervical radicular pain	Interlaminar epidural corticosteroid administration	2 B+	Moderate	Weak

[1]Van Zundert J, Huntoon M, Patijn J, Lataster A, Mekhail N, van Kleef M. 4. Cervical radicular pain. Pain Pract. 2009;10:1–17
[2]Kleijnen Systematic Reviews Ltd.: Search and evaluation of the literature. 2015
[3]Huygen F, Kallewaard JW, van Tulder M, Van Boxem K, Vissers K, van Kleef M, et al. "Evidence-based interventional pain medicine according to clinical diagnoses: update 2018. *Pain Pract*. 2019;19:664–75
[4]https://www.anesthesiologie.nl/publicaties/praktische-richtlijnen-anesthesiologische-pijnbestrijding

Table 1.2 Level of evidence based on the American Society of Interventional Pain Physicians (ASIPP) review of the literature

Cervical interlaminar epidural injections[1]	Evidence
Disc herniation	Level II
Discogenic pain	Level II
Central spinal stenosis	Level II
Post-cervical surgery syndrome	Level II

[1]Manchikanti L, Schultz DM, Falco FJE. Cervical epidural injections. In: Manchikanti L, Kaye AD, Falco FJE, Hirsch JA, editors. Essentials of interventional techniques in managing chronic pain. Springer International Publishing; 2018. p. 209–40.

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Derby R, Melnik I, Choi J, Lee S-H, Lee J-E. Reliability and safety of contra-lateral oblique view for interlaminar epidural needle placement. Pain Physician. 2017;20:E65–73.

Gill JS, Aner M, Jyotsna N, Keel JC, Simopoulos TT. Contralateral oblique view is superior to lateral view for interlaminar cervical and cervicothoracic epidural access. Pain Med. 2015;16:68–80.

Manchikanti L, Pampati V, Parr I, A, Manchikanti MV, Sanapati MR, Kaye AD, et al. Cervical interlaminar epidural injections in the treatment of cervical disc herniation, post surgery syndrome, or discogenic pain: cost utility analysis from randomized trials. Pain Physician. 2019;22(5):421–31.

Tamayo AC, Guajardo-Rosas J, Hernandez-Ortiz A. Cervical epidural injections for radicular pain. Tech Reg Anesth Pain Manag. 2010;14:106–12.

Zhou Y, Zhou B. A new way to obtain clear lateral fluoroscopic pictures for cervical epidural steroid injections. Tech Orthop. 2013;28:44–9.

The Cervical Interlaminar Epidural chapter was reviewed by Andrea M. Trescot; Milan Stojanovic; Peter S. Staats; Agnes R. Stogicza; Andre M. Mansano; Jan Van Zundert; Massimo Barbieri and Athmaja Thottungal.

Intraarticular Cervical Facet Joint Block, C2-T1 – Posterior and Lateral Approach

2

Alicia Villarreal Fuentes

Equipment and Monitoring

- Standard ASA monitoring
- Fluoroscopy
- Sterile prep, and drape
- Skin local anesthesia prior to any needle larger than 25G (unless sedation is used)
- Coaxial view is always used to advance the needle, unless otherwise specified
- CPR equipment and medications available
- 22–25G, 2 inch (50 mm) needle for lateral approach, tip curved to facilitate steering
- 22–25G, 3.5 inch (90 mm) needle for posterior approach, tip curved to facilitate steering
- Nonionic contrast material
- Preservative-free local anesthetic
- Particulate or nonparticulate steroid

Anatomy

- The cervical facet joints are formed by the superior and inferior articular processes of two adjacent vertebrae. A fibrous capsule encloses every facet joint
- The cervical facet joints form paired columns or "articular pillars"
- Cervical facet joints are angled approximately 25–35° in a caudal direction

Structures to Keep in Mind and Possible Complications

- Vertebral artery travels through the intervertebral foramina of the transverse processes of the C1–C6 vertebrae (anterior to the target in this approach) → intravascular injection → seizures. Anatomic variations are common
- Ascending cervical artery, feeding into vertebral artery → bleeding, possible embolism, stroke, and ischemia (Fig. 2.1)
- Carotid artery → bleeding, embolism, stroke, ischemia
- Exiting nerve roots → nerve injury

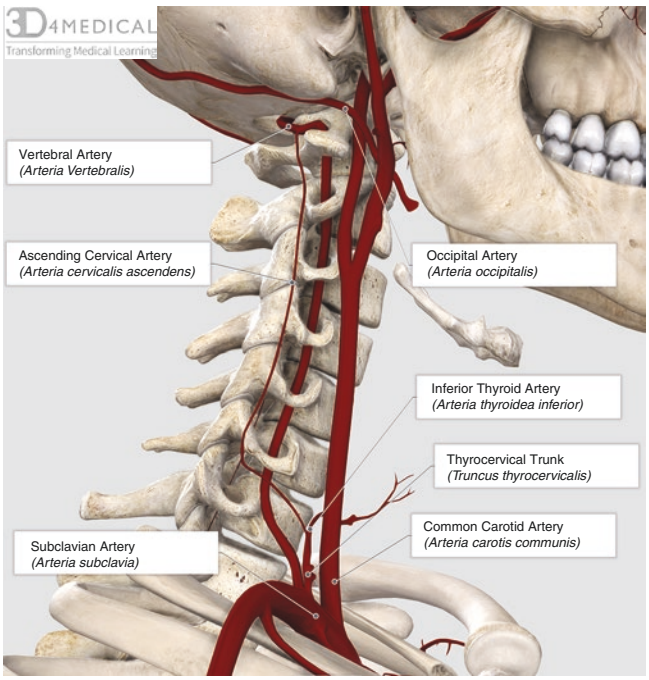

Fig. 2.1 Inferior thyroid artery, ascending cervical artery, vertebral artery connection. Complete Anatomy image

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- Epidural, subdural, intrathecal space → death, paralysis, spinal cord injury, high spinal anesthesia, epidural anesthesia (more likely with lateral approach)
- Lung (lower cervical facets) → pneumothorax
- Infection
- Bleeding
- Postprocedure pain
- Vasovagal reaction
- Allergic reaction

Fluoroscopy Technique, Target Localization – Posterior approach

- Prone patient with a head gel ring, neck flexed as much as patient comfort allows in order to open posterior joint openings
- Anteroposterior (AP) image. Make sure spinous processes are in the midline (true AP image) (Fig. 2.2a–c)
- 25–35° caudad tilt – depending on patient position – to open the articular space of interest (Fig. 2.3a–c)
- Skin entry is in the lateral half of the joint line

Procedure Steps – Posterior Approach

- Coaxial approach to touch the cephalad edge of the superior articular process (Fig. 2.3d)
- Adjust needle tip to enter in the joint
- Avoid penetrating through the ventral aspect of the joint (exiting nerve root and vertebral artery is in the trajectory)
- Lateral image confirms the depth of the needle (Fig. 2.4a–c)
- 0.2 ml of contrast verifies good spread in the joint (Fig. 2.4d)

Fluoroscopy Technique, Target Localization – Lateral approach

- Supine patient
- Lateral view. Usually initially not a true lateral (Fig. 2.5a, b) – posterior aspects of articular pillars do not overlap, so head or C-arm needs adjusting (rotating around the cephalo-caudad axis, in this case)
- A true lateral image is crucial: ipsilateral and contralateral joint lines and posterior aspects of articular pillars overlap, no double joint shadows (Fig. 2.6a, b). In arthritic, postsurgical neck, the image often needs adjusting from level to level, if multiple levels are injected. (Detailed description of true lateral in Chap. 4, Cervical Medial Branch Block-Lateral Approach)
- Skin entry point is at the middle third of the joint line (Fig. 2.6a, b)

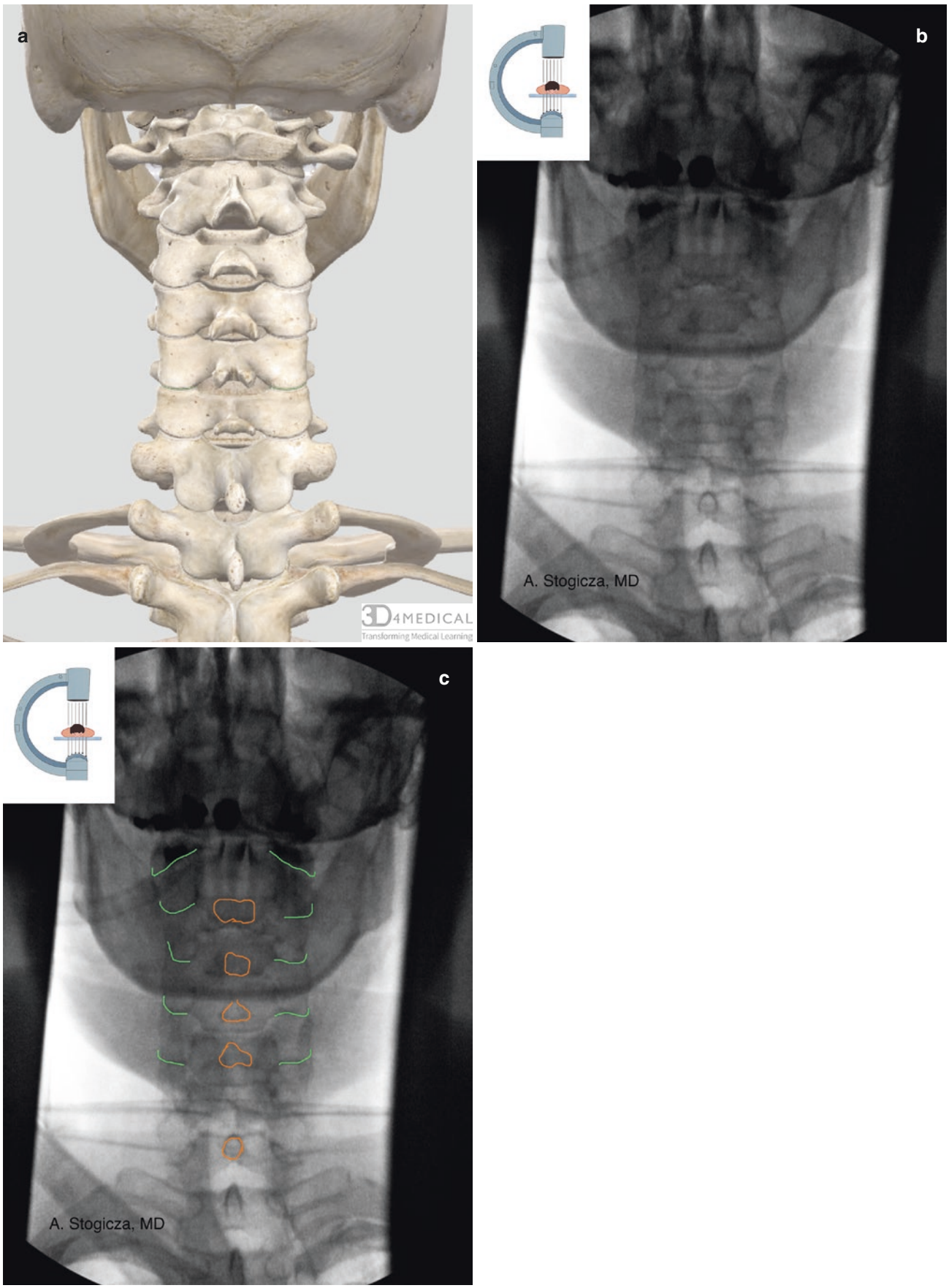

Fig. 2.2 AP image of the cervical spine. Orange = spinous process; light green = inferior articular process. Complete Anatomy image (**a**), native (**b**) and edited fluoroscopy images (**c**)

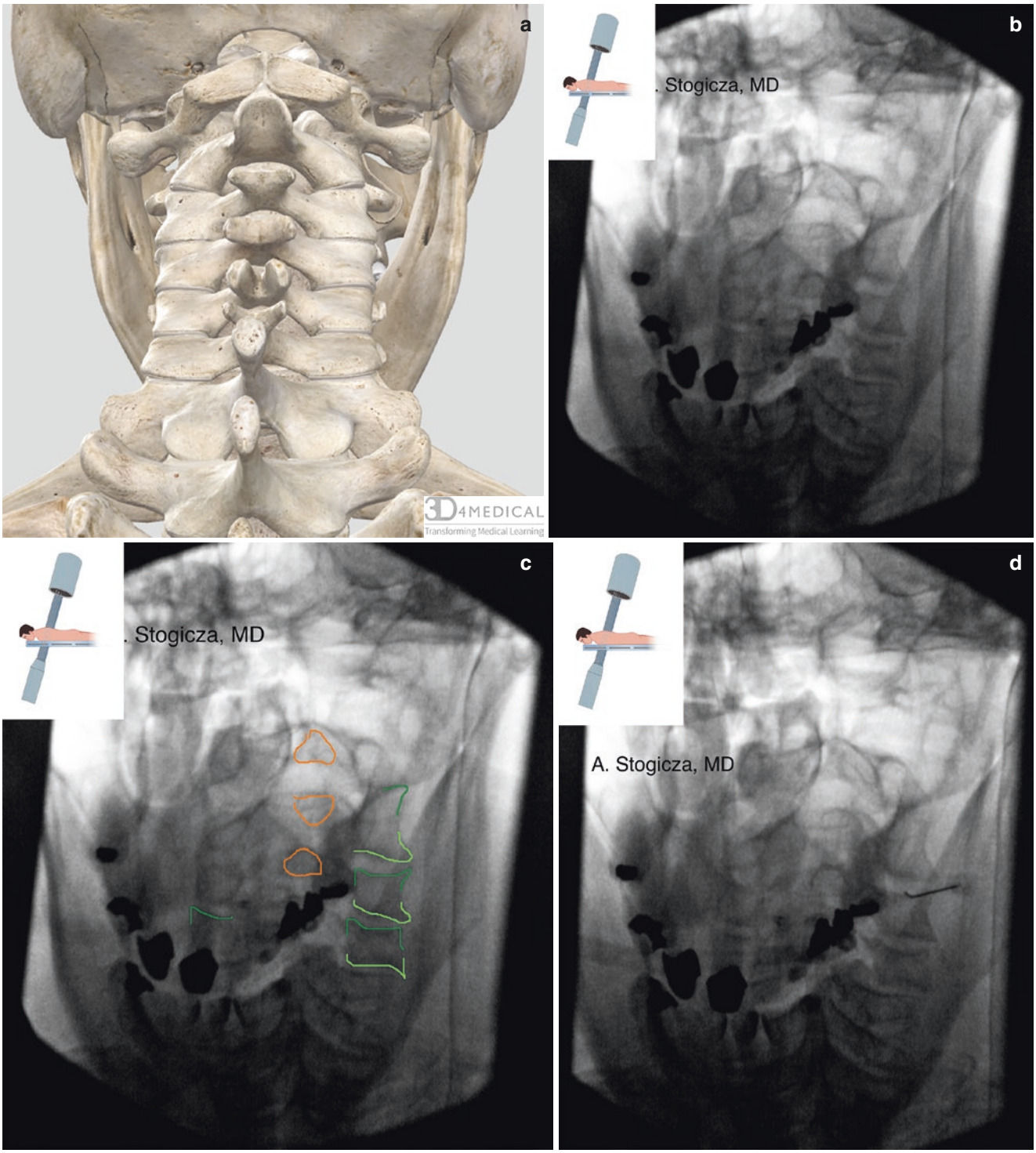

Fig. 2.3 AP image of the cervical spine, with a 30-degree caudal tilt of the C-arm, to open the articular spaces of interest. Orange = spinous process; dark green = superior articular process; light green = inferior articular process. Complete Anatomy image (**a**) and native (**b**) and edited fluoroscopy images (**c**). Needle in coaxial approach on the cephalad edge of the superior articular process, then advanced into the joint from posterior (**d**)

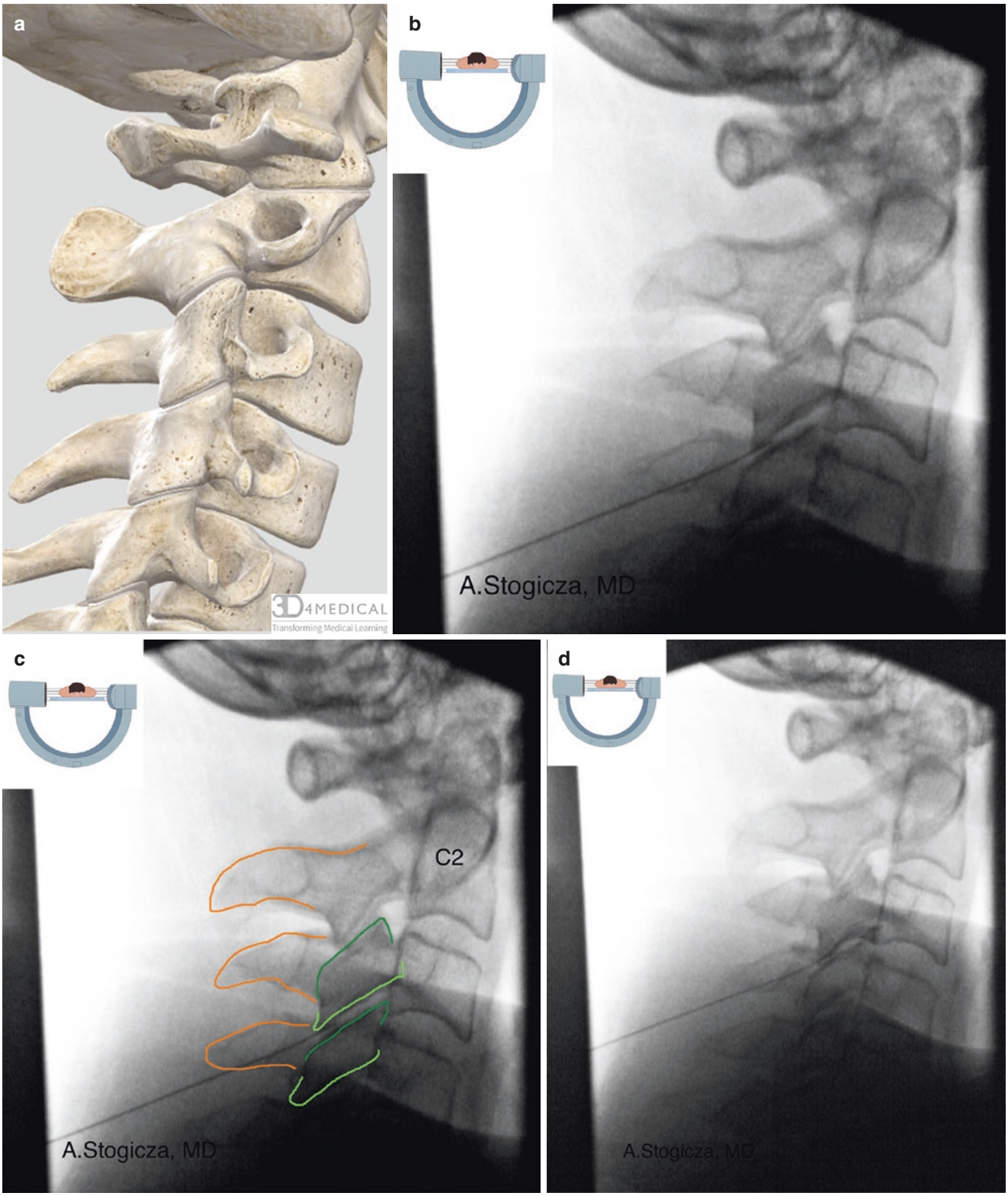

Fig. 2.4 Cervical facet injection, posterior approach. Lateral image confirms the depth of the needle. Orange = spinous process, dark green = SAP, light green = IAP. Complete Anatomy image (**a**) and native (**b**) and edited fluoroscopy images (**c**). 0.2 ml of contrast verifies good spread in the joint (**d**)

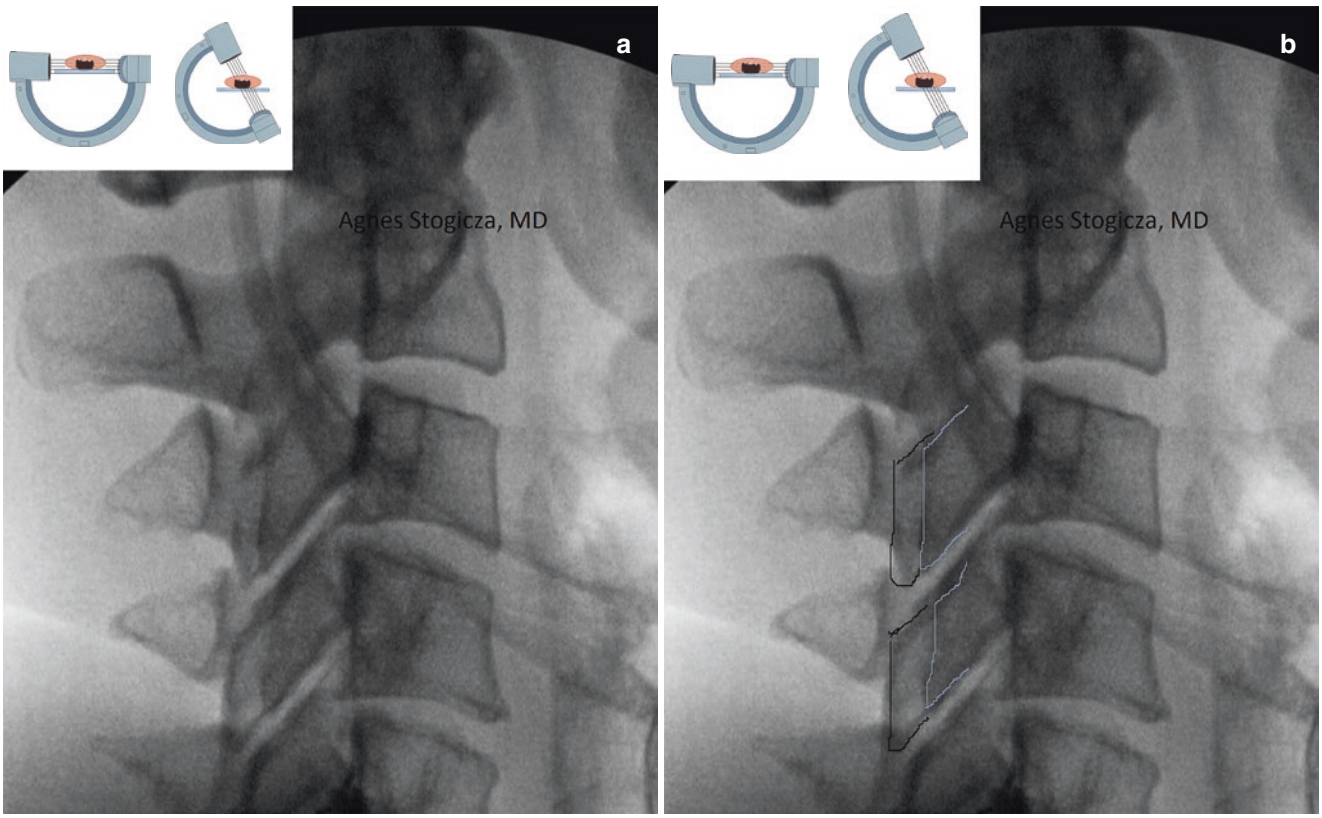

Fig. 2.5 Lateral view (**NOT TRUE LATERAL**) of the cervical facets. Ipsi- and contralateral joints overlap; however, the posterior aspects of the articular pillars do not. In order to achieve a true lateral in this situation, the C-arm needs to be slightly rotated around cephalocaudad axis. Blue and black marks the posterior aspect of the ipsi- and contralateral articular pillars. (Native (**a**) and edited fluoroscopy images (**b**))

Procedure Steps – Lateral Approach

- Coaxial approach to direct the needle into joint; avoid penetrating through the medial aspect of the joint (intrathecal space and spinal cord is in the trajectory) (Fig. 2.6a, b)
- Posteroanterior (PA) image confirms depth of needle in the joint (Fig. 2.7a, b)
- 0.2 ml of contrast is injected, filling the joint space (Fig. 2.7a, b)

Clinical Pearls

- It is often difficult to obtain a good AP image, as the jawline or teeth can cover the joint when visualized with an AP view. Minimal ipsi- or contralateral oblique (2–5°) tilt allows visualization of the joint of interest
- Posterior approach requires longer needle path, and it is less comfortable for the patient. Vertebral artery, exiting nerve root, and dorsal root ganglion in the trajectory; problems may arise if needle passed through the joint
- Lateral approach allows for shorter needle path, technically less demanding, but a true lateral fluoroscopy image may be challenging to obtain. Spinal cord is in the trajectory
- The upper levels are easily performed with the lateral approach, with the patient lying in a supine position
- For the lower levels, especially C7–T1 facet joint, posterior approach is more suitable, due to the risk of pneumothorax and the proximity to other neurovascular structures. Shoulder makes lateral view more difficult to visualize
- Inject no more than 0.5 ml of total volume to prevent capsule rupture

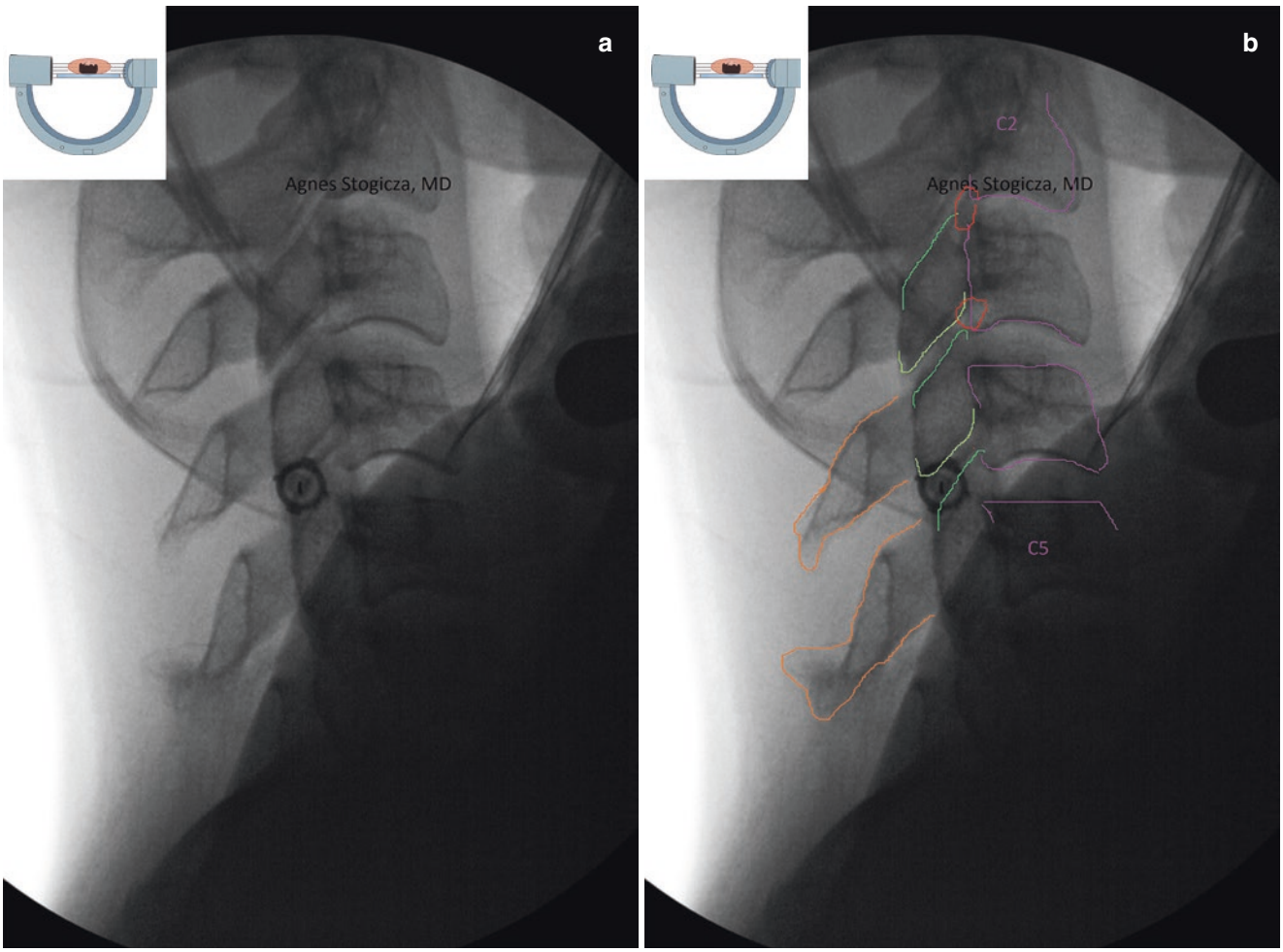

Fig. 2.6 Cervical facet injection, lateral approach. A true lateral image is crucial: ipsilateral and contralateral joint lines and posterior aspects of the articular pillars overlap, no double joint shadows visible. Needle is at the joint line. Orange = spinous process and lamina; dark green = superior articular process; light green = inferior articular process; red = intervertebral foramen; purple = vertebral body. Native (**a**) and edited fluoroscopy images (**b**)

Unacceptable, Potentially Harmful Needle Placement on Exam

- Needle passing through the joint in either approach
- Intrathecal space compromise
- Not checking multiple fluoroscopy views (AP and lateral)
- Rough needle manipulation
- Any proof of lack of understanding of cervical spine anatomy; for example, needle positioned far posterior to the joint line, and believing it is in the joint

Unacceptable, But Not Harmful Needle Placement on Exam

- The procedure was abandoned after unsuccessful attempts, but it was clear that the examinee was cognizant of the safety aspects of the procedure, the needle did not compromise vital structures

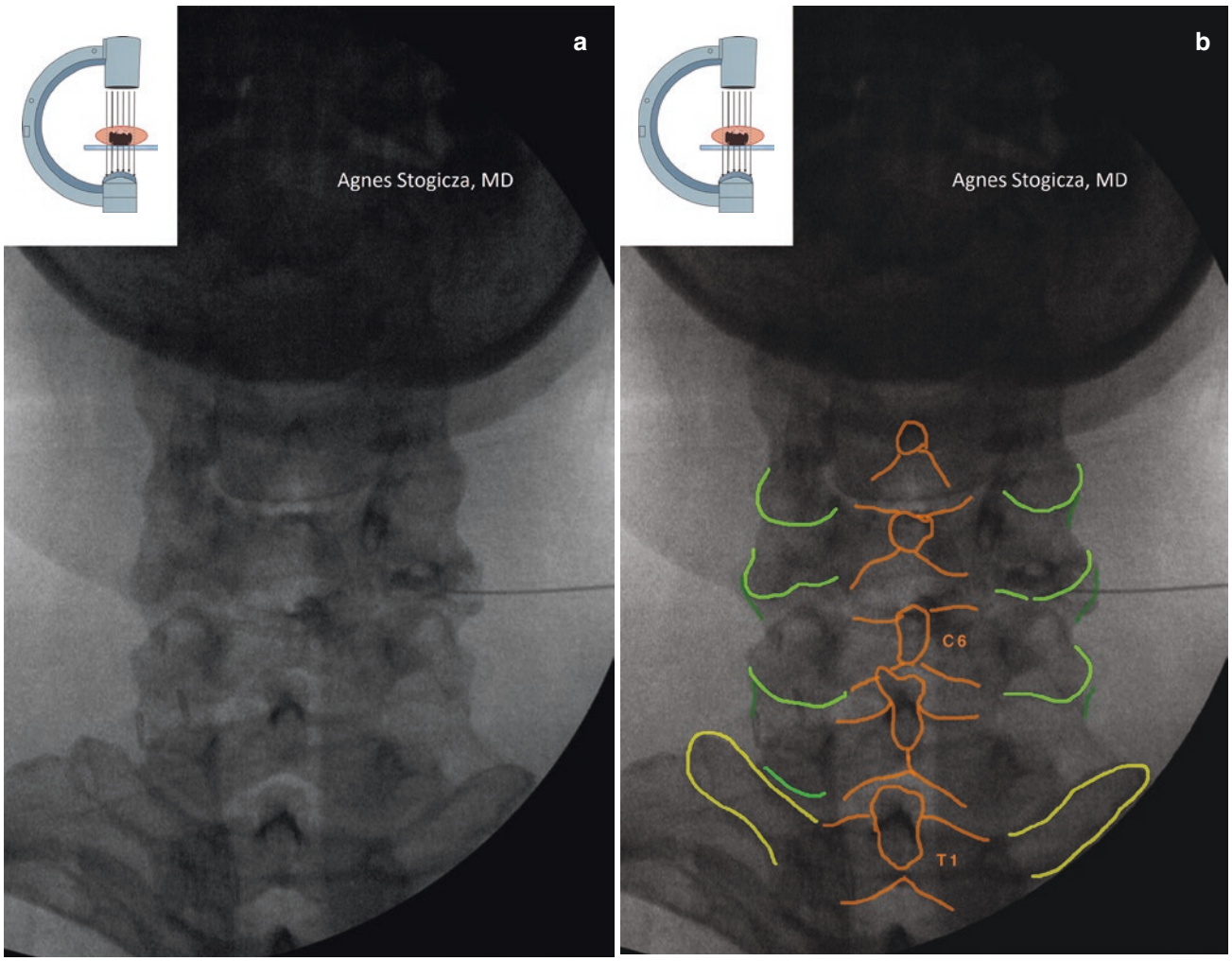

Fig. 2.7 Cervical facet injection, lateral approach. PA image confirms depth of needle. 0.2 ml of contrast verifies good spread in the joint. Orange = spinous process and lamina; yellow = transverse process; dark green = superior articular process; light green = inferior articular process. Native (**a**) and edited fluoroscopy images (**b**)

Evidence

Table 2.1 Level of evidence and recommendations by the Benelux section of the World Institute of Pain
These recommendations are based on both a review of the literature in 2015 by an independent third party (Kleijnen Systematic Reviews LTD) and the previous published guidelines published in Pain Practice. The recent literature, the potential risk for complications, and the grade of invasiveness were considered when deciding to upgrade or downgrade the recommendation.

Indication	Procedure	Recommendation 2009[1]	Grade 2015[2]	Recommendation 2018[3,4]
Cervical facet joint pain	Intra-articular corticosteroid administration		Low	Weak against

[1]van Eerd M, Patijn J, Lataster A, Rosenquist RW, van Kleef M, Mekhail N, et al. 5. Cervical facet pain. Pain Pract. 2010;10:113–23
[2]Kleijnen Systematic Reviews Ltd.: Search and evaluation of the literature. 2015
[3]Huygen F, Kallewaard JW, van Tulder M, Van Boxem K, Vissers K, van Kleef M, et al. "Evidence-based interventional pain medicine according to clinical diagnoses: update 2018. Pain Pract. 2019;19:664–75
[4]https://www.anesthesiologie.nl/publicaties/praktische-richtlijnen-anesthesiologische-pijnbestrijding

Table 2.2 Level of evidence based on the American Society of Interventional Pain Physicians (ASIPP) review of the literature

Indication	Evidence
Cervical intra-articular injections[1]	Level IV

[1]Manchikanti L, Schultz DM, Falco FE, Singh V. Cervical facet joint interventions. In: Manchikanti L, Kaye AD, Falco FJE, Hirsch JA, editors. *Essentials of interventional techniques in managing chronic pain*. Springer International Publishing; 2018. p. 387–412.

Suggested Reading

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Manchikanti L, Schultz DM, Falco FJE, et al. Cervical facet joint interventions. In: Manchikanti L, Singh V, editors. Interventional techniques in chronic spinal pain. Paducah: ASIPP Publishing; 2007. p. 295–320.
Matula C, Trattnig S, Tschabitscher M, Day JD, Koos WT. The course of the prevertebral segment of the vertebral artery: anatomy and clinical significance. Surg Neurol. 1997;48:125–31.
Lim JW, Cho YW, Lee DG, Chang MC. Comparison of intraarticular pulsed radiofrequency and intraarticular corticosteroid injection for management of cervical facet joint pain. Pain Physician. 2017;20(6):E961–7.
van Eerd M, Patijn J, Lataster A, Rosenquist RW, van Kleef M, Mekhail N, et al. Cervical Facet Pain. Pain Pract. 2010;10(2):113–23.
Falco FJE, Erhart S, Wargo BW, Bryce DA, Atluri S, Datta S, et al. Systematic review of diagnostic utility and therapeutic effectiveness of cervical facet joint interventions. Pain Physician. 2009;12(2):323–44.

The cervical intraarticular chapter was reviewed by Andrea M. Trescot; Milan Stojanovic; Peter S. Staats; Agnes R. Stogicza; Andre M. Mansano

Cervical Medial Branch Block and Radiofrequency Ablation – Posterior Approach

3

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Equipment and Monitoring

- Standard ASA monitoring
- Fluoroscopy
- Sterile prep, and drape
- Skin local anesthesia prior to any needle larger than 25G (unless sedation is used)
- Coaxial view is always used to advance needle, unless otherwise specified
- CPR equipment and medications available
- For diagnostic block
  - 22–25G 2 inch (50 mm) - 3.5 inch (90 mm) needle, tip curved to facilitate steering. 0.3 ml local anesthetic/level
  - Nonionic contrast (optional)
- For radiofrequency ablation (RFA)
  - 18–22G 100 mm radiofrequency cannula, 5-10 mm active tip
  - Grounding pad
  - RF generator with capacity for unipolar and bipolar lesions
  - Local anesthetic

Anatomy

- Prevalence studies, physical exam, and pain referral maps can be utilized to choose levels. C2-3 and C5-6 levels are the most common causes of cervicogenic headache and neck pain, respectively
- At the C3 level, there is a superficial medial branch (third occipital nerve) that is located in close proximity to the C2/3 facet joint and serves to innervate that joint as well as the suboccipital area
- The deep medial branch of C3 (which is analogous to the medial branches of C4, C5, and C6) courses along the waist of the corresponding articular pillars and supplies the adjacent vertebral segments (for instance, the C4 and C5 medial branches supply the zygapophyseal joint of C4/5)
- The C5 medial branch is located in the waist of the articular pillar of C5. The C3, C4, and C6 medial branches are located slightly above the waist of the corresponding articular pillars, variations exist
- The C7 vertebra has a prominent transverse process (TP), and the location of the medial branch at this level is variable. It can be found as far caudal as the TP/superior articular process (SAP) junction and as far rostral as the apex of the C7 SAP

The needle placement techniques for the diagnostic MBB and the Radiofrequency (RF) denervation are very similar:

For diagnostic block: the needle is placed to the center of the articular pillar in the lateral fluoroscopic view.

For RF denervation: the needle is placed to the anterior third of the articular pillar in the lateral fluoroscopic view.

Pros of Posterior Approach

- Safer: no vital structures in trajectory
- It allows parallel placement of the RF cannula to the medial branch, which maximizes denervation success

Cons of Posterior Approach

- Longer needle track and more patient discomfort than lateral approach for diagnostic blocks
- More difficult to overlap articular pillars from opposite sides than in the lateral approach with patient in lateral or supine position (for diagnostic MBB)

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Structures to Keep in Mind and Possible Complications

- Ascending cervical artery → potential stroke through vertebral artery if particulate steroids administered
- Radicular artery occlusion → spinal cord ischemia, risk possibly higher if particulate steroids administered
- Cervical exiting nerve root → nerve injury
- Epidural, subdural, intrathecal space → death, paralysis, spinal cord injury, high spinal anesthesia, epidural anesthesia (more likely with lateral approach)
- Infection
- Bleeding
- Postprocedure pain
- Vasovagal reaction
- Allergic reaction

Fluoroscopy Technique, Target Localization

- Patient in a prone position
- Start with Anteroposterior (AP) image, an open mouth view to identify the odontoid process (dens) and C1-2 facet joint space, count the articular pillars caudally starting from that level
- Identify the middle portion of the articular pillar at the target level in AP/slight ipsilateral oblique view
- Identify the narrowest portion of the vertebral body, the "waist" of the articular pillar
- *For diagnostic block:* The middle of the articular pillar is the entry point (Fig. 3.1b)
- *For RF ablation:* tilt the C-arm 20–30° caudal to identify skin entry (Fig. 3.3a–c)
  - If articular pillar is difficult to visualize with this caudad C-arm tilt, one can keep the less caudad C-arm tilt, but then needle is placed without coaxial view using a slightly caudal skin entry point

Procedure Steps – Diagnostic Block

- Advance the needle until concavity (the "waist") of the articular pillar is contacted; then, rotate the needle curve laterally and slide the needle more anteriorly over the lateral margin of articular pillar and then rotate the needle back again (Fig. 3.1b)

Fig. 3.1 AP view of the cervical spine Complete Anatomy image (**a**). Diagnostic medial branch block. The target is the middle of the articular pillar. Needle is placed to the C4 Medial Branch (**b**). Contrast is injected, and demonstrates no vascular uptake (**c**). Orange = spinous process, light green = inferior articular process; yellow arrows mark further target points for medial branch block

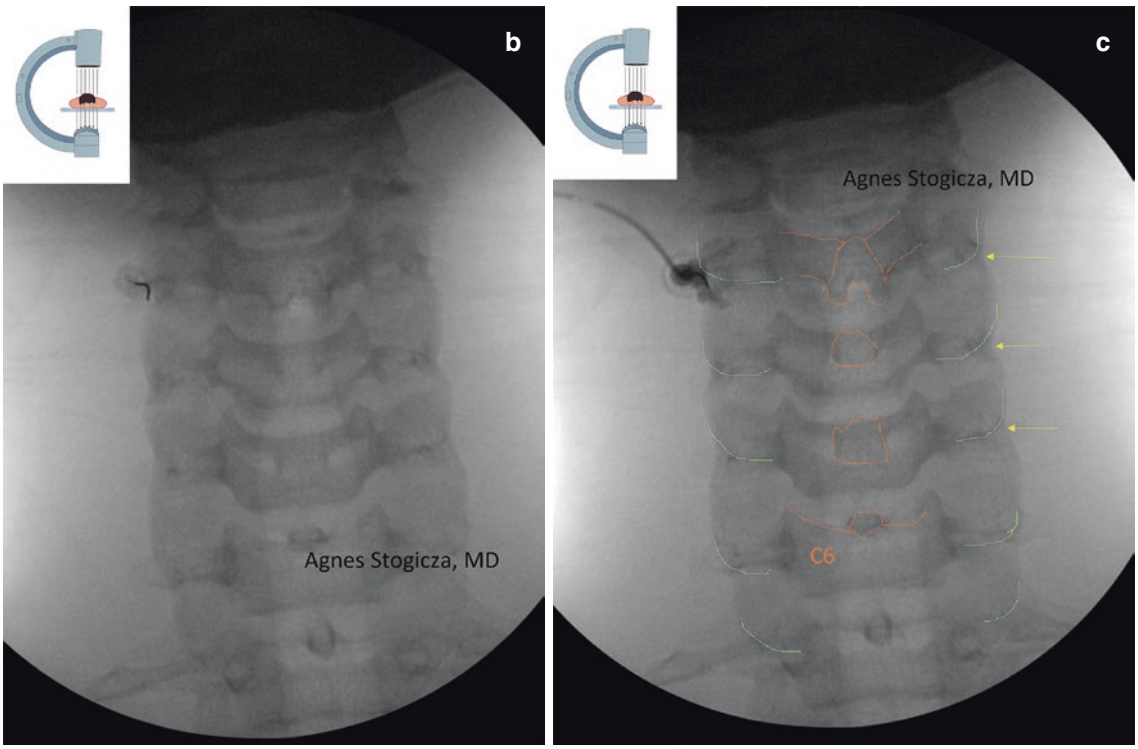

Fig. 3.1 (continued)

- Rotate the C-arm to the "true" lateral view
- In a true lateral, the articular pillars overlap and are clear and crisp. The facet joints above and below the level of interest must be crisp. The disc spaces must be clear. The anterior and posterior tubercles on each side should form a superimposed curvilinear line located in the superior posterior quadrant of the vertebral body shadow (Fig. 4.1 a and b – Chap. 4. "Cervical Medial Branch Block – Lateral Approach")
- In the lateral view, advance the needle toward the center of the articular pillar while rotating the needle tip medially for the final position in the middle of the articular pillar (Fig. 3.2a, b)
- Contrast injection confirms lack of vascular uptake for diagnostic procedure (Fig. 3.1c)
- 0.3cc of local anesthetic is injected for diagnostic block
- Advance the cannula until the concavity (the "waist") of the articular pillar is contacted, then rotate the cannula curve laterally, and slide the cannula more anteriorly over the lateral margin of articular pillar (Fig. 3.3d)
- Rotate the C-arm to the "true" lateral view, making sure that the articular pillars overlap from opposite sides
- In the lateral view, advance the cannula to the anterior margin of the articular pillar while rotating the curved cannula tip medially for the final position in the anterior third of the articular pillar (Fig. 3.4a, b)
- After appropriate sensory (0.4V reproduces patient's pain) and motor (1.5V, muscle twitch only in the multifidus muscle, and none elsewhere) testing and local anesthetics administration, a lesion at 80°C for 90 seconds, twice should be performed

Procedure Steps – RF Ablation Sagittal Pass

- The RF cannula should be inserted in cephalad direction, in order to be parallel to the plane of facet joints and medial branches. This cephalad angulation can be identified prior to skin entry by lateral view of the C-spine, identifying the angle of the joint lines (Fig. 3.2a, b)

Clinical Pearls

- Make sure that in lateral fluoroscopic view articular pillars do overlap (so the opposite side is not mistaken for treated side). If not sure, "un-align," and then again align the margins of proximal and distal articular pillar in the lateral view

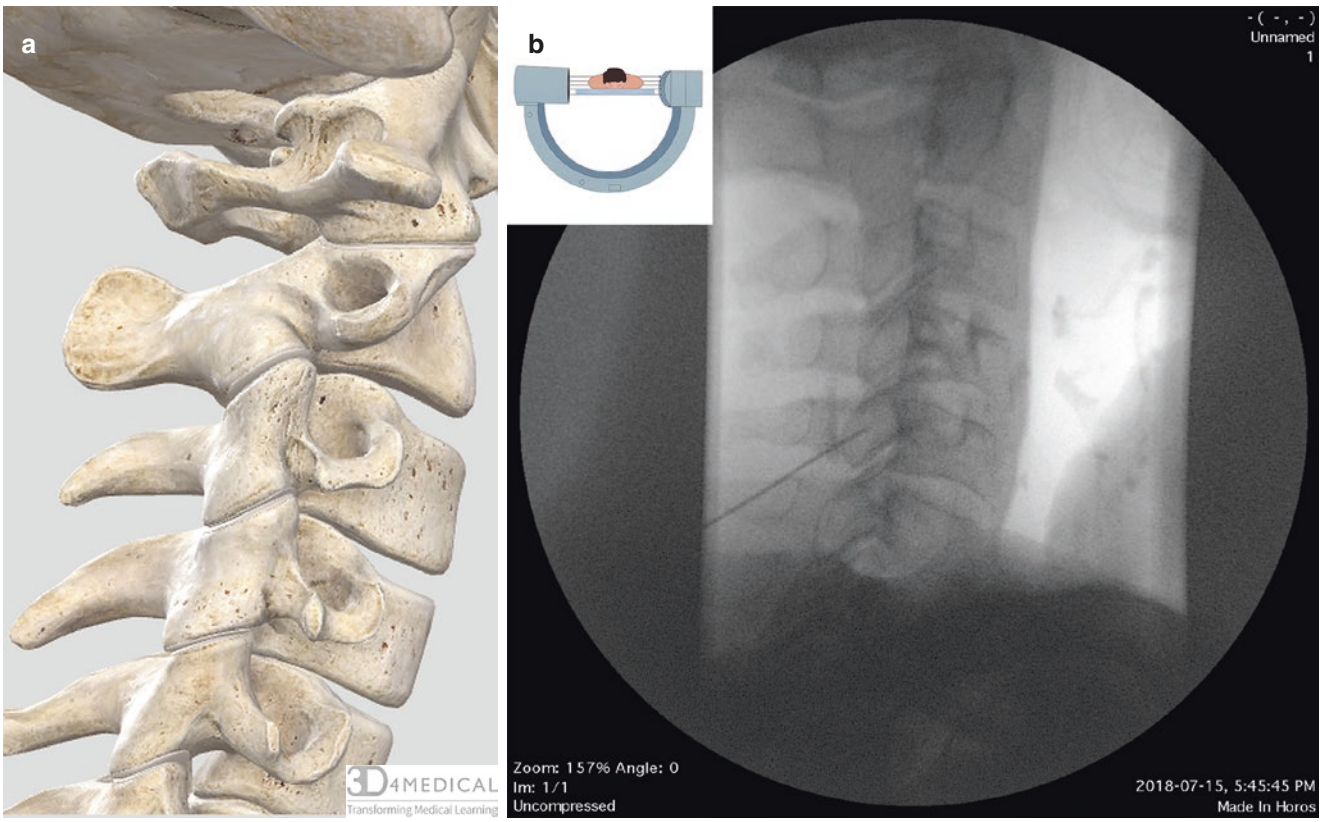

Fig. 3.2 Lateral view of the cervical spine, needle is placed to the middle of the articular pillar for diagnostic block. Complete Anatomy image (**a**) and native fluoroscopy image (**b**)

- Keep in mind that the location of medial branches varies at each level (C3 and C4 more cephalad, C5, 6, and 7 closer to the waist of articular pillar). Place the active tip of the RF cannula to target location, parallel and over the medial branch
- The procedure at the C7 level follows the same principles; however, it may be difficult to obtain clear lateral images due to image obstruction by the shoulders
- Keep the C-arm in the lateral view during lesioning to make sure that cannula is not inadvertently advanced further anteriorly
- Make sure that the curved cannula tip "hugs" the articular pillar for full contact with the medial branch
- Consideration to perform up to three lesions at each level (depending on the size of RF cannula used) should be taken in order to increase odds of success
- In addition to posterior (sagittal) approach, consider performing an additional lesion using an oblique, 30-degree approach to capture the part of the medial branch positioned anterolateral to the articular pillar
- Avoid administration of particulate steroids through the cannula due to rare but possible chances of intravascular spread and possible embolization

Unacceptable, Potentially Harmful Needle Placement on Exam

- Not checking lateral view
- Needle through facet joint or compromised intraspinal space
- Needle tip too anterior
- Needle in foramen
- Any proof of lack of understanding of cervical spine anatomy, for example, the needle left far posterior between spinous processes and believing it is in the right place

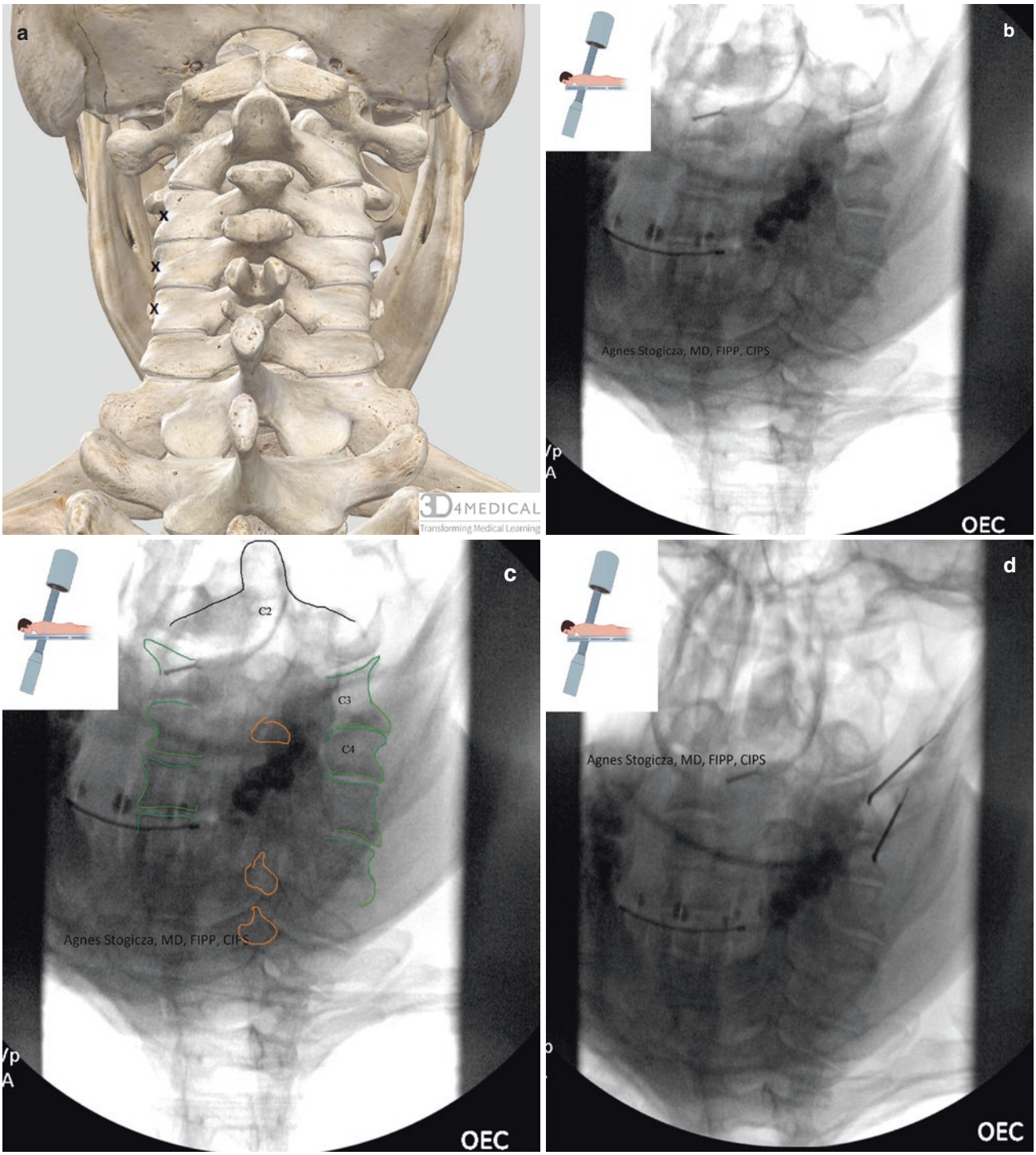

Fig. 3.3 Cervical medial branch denervation. AP view with the C-arm tilted caudally. Complete Anatomy image (**a**), native (**b**) and edited fluoroscopy images (**c**). Cannulas positioned at the C3, 4 levels (**d**). Orange = spinous process; dark green = superior articular process; light green = inferior articular process; black = dens and vertebral body of axis

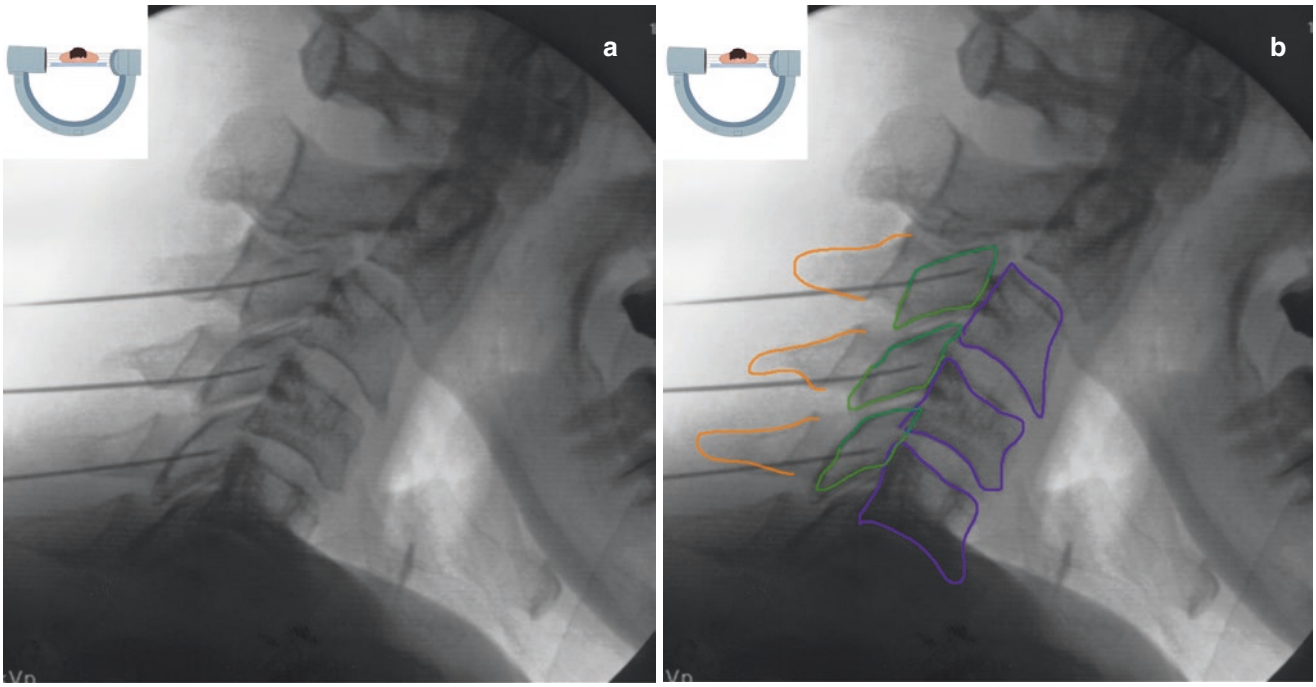

Fig. 3.4 Cervical medial branch denervation, lateral view: Cannulas positioned at the C3, C4, C5 levels. Orange = spinous process; dark green = superior articular process; light green = inferior articular process; purple = vertebral body. Native (**a**) and edited (**b**) fluoroscopy image

Unacceptable, But Not Harmful Placement on Exam

- Unnecessarily large bore needle
- Not obtaining an acceptable lateral view
- The examinee abandoned the procedure after unsuccessful attempts, but it was clear that the examinee was cognizant of the safety aspects of the procedure, the needle did not compromise vital structures, did not reach the epidural space, spinal cord, or vertebral artery

Evidence

Table 3.1 Level of evidence and recommendations by the Benelux section of the World Institute of Pain
These recommendations are based on both a review of the literature in 2015 by an independent third party (Kleijnen Systematic Reviews LTD) and the previous published guidelines published in Pain Practice. The recent literature, the potential risk for complications, and the grade of invasiveness were considered when deciding to upgrade or downgrade the recommendation.

Indication	Procedure	Recommendation 2009	Grade 2015[2]	Recommendation 2018[3,4]
Cervical facet joint pain[1]	Therapeutic (repetitive) injections with local anesthetic with or without corticosteroid of the medial branch (cervical ramus medialis of the ramus dorsalis)	2B+	Moderate	Weak
Cervical facet joint pain[1]	Radiofrequency treatment (ablation) of the medial branch (cervical ramus medialis of the ramus dorsalis)	2C+	Low	Weak
Cervicogenic headache[5]	Radiofrequency treatment (ablation) of the medial branch (cervical ramus medialis of the ramus dorsalis)	2C+/–	Very low	Very weak
Whiplash associated disorder[6]	Radiofrequency treatment (ablation) of the medial branch (cervical ramus medialis of the ramus dorsalis)	2B+	Low	Moderate

[1]van Eerd M, Patijn J, Lataster A, Rosenquist RW, van Kleef M, Mekhail N, et al. 5. Cervical facet pain. Pain Pract. 2010;10:113–23
[2]Kleijnen Systematic Reviews Ltd.: Search and evaluation of the literature. 2015
[3]Huygen F, Kallewaard JW, van Tulder M, Van Boxem K, Vissers K, van Kleef M, et al. "Evidence-based interventional pain medicine according to clinical diagnoses": update 2018. Pain Pract. 2019;19:664–75
[4]https://www.anesthesiologie.nl/publicaties/praktische-richtlijnen-anesthesiologische-pijnbestrijding
[5]van Suijlekom H, Van Zundert J, Narouze S, van Kleef M, Mekhail N. 6. Cervicogenic headache. Pain Pract. 10:124–30
[6]van Suijlekom H, Mekhail N, Patel N, Van Zundert J, van Kleef M, Patijn J. 7. Whiplash-associated disorders. Pain Pract. 10:131–6

Table 3.2 Level of evidence based on the American Society of Interventional Pain Physicians (ASIPP) review of the literature

Cervical facet joint injections	Evidence
Diagnostic facet joint nerve blocks	Level II
Cervical facet joint nerve blocks	Level II
Cervical facet joint radiofrequency neurotomy	Level II

Manchikanti L, Schultz DM, Falco FJE, Singh V. Cervical facet joint interventions. In: Manchikanti L, Kaye AD, Falco FJE, Hirsch JA, editors. Essentials of interventional techniques in managing chronic pain. Springer International Publishing; 2018. p. 387–412.

Suggested Reading

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Lord SM, Barnsley L, Wallis BJ, McDonald GJ, Bogduk N. Percutaneous radio-frequency neurotomy for chronic cervical zygapophyseal-joint pain. N Engl J Med. 1996;335:1721–6.

Manchikanti L, Pampati V, Kaye AD, Hirsch JA. Cost utility analysis of cervical therapeutic medial branch blocks in managing chronic neck pain. Int J Med Sci. 2017;14(13):1307–16.

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van Eerd M, Patijn J, Lataster A, Rosenquist RW, van Kleef M, Mekhail N, et al. Cervical facet pain. Pain Pract. 2010;10(2):113–23.

Falco FJE, Erhart S, Wargo BW, Bryce DA, Atluri S, Datta S, et al. Systematic review of diagnostic utility and therapeutic effectiveness of cervical facet joint interventions. Pain Physician. 2009;12(2):323–44.

The Cervical Medial Branch chapter was reviewed by Andrea M. Trescot; Peter S. Staats; Agnes R. Stogicza; Andre M. Mansano; Sudhir Diwan; Standiform Helm, Jianguo Cheng; Charles Gauci

Cervical Medial Branch Block – Lateral Approach

4

Aaron K. Calodney and Varun K. Rimmalapudi

Equipment and Monitoring

- Standard ASA monitoring
- Fluoroscopy
- Sterile prep, and drape
- Skin local anesthesia prior to any needle larger than 25G (unless sedation is used)
- Coaxial view is always used to advance needle, unless otherwise specified
- CPR equipment and medications available
- For diagnostic block
  - 22–25G, 2 inch (50 mm)–3.5 inch (90 mm) needle, tip curved to facilitate steering
  - 0.3–0.5 ml local anesthetic/level
  - Nonionic contrast (optional)
- For RFA
  - This approach is only suitable for RFA if special cannulas are used, which create a larger lesion at their tips. For example Cooled RFA or Tripod cannulas

Anatomy

- Prevalence studies, physical exam, and pain referral maps can be utilized to choose levels. C2–3 and C5–6 levels are the most common causes of cervicogenic headache and neck pain, respectively
- At the C3 level, there is a superficial medial branch (third occipital nerve) that is located in close proximity to the C2/3 facet joint and serves to innervate that joint as well as the suboccipital area
- The deep medial branch of C3 (which is analogous to the medial branches of C4, C5, and C6) courses along the waist of the corresponding articular pillars and supplies the adjacent vertebral segments (for instance, the C4 and C5 medial branches supply the zygapophyseal joint of C4/5)
- The C5 medial branch is located in the waist of the articular pillar of C5. The C3, C4, and C6 medial branches are located slightly above the waist of the corresponding articular pillars, and variations exist
- The C7 vertebra has a prominent transverse process (TP), and the location of the medial branch at this level is variable. It can be found as far caudal as the TP/superior articular process (SAP) junction and as far rostral as the apex of the C7 SAP

Pros of Lateral Approach

- Shorter needle track and less patient discomfort than posterior approach for diagnostic blocks
- Easier patient positioning

Cons of Lateral Approach

- Vital structures (spinal cord) in needle trajectory.
- Parallel placement of an RF cannula to the medial branch nerve is not possible, technique is not suitable for RF ablation (unless special needles are used)

Structures to Keep in Mind and Possible Complications

- Vertebral artery (if needle is more anterior than appropriate target) → seizure, dissection, stroke
- Inadvertent intraarticular facet injection
- Inadvertent passage of needle though a facet joint → intrathecal, epidural medication administration, high spinal anesthesia, spinal cord injury, paralysis, death
- Injection of spinal nerve root → nerve damage, intrathecal injection
- Injection of a vascular structure that may be in contiguity with a radicular artery → spinal cord infarct
- Infection

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A. R. Stogicza et al. (eds.), *Interventional Pain*, https://doi.org/10.1007/978-3-030-31741-6_4

- Bleeding
- Postprocedure pain
- Vasovagal reaction
- Allergic reaction

Fluoroscopy Technique, Target Localization

- Supine or lateral decubitus patient position
- A true lateral view of the cervical spine must be obtained, making C-arm adjustments at each individual level if necessary
- In a true lateral, the distance between the posterior laminar line and the posterior aspect of the articular pillar must be at its greatest. The facet joints above and below the level of interest must be crisp. The disc spaces must be clear. The anterior and posterior tubercles on each side should form a superimposed curvilinear line located in the superior posterior quadrant of the vertebral body shadow (Fig. 4.1a, b)
- Traction at both shoulders may be necessary to obtain lateral radiographs of adequate quality at the lower cervical levels
- Target for TON is at the midpoint of C2–3 joint line (Fig. 4.2)
- Target for C3–6 is at the centroid of the articular pillar (Fig. 4.2)
- Target for C7 is near the apex of the SAP of the C7 (Fig. 4.2)

Procedure Steps

These procedures are preferably done in the supine position. Prone or lateral decubitus positioning can be utilized as well.

Third Occipital Nerve Block

- Obtain a true lateral view of the C2–3 joint
- Identify the midpoint of the C2–3 facet. Imagine a vertical line bisecting this joint. Injection of the TON is carried out at, just above, and just below the joint along this line
- Insert needle and make osseous contact in close proximity to the midpoint of the joint. (Fig. 4.3a) Inject 0.25 ml of contrast under live fluoroscopy and rule out intravascular or intraarticular spread
- Obtain a Posteroanterior (PA) view. The needle tip with contrast must be visualized at the lateral aspect of the articular pillars just lateral to the C2/3 joint (Fig. 4.3b)
- Once needle position is confirmed in 2 views and intravascular or intraarticular contrast spread is ruled out, inject 0.3 ml of local anesthetic
- Withdraw the needle and reposition it, making osseous contact just above the C2–3 joint and just below the joint along the aforementioned vertical bisector, and inject an additional 0.3 ml of local anesthetic at each of these points
- If the initial contrast injection shows a robust but contained pattern encompassing the injection sited described above, a "pragmatic" single injection technique can be carried out using 1 ml of injectate

C3–6 Medial Branch Block

- Obtain a true lateral view of the targeted level
- Insert needle and make osseous contact on the targeted articular pillar at the centroid of the articular pillar at the desired level (Fig. 4.4a, b)
- Inject 0.25 ml of contrast under live fluoroscopy and rule out intravascular or intraarticular spread
- Obtain a PA view. The needle tip with contrast must be visualized at the waist of the corresponding articular pillar (Fig. 4.5)
- Once needle position is confirmed in 2 views and intravascular or intraarticular contrast spread is ruled out, inject 0.3 ml of local anesthetic

C7 Medial Branch Block

- Obtain a true lateral view of the C6–7 level (Fig. 4.2)
- Insert needle and make osseous contact near the apex of the superior articular process of C7. Inject 0.25 ml of contrast under live fluoroscopy and rule out intravascular or intraarticular spread
- Obtain a PA view. The needle tip with contrast must be visualized near the apex of the SAP and not laterally on the TP
- Once needle position is confirmed in 2 views, and intravascular or intraarticular contrast spread is ruled out, inject 0.3 ml of local anesthetic
- In patients with a tall peaked C7 SAP, an additional aliquot of local anesthetic may be placed at the base of the SAP near the junction with the TP

Clinical Pearls

- A true lateral view is paramount in performing this injection, which is easiest to obtain with the patient in a supine position. Minimizing parallax is the key to obtaining satisfactory images. Not having a true lateral view can result in unsafe needle placement

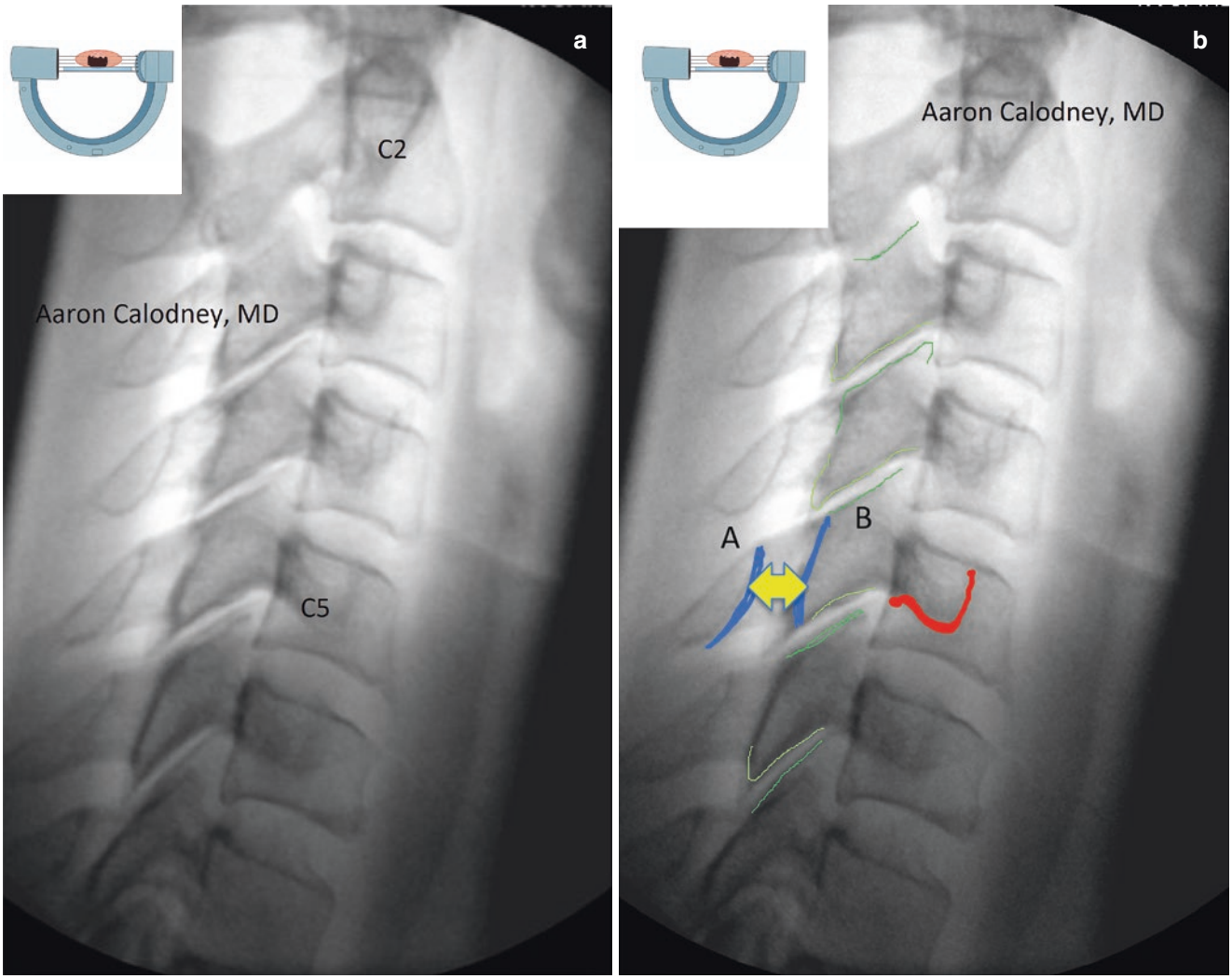

Fig. 4.1 True lateral image of the cervical spine. The distance between the posterior laminar line and the posterior aspect of the articular pillar must be at its greatest. The facet joints above and below the level of interest must be crisp. The disc spaces must be clear. The anterior and posterior tubercles on each side should form a superimposed curvilinear line located in the superior posterior quadrant of the vertebral body shadow. Red = anterior and posterior tubercles; blue = posterior laminar line and posterior aspect of the articular pillar; dark green = superior articular process; light green = inferior articular process. Native (**a**) and edited fluoroscopy images (**b**)

- The diagnostic (rather than therapeutic) nature of the medial branch blocks must be emphasized to the patient and family prior to the procedure
- Cervical facet joint pain is the single most common source of chronic neck pain after a whiplash injury to the neck and must be high on the differential in this group of patients
- Due to the poor predictive value of single diagnostic blocks, dual medial branch blocks may be performed to make the diagnosis of facet joint pain prior to proceeding to the definitive radiofrequency treatment
- An initial vascular spread pattern of contrast poses a higher risk of a "false-negative" diagnostic block at that level
- Adequately performed third occipital nerve blocks should cause numbness in the suboccipital skin in the cutaneous distribution of the TON

Unacceptable, Potentially Harmful Needle Placement on Exam

- Rough needle manipulation
- Not having a true lateral image
- Not checking PA view
- Needle through facet joint or compromised intraspinal space
- Needle too medial and potentially compromising spinal cord or foramen

Fig. 4.2 Lateral view of the C-spine. The target for TON, C3, C4, and C7 MBB is marked with a white circle (Native fluoroscopy image)

- Any proof of lack of understanding of cervical spinal anatomy (like placing the needle on the spinous process, and believing it is on target)

Unacceptable, But Not Harmful Needle Placement on Exam

- Unnecessarily large bore needle
- The procedure was abandoned after unsuccessful attempts, but it was clear that the examinee was cognizant of the safety aspects of the procedure, the needle did not compromise vital structures

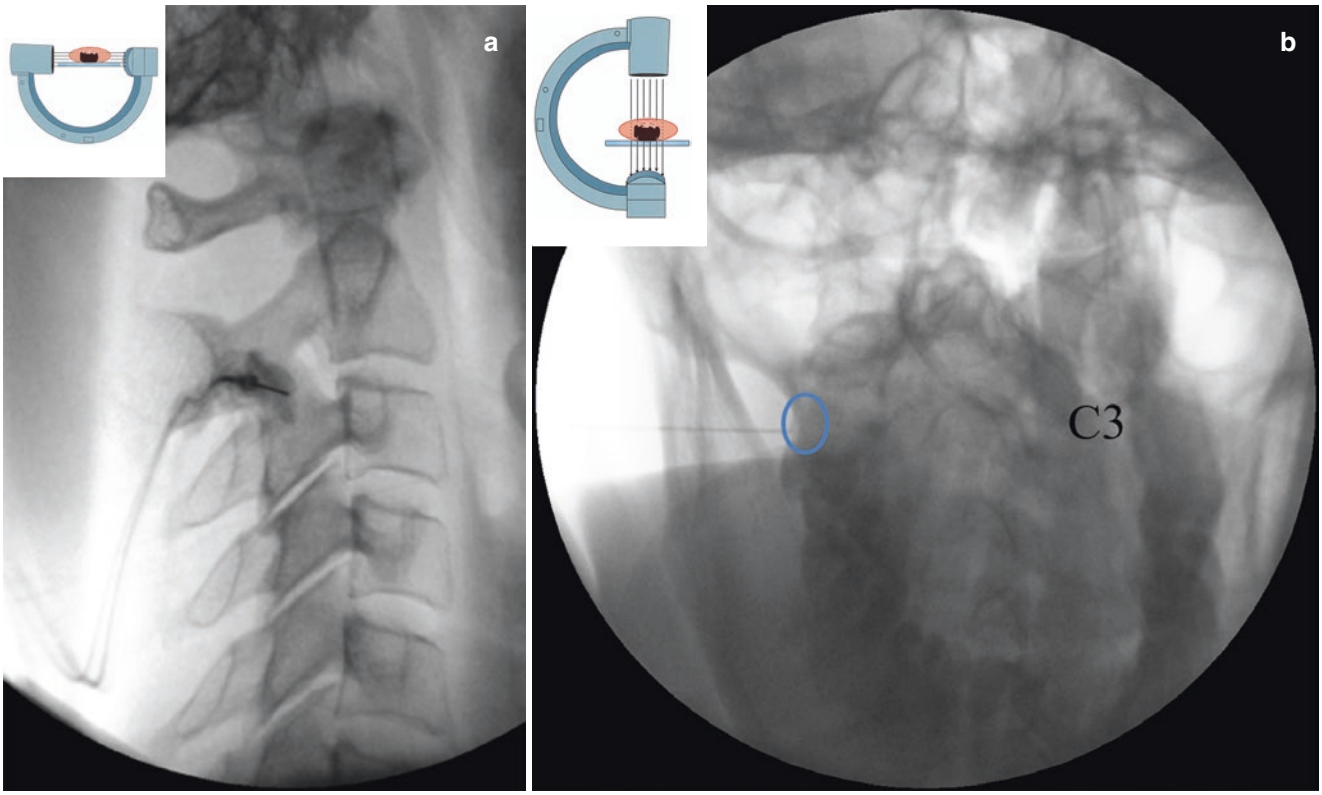

Fig. 4.3 Lateral (**a**) and PA fluoroscopy view (**b**) of the C-spine. Needle in place for TON block at the C2–3 joint line

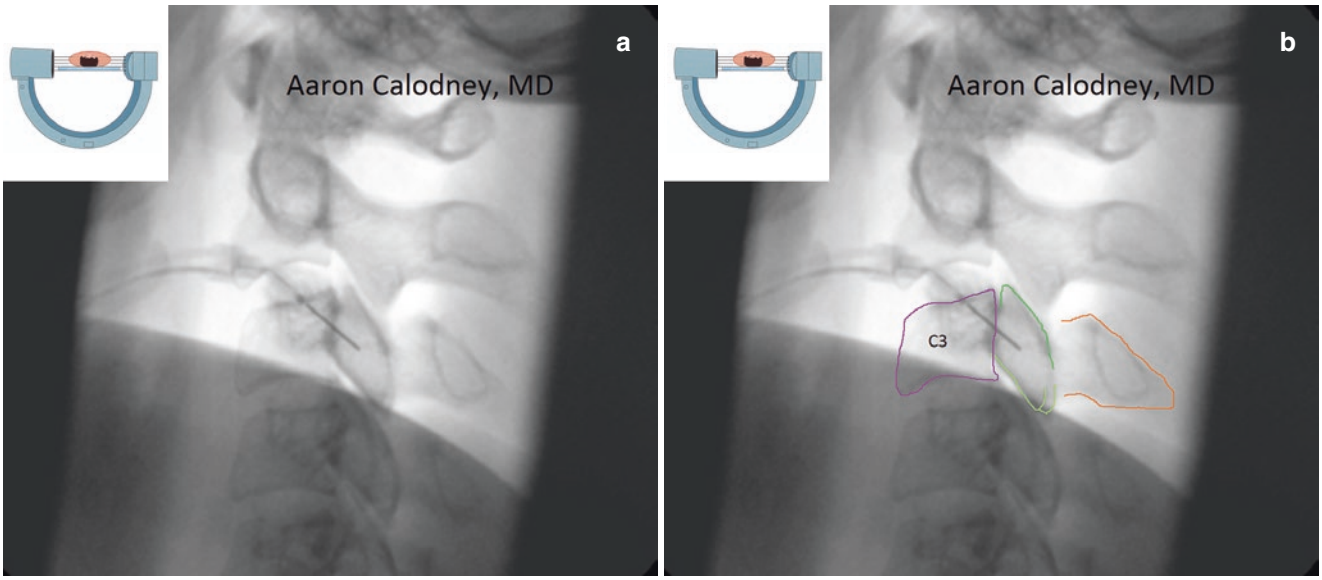

Fig. 4.4 Lateral view of the C-spine. Needle in place for C3 medial branch block at the centroid of the C3 joint articular pillar. Orange = spinous process and lamina; dark green = superior articular process; light green = inferior articular process; purple = vertebral body. Native (**a**) and edited fluoroscopy images (**b**)

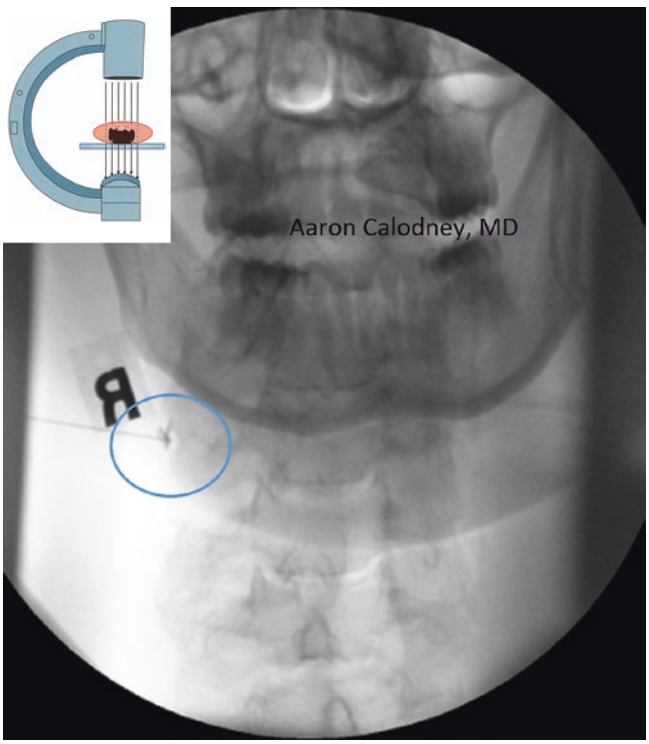

Fig. 4.5 PA view of the C-spine. Needle in place for C3 medial branch block at the centroid of the C3 joint articular pillar. Contrast shows no vascular uptake

Evidence

Table 4.1 Level of evidence and recommendations by the Benelux section of the World Institute of Pain
These recommendations are based on both a review of the literature in 2015 by an independent third party (Kleijnen Systematic Reviews LTD) and the previous published guidelines published in Pain Practice. The recent literature, the potential risk for complications, and the grade of invasiveness were considered when deciding to upgrade or downgrade the recommendation.

Indication	Procedure	Recommendation 2009	Grade 2015[2]	Recommendation 2018[3,4]
Cervical facet joint pain[1]	Therapeutic (repetitive) injections with local anesthetic with or without corticosteroid of the medial branch (cervical ramus medialis of the ramus dorsalis)	2B+	Moderate	Weak
Cervical facet joint pain[1]	Radiofrequency treatment (ablation) of the medial branch (cervical ramus medialis of the ramus dorsalis)	2C+	Low	Weak
Cervicogenic headache[5]	Radiofrequency treatment (ablation) of the medial branch (cervical ramus medialis of the ramus dorsalis)	2C+/–	Very low	Very weak
Whiplash associated disorder[6]	Radiofrequency treatment (ablation) of the medial branch (cervical ramus medialis of the ramus dorsalis)	2B+	Low	Moderate

[1]van Eerd M, Patijn J, Lataster A, Rosenquist RW, van Kleef M, Mekhail N, et al. 5. Cervical facet pain. Pain Pract. 2010;10:113–23
[2]Kleijnen Systematic Reviews Ltd.: Search and evaluation of the literature. 2015
[3]Huygen F, Kallewaard JW, van Tulder M, Van Boxem K, Vissers K, van Kleef M, et al. "Evidence-based interventional pain medicine according to clinical diagnoses": update 2018. Pain Pract. 2019;19:664–75
[4]https://www.anesthesiologie.nl/publicaties/praktische-richtlijnen-anesthesiologische-pijnbestrijding
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Table 4.2 Level of evidence based on the American Society of Interventional Pain Physicians (ASIPP) review of the literature

Cervical facet joint injections	Evidence
Diagnostic facet joint nerve blocks	Level II
Cervical facet joint nerve blocks	Level II
Cervical facet joint radiofrequency neurotomy	Level II

Manchikanti L, Schultz DM, Falco FJE, Singh V. Cervical facet joint interventions. In: Manchikanti L, Kaye AD, Falco FJE, Hirsch JA, editors. Essentials of interventional techniques in managing chronic pain. Springer International Publishing; 2018. p. 387–412.

Suggested Reading

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Manchikanti L, Pampati V, Kaye AD, Hirsch JA. Cost utility analysis of cervical therapeuticmedial branch blocks in managing chronic neck pain. Int J Med Sci. 2017;14(13):1307–16.

Engel A, Rappard G, King W, Kennedy DJ. Standards division of the international spine intervention society. The effectiveness and risks of fluoroscopically-guided cervical medial branch thermal radiofrequency neurotomy: a systematic review with comprehensive analysis of the published data. Pain Med. 2016;17(4):pme12928.

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Falco FJE, Erhart S, Wargo BW, Bryce DA, Atluri S, Datta S, et al. Systematic review of diagnostic utility and therapeutic effectiveness of cervical facet joint interventions. Pain Physician. 2009;12(2):323–44.

The cervical MBB chapter was reviewed by Jianguo Cheng; Maarten Van Kleef; Andrea M. Trescot; Milan Stojanovic; Peter S. Staats; Agnes R. Stogicza; Andre M. Mansano

Cervical Medial Branch Block and Radiofrequency Ablation – Oblique Approach

5

Harold J. Cordner and André M. Mansano

Pros of Oblique Approach

- Shorter needle track and less patient discomfort than posterior approach
- Patient in supine position, affords better comfort, communication, and airway access
- Easy visualization of lower levels

Cons of Oblique Approach

- Vital structures (spinal cord and vertebral artery) in needle trajectory
- Parallel placement of an RF cannula to the medial branch nerve is not possible, technique is less suitable for RF ablation (unless special needles are used)

Equipment and Monitoring

- Standard ASA monitoring
- Fluoroscopy
- Sterile prep, and drape
- Skin local anesthesia prior to any needle larger than 25G (unless sedation is used)
- Procedure is not performed with a coaxial view
- CPR equipment and medications available
- For diagnostic block
  - 22–25G, 2 inch (50 mm) - 3.5 inch (90 mm) needle, tip curved to facilitate steering. 0.3- 0.5 ml local anesthetic/level
  - Non-ionic contrast (optional)
- For RFA
  - 18–22G, 2 inch (50 mm) – 3.5 inch (90 mm) radiofrequency cannula: 5–10 mm active tip
  - Grounding pad
  - RF generator with capacity for unipolar and bipolar lesions
  - Local anesthetic

Anatomy

- Prevalence studies, physical exam, and pain referral maps can be utilized to choose levels
- C2–3 and C5–6 levels are the most common causes of cervicogenic headache and neck pain, respectively
- At the C3 level, there is a superficial medial branch (third occipital nerve) that is located in close proximity to the C2/3 facet joint and serves to innervate that joint as well as the suboccipital area
- The deep medial branch of C3 (which is analogous to the medial branches of C4, C5, and C6) courses along the waist of the corresponding articular pillars and supplies the adjacent vertebral segments (for instance, the C4 and C5 medial branches supply the zygapophyseal joint of C4/5)
- The C5 medial branch is located in the waist of the articular pillar of C5. The C3, C4, and C6 medial branches are located slightly above the waist of the corresponding articular pillars, and variations exist
- The C7 vertebra has a prominent transverse process (TP), and the location of the medial branch at this level is variable. It can be found as far caudal as the TP/superior articular process (SAP) junction and as far rostral as the apex of the C7 SA

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A. R. Stogicza et al. (eds.), *Interventional Pain*, https://doi.org/10.1007/978-3-030-31741-6_5

Structures to Keep in Mind and Possible Complications

- Vertebral artery (if needle is more anterior than appropriate target) → seizure, dissection, stroke
- Inadvertent intraarticular facet injection
- Inadvertent passage of needle though a facet joint → intrathecal, epidural medication administration, high spinal anesthesia, spinal cord injury, paralysis, death
- Injection of spinal nerve root → nerve damage, epidural, intrathecal injection
- Injection of a vascular structure that may be in contiguity with a radicular artery → spinal cord infarct
- Infection
- Bleeding
- Postprocedure pain
- Vasovagal reaction
- Allergic reaction

Fluoroscopy Technique, Target Localization

- Supine patient position
- C-arm in lateral view. In a true lateral, the articular pillars overlap and are clear and crisp. The facet joints above and below the level of interest must be crisp. The disc spaces must be clear. The anterior and posterior tubercles on each side should form a superimposed curvilinear line located in the superior posterior quadrant of the vertebral body shadow (Fig. 4.1a and b – Chap. 4. "Cervical Medial Branch Block – Lateral Approach")
- A cranio-caudal or dorsoventral adjustment may be needed to get an optimal view of the articular pillar
- At this point, oblique the C-arm until the neural foramens are clearly visualized (Fig. 5.1a–c)
- The target point is the base of the superior articular process (SAP) at or just below the most inferior aspect of the intervertebral foramen
- The skin entry point (Fig. 5.2a, b) is slightly posterior and caudal to the target

Procedure Steps

- Insert needle just posterior and caudal to the base of SAP (Fig. 5.1b, c)
- Advance the needle until bony contact at the base of SAP (Fig. 5.2a, b). Keep in mind that this procedure is not done in a coaxial view
- Posteroanterior (PA) view to check the optimal needle position at the waist of the articular pillar (Fig. 5.3a–c)
- Once needle position is confirmed in two views, sensory and motor testing is performed to confirm needle is within effective proximity to the medial branch nerve and not in proximity to the motor nerve root. Ideally, sensory testing will reveal paresthesia <0.5 V and motor testing at 1.5–2.0 V should produce no motor response in upper extremity or face
- Inject 0.3–0.5 cc of contrast media to detect possible intravascular spread for diagnostic procedure
- Inject 0.3 cc of local anesthetic for block
- Radiofrequency lesioning can then be performed at 75–80°C for 60–120 seconds

Clinical Pearls

- An optimal view of the cervical foramen is paramount in performing this procedure
- Good sensory and motor stimulation is necessary to ensure more consistent success
- Due to the poor predictive value of single diagnostic blocks, dual medial branch blocks may be performed to make the diagnosis of facet joint pain prior to proceeding to the definitive radiofrequency treatment
- Small amount of corticosteroid may help prevent neuritis or postlesioning pain

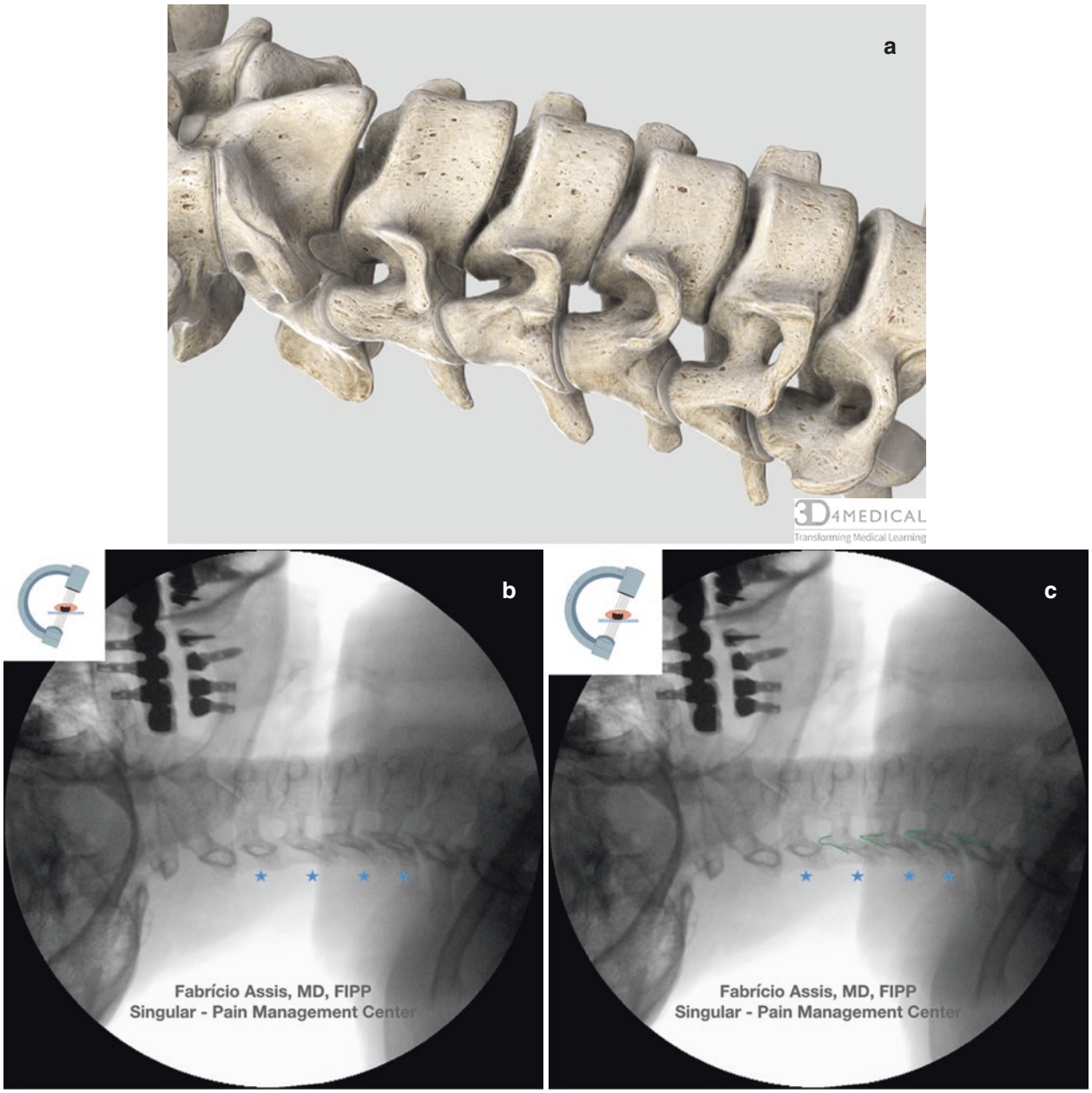

Fig. 5.1 Foraminal view of the cervical spine. Blue Asterisk marks the optimal skin entry. Dark green = superior articular process. Complete Anatomy image (**a**), native (**b**) and edited fluoroscopy images (**c**)

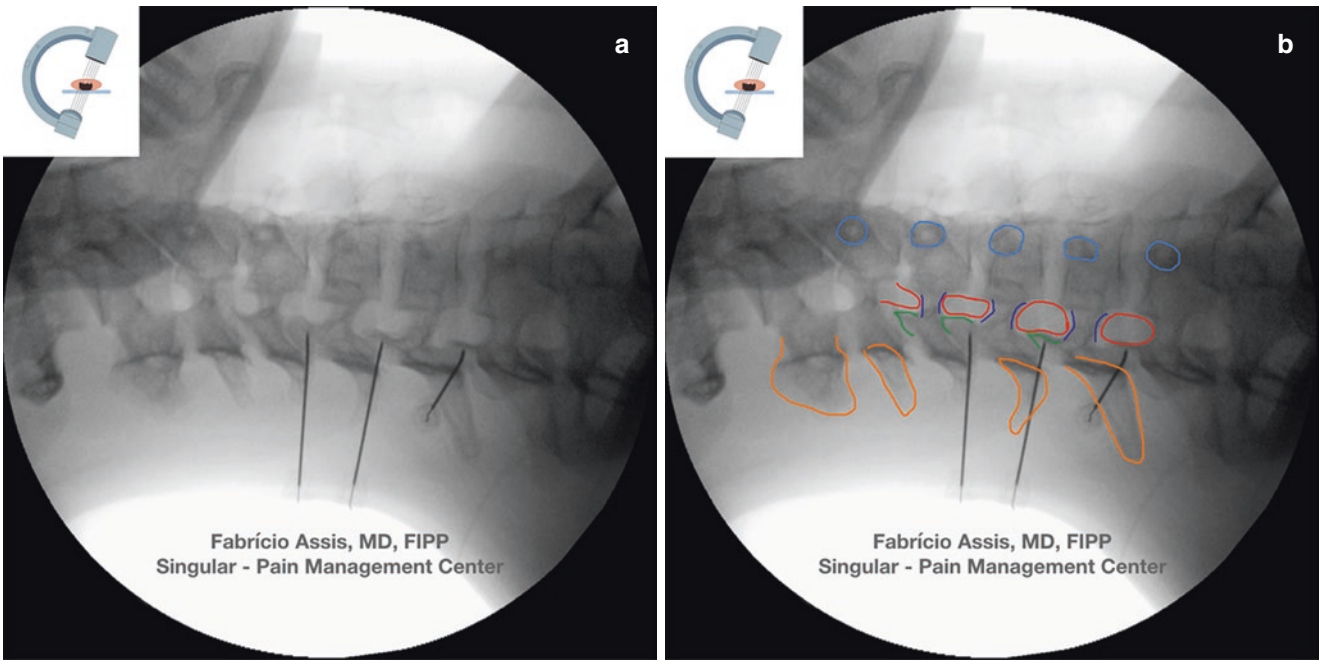

Fig. 5.2 Native and edited images of oblique view of the cervical spine. Needles in place, touching the articular pillar. Orange = spinous process and lamina; dark green = superior articular process; red = intervertebral foramen; dark blue = ipsilateral pedicle; light blue = contralateral pedicle. Native (**a**) and edited fluoroscopy images (**b**)

Unacceptable, Potentially Harmful Needle Placement on Exam

- Not checking PA view
- Needle through facet joint or compromised intraspinal space
- Needle tip too anterior
- Needle in foramen
- Any proof of lack of understanding of cervical spine anatomy

Unacceptable, But Not Harmful Placement on Exam

- Unnecessarily large bore needle
- Not obtaining a good oblique view
- The procedure was abandoned after unsuccessful attempts, but it was clear that the examinee was cognizant of the safety aspects of the procedure, the needle did not compromise vital structures, did not reach the epidural space, spinal cord or vertebral artery

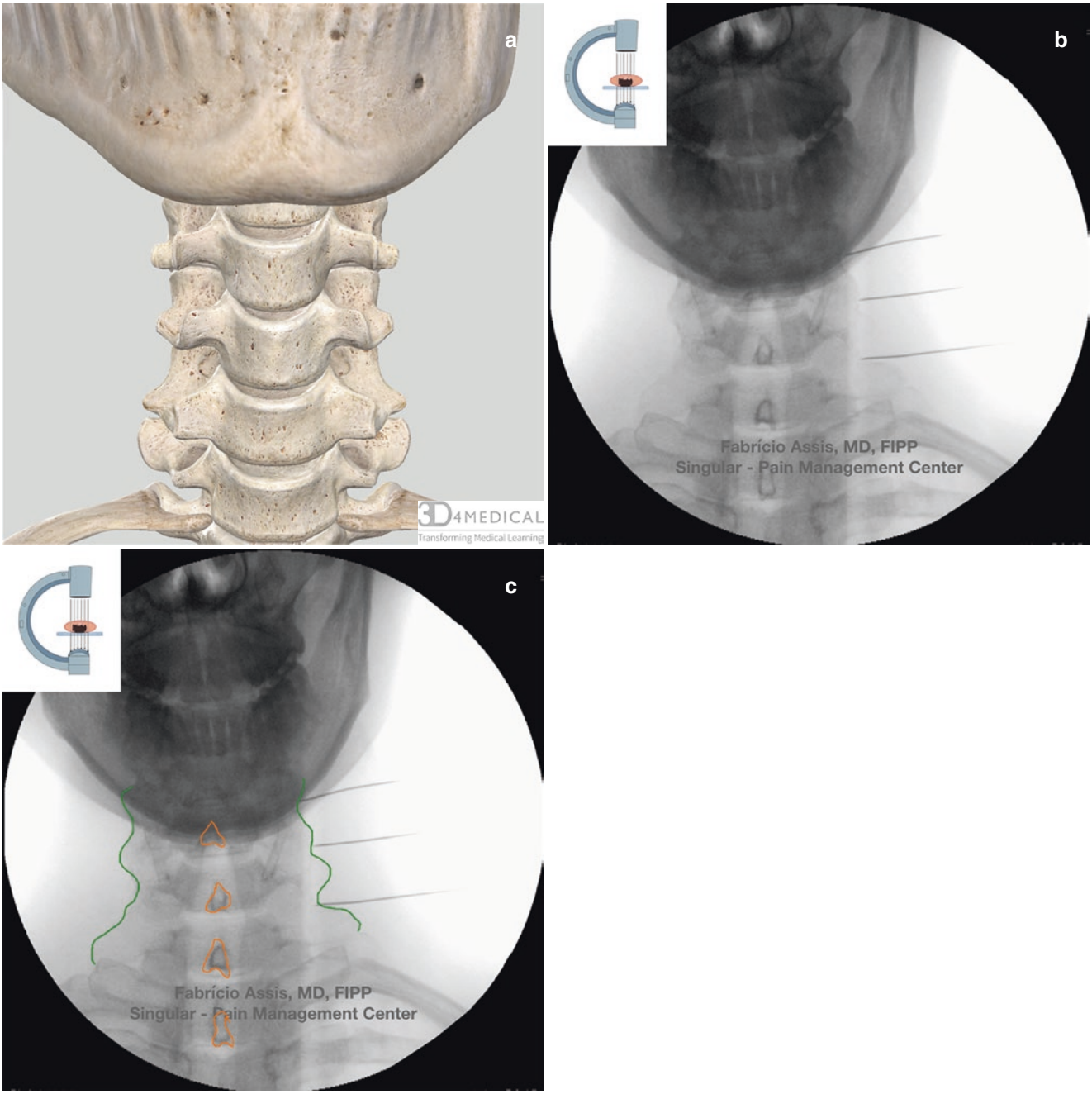

Fig. 5.3 PA view of the cervical spine, needles in place for C5, 6, 7 MBB.
Orange = spinous process; dark green = articular pillar line. Complete Anatomy image (**a**), native (**b**) and edited fluoroscopy images (**c**)

Evidence

Table 5.1 Level of evidence and recommendations by the Benelux section of the World Institute of Pain
These recommendations are based on both a review of the literature in 2015 by an independent third party (Kleijnen Systematic Reviews LTD) and the previous published guidelines published in Pain Practice. The recent literature, the potential risk for complications, and the grade of invasiveness were considered when deciding to upgrade or downgrade the recommendation.

Indication	Procedure	Recommendation 2009	Grade 2015[2]	Recommendation 2018[3,4]
Cervical facet joint pain[1]	Therapeutic (repetitive) injections with local anesthetic with or without corticosteroid of the medial branch (cervical ramus medialis of the ramus dorsalis)	2B+	Moderate	Weak
Cervical facet joint pain[1]	Radiofrequency treatment (ablation) of the medial branch (cervical ramus medialis of the ramus dorsalis)	2C+	Low	Weak
Cervicogenic headache[5]	Radiofrequency treatment (ablation) of the medial branch (cervical ramus medialis of the ramus dorsalis)	2C+/–	Very low	Very weak
Whiplash associated disorder[6]	Radiofrequency treatment (ablation) of the medial branch (cervical ramus medialis of the ramus dorsalis)	2B+	Low	Moderate

[1]van Eerd M, Patijn J, Lataster A, Rosenquist RW, van Kleef M, Mekhail N, et al. 5. Cervical facet pain. Pain Pract. 2010;10:113–23
[2]Kleijnen Systematic Reviews Ltd.: Search and evaluation of the literature. 2015
[3]Huygen F, Kallewaard JW, van Tulder M, Van Boxem K, Vissers K, van Kleef M, et al. "Evidence-based interventional pain medicine according to clinical diagnoses": update 2018. Pain Pract. 2019;19:664–75
[4]https://www.anesthesiologie.nl/publicaties/praktische-richtlijnen-anesthesiologische-pijnbestrijding
[5]van Suijlekom H, Van Zundert J, Narouze S, van Kleef M, Mekhail N. 6. Cervicogenic headache. Pain Pract. 10:124–30
[6]van Suijlekom H, Mekhail N, Patel N, Van Zundert J, van Kleef M, Patijn J. 7. Whiplash-associated disorders. Pain Pract. 10:131–36

Table 5.2 Level of evidence based on the American Society of Interventional Pain Physicians (ASIPP) review of the literature

Cervical facet joint injections	Evidence
Diagnostic facet joint nerve blocks	Level II
Cervical facet joint nerve blocks	Level II
Cervical facet joint radiofrequency neurotomy	Level II

Manchikanti L, Schultz DM, Falco FJE, Singh V. Cervical facet joint interventions. In: Manchikanti L, Kaye AD, Falco FJE, Hirsch JA, editors. Essentials of interventional techniques in managing chronic pain. Springer International Publishing; 2018. p. 387–412.

Suggested Reading

Sluijter M, Metha M. Treatment of chronic back and neck pain by percutaneous thermal lesions. In: Lipton S, editor. Persistent pain, modern methods of treatment. London: Academic Press; 1981. p. 141–79.

Manchikanti L, Pampati V, Kaye AD, Hirsch JA. Cost utility analysis of cervical therapeuticmedial branch blocks in managing chronic neck pain. Int J Med Sci. 2017;14(13):1307–16.

Engel A, Rappard G, King W, Kennedy DJ. Standards division of the international spine intervention society. The effectiveness and risks of fluoroscopically-guided cervical medial branch thermal radiofrequency neurotomy: a systematic review with comprehensive analysis of the published data. Pain Med. 2016;17(4):pme12928.

van Eerd M, Patijn J, Lataster A, Rosenquist RW, van Kleef M, Mekhail N, et al. Cervical facet pain. Pain Pract. 2010;10(2):113–23.

Falco FJE, Erhart S, Wargo BW, Bryce DA, Atluri S, Datta S, et al. Systematic review of diagnostic utility and therapeutic effectiveness of cervical facet joint interventions. Pain Physician. 2009;12(2):323–44.

The cervical MBB chapter was reviewed by Jianguo Cheng; Standiford Helm; Maarten Van Kleef; Andrea M. Trescot; Milan Stojanovic; Peter S. Staats; Agnes R. Stogicza; Andre M. Mansano.

6 Pterygopalatine Ganglion Block (Sphenopalatine Ganglion Block) and Radiofrequency Ablation – Coaxial and Coronoid (Traditional) Approach

Gabriel Gaviria-Suarez and Juan C. Flores

Equipment and Monitoring

- Standard ASA monitoring
- Fluoroscopy
- Sterile prep, and drape
- Skin local anesthesia prior to any needle larger than 25G (unless sedation is used)
- Coaxial view is always used to advance needle, unless otherwise specified
- CPR equipment and medications available
- 20–22G, 3.5 inch (90 mm), sharp or blunt needle for the injection, tip curved to facilitate steering
- Nonionic contrast with low volume tubing
- Local anesthetic
- 20–22G, 3.9 inch (100 mm) radiofrequency (RF) needle, 5 mm active tip, for radiofrequency ablation (RFA)
  - Grounding pad
  - RF generator with capacity for unipolar and bipolar lesions

Anatomy

- Pterygopalatine fossa (PPF): between the pterygoid process and maxillary sinus
- Lateral entry: pterygomaxillary fissure
- Medially bound by (thin) perpendicular plate of the palatine bone
- Opening to nasal cavity: sphenopalatine foramen
- The sphenopalatine ganglion (SPG) is located in the superior third of the PPF

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- Target:
  - Cephalad third of the PPF on lateral view
  - Lateral aspect of the perpendicular plate of the palatine bone at the middle nasal turbinate level on anteroposterior (AP) view

Structures to Keep in Mind and Possible Complications (Fig. 6.1)

- Maxillary artery and overlaying venous pterygoid plexus → A local hematoma or a retrobulbar hematoma can occur secondary to bleeding through the inferior orbital fissure
- Sphenopalatine artery
- The maxillary artery occasionally communicates with the internal carotid artery through the pterygoid or vidian canal → embolism can theoretically occur if particulate steroid injected
- Maxillary nerve (V2, from foramen rotundum) branches → nerve injury that may cause hypoesthesia/dysesthesia in the palate, maxilla or posterior pharynx
  - Posterior superior alveolar nerves to upper teeth
  - Nasopalatine nerve (through sphenopalatine foramen and to nose, septum)
  - Greater and lesser palatine nerves and arteries to palate
  - Infraorbital nerve
- Lateral nasal wall → epistaxis (if the needle passes across this structure)
- Oral and nasal mucosa penetration → Infection
- Rich parasympathetic connections →Vasovagal reaction and temporary post block/RFA dryness of the eye
- Postprocedure pain
- Allergic reaction

Fluoroscopy Technique, Target Localization

- Patient supine, head taped
- Lateral view (Fig. 6.2 and 6.3a, b)

A. R. Stogicza et al. (eds.), *Interventional Pain*, https://doi.org/10.1007/978-3-030-31741-6_6

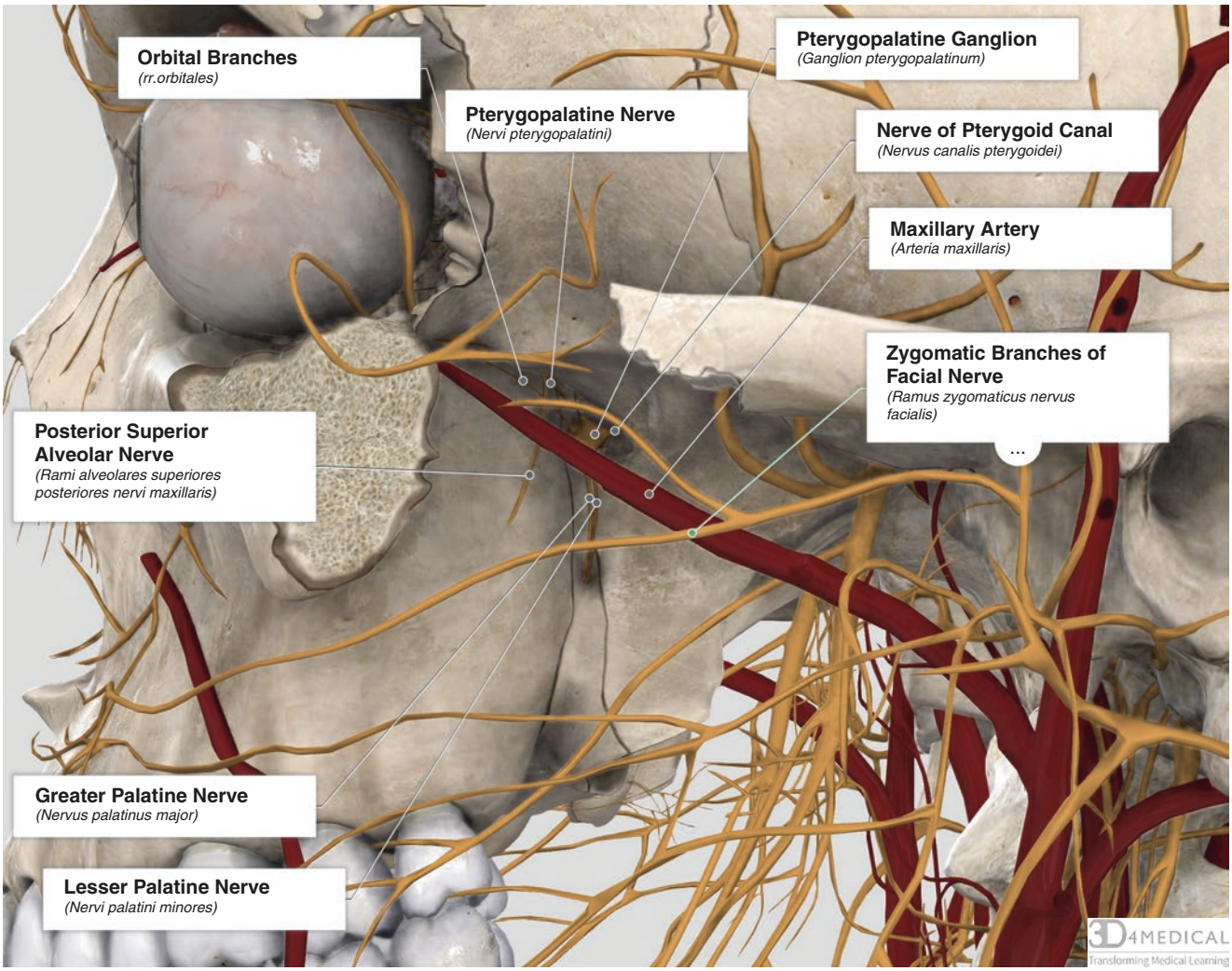

Fig. 6.1 Anatomy drawing of the pterygopalatine fossa. Zygoma and mandible removed for better visualization of structures in the fossa. Complete Anatomy image

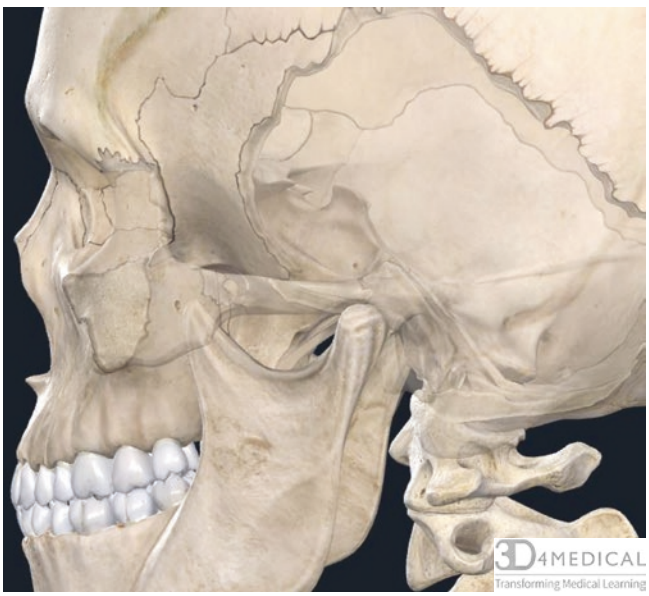

Fig. 6.2 Skull lateral view. Temporal, zygomatic bones faded to visualize the pterygopalatine fossa. Complete Anatomy image

- Rotate the head left or right until the ipsi- and contralateral pterygopalatine fossae are superimposed at the posterior wall of the maxillary sinus in the "true" lateral view (Fig. 6.4a, b)
- Identify other important structures: The maxillary sinus, zygomatic arch, mandibular notch, coronoid process of the mandible, orbits, sphenoid sinus, and sella turcica (Fig. 6.4a, b)
- Posteroanterior (PA) view: The target is the lateral wall of the nasal fossa at the level of the middle turbinate (Fig. 6.5a, b)

Procedure Steps – Coaxial Approach

- Identify the needle entry point: Inferior to the zygomatic arch, posterior/cephalad to the coronoid process of the mandible (opening the mouth allows creating a generous

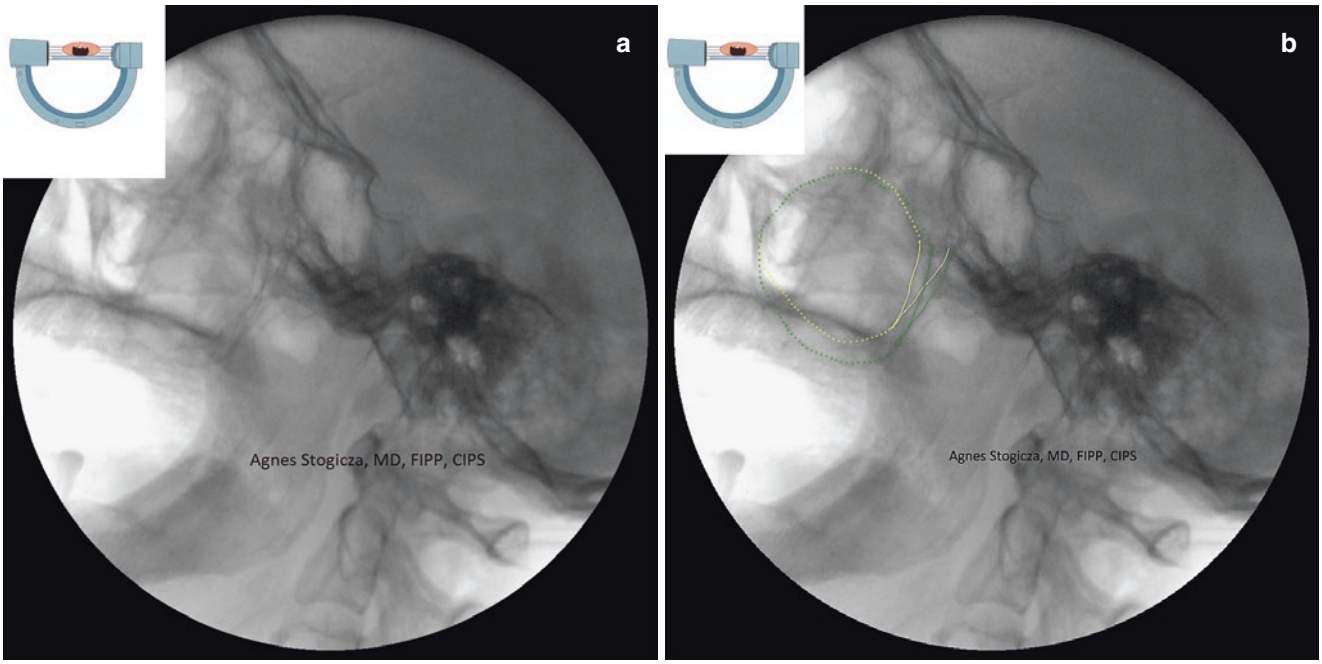

Fig. 6.3 Lateral view (not true lateral) of the head. Lack of upper teeth. The posterior walls of the maxillary sinuses (yellow and green, partly dotted) and therefore the pterygopalatine fossae (yellow and green) do not overlap. Native (**a**) and edited (**b**) images

area for skin entry, without having the coronoid process in the needle trajectory) (Fig. 6.4a–c)
- The needle is directed medial in coaxial view until the zygomatic arch (very superficial) is passed (Fig. 6.4c)
- The needle is then redirected slightly cephalad into the pterygopalatine fossa with intermittent fluoroscopy (Fig. 6.4d)
- Posteroanterior (PA) view. The needle should be at the lateral wall of the nasal fossa at the level of the middle turbinate (Fig. 6.5)

Procedure Steps – Coronoid (Traditional) Approach

- Identify needle entry point: in the mandibular notch on the lateral view (Fig. 6.6a, b)
- The needle is directed anterior, medial, and slightly cephalad toward the fossa. You may contact the lateral pterygoid plate. The needle should then be walked off anteriorly (Fig. 6.7a)
- PA view. The needle should be at (and not beyond) the lateral wall of the nasal fossa at the level of the middle turbinate (Fig. 6.5 and 6.8)

Diagnostic Injection

- Inject 0.5 cc of nonionic water-soluble contrast to exclude vascular uptake (Figs. 6.7b and 6.8)
- 1–2 ml of local anesthetic is injected

Radiofrequency Lesioning (RF)

- RF needle is placed via coaxial or coronoid approach as above
- Stimulation should be felt at the base of the nose at < 0.5 V
- After proper sensory stimulation, 0.2 ml of contrast agent is injected under real time fluoroscopy to rule out intravascular spread
- Lidocaine 1 to 2% is injected prior to conventional radiofrequency lesioning at 80°C for 60 seconds
- PRF can be used at lower temperature (42°C) (Figs 6.4d and 6.5)

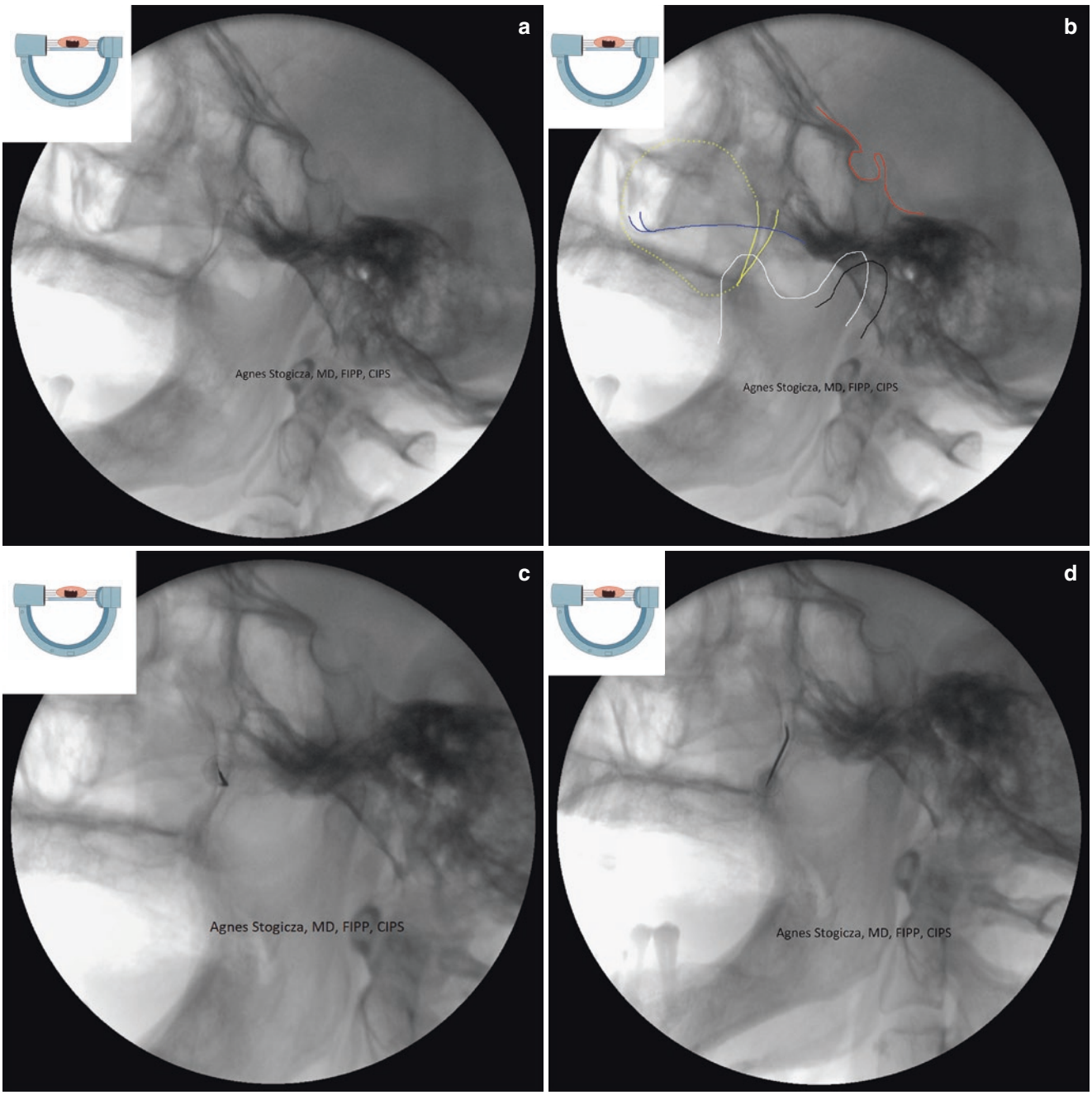

Fig. 6.4 True lateral image of the head, with focus on the pterygopalatine fossae. Ipsi- and contralateral pterygopalatine fossae (yellow) and zygomatic arches overlap. Mandibles do not always overlap, focus should stay on overlapping the walls of the pterygopalatine fossae. Lack of upper teeth. Needle entry anywhere in the quadrangle, bordered by the two yellow, the blue and white lines. Yellow dotted = maxillary sinus, blue = caudad edge of the zygomatic arches, white and black = ipsi- and contralateral mandibular processes, red = sella turcica. Native (**a**) and edited (**b**) images. Pterygopalatine block, needle is placed in coaxial view toward the fossa, past the zygomatic arch (**c**), then slightly redirected cranially (**d**)

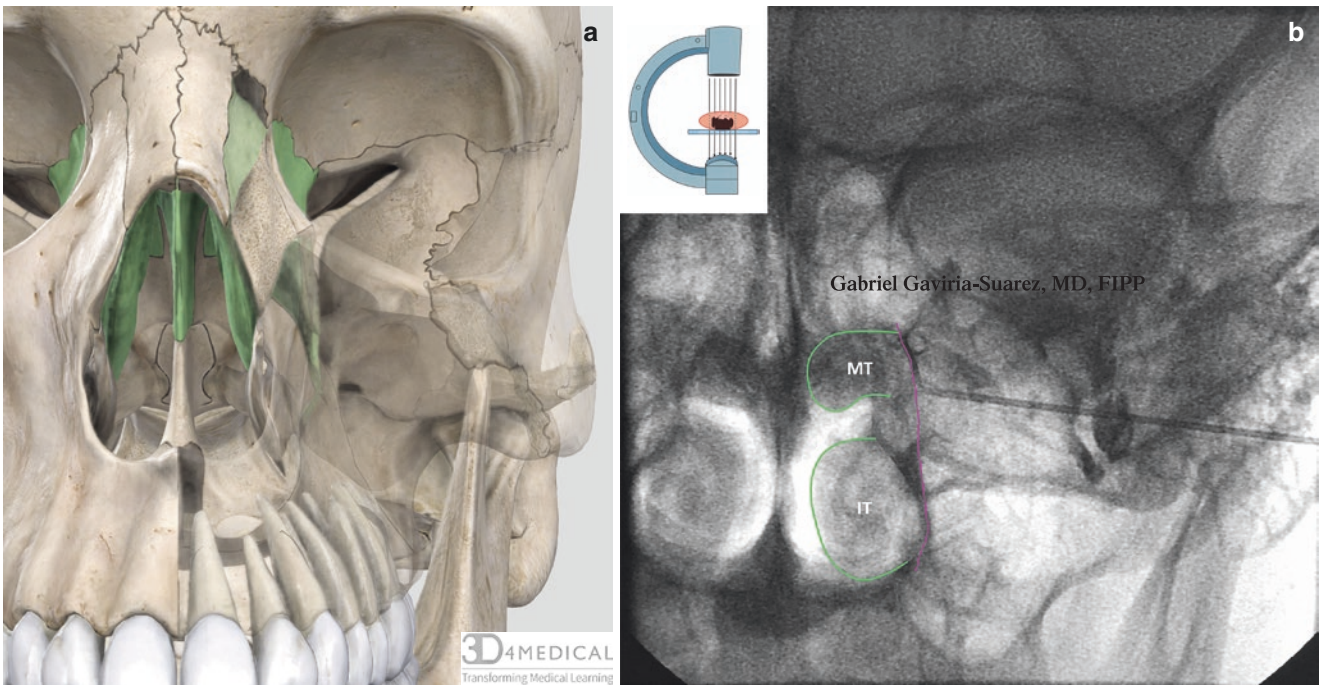

Fig. 6.5 Pterygopalatine ganglion block, PA view. Needle in the pterygopalatine fossa, just lateral to the nasal wall at the level of the middle turbinate (MT). Green line = inferior and middle turbinates, IT = inferior turbinate. Complete Anatomy image with maxilla faded on left (**a**), edited fluoroscopy image (**b**)

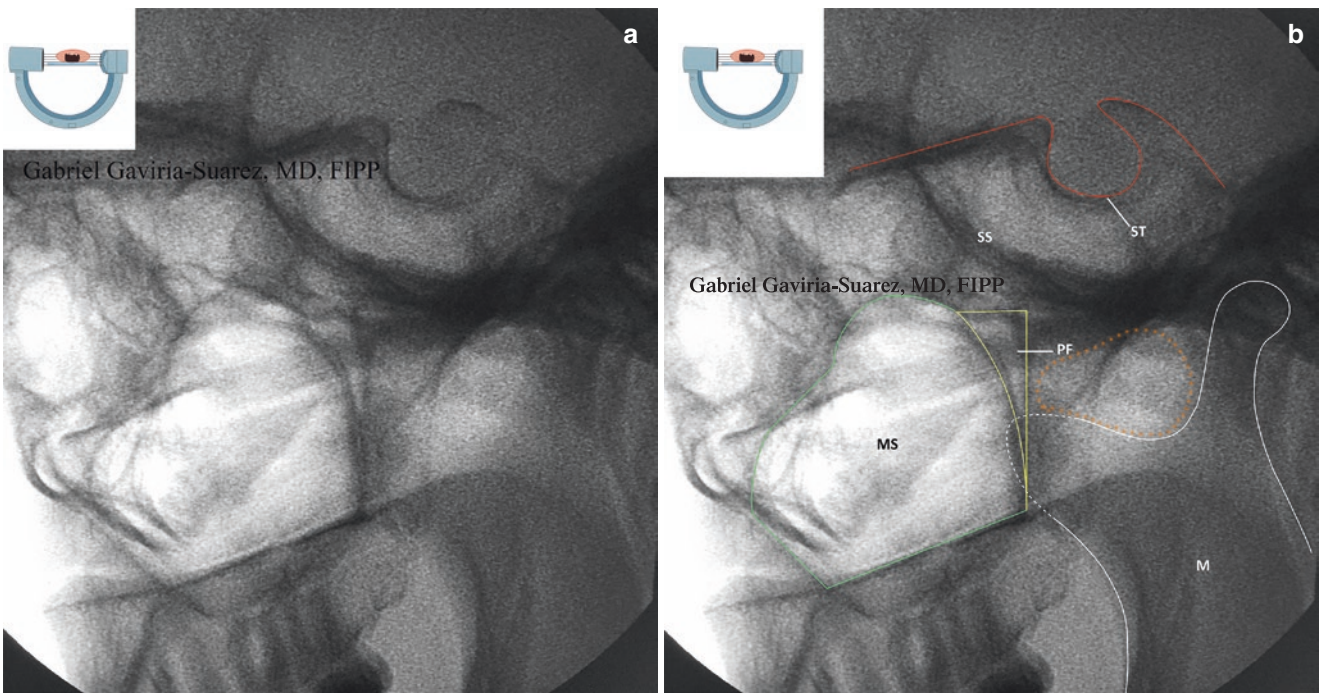

Fig. 6.6 Access to the pterygopalatine fossa (PF) = yellow, with a coronoid approach. Orange dotted zone marks the possible skin entry sites. Of note, in this case coaxial approach would also be possible. Maxillary sinus (MS) = green, mandible = white, sella turcica (ST) = red, sphenoid sinus (SS). Native (**a**) and edited fluoroscopy image (**b**)

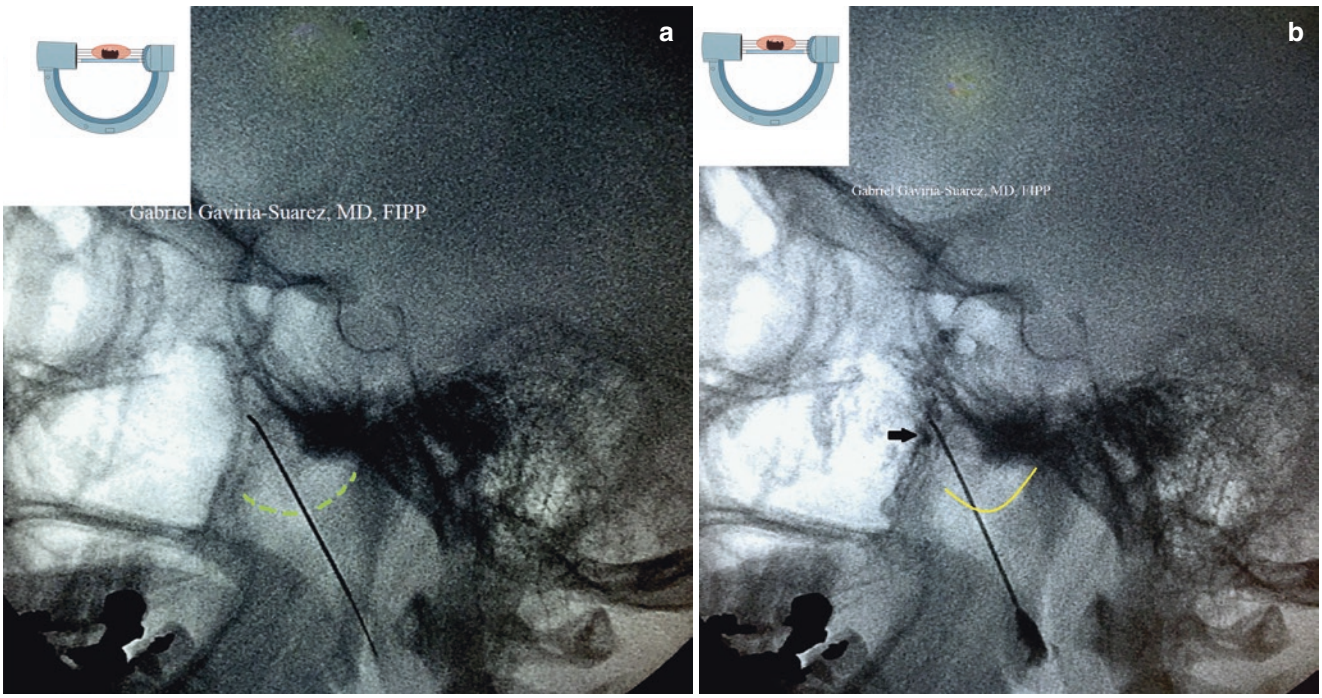

Fig. 6.7 Pterygopalatine ganglion block, coronoid approach, lateral view. Yellow dotted lines = mandibular notch. Notice the direction of the needle through the mandibular notch in a non-coaxial view. (**a**) Contrast is deposited in the pterygopalatine fossa (**b**)

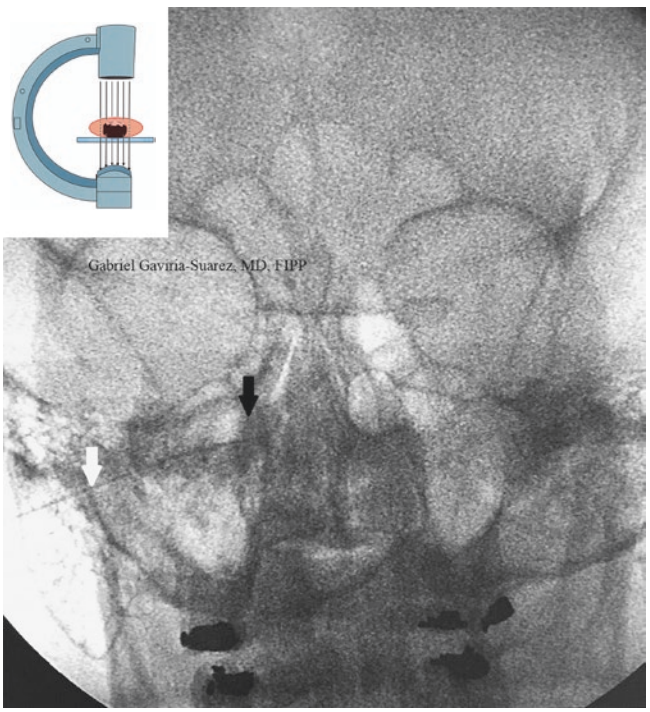

Fig. 6.8 Pterygopalatine ganglion block, coronoid approach, PA view. Image shows the needle (white arrow) contacting the lateral nasal wall and nonionic contrast around the tip of the needle (black arrow) at the level of middle turbinate

Clinical Pearls

- Do not perform the procedure unless the superimposed images of both pterygopalatine fossae are clearly visualized
- In the *coaxial approach,* one can move the coronoid process of the mandible out of the way (use something such as a folded gauze pad to keep the mouth slightly open)
- If the target is completely covered by the zygomatic bone, one should not try the *coaxial approach*
- Use of a curved needle allows slow, step-by-step advancing, avoiding multiple needle entry and redirection, decreasing the chance of hematoma. A blunt tipped needle (with an introducer) may also decrease the risk of bleeding
- When using stimulation prior to radiofrequency lesioning, a tingling sensation in the upper teeth is a sign of being too close to the superior alveolar nerves. In this setting the needle should be redirected posteriorly. Tingling sensation in the palate is a sign of being too close to the palatine nerves. When this occurs the needle should be slightly redirected cranial to avoid injury of these nerves
- *Coronoid approach* could be painful when the lateral pterygoid plate is contacted

- Some pain interventionists prefer the *coaxial approach* because it is easier needle guidance, it is less painful as the needle does not contact the lateral pterygoid plate and it is easier to steer the needle within the fossa

Unacceptable, Potentially Harmful Needle Placement on Exam

- Failing to check PA view
- Any proof of lack of understanding of facial/cranial anatomy, for example forcing the needle through bone or leaving the needle in the nasal or oral cavity and indicating that the needle is in the correct position
- Placing the needle in the orbit
- Multiple entries in nasal cavity
- Rough manipulation of the needle
- Unnecessarily large bore needle

Unacceptable, But Not Harmful Needle Placement on Exam

- The procedure was abandoned after unsuccessful attempts, but it was clear that the examinee was cognizant of the safety aspects of the procedure, the needle did not compromise vital structures
- Placing the needle (once) in the nasal cavity if recognized
- Needle not in pterygopalatine fossa, but it is recognized and procedure abandoned

Evidence

Table 6.1 Level of evidence and recommendations by the Benelux section of the World Institute of Pain
These recommendations are based on both a review of the literature in 2015 by an independent third party (Kleijnen Systematic Reviews LTD) and the previous published guidelines published in Pain Practice. The recent literature, the potential risk for complications, and the grade of invasiveness were considered when deciding to upgrade or downgrade the recommendation.

Indication	Procedure	Recommendation 2009	Grade 2015[2]	Recommendation 2018[3,4]
Persistent idiopathic facial pain[1]	Pulsed radiofrequency of the sphenopalatine ganglion (ganglion pterygopalatinum)	2C+	Very low	Very weak
Persistent idiopathic facial pain[1]	Radiofrequency of the sphenopalatine ganglion (ganglion pterygopalatinum)		Very low	Very weak
Cluster headache[5]	Radiofrequency of the sphenopalatine ganglion (ganglion pterygopalatinum)	2C+	Very low	Weak

[1]Cornelissen P, van Kleef M, Mekhail N, Day M, van Zundert J. Evidence-based interventional pain medicine according to clinical diagnoses. 3. Persistent idiopathic facial pain. Pain Pract. 2009;9:443–8
[2]Kleijnen Systematic Reviews Ltd.: Search and evaluation of the literature. 2015
[3]Huygen F, Kallewaard JW, van Tulder M, Van Boxem K, Vissers K, van Kleef M, et al. Evidence-based interventional pain medicine according to clinical diagnoses: update 2018. Pain Pract. 2019;19:664–75
[4]https://www.anesthesiologie.nl/publicaties/praktische-richtlijnen-anesthesiologische-pijnbestrijding
[5]van Kleef M, Lataster A, Narouze S, Mekhail N, Geurts JW, van Zundert J. Evidence-based interventional pain medicine according to clinical diagnoses. 2. Cluster headache. Pain Pract. 2009;9:435–42

Table 6.2 Level of evidence based on the American Society of Interventional Pain Physicians (ASIPP) review of the literature

Sphenopalatine ganglion blocks[1]	Evidence
Thermal radiofrequency – cluster headache	Level IV
Thermal radiofrequency – sphenopalatine neuralgia	Level IV
Pulsed radiofrequency – facial pain	Level IV
Sphenopalatine block	Level IV

[1]Bryan Skulpoonkitti, Miles D. Sphenopalatine ganglion blocks. In: Manchikanti L, Kaye AD, Falco FJE, Hirsch JA, editors. Essentials of interventional techniques in managing chronic pain. Springer International Publishing; 2018. p. 519–530.

Suggested Reading

Leong M, Gjolaj M. Sphenopalatine ganglion block. In: Deer TR, editor. Treatment of chronic pain by interventional approaches, the American Academy of pain medicine. New York: Springer New York; 2015. p. 95–7.

Narouze S. Sphenopalatine ganglion block and radiofrequency ablation. In: Narouze S, editor. Interventional management of head and face pain, nerve blocks and beyond. New York: Springer New York; 2014. p. 47–52.

Raj PP, Erdine S. Interventional pain procedures in the head. In: Pain-relieving procedures: the illustrated guide. Chichester: Wiley-Blackwell; 2012. p. 154–65.

Sociedad Española del Dolor, de Andres J, Diaz L, Cid J, Gomez Caro L. Bloqueo y radiofrecuencia del ganglio esfenopalatino para el tratamiento de algias faciales. Rev Soc Esp Dolor. 2011;18(5):303–10.

The Sphenopalatine Ganglion Block chapter was reviewed by Frank Huygen; Miles Day; Maarten Van Kleef; Javier De Andres Ares; Andrea M. Trescot; Milan Stojanovic; Peter S. Staats; Agnes R. Stogicza; Andre M. Mansano and Edit Racz.

Stellate Ganglion Block

7

Mahdi Panahkhahi, Mohamed A. R. Nasr,
and Agnes R. Stogicza

Disclaimer: The use of ultrasound can significantly increase the safety and accuracy of this procedure.

Equipment and Monitoring

- Standard ASA monitoring
- Fluoroscopy
- Sterile prep, and drape
- Skin local anesthesia prior to any needle larger than 25G (unless sedation is used)
- Coaxial view is always used to advance needle, unless otherwise specified
- CPR equipment and medications available
- 22–25G, 1.5–2 inch (40–50 mm) needle for block
- 22G, 100 mm, 5 mm active tip cannula for radiofrequency ablation (RFA)
- Skin temperature monitor
- Nonionic contrast
- Low volume tubing
- Local anesthetic

Anatomy

- Target: the junction of C6 or C7 transverse process (just inferior to the uncinate process) and the vertebral body. Medication will spread in a cephalocaudad direction
- Stellate ganglion (cervicothoracic ganglion = fusion of inferior cervical and superior thoracic ganglion) is immediately anterolateral to the longus colli muscle at C7–T1 level (80% of patients)

Structures to Keep in Mind and Possible Complications

- Carotid artery → seizure, stroke, dissection, bleeding
- Jugular vein: → bleeding
- Recurrent laryngeal nerve: injury → vocal cord paralysis
- Vagus → bradycardia
- Phrenic nerve → diaphragm paralysis
- Thyroid gland: → bleeding causing airway compromise
- Esophagus → discomfort, infection, mediastinal infection
- Trachea
- Brachial plexus → nerve injury, somatic block instead of sympathetic block
- Vertebral artery → seizure, arterial dissection, stroke (C7 higher risk than C6)
  - At C7 level, the vertebral artery is more exposed; it carries a bigger risk than at C6, where it is partially protected by bone at the transverse process and vertebral body junction. However, in 10% of the cases, the vertebral artery enters the transverse foramina at higher levels (C3–5)
- Dural sleeve of exiting nerves → epidural/spinal block
- Exiting nerve roots → nerve damage
- Pleura and apex of lung → pneumothorax (if injected at C7)
- Disc → discitis
- Infection
- Bleeding
- Postprocedure pain

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A. R. Stogicza et al. (eds.), *Interventional Pain*, https://doi.org/10.1007/978-3-030-31741-6_7

- Vasovagal reaction
- Allergic reaction

Fluoroscopy Technique, Target Localization – Anterior Approach

- Patient in supine position
- Posteroanterior (PA) image
- Identify the C6 or C7 vertebral body
- Square off vertebral body, identify its junction with the transverse process (medial portion of the pedicle line) (Fig. 7.1a–c)

Procedure Steps – Anterior Approach

- Make sure that large blood vessels (common carotid artery and internal jugular vein) are not in the needle path
- Advance a short bevel needle to the target point to touch bone; coaxial view is desirable (Fig. 7.2a, b)
- Withdraw the needle 1–2 mm and inject 1–2 ml of contrast after negative aspiration (Fig. 7.3)
- Check the lateral view (Fig. 7.4a–c)
- Confirm spread and lack of vascular uptake of contrast with live fluoroscopy; it usually shows spread of contrast along longus colli muscle
- Inject up to 5 cc of local anesthetic in divided doses with intermittent aspiration

Fluoroscopy Technique, Target Localization - Oblique Approach

- Patient position – supine
- Posteroanterior (PA) image
- Square off vertebral body (C6 or C7)
- Visualize junction of transverse process (just inferior to the uncinate process) and the vertebral body by fluoroscopy on PA view
- Oblique C-arm ipsilaterally about 15–20°. The carotid sheath is often in needle trajectory, so one needs to push it aside to avoid puncturing it (Fig. 7.5a, b)
- Figure 7.5c shows too much oblique tilt of the C-arm, to foraminal view, demonstrating the vertebral artery and foramen getting exposed

Procedure Steps – Oblique Approach

- Advance a short bevel needle to the target point to touch the bone, coaxial view is desirable (Fig. 7.6a, b)
- Check the lateral and PA view as well (Figs. 7.7 and 7.8a, b)
- Withdraw the needle 1–2 mm and inject 1–2 ml of the contrast after a negative aspiration for blood and CSF
- Confirm spread of contrast with live fluoroscopy; it usually shows spread of contrast along longus colli muscle
- Inject 5 cc of local anesthetic in divided doses

Clinical Pearls

- Slight head up position for patient while fluoroscope is still perpendicular to the patient may be useful. Pillow underneath the shoulders may make anterior approach easier
- Slight ipsilateral rotation (oblique view) of fluoroscope can help better visualization of the target point
- Identify the cervical foramina to make sure to avoid them with oblique approach
- Avoid carotid puncture with oblique approach
- The presence of Horner's syndrome (ptosis, miosis, anhydrosis, enophthalmos) is a confirmatory sign of successful stellate ganglion blockade, as are warmer and dry extremity and dilated veins on the treated side. However, since the Kuntz fibers bypass the stellate ganglion, a lack of effect in the hand does not confirm lack of sympathetic influence
- Arm weakness and/or numbness are generally a sign of brachial plexus block, with or without sympathetic block. Therefore, in this case, no conclusion is to be drawn whether or not the pain is sympathetically maintained
- Monitor pre- and postprocedure ipsilateral arm temperature to confirm adequate block

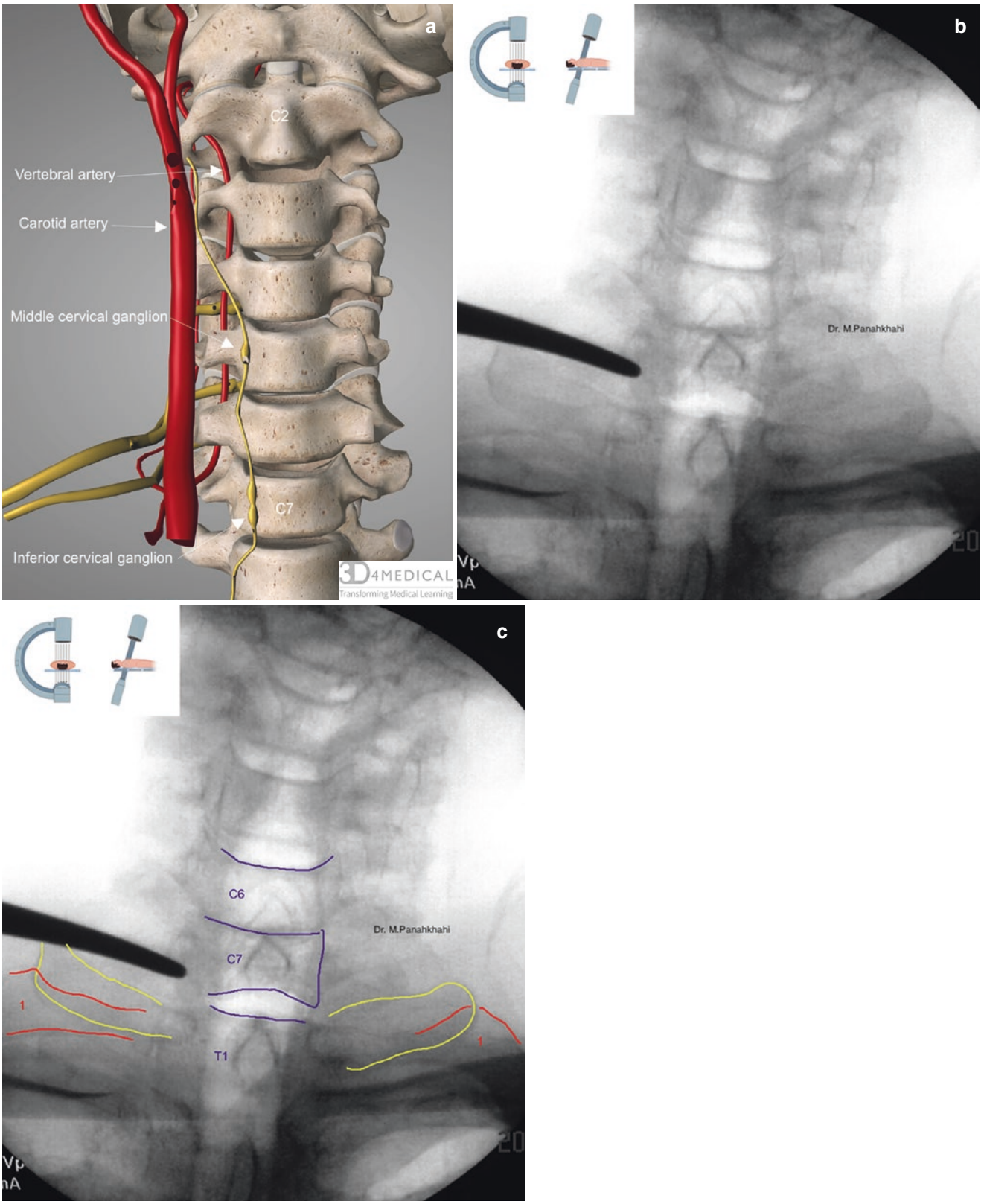

Fig. 7.1 Cervical spine in PA view. Marker identifies the junction of C7 transverse process and vertebral body. Yellow = transverse process; red = ribs; purple = vertebral body; Complete Anatomy image (**a**), native (**b**), and edited fluoroscopy image (**c**)

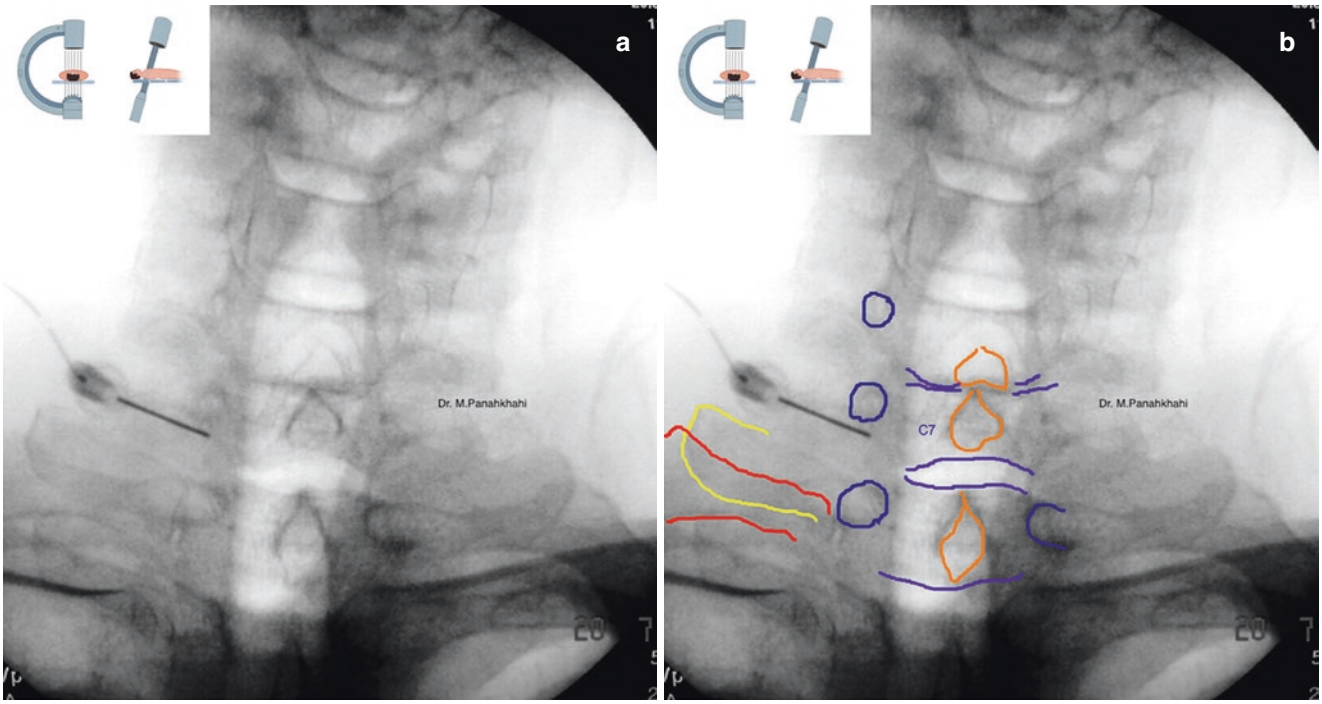

Fig. 7.2 Stellate ganglion block, PA view. Needle tip at C7 level at the junction of the vertebral body and pedicle. Anterior approach. Orange = spinous process; yellow = transverse process; dark blue = pedicle; red = ribs. Native (**a**) and edited fluoroscopy image (**b**)

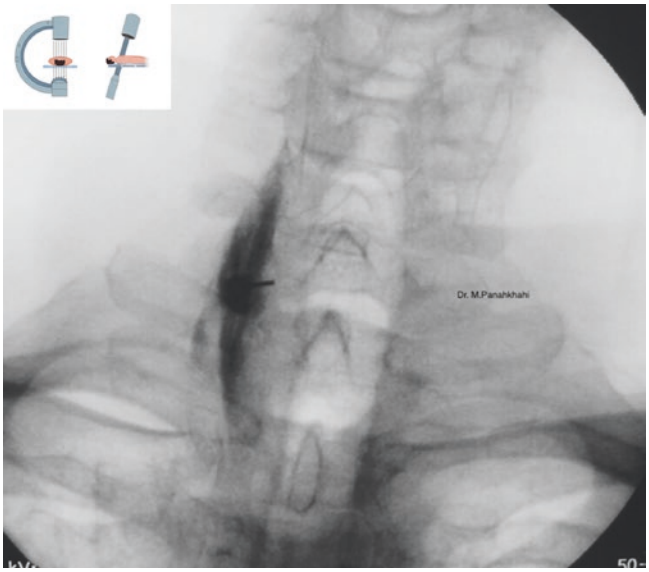

Fig. 7.3 Stellate ganglion block, PA view. Spread of contrast after a negative aspiration for blood and CSF, contrast spreads within and along the longus colli muscle in both cephalad and caudad directions. Native fluoroscopy image

- For radiofrequency (RF) procedures, motor stimulation (2 Hz) should be negative; ask the patient to say a sustained "E" (looking for stuttering sounds) to evaluate possible the recurrent laryngeal nerve, and feel the abdomen for diaphragmatic stimulation to avoid phrenic lesioning. Conventional RF lesioning is performed at 80°C for 1 minute or pulsed RF at 42°C for 120 seconds

Disclaimer There is no evidence for effectiveness and safety of RF denervation of stellate ganglion.

Unacceptable, Potentially Harmful Needle Placement on Exam

- Not checking multiple fluoroscopy views (PA and lateral)
- Needle tip sitting in the foramen or intervertebral disc
- Needle insertion at T1 or C5 level
- Using unnecessary large bore needle (16G)
- Rough manipulation of the needle
- Needle placement too medial
- Obvious signs of lack of understanding of cervical anatomy

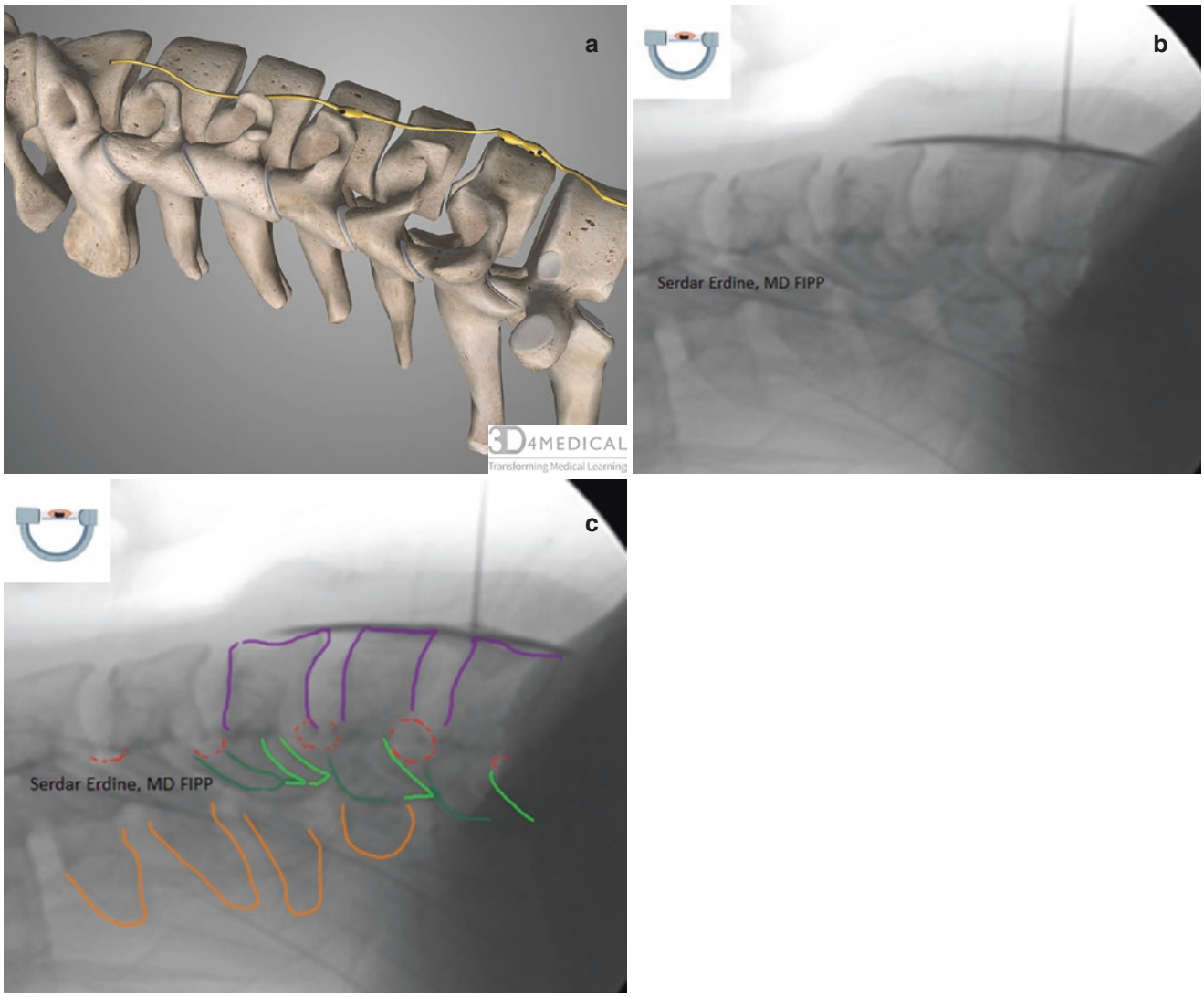

Fig. 7.4 Cervical spine, lateral view. Needle and spread of contrast along the longus colli muscle from anterior approach. Orange = spinous process; dark green = superior articular process; light green = inferior articular process; red = intervertebral foramen; purple = vertebral body. Complete Anatomy image (**a**), native (**b**) and edited (**c**) fluoroscopy image

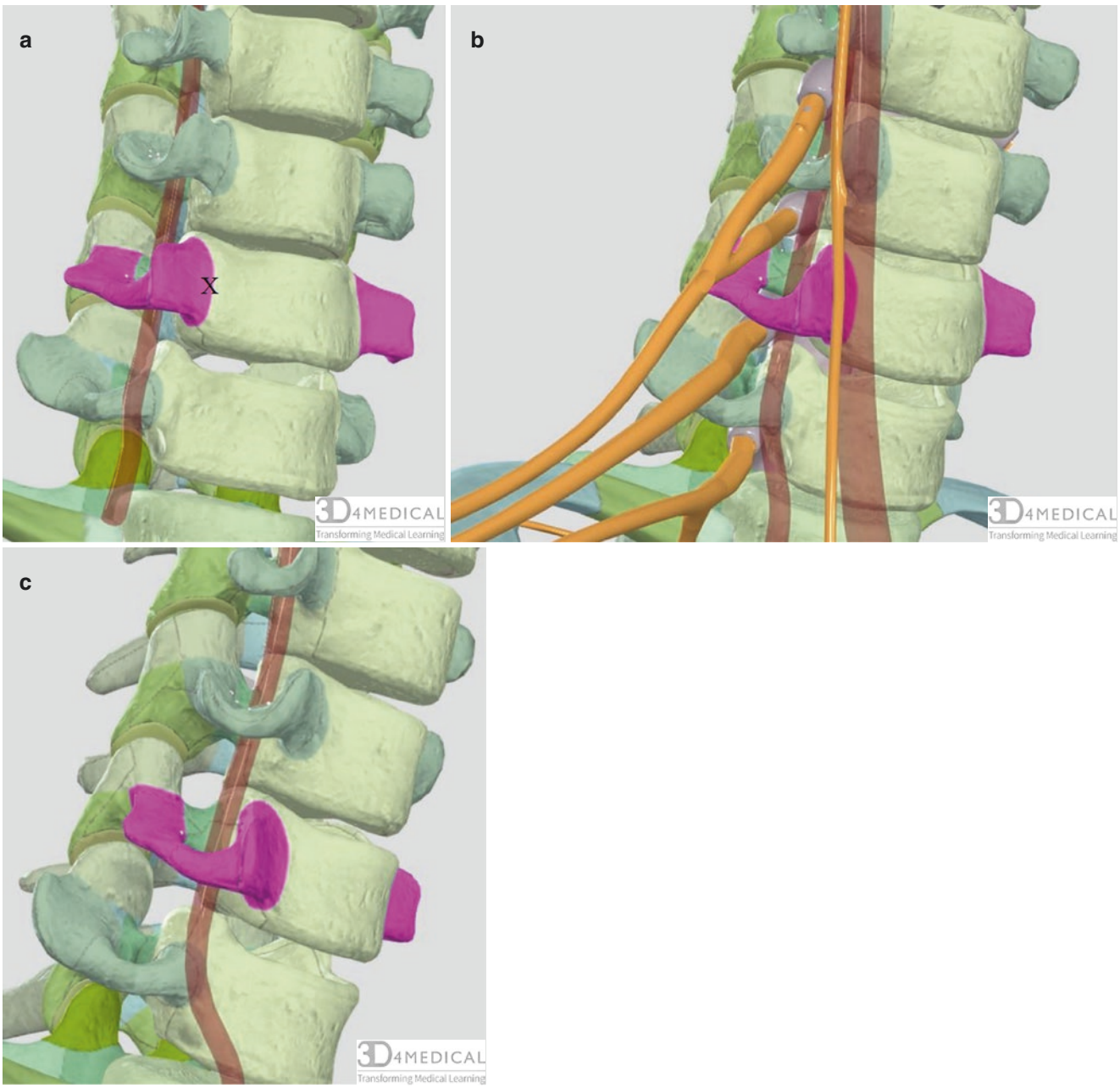

Fig. 7.5 Oblique view of the cervical spine. X marks the target for stellate ganglion block, oblique approach, oblique view (**a**). The carotid sheath often overlays the needle trajectory (**b**). The usual oblique, foraminal view exposes both the exiting nerve root and the vertebral artery to puncture if aiming at the lateral part of the vertebral body (**c**). Complete Anatomy images

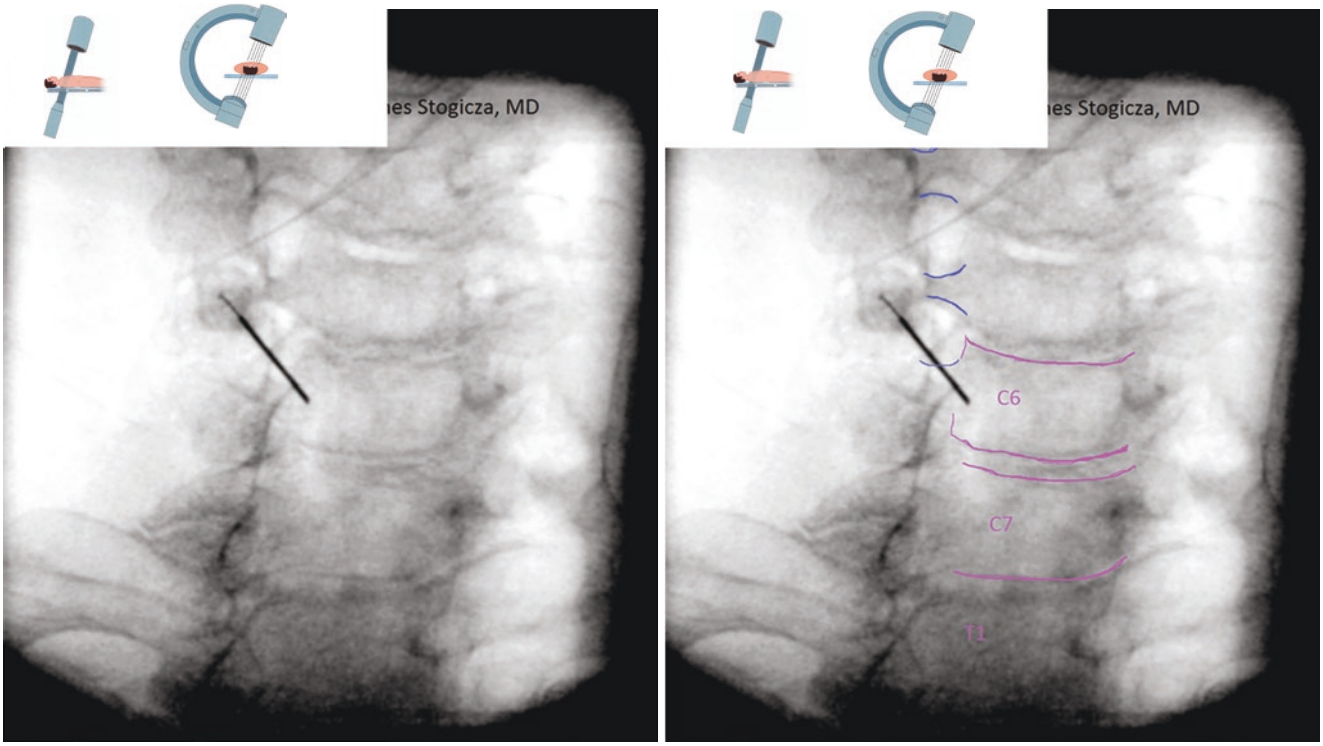

Fig. 7.6 Stellate ganglion block, oblique approach, oblique view. Needle at the junction of the vertebral body and transverse process. Purple = vertebral body; blue = pedicle. Native (**a**) and edited fluoroscopy images (**b**)

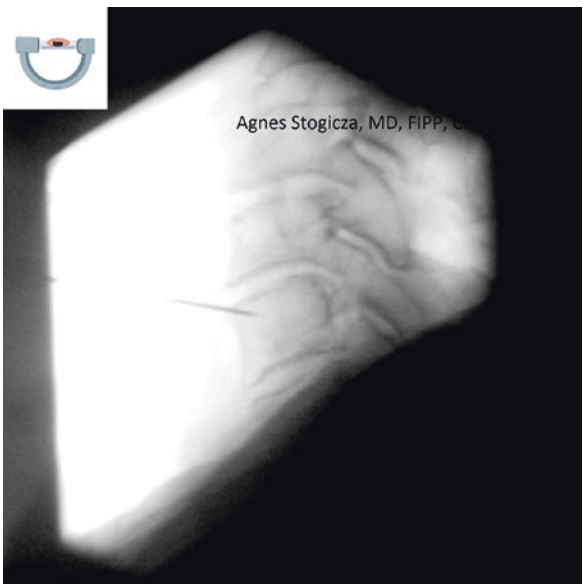

Fig. 7.7 Stellate ganglion block, oblique approach, lateral fluoroscopy view. Needle at the junction of the vertebral body and transverse process

Unacceptable, But Not Harmful Needle Placement on Exam

- The procedure was abandoned after unsuccessful attempts, but it was clear that the examinee was cognizant of the safety aspects of the procedure, the needle did not compromise vital structures, never compromised exiting nerve root, disc or spinal canal

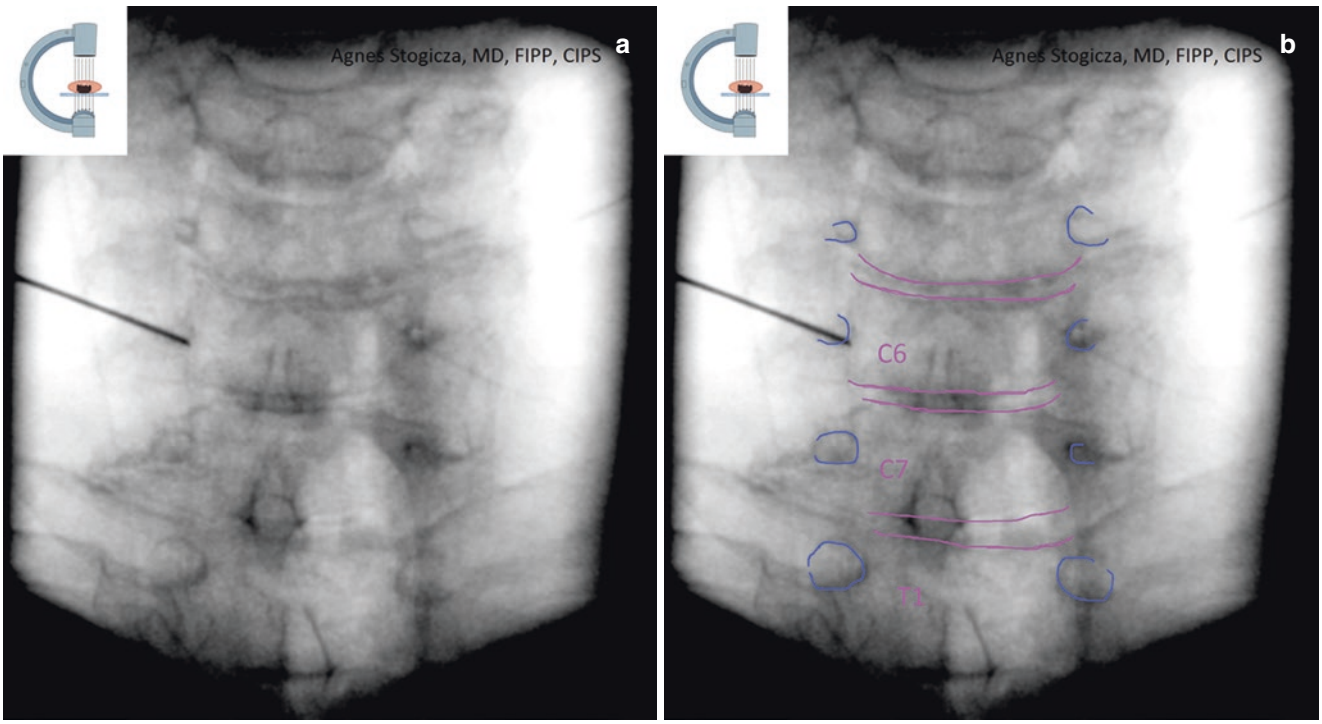

Fig. 7.8 Stellate ganglion block, oblique approach, PA view. Needle at the junction of the vertebral body and transverse process. Purple = vertebral body; pedicle = blue. Native (**a**) and edited (**b**) fluoroscopy image

Evidence

Table 7.1 Level of evidence and recommendations by the Benelux section of the World Institute of Pain
These recommendations are based on both a review of the literature in 2015 by an independent third party (Kleijnen Systematic Reviews LTD) and the previous published guidelines published in Pain Practice. The recent literature, the potential risk for complications, and the grade of invasiveness were considered when deciding to upgrade or downgrade the recommendation.

Indication	Procedure	Recommendation 2009[1]	Grade 2015[2]	Recommendation 2018[3,4]
Herpes zoster and posttherpeutic neuralgia	Acute phase: stellate ganglion block (ganglion stellatum)	2C+	Low	Weak

[1]van Wijck AJ, Wallace M, Mekhail N, van Kleef M. Evidence-based interventional pain medicine according to clinical diagnoses. 17. Herpes zoster and post-herpetic neuralgia. Pain Pract. 2011;11:88–97
[2]Kleijnen Systematic Reviews Ltd.: Search and evaluation of the literature. 2015.
[3]Huygen F, Kallewaard JW, van Tulder M, Van Boxem K, Vissers K, van Kleef M, et al. Evidence-based interventional pain medicine according to clinical diagnoses: update 2018. Pain Pract. 2019;19:664–75
[4]https://www.anesthesiologie.nl/publicaties/praktische-richtlijnen-anesthesiologische-pijnbestrijding

Table 7.2 Level of evidence based on the American Society of Interventional Pain Physicians (ASIPP) review of the literature

Stellate ganglion blocks[1]	Evidence
Ganglion stellate block for CRPS	Level III

[1]Vydyanathan A, Bryan G, Gritsenko K, Hansen H, Manhikanti L. Cervical and thoracic sympathetic blocks. In: Manchikanti L, Kaye AD, Falco FJE, Hirsch JA, editors. *Essentials of interventional techniques in managing chronic pain*. Springer International Publishing; 2018. p. 531–550

Suggested Reading

Abdi S, Zhou Y, Patel N, Saini B, Nelson J. A new and easy technique to block the stellate ganglion. Pain Physician. 2004;7:327–31.
Jadon A. Revalidation of a modified and safe approach of stellate ganglion block. Indian J Anaesth. 2011;55:52–6.
Sluijter ME. Sympathetic blocks in cervical region. In: Radiofrequency. Flivo Press; 2003. p. 129–133.
Day M. Sympathetic blocks: the evidence. Pain Pract. 2008;8(2):98–109.

The Stellate Ganglion Block chapter was reviewed by Serdar Erdine; Frank Huygen; Andrea M. Trescot; Milan Stojanovic; Peter S. Staats; Agnes R. Stogicza; Andre M. Mansano

8 Trigeminal Ganglion Block, Trigeminal Ganglion Radiofrequency Ablation and Percutaneous Balloon Compression

Lucian M. Macrea and Fabricio D. Assis

Equipment and Monitoring

- Standard ASA monitoring
- CPR equipment and medications available
- Fluoroscopy
- Sterile prep, and drape
- Local anesthesia prior to any needle larger than 25G (unless sedation is used)
- Coaxial view is always used to advance needle, unless otherwise specified
- Moderate sedation
- 22–25G, 3.5 inch (90 mm) needle, tip curved to facilitate steering
- Nonionic contrast
- Preservative-free local anesthetic
- Extension tubing
- 22G, 100–145 mm, 2–5 mm active tip radiofrequency cannula for radiofrequency ablation (RFA)
  - Grounding pad
  - RF generator with capacity for unipolar and bipolar lesions
- 14G, 100 mm needle and Fogarty catheter (4 French) for percutaneous balloon compression

Anatomy

- Trigeminal (Gasserian) ganglion is located in a dural pouch that contains cerebral spinal fluid (Meckel's cave). The ganglion is bounded medially by the cavernous sinus and the optic and trochlear nerves, superiorly by the inferior surface of the temporal lobe of the brain; and posteriorly by the brain stem
- In order to access the ganglion, the needle should pass through the foramen ovale
- The foramen ovale is situated in the posterior part of the sphenoid bone, posterolateral to the foramen rotundum. The mandibular and lesser petrosal nerves and the accessory meningeal artery pass through the foramen ovale
- There are three divisions of the trigeminal ganglion: the ophthalmic (sensory), maxillary (sensory), and mandibular (mixed motor and sensory) nerves
- Ophthalmic nerve (V1):
  - cranium exit point: superior orbital fissure
  - sensory innervation: the anterior scalp, forehead, eyebrow, eyelid, cornea, conjunctiva, ciliary body, the iris, the lacrimal gland, and nasal mucosa
  - motor innervation: none
- Maxillary nerve (V2):
  - cranium exit point: foramen rotundum
  - sensory innervation: upper lip, cheek, lower eyelid, area of the temple and zygomatic region, the side of the nose, upper jaw, teeth, gums, hard and soft palate, mucosa of the maxillary sinus, and dura matter of the middle cranial fossa
  - motor innervation: none
- Mandibular nerve (V3):
  - cranium exit point: foramen ovale
  - sensory innervation: the chin, lower lip, lower jaw, and anterior two-thirds of the tongue, anterosuperior ear, external auditory meatus, temporomandibular joint
  - motor innervation: muscles of mastication

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A. R. Stogicza et al. (eds.), *Interventional Pain*, https://doi.org/10.1007/978-3-030-31741-6_8

Structures to Keep in Mind and Possible Complications

- Brainstem anesthesia (signs: nausea can be the first sign, profuse sweating, vomiting, horizontal nystagmus, vertigo, ataxia, respiratory arrest)
- Carotid artery, accessory meningeal artery → intracerebral hematoma
- Clivus and petrous ridge of the temporal bone → cerebral cortex injury
- Lesser petrosal nerve → nerve injury resulting in Crocodile tears syndrome
- Retrobulbar hematoma
- Meningitis
- Adjacent cranial nerve palsies [oculomotor nerve (III), trochlear nerve (IV) and abducens nerve (VI)]
- Masseter weakness
- Keratitis
- Corneal anesthesia
- Anesthesia dolorosa
- Dural arteriovenous fistulae
- Local puncture pain and hematoma of the cheek for a few days
- Infection
- Bleeding
- Postprocedure pain
- Vasovagal reaction
- Allergic reaction

Fluoroscopy Technique, Target Localization

- Patient position – supine, head taped
- Posteroanterior (PA) view
- C-arm is angled caudally (the amount of caudad tilt depends on the patient's head position, but enough to obtain a submental view)
- Oblique (not much, about 15 degrees) to the desired side permits to visualize the foramen ovale medially to the mandibular process
- Coaxial view approach to the foramen ovale (Fig. 8.1a–c)
- Lateral view to confirm depth of needle

Procedure Steps for Trigeminal Ganglion Block

Disclaimer: Diagnostic block of the Gasserian ganglion is controversial, as the diagnosis of trigeminal neuralgia is a clinical diagnosis. Older publications describe successful phenol injection and (also glycerol injection in seated position).

- Needle entry 2–3 cm lateral to the corner of the mouth
- Placing a finger in the mouth of the patient permits detection of an oral mucosal penetration
- Advance the needle in submental, oblique view until needle is engaged (or has touched the edge of the foramen) (Fig. 8.2a, b)
- Control the depth in the lateral view (Fig. 8.3a–c)
- Inject 1cc of contrast to confirm the lack of vascular uptake

Procedure Steps for Trigeminal Ganglion RFA

- Radiofrequency ablation (RFA) cannula is placed as described above for trigeminal ganglion block (Fig. 8.4a, b)
- Once the needle passed the base of the opening at the foramen ovale, it is engaged in the ganglion, at 2Hz stimulation masseter twitches (V3) are visible (Fig. 8.5a)
- Advance the needle until paresthesia is reached at the desired branch (50Hz, up to 1V setting). Masseter twitch fades as V2 reached (Fig. 8.5b)
- Lesioning at 60 °C for 60 seconds, then 65 °C for 60 seconds and 70 °C for 60 seconds. Do not use temperatures higher than 70 °C
- Stimulate the nerve again to compare the level of motor response and the level of paresthesia
- If the ophthalmic nerve (V1) branch is affected, evaluate the corneal reflex after each lesioning
- Observe the patient after the procedure
- Pulsed radio frequency (PRF) not higher than 42°C does not require local anesthetic

Procedure Steps for Trigeminal Ganglion Percutaneous Balloon Compression

- 14G needle is placed as above for trigeminal ganglion block
- Do not advance beyond the entrance of the foramen ovale
- Next, introduce and advance the tip of the Fogarty catheter (4 French) through the needle into the foramen ovale in the lateral view (Fig. 8.6a, b)
- Inflate the balloon of the Fogarty catheter by injecting 1 ml of nonionic contrast material. In the lateral fluoroscopic view, the balloon should resemble a pear, with the stem end pointing posteriorly. Verify this view in both lateral and posteroanterior (PA) fluoroscope images

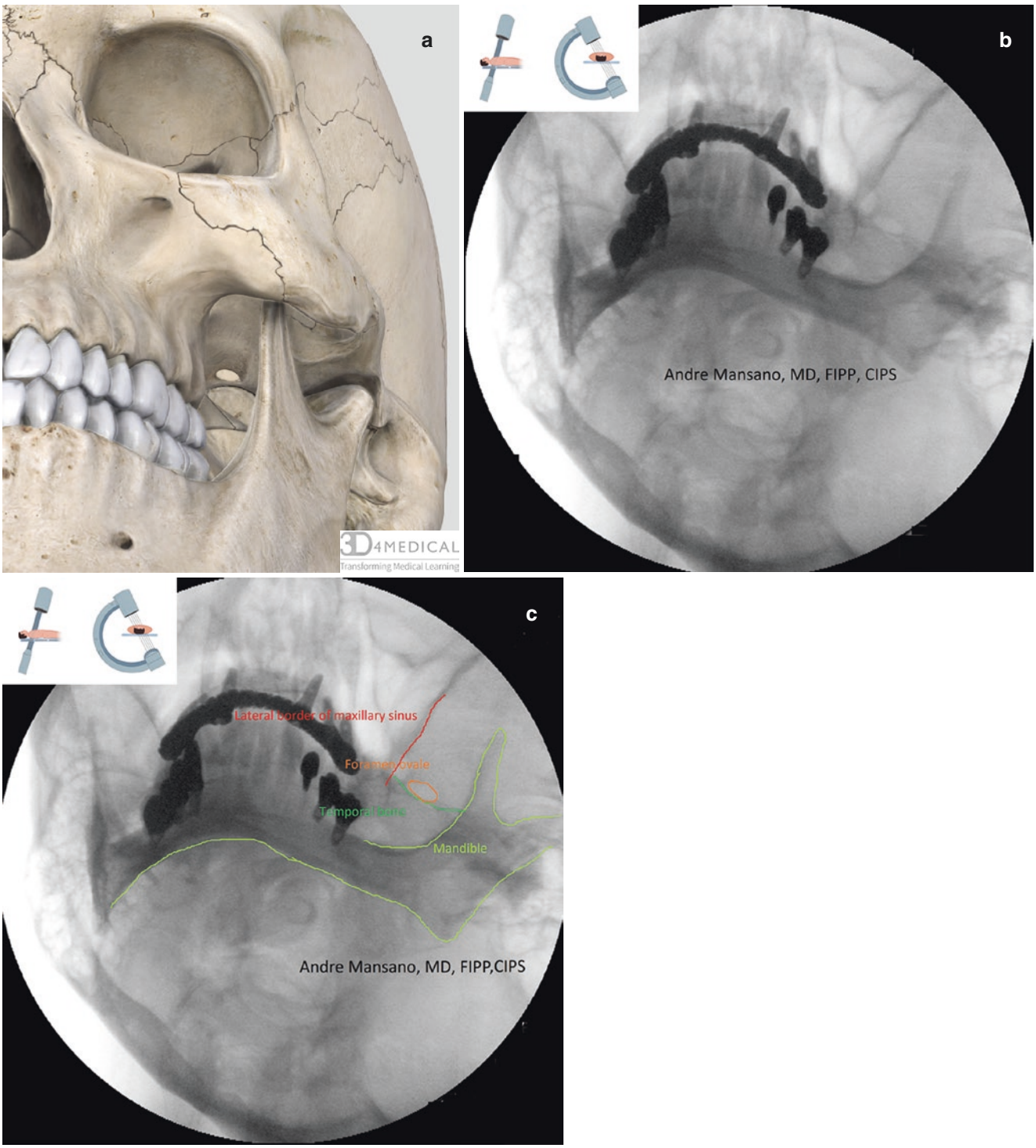

Fig. 8.1 Foramen ovale (orange) is visualized at the base of the skull in generous caudad and slight ipsilateral tilt. Image is not magnified. Mandible = yellow; maxillary sinus = red; petrosal bone = green. Notice the main landmarks that are always reliably identifiable (marked with red, green and yellow) form a letter "H". The foramen ovale is always found "sitting on the crossbar" of the "H". Complete Anatomy image (**a**), native (**b**), and edited fluoroscopy image (**c**)

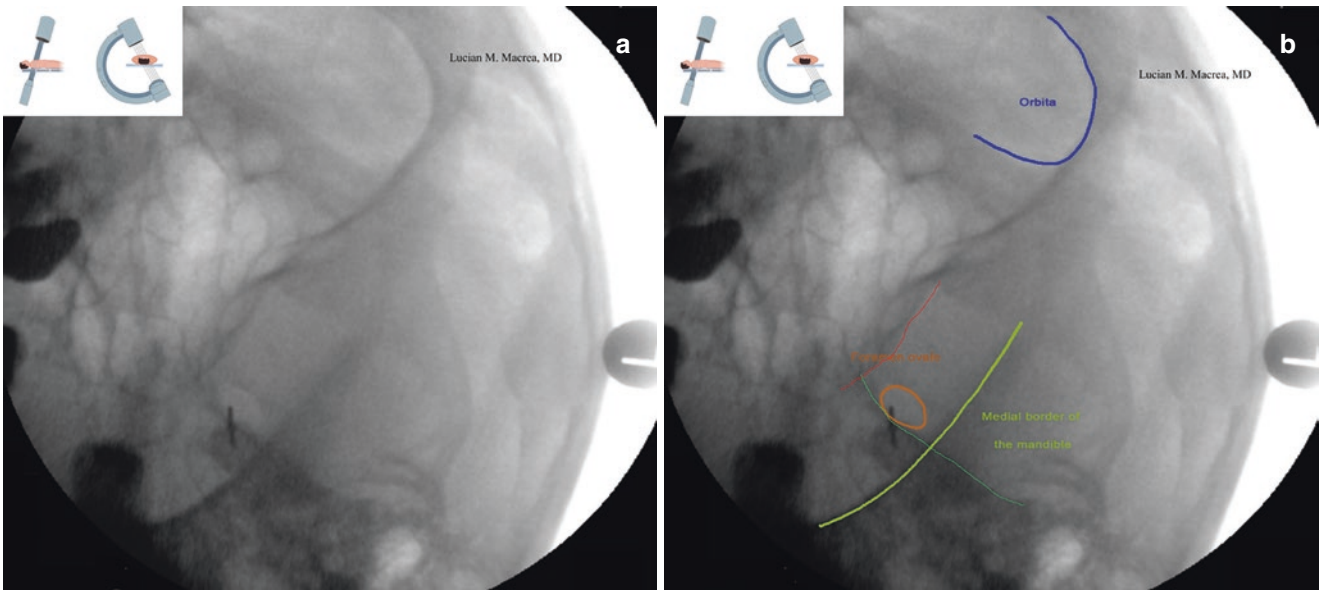

Fig. 8.2 Trigeminal ganglion block, submental view (C-arm in caudad and ipsilateral tilt), magnified image. Foramen ovale is visualized by fluoroscopy between the radiographic shadow of the mandibular ramus (lateral) and the maxillary sinus (medial), cephalad to the petrosal bone. Needle is placed on the inferior margin of the foramen ovale. Orange = foramen ovale; yellow = mandible; green = petrosal bone; red = lateral wall of the maxillary sinus; blue = orbital margin. Native (**a**) and edited fluoroscopy images (**b**)

- Inflate the balloon and maintain it for 60 seconds. Analgesia is usually immediate (Fig. 8.6c)
- After completing the desired time for inflation, aspirate the contrast solution and confirm that the balloon appears to be deflated
- Then, withdraw the catheter together with the needle as one unit
- Observe the patient for at least 2 hours confirming lack of hematoma and intact corneal reflex

Clinical Pearls

- Puncture of the oral cavity increases the risk of meningitis
- Meticulous exclusion of intravascular injection is necessary. Contrast agent should be injected under real-time fluoroscopy. Utilization of digital subtraction angiography (DSA) is recommended
- When the needle enters the Gasserian ganglion, it can be quite painful

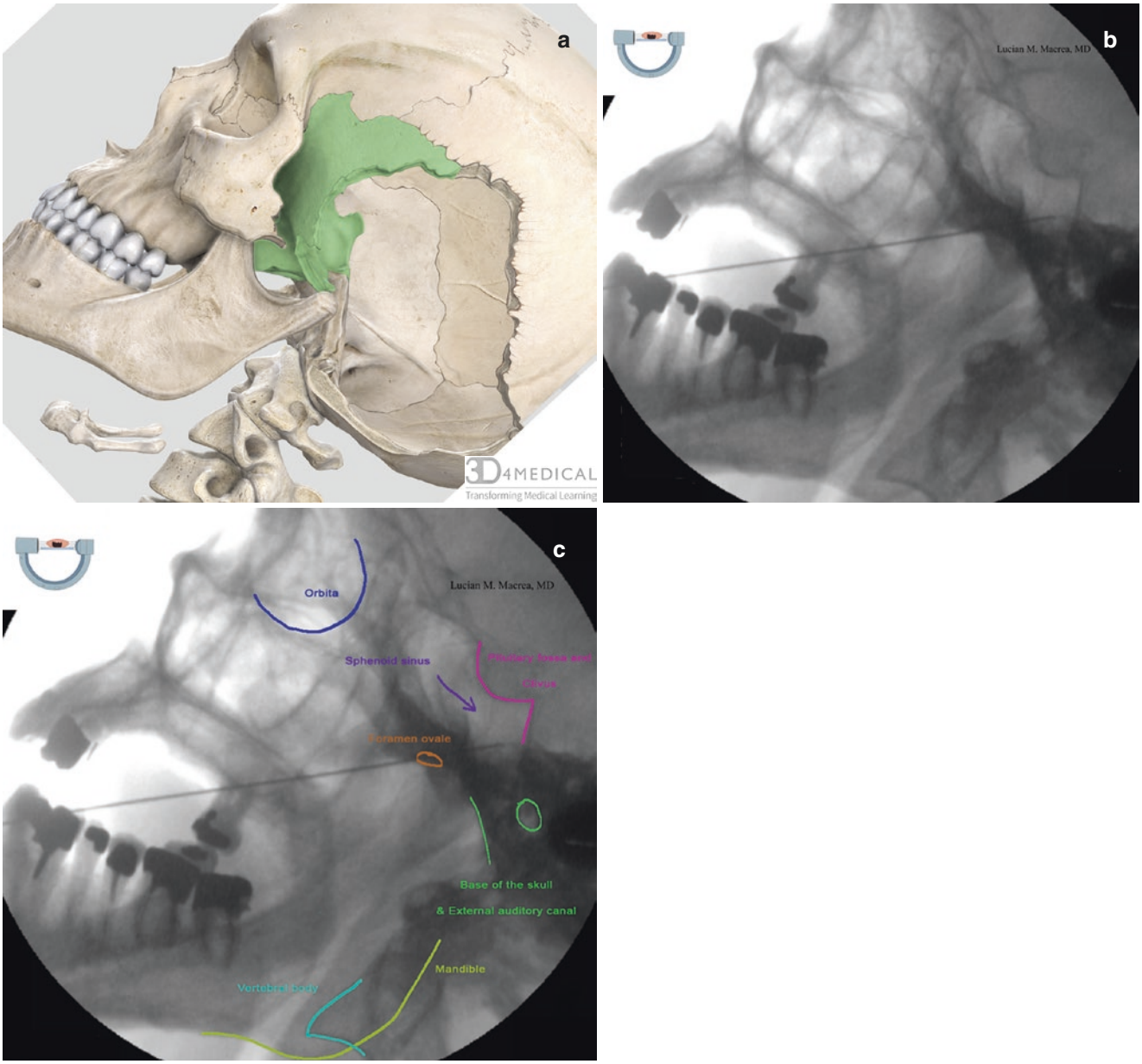

Fig. 8.3 Lateral view of the skull. Temporal bone removed, sphenoid highlighted in green. Complete Anatomy image (**a**). Needle inside the Meckel's cave. Orange = foramen ovale; yellow = mandible; green = petrosal bone; blue = orbital margin; pink = clivus and pituitary fossa. Native (**b**) and edited fluoroscopy image (**c**)

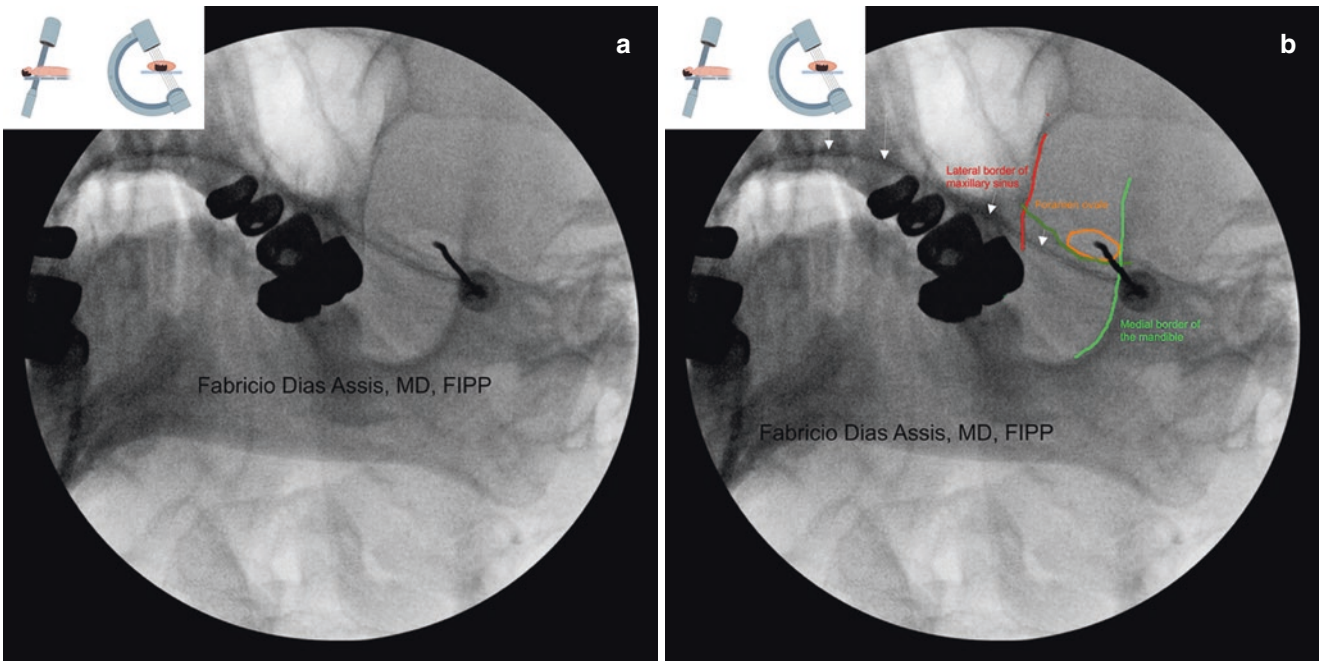

Fig. 8.4 Submental view showing RF needle in place. Foramen ovale = orange; maxillary sinus = red; petrosal bone = dark green, white arrows point at RF cabel. Native (**a**) and edited fluoroscopy image (**b**)

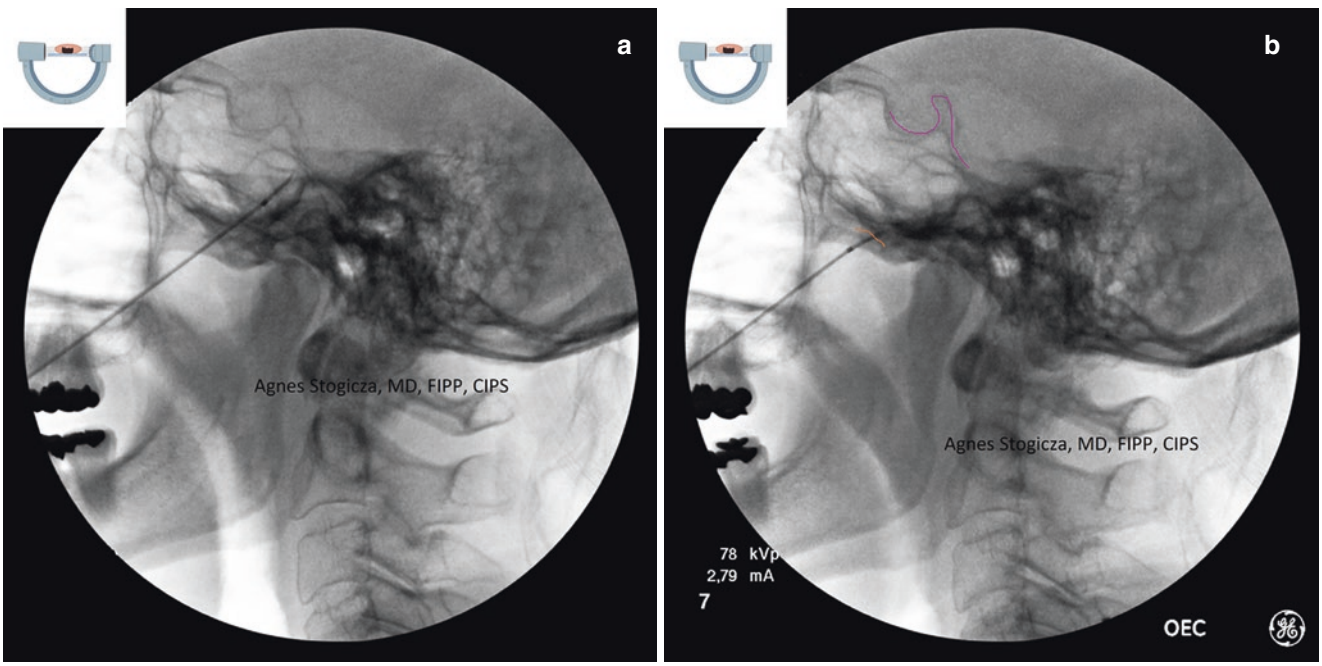

Fig. 8.5 RF needle passing through the foramen ovale. Location to start motor stimulation (**a**). RF needle inside the Meckel cave, final position for V2 lesion. Stimulation confirms needle position. Orange = Foramen ovale; pink = clivus. Native (**a**) and edited (**b**) fluoroscopy image

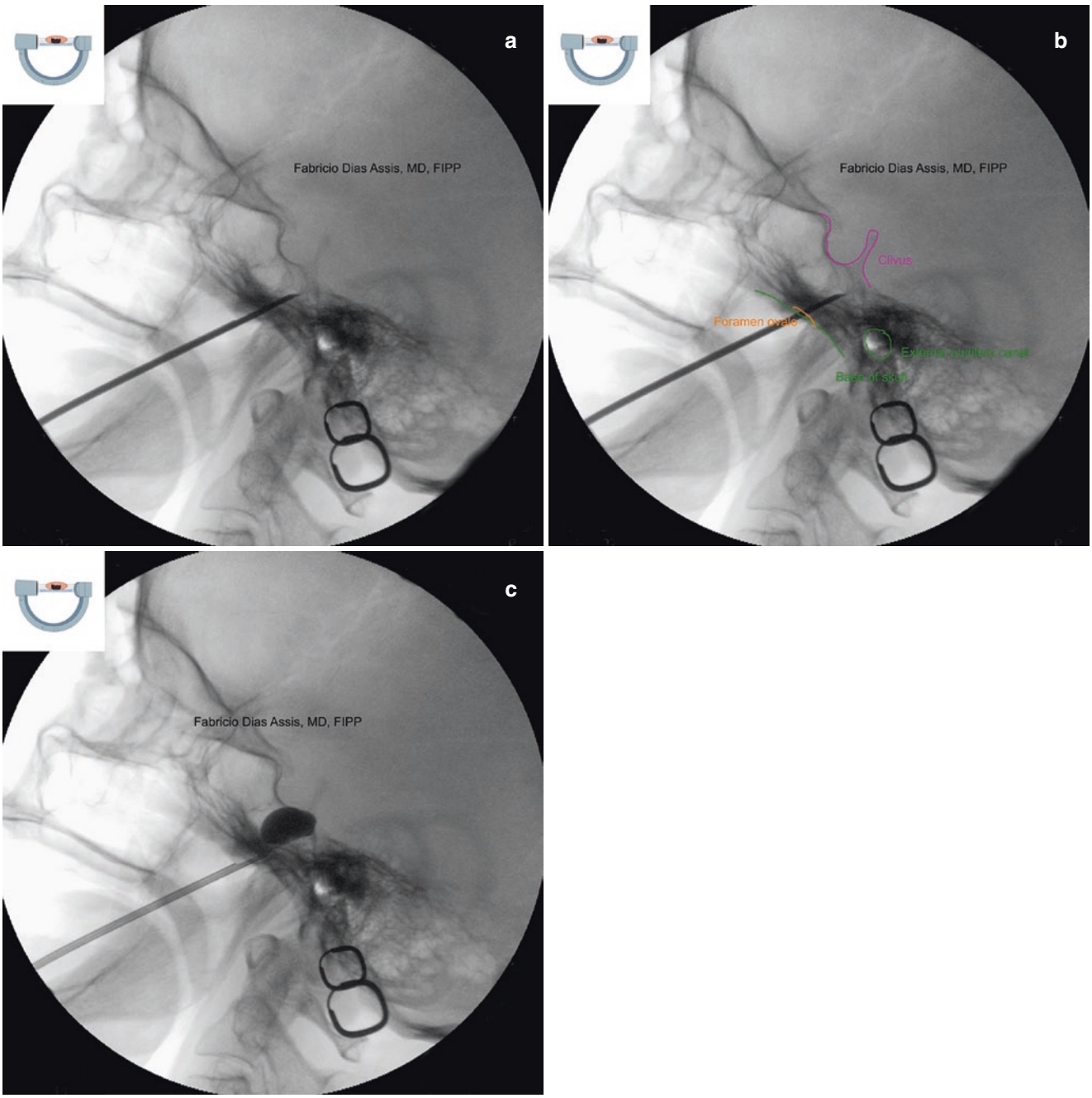

Fig. 8.6 Gasserian ganglion balloon compression. Needle inside the Meckel cave. Native (**a**) and edited (**b**) fluoroscopy image. Fogarty balloon inflated. Desired pear shape visible (**c**)

- First, the needle reaches the V3, then the V2, then the V1 branches
- V1 is often, V2 is occasionally intrathecal, which is shown by cerebrospinal fluid (CSF) return

Unacceptable, Potentially Harmful Needle Placement on Exam

- Failing to check lateral view
- Needle tip passed the clivus on the lateral view. Placing the needle in the brainstem
- Rough manipulation of the needle
- Any proof of lack of understanding of cranio-facial anatomy, for example targeting various oval shaped structures at the wrong area

Unacceptable, But Not Harmful Needle Placement on Exam

- The procedure was abandoned after unsuccessful attempts, but it was clear that the examinee was cognizant of the safety aspects of the procedure, the needle did not compromise vital structures, did not reach the brainstem, the orbit etc.
- Unable to identify foramen ovale on either side

Evidence

Table 8.1 Level of evidence and recommendations by the Benelux section of the World Institute of Pain
These recommendations are based on both a review of the literature in 2015 by an independent third party (Kleijnen Systematic Reviews LTD) and the previous published guidelines published in Pain Practice. The recent literature, the potential risk for complications, and the grade of invasiveness were considered when deciding to upgrade or downgrade the recommendation.

Indication	Procedure	Recommendation 2009[1]	Grade 2015[2]	Recommendation 2018[3,4]
Trigeminal neuralgia	Radiofrequency treatment (ablation) of the Gasser ganglion (Gasseri)	2B+	Low	Weak
Trigeminal neuralgia	Pulsed radiofrequency treatment of the Gasser ganglion (Gasseri)	2B−	Very low	Very weak

[1]van Kleef M, van Genderen WE, Narouze S, Nurmikko TJ, van Zundert J, Geurts JW, et al. 1. Trigeminal neuralgia. Pain Pract. 2009;9:252–9
[2]Kleijnen Systematic Reviews Ltd.: Search and evaluation of the literature. 2015.
[3]Huygen F, Kallewaard JW, van Tulder M, Van Boxem K, Vissers K, van Kleef M, et al. Evidence-based interventional pain medicine according to clinical diagnoses: update 2018. Pain Pract. 2019;19:664–75
[4]https://www.anesthesiologie.nl/publicaties/praktische-richtlijnen-anesthesiologische-pijnbestrijding

Table 8.2 Level of evidence based on the American Society of Interventional Pain Physicians (ASIPP) review of the literature

Trigeminal nerve blocks and neurolysis[1]	Evidence
Trigeminal nerve blocks	Level III
Trigeminal nerve thermal radiofrequency	Level III
Trigeminal nerve pulsed radiofrequency	Level III

[1]Lin C.-S, Cheng J. Trigeminal nerve blocks and neurolysis. In: Manchikanti L, Kaye AD, Falco FJE, Hirsch JA, editors. Essentials of interventional techniques in managing chronic pain. Springer International Publishing; 2018. p. 451–461.

Suggested Reading

Henderson WR. The anatomy of the gasserian ganglion and the distribution of pain in relation to injections and operations for trigeminal neuralgia. Ann R Coll Surg Engl. 1965;37:346–73.
Hong T, Ding Y, Yao P. Long-term efficacy and complications of radiofrequency thermocoagulation at different temperatures for the treatment of trigeminal neuralgia. Biochem Res Int. 2020;2020.
Jain A. Comparative analysis of balloon compression and radiofrequency ablation in idiopathic trigeminal neuralgia: a retrospective study with a 24-month follow-up. Turkish J Anaesthesiol Reanim. 2019;47(2):146–50.
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Unal TC, Unal OF, Barlas O, Hepgul K, Ali A, Aydoseli A, et al. Factors determining the outcome in trigeminal neuralgia treated with percutaneous balloon compression. World Neurosurg. 2017;107:69–74.
Van Kleef M, Van Genderen WE, Narouze S, Nurmikko TJ, Van Zundert J, Geurts JW, et al. Trigeminal neuralgia. Pain Pract. 2009;9:252–9.
Wu H, Zhou J, Chen J, Gu Y, Shi L, Ni H. Therapeutic efficacy and safety of radiofrequency ablation for the treatment of trigeminal neuralgia: A systematic review and meta-analysis. J Pain Res. 2019;12:423–41.

The Trigeminal Diagnostic Block chapter was reviewed by Miles Day; Matthew Rupert; Maarten Van Kleef; Serdar Erdine; Javier De Andres Ares; Andrea M. Trescot; Milan Stojanovic; Peter S. Staats; Agnes R. Stogicza; Andre M. Mansano.

Part II

Thoracic Procedures

Intercostal Nerve Block

9

Hariharan Shankar

Equipment and Monitoring

- Standard ASA monitoring
- Fluoroscopy
- Sterile prep, and drape
- Skin local anesthesia prior to any needle larger than 25G (unless sedation is used)
- Coaxial view is always used to advance needle, unless otherwise specified
- CPR equipment and medications available
- 22–25G, 2 inch (50 mm) – 3.5 inch (90 mm) needle, tip curved for easier guidance
- Nonionic contrast
- Local anesthetic
- Particulate steroid

Anatomy

- T1–T12 ribs
- Three muscle layers at each level: external, internal, and innermost intercostal muscles
- Intercostal neurovascular bundle located within the internal intercostal muscle, just beneath the inferior edge of each rib
- Pleura (intercostal and visceral)

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Structures to Keep in Mind and Possible Complications

- Pleura, lung → pneumothorax
- Intercostal nerves and vessels at each level → local anesthetic toxicity, nerve damage
- Medial spread can cause neuraxial blockade
- Infection
- Bleeding
- Postprocedure pain
- Vasovagal reaction
- Allergic reaction

Fluoroscopy Technique, Target Localization

- Patient in prone position
- Anteroposterior (AP) image
- Identify the target level by counting from above or below
- Entry point approximately 5–6 cm from spinal midline
- Target is beneath the inferior border of rib

Procedure Steps

- Coaxial entry of needle until it makes contact with the lower border of rib with the curved end facing cephalad (Fig. 9.1)
- Rotate the curved needle and gently advance, so that the needle slips past the rib
- Rotate 180 degrees again, so that the needle tip is beneath the rib
- Inject 0.5 ml of contrast to ensure appropriate spread (Fig. 9.2a, b)

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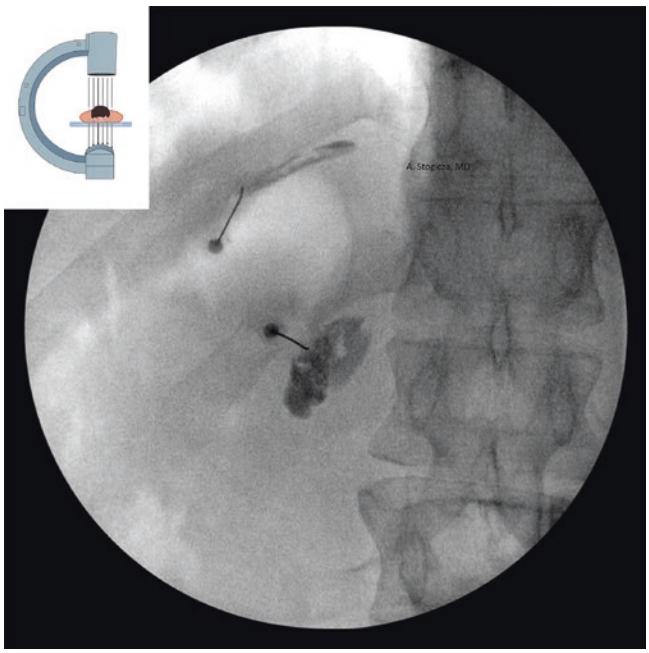

Fig. 9.1 Appropriate contrast spread after intercostal block at the upper needle. Lower needle with inadequate spread. Native fluoroscopy image

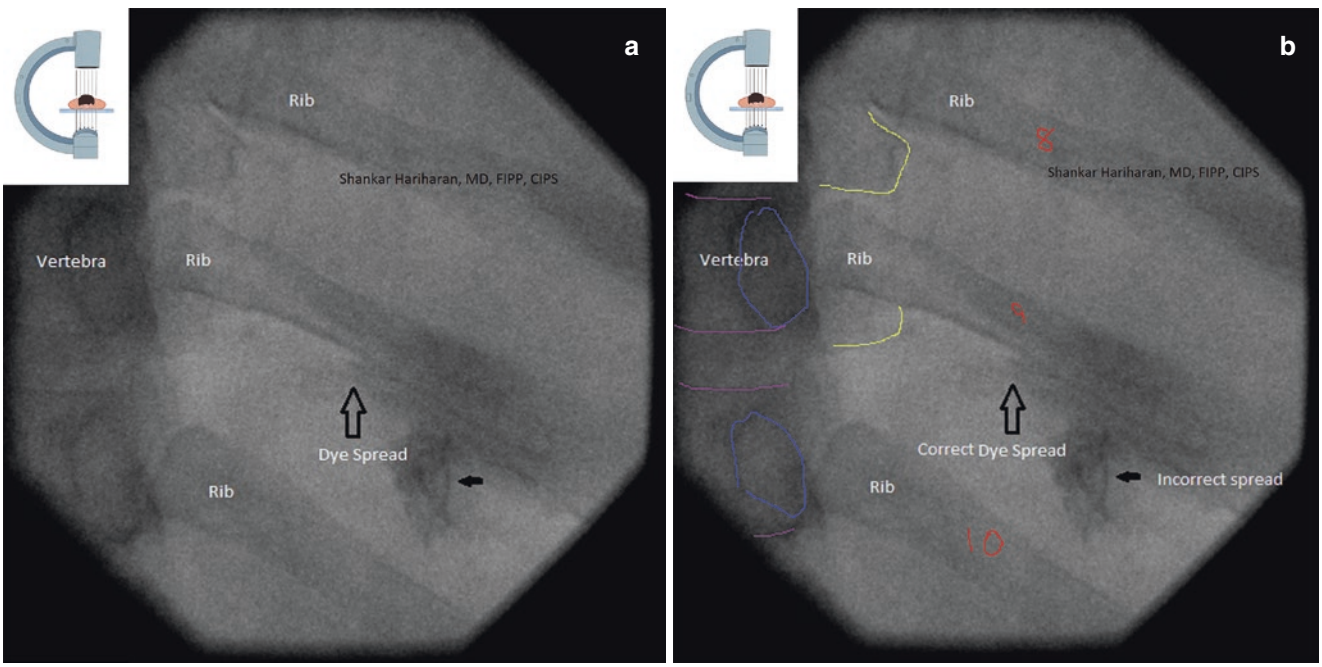

Fig. 9.2 Contrast patterns of intercostal injection. Dark arrow: incorrect dye spread. Hollow arrow: correct dye spread. Yellow = transverse process; blue = pedicle; red = ribs, numbered; purple = vertebral body endplates. Native (**a**) and edited (**b**) fluoroscopy image

Clinical Pearls

- Never advance the needle more than a few millimeters after rib contact as pleura may be damaged
- Linear spread of contact beneath the rib ensures that the needle tip is within the neurovascular bundle
- If concerned of possible pneumothorax, evaluate by chest X-ray and administer oxygen by nonrebreathing mask
- Consider ultrasound-guided approach if available

Unacceptable, Potentially Harmful Needle Placement on Exam

- Lung compromise by rough needle manipulation
- Lack of understanding of relevant anatomy

Unacceptable, But Not Harmful Needle Placement on Exam

- The procedure was abandoned after unsuccessful attempts, but it was clear that the examinee was cognizant of the safety aspects of the procedure, the needle did not compromise lung or intraspinal space

Evidence

No recommendation is available by the WIP Benelux Section.

Table 9.1 Level of evidence based on the American Society of Interventional Pain Physicians (ASIPP) review of the literature

Intercostal nerve injections	Evidence
Intercostal nerve injections[1]	Level IV

[1]Burlison S, Doulatram GR. Chest wall blocks and neurolysis. In: Manchikanti L, Kaye AD, Falco FJE, Hirsch JA, editors. Essentials of interventional techniques in managing chronic pain. Springer International Publishing; 2018. p. 481–8.

Disclaimer: The use of ultrasound may significantly increase the safety and ease of performance of this procedure.

Suggested Reading

Gulati A. Intercostal nerve block. In: Diwan S, Staats PS, editors. Atlas of pain medicine procedures. New York: McGraw-Hill; 2015.

Smith HS, Burton AW, Nguyen R, Chopra P. Intercostal nerve blocks. In: Manchikanti L, Singh V, editors. Interventional techniques in chronic non-spinal pain. USA: ASIPP Publishing; 2009.

HJ Lee, HS Park, HI Moon, SY Yoon. Effect of ultrasound-guided intercostal nerve block versus fluoroscopy- guided epidural nerve block in patients with thoracic herpes zoster: a comparative Study. J Med Ultrasound. 2009;38(3):725–31.

The Intercostal Nerve Block chapter was reviewed by Einar Ottestad; Frank Huygen; Andrea M. Trescot; Milan Stojanovic; Peter S. Staats; Agnes R. Stogicza; Andre M. Mansano.

Splanchnic Block and Radiofrequency Ablation

10

André M. Mansano

Equipment and Monitoring

- Standard ASA monitors
- Fluoroscopy
- Sterile prep, and drape
- Skin local anesthesia prior to any needle larger than 25G (unless sedation is used)
- Coaxial view is always used to advance needle, unless otherwise specified
- CPR equipment and medications available
- 22G, 3.5 inch (90 mm) – 7 inch (180 mm) needle, tip curved for diagnostic injection
- 18–20G, 3.5 inch (90 mm) – 7 inch (180 mm) curved tip radiofrequency cannula with 10 mm active tip for radiofrequency ablation (RF)
  - Grounding pad
  - RF generator with capacity for unipolar and bipolar lesions
- Infusion of 500 ml fluid preprocedure
- Local anesthetic
- Nonionic contrast

Anatomy

- The splanchnic nerves are comprised of medial branches from the lower seven thoracic sympathetic ganglia
- The greater splanchnic nerve is derived from the fifth to ninth thoracic ganglia, with the potential for contribution from the tenth thoracic ganglion
- The greater splanchnic nerves descend in the paravertebral space, obliquely, giving off branches to the descending aorta and perforating the crus of the diaphragm
- The greater splanchnic nerve synapses in the superior aspect of celiac ganglia
- Innervates: Gastrointestinal tract (from distal esophagus to mid-transverse colon) pancreas, stomach, liver, adrenals, ureters, abdominal vessels
- T11 vertebral body
- The target is the anterior third of the T11 vertebral body in lateral view

Structures to Keep in Mind and Possible Complications

- Thoracic nerve roots → nerve injury
- Intercostal blood vessels and nerves → nerve injury, bleeding
- Intervertebral disc → discitis
- Lung/pleura → pneumothorax
- Thoracic duct → chylothorax
- Diaphragm → hemidiaphragmatic paralysis
- Aorta/inferior vena cava → bleeding, local anesthetic toxicity
- Segmental/intercostal artery, possibly feeding the anterior spinal artery (artery of Adamkiewicz) → spinal cord injury/ischemia
- Infection
- Bleeding
- Postprocedure pain
- Vasovagal reaction
- Allergic reaction
- Hypotension caused by splanchnic vasodilation

Fluoroscopy Technique, Target Localization

- Patient in prone position
- Anteroposterior (AP) image (Fig. 10.1a–c)
- Identify T11 level (Some also perform procedure at T10, as well as T12 level)

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A. R. Stogicza et al. (eds.), *Interventional Pain*, https://doi.org/10.1007/978-3-030-31741-6_10

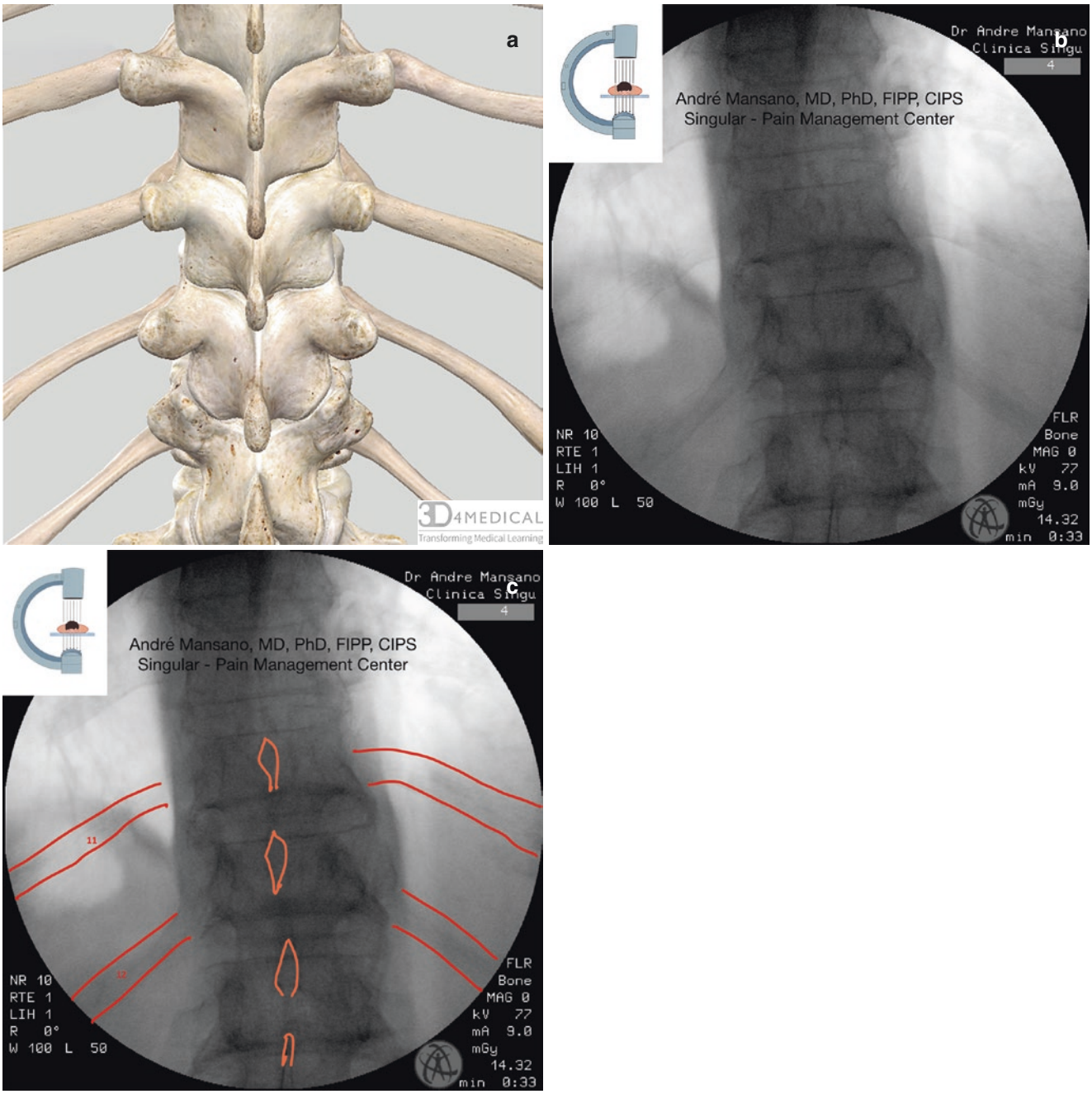

Fig. 10.1 AP view of the thoracic spine. Red = ribs; orange = spinous process. Complete Anatomy image (**a**), native (**b**) and edited fluoroscopy image (**c**)

- Square off the inferior endplate of T11 (Fig. 10.2a–c)
- Move the C-arm 15–20° to ipsilateral oblique position (Fig. 10.3a–c)
- Identify diaphragm movement during inspiration and expiration, particularly if performing the procedure at T12 level (as well). If the diaphragm shadows the lateral edge of the T12 vertebral body, then only do the T11 or T10 and T11 level

Procedure Steps

- The entry point for all levels is just lateral to the vertebral body, caudad to the rib (Fig. 10.4a, b)
- Advance the needle in a coaxial view until touching the vertebral body
- Lateral view to confirm the depth of needle

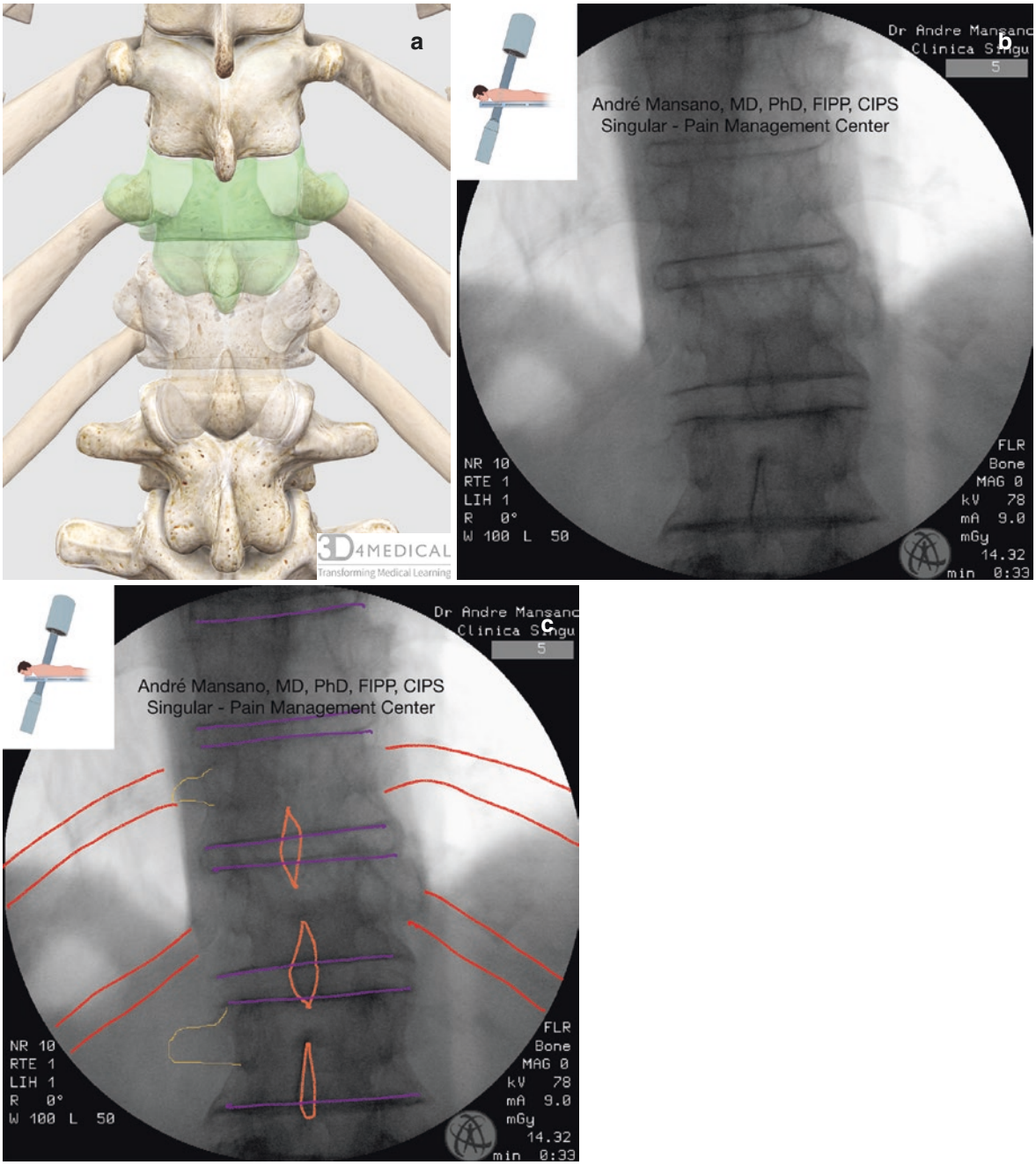

Fig. 10.2 AP view of the thoracic spine with caudad tilt of the C-arm, squared endplates of T11 vertebra. Red = ribs; orange = spinous process; yellow = transverse process; purple = vertebral body endplates. Complete Anatomy image, T11 vertebra faded and highlighted, and T12 vertebra faded (**a**), native (**b**) and edited fluoroscopy image (**c**)

- Slip the needle smoothly along the vertebral body anteriorly and medially until it reaches the junction of anterior one third and posterior two thirds of the lateral surface of the vertebral body. (Fig. 10.5a, b)
- Return to AP view to confirm the position of the tip of the needle

For diagnostic block:

– Aspirate for fluid (blood, cerebrospinal fluid (CSF) or chyle)
– Inject 1–3 ml of nonionic contrast media (Fig. 10.6)
– Check the optimal dispersion of the contrast media in AP and lateral view. The contrast media must "hug" the vertebral body laterally (Fig. 10.7a, b)
– Inject 5–8 ml of local anesthetic
– The procedure must be performed bilaterally

For chemical neurolysis:

– Aspirate for fluid (blood, CSF, or chyle)
– Inject 1–3 ml of nonionic contrast media

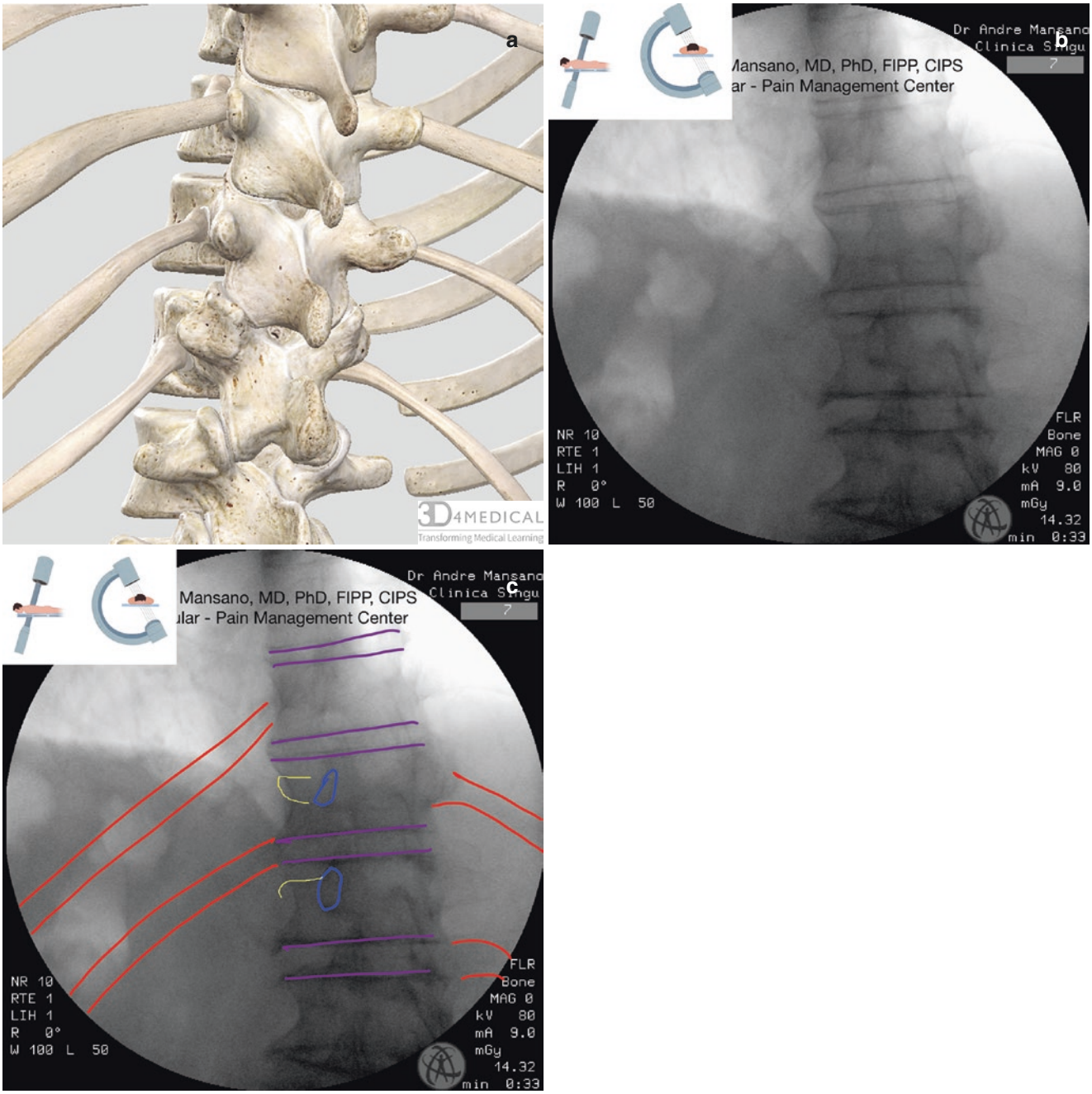

Fig. 10.3 Oblique view of the thoracic spine. Red = ribs; Blue = pedicle; yellow = transverse process; purple = vertebral body endplates. Complete Anatomy image (**a**), native (**b**) and edited fluoroscopy image (**c**)

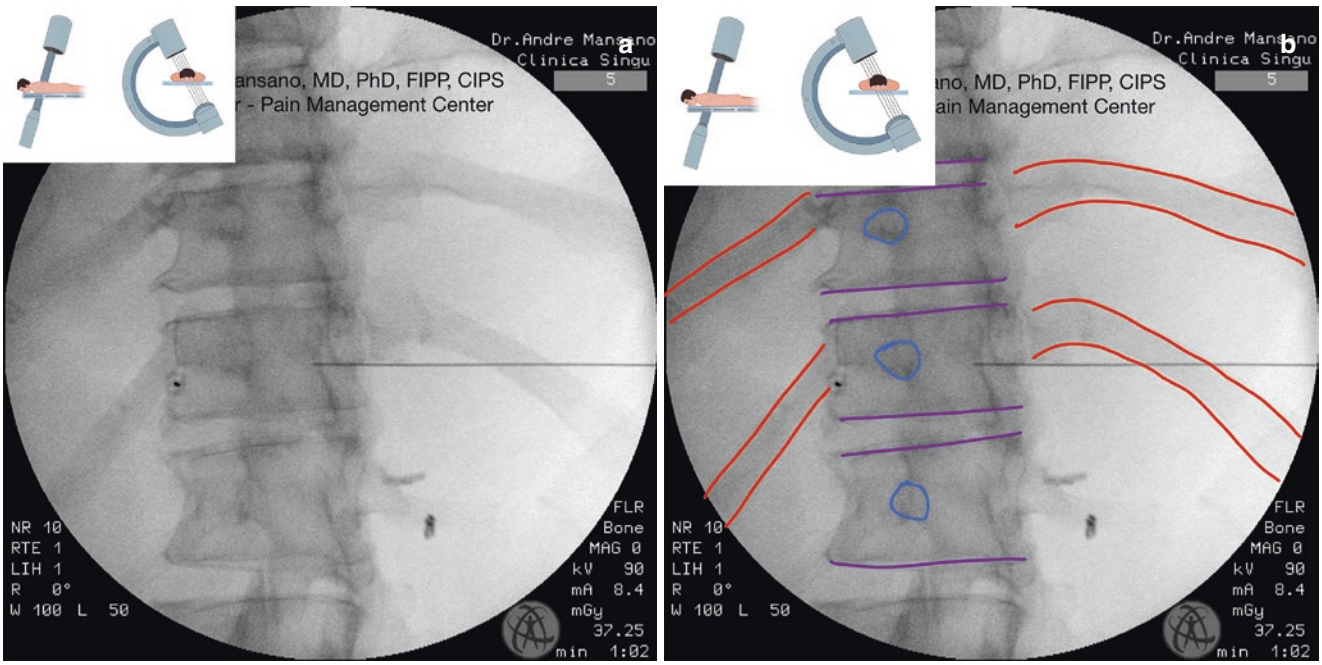

Fig. 10.4 Oblique view of the thoracic spine. Note the entry point at the left side just lateral to the vertebral body under the rib. The right needle is already in place. Blue = pedicle; purple = endplates; red = ribs. Native (**a**) and edited (**b**) fluoroscopy image

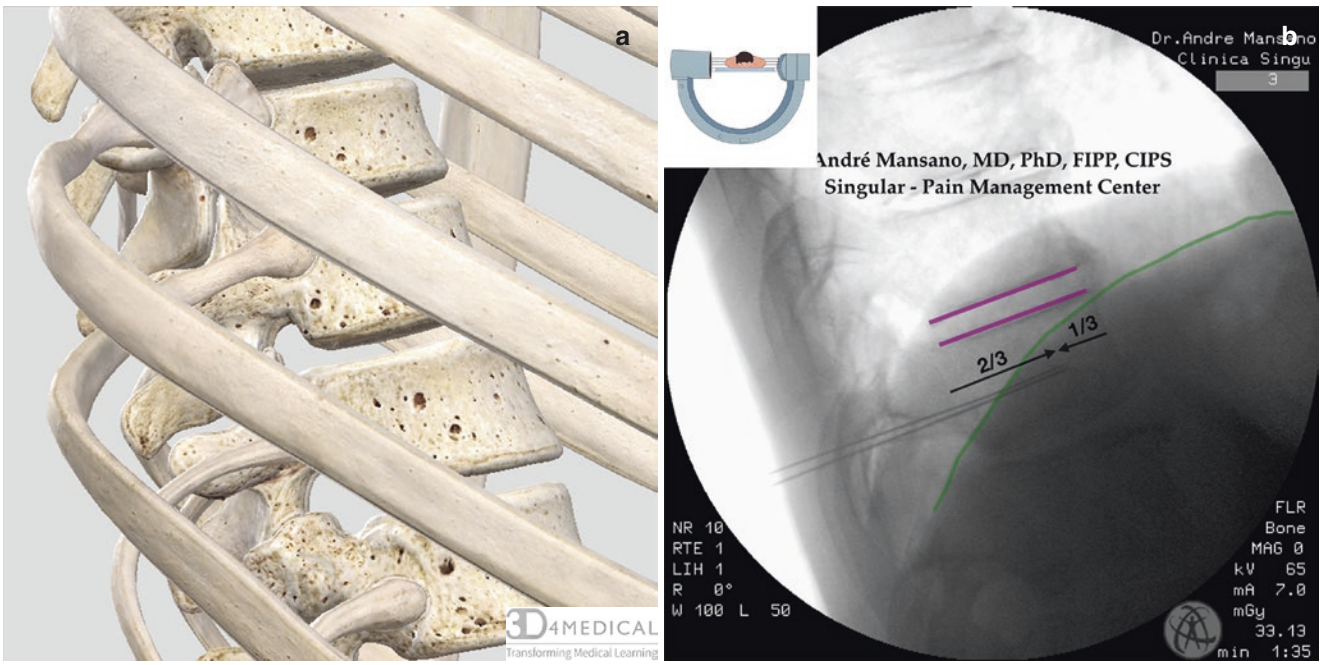

Fig. 10.5 Lateral view of the thoracic spine. Note the final position of the needles at the anterior third of the vertebral body. Green = diaphragm; purple = vertebral body endplates. Complete Anatomy image (**a**), edited fluoroscopy image (**b**)

– Check the optimal dispersion of the contrast media in AP and lateral view. The contrast media must "hug" the vertebral body laterally
– Inject 4–8 ml of phenol 6–10% (not painful) or alcohol 80% after local anesthetic (otherwise extremely painful)
– The procedure must be performed bilaterally

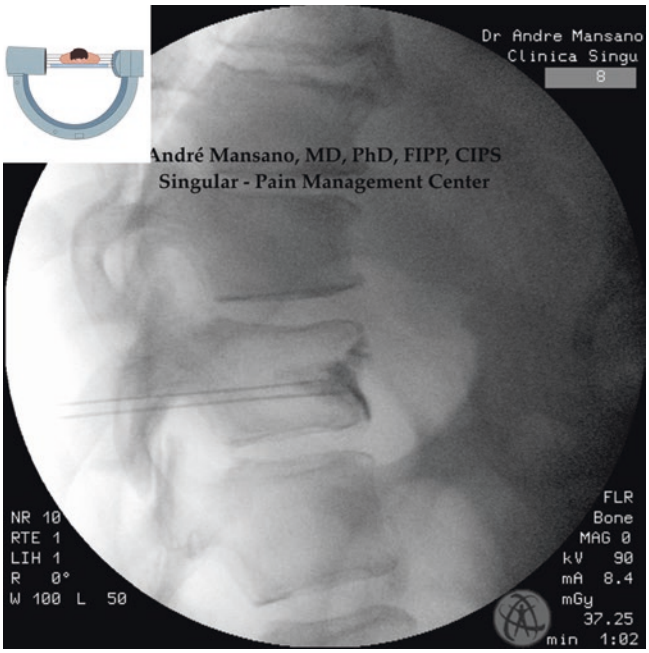

Fig. 10.6 Lateral view. Splanchnic nerve block. Note the optimal contrast media dispersion. Native fluoroscopy image

For radiofrequency (RF):

– Perform sensory and motor stimulation
  At 50 Hz, the sensory stimulation is conducted up to 1 V
  The patient may report stimulation in the epigastric region
  If the stimulation is in a girdle-like fashion around the intercostal spaces, then the needle needs to be advanced anteriorly
  At 2 Hz, motor stimulation is conducted up to 2 V, while checking for intercostal muscle contraction. If this is negative, then test stimulation is satisfactory
– Inject 2–3 ml of local anesthetic
– Perform the RF lesion (60–90 seconds, 80 °C). Turn the RF needle 180° and perform another lesion
– The procedure must be performed bilaterally

Clinical Pearls

- There are also approaches at T12 (target: anterior third of the vertebral body on lateral view) and T10 the (target: middle of the vertebral body on lateral view)
- The occurrence of pneumothorax is the primary complication. Its occurrence can be avoided by keeping the needle in close proximity to the vertebral body
- The chemical neurolysis can be harmful, especially if the solution disperses backwards to the exiting nerve root. Look carefully at the contrast media dispersion
- All patients must receive intravenous infusion of 500 ml crystalloids to prevent hypotension caused by splanchnic vasodilatation

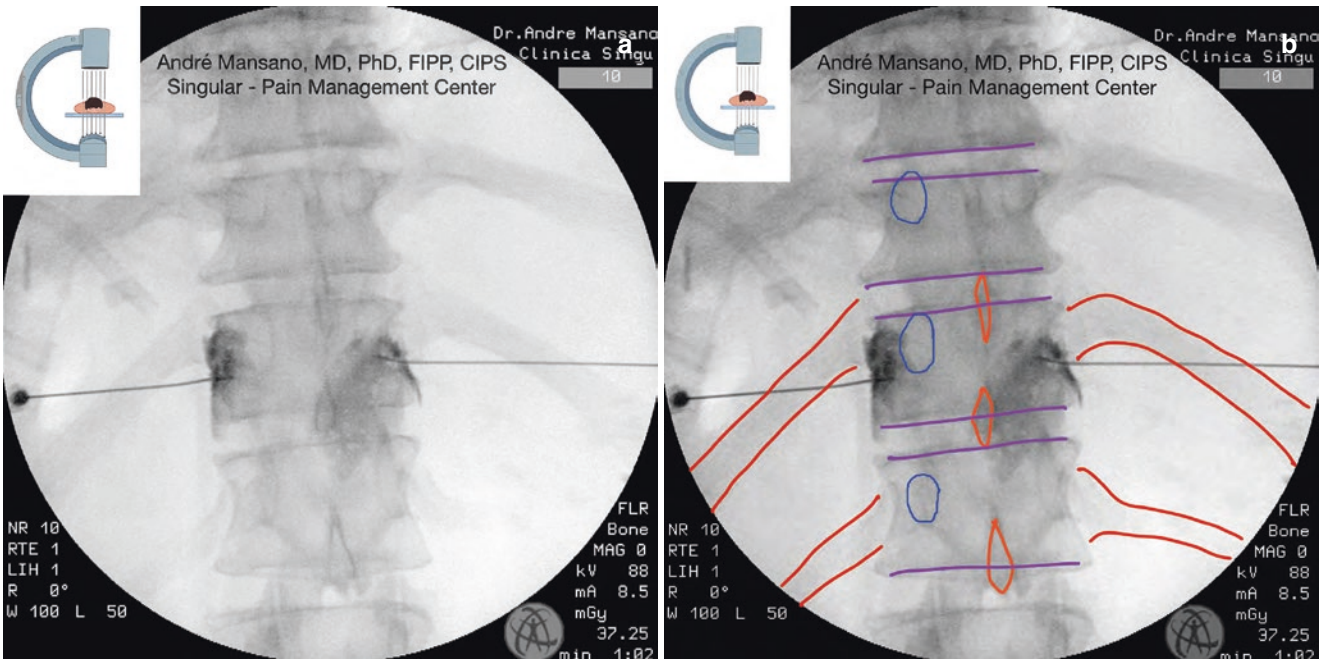

Fig. 10.7 AP view of the thoracic spine. Splanchnic nerve block. Note the contrast media dispersion "hugging" the vertebral body laterally. Red = ribs; orange = spinous process; purple = vertebral body endplates. Native (**a**) and edited (**b**) fluoroscopy image

Unacceptable, Potential Harmful Needle Placement

- Rough needle manipulation
- Needle too lateral (risk of pneumothorax)
- Not checking multiple fluoroscopy views (AP and lateral)
- Needle anterior to vertebral body (risk of great vessel puncture)
- Any position in the spinal canal
- Any proof of lack of understanding of thoracic spine anatomy, for example leaving the needle between the spinous processes and believing it is the right place

Unacceptable, But Not Harmful Needle Placement

- Use of large bore needles (increased risk of pneumothorax)
- Procedure at inappropriate level
- Disc puncture
- The procedure was abandoned after unsuccessful attempts, but it was clear that the examinee was cognizant of the safety aspects of the procedure, the needle did not compromise vital structures, did not reach the epidural space and there was no cord compromise

Evidence

Table 10.1 Level of evidence and recommendations by the Benelux section of the World Institute of Pain
These recommendations are based on both a review of the literature in 2015 by an independent third party (Kleijnen Systematic Reviews LTD) and the previous published guidelines published in Pain Practice. The recent literature, the potential risk for complications, and the grade of invasiveness were considered when deciding to upgrade or downgrade the recommendation.

Indication	Procedure	Recommendation 2009	Grade 2015[2]	Recommendation 2018[3,4]
Pancreatic cancer-related abdominal pain[1]	Bilateral splanchnic nerve (nervus splanchnicus) neurolytic (alcohol/phenol) block	2 B +	Not graded	Very weak
Pancreatic cancer-related abdominal pain[1]	Bilateral splanchnic nerve (nervus splanchnicus) radiofrequency treatment (ablation)		Not graded	Very weak
Chronic pancreatitis-related abdominal pain[5]	Bilateral T11, T12 splanchnic nerve (nervus splanchnicus) radiofrequency treatment (ablation)	2 C+ (RF)	Very low	Very weak

[1]Vissers KC, Besse K, Wagemans M, Zuurmond W, Giezeman MJ, Lataster A, et al. 23. Pain in patients with cancer. Pain Pract. 2011;11:453–75
[2]Kleijnen Systematic Reviews Ltd.: Search and evaluation of the literature. 2015
[3]Huygen F, Kallewaard JW, van Tulder M, Van Boxem K, Vissers K, van Kleef M, et al. "Evidence-based interventional pain medicine according to clinical diagnoses": update 2018. Pain Pract. 2019;19:664–75
[4]https://www.anesthesiologie.nl/publicaties/praktische-richtlijnen-anesthesiologische-pijnbestrijding
[5]Puylaert M, Kapural L, Van Zundert J, Peek D, Lataster A, Mekhail N, et al. 26. Pain in chronic pancreatitis. Pain Pract. 2011;11:492–505

Table 10.2 Level of evidence based on the American Society of Interventional Pain Physicians (ASIPP) review of the literature

Thoracic splanchnic nerve block	Evidence
Thoracic splanchic nerve block[1]	Level III

[1]Babu V, Kura K, Gritsenko K. Celiac plexus blocks and splanchnic nerve blocks. In: Manchikanti L, Kaye AD, Falco FJE, Hirsch JA, editors. Essentials of interventional techniques in managing chronic pain. Springer International Publishing; 2018. p. 595–610.

Suggested Reading

Chen M, et al. Clinical research of percutaneous bilateral splanchnic nerve lesion for pain relief in patients with pancreatic cancer under X-ray guidance. Int J Clin Exp Med. 2015;8:20092–6.

Lillemoe KD, et al. Chemical splanchnicectomy in patients with unresectable pancreatic cancer. A prospective randomized trial. Ann Surg. 1993;217:447–55; discussion 456–7.

Papadopoulos D, Kostopanagiotou G, Batistaki C. Bilateral thoracic splanchnic nerve radiofrequency thermocoagulation for the management of end-stage pancreatic abdominal cancer pain. Pain Physician. 2013;16:125–33.

Raj PP, Erdine S. Percutaneous block and lesioning of the splanchnic nerve. In: Raj PP, Erdine S, editors. Pain-relieving procedures – the illustrated guide. Wiley: Blackwell; 2012. p. 256–63.

Raj PP, Sahinler B, Lowe M. Radiofrequency lesioning of splanchnic nerves. Pain Pract. 2002;2:241–7.

Staats PS, Hekmat H, Sauter P, Lillemoe K. The effects of alcohol celiac plexus block, pain, and mood on longevity in patients with unresectable pancreatic cancer: a double-blind, randomized placebo-controlled study. Pain Medicine. 2001;2:28–34.

The Thoracic Splanchnic block and radiofrequency ablation chapter was reviewed by Ricardo Placarte; Sandra van den Heuvel; Andrea M. Trescot; Milan Stojanovic; Peter S. Staats; Agnes R. Stogicza; Massimo Barbieri.

Thoracic Sympathetic Block and Radiofrequency Ablation

11

Agnes R. Stogicza

Equipment and Monitoring

- Standard ASA monitoring
- Fluoroscopy
- Sterile prep, and drape
- Skin local anesthesia prior to any needle larger than 25G (unless sedation is used)
- Coaxial view is always used to advance needle, unless otherwise specified
- CPR equipment and medications available
- 22G, 3.5 inch (90 mm)–5 inch (130 mm) needle for diagnostic block, tip curved to facilitate steering
- 18–21G, 3.5 inch (90 mm)–5 inch (130 mm), 5 or 10 mm curved active tip radiofrequency cannula for radiofrequency ablation
- 2 ml 1% Lidocaine per site for diagnostic block and before radiofrequency ablation (RFA)
- Nonionic contrast

Anatomy

- Sympathetic chain at T2 and T3 thoracic level
- Target the junction of the posterior 1/3 and anterior 2/3 of the vertebral body

Structures to Keep in Mind and Possible Complications

- Intercostal artery, vein, nerve → bleeding/nerve damage
- Lung → pneumothorax
- Exiting nerve roots → nerve injury
- Intraspinal structures → spinal, epidural injection
- Vena azygos → bleeding
- Thoracic duct → chylothorax (left side)
- Esophagus → discomfort, infection
- Trachea
- Vagus nerve
- Infection
- Bleeding
- Postprocedure pain
- Vasovagal reaction
- Allergic reaction

Fluoroscopy Technique, Target Localization

- Patient in prone position
- Anteroposterior (AP) image (Fig. 11.1a–c)
- Identify T2 level (then T3 for second needle placement)
- Square off vertebra with cephalad tilt (so needle will be eventually parallel to vertebral body endplates) (Fig. 11.2a–c)
- Oblique C-arm until vertebral body visualizes lateral to laminar edge (about 15–20°) (Fig. 11.3a, b)
- Entry point should be about 4 cm off midline, depending on body habitus
- Identify cephalad edge of corresponding rib and transverse process (TP)

Procedure Steps

- The procedure must be performed on the affected side at both T2 and T3 levels
- Needle #1 entry at T2 just cephalad to the 3rd rib and TP, at the junction of rib and vertebral body shadow
- Needle #2 entry at T3 just cephalad to the 4th rib and TP, at the junction of rib and vertebral body shadow

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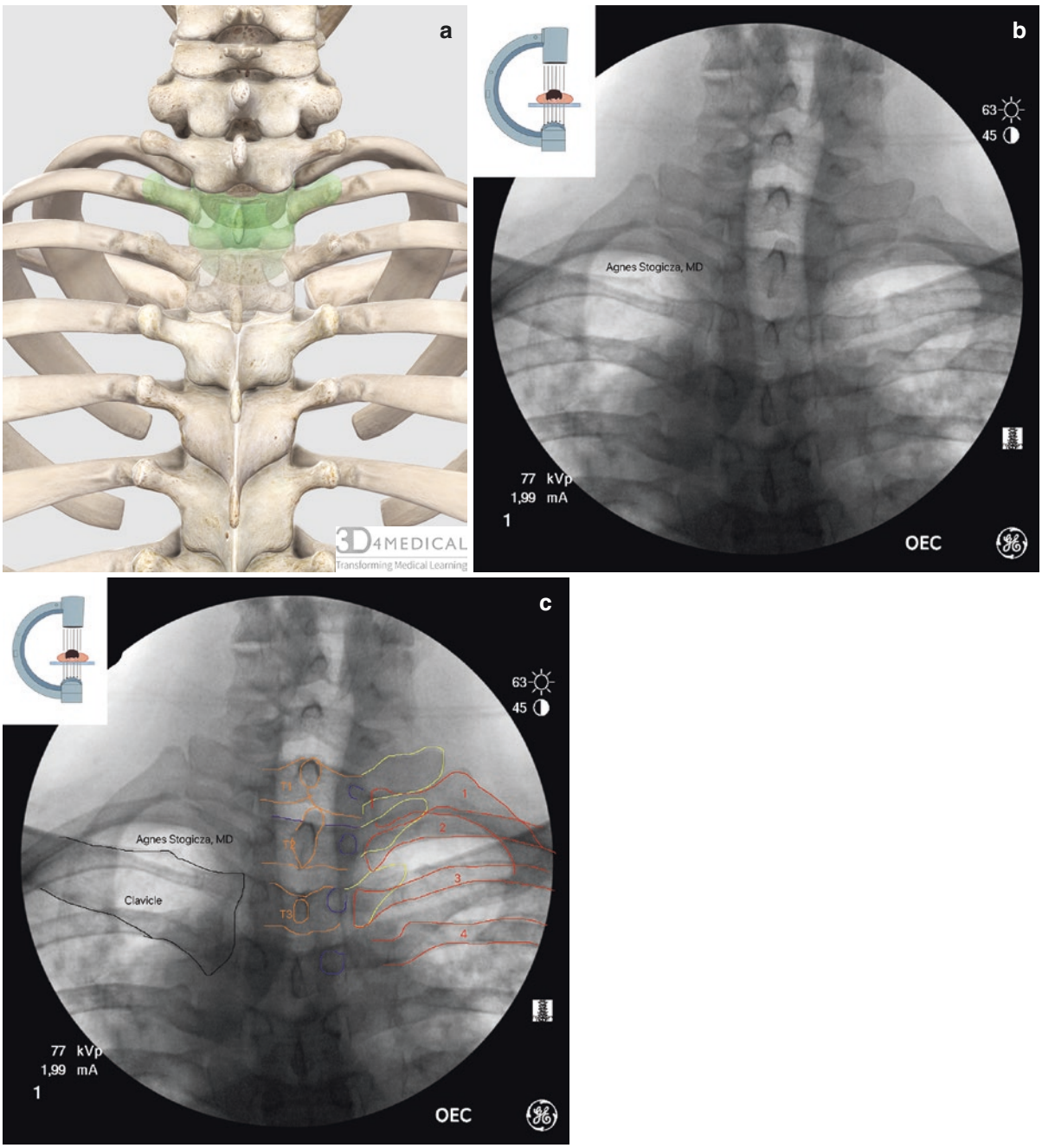

Fig. 11.1 AP view of the thoracic spine. True AP view, spinous processes in the midline. T1 is identified by the first rib. Orange = spinous process and lamina; yellow = transverse process; dark blue = pedicle; red = ribs; Black = clavicle. Complete Anatomy image, T2 vertebra green highlighted, faded, T3 vertebra faded (**a**), native (**b**) and edited fluoroscopy images (**c**)

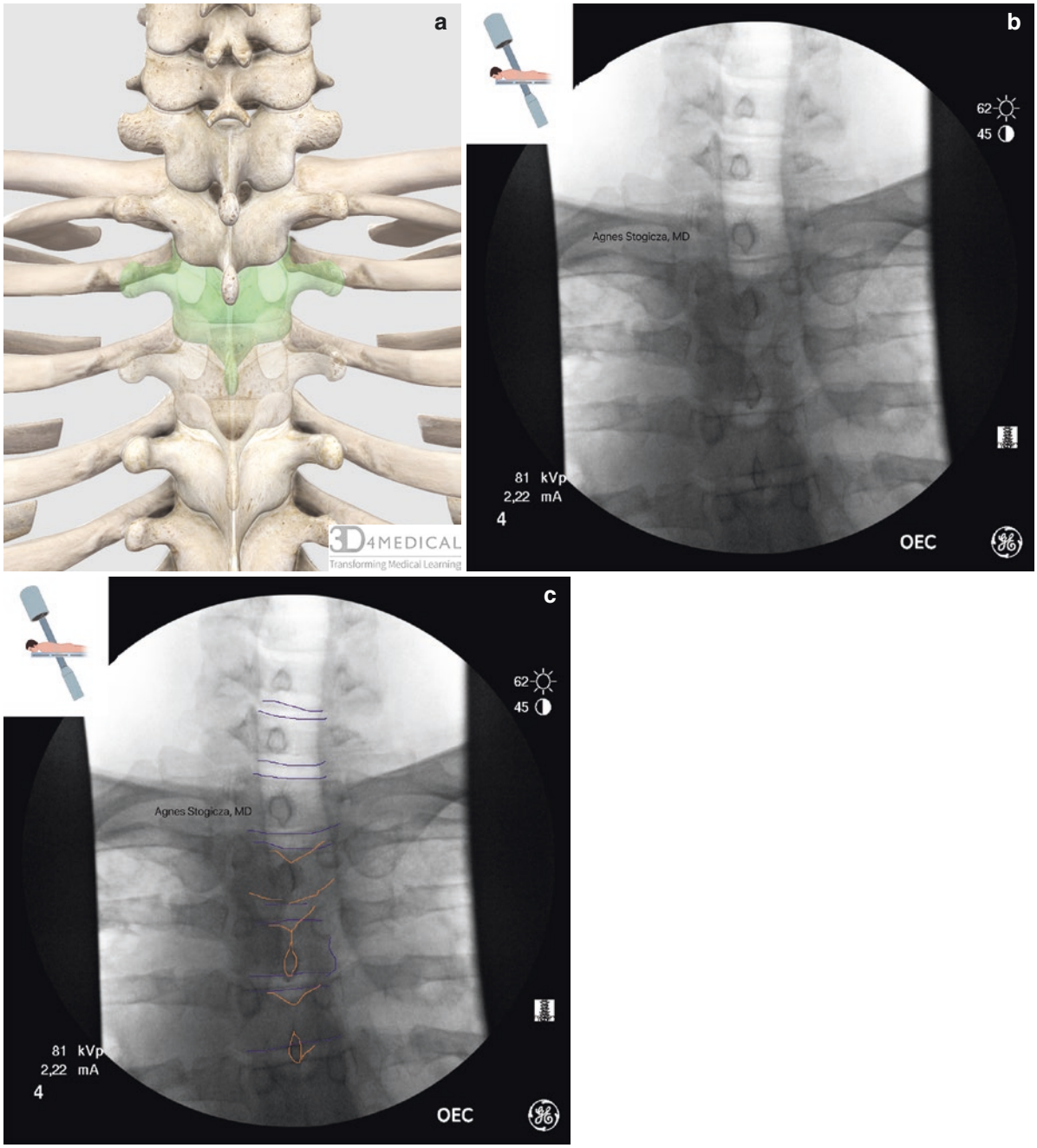

Fig. 11.2 AP view of the thoracic spine with cephalad tilt of the C-arm. Vertebral body endplates are lined up at the area of interest, which will allow the needle to be placed parallel to the endplates. Orange = spinous process and lamina; purple = vertebral body. Complete Anatomy image, T2 vertebra green highlighted, faded, T3 vertebra faded (**a**), native (**b**) and edited fluoroscopy image (**c**)

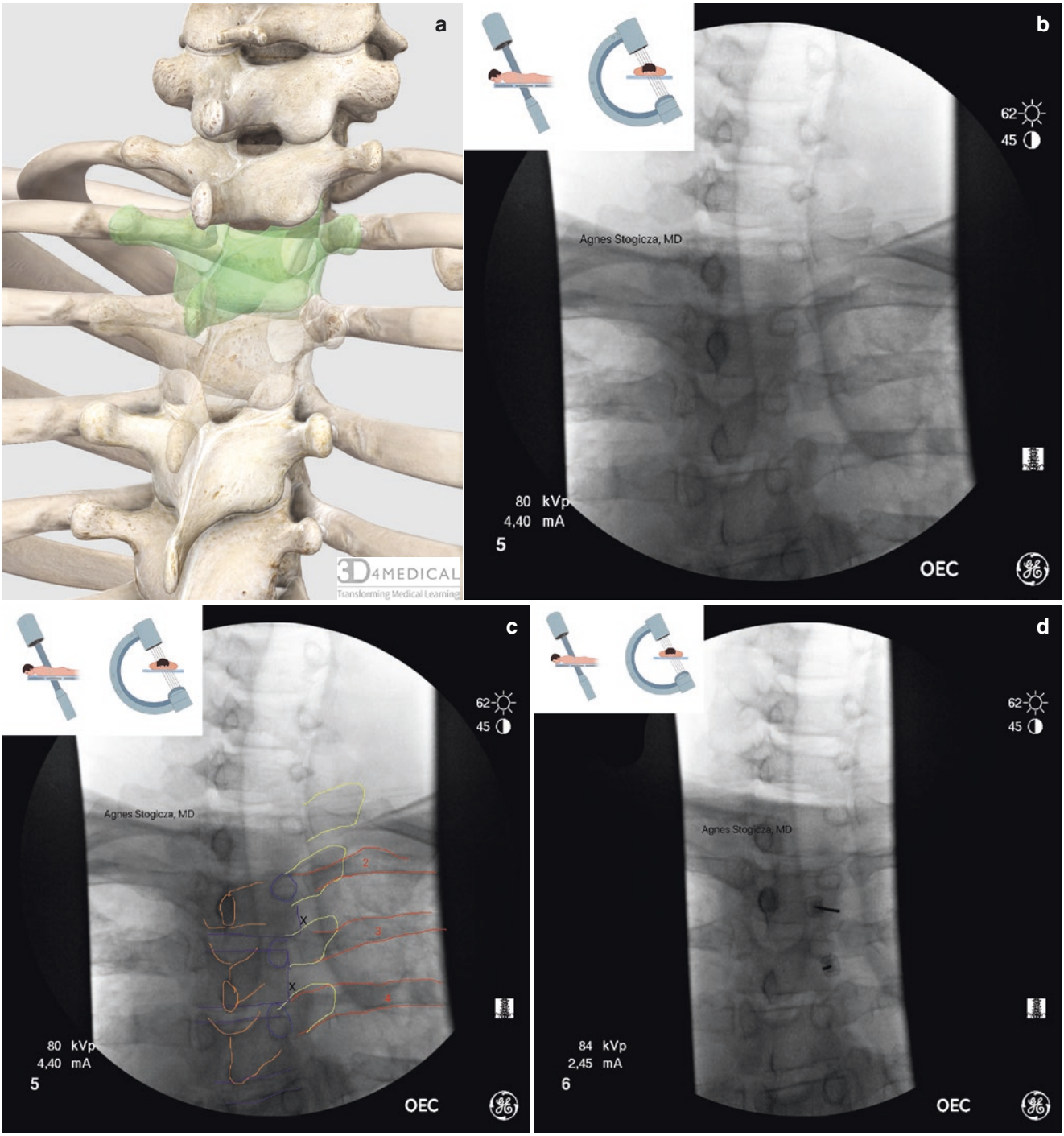

Fig. 11.3 Oblique view of the thoracic spine. C-arm is tilted in the cephalad then ipsilateral direction. Orange = spinous process and lamina; yellow = transverse process; dark blue = pedicle; red = ribs; purple = vertebral body, x marks the needle entry points, just cephalad from the transverse processes. Collimation helps visualization of the area of interest, and decreases radiation. Complete Anatomy image, T2 vertebra green highlighted, faded, T3 vertebra faded (**a**), native (**b**) and edited fluoroscopy image (**c**). Needles are advanced in coaxial view to touch the vertebral body (**d**)

- Coaxial approach in order to touch vertebral body (Fig. 11.3c, d)
- Check lateral view to assess depth of needle
- Once the vertebral body is touched, wiggle anteriorly (rotate needle tip to and away from the vertebral body while advancing the needle) in lateral view, constantly keeping the needle contacting bone with fluoroscopy control until target is reached (Fig. 11.4a–c)
- AP view to confirm appropriate needle position (Fig. 11.5)

For diagnostic block:
- Aspirate for fluid (blood, cerebrospinal fluid (CSF) or chyle)
- Inject 1–2 ml of nonionic contrast
- Check the optimal dispersion of the contrast media in AP and lateral view. The contrast media must "hug" the vertebral body laterally
- Inject 2-3 ml of local anesthetic

For chemical neurolysis:
- Aspirate for fluid (blood, cerebrospinal fluid (CSF) or chyle)
- Inject 1–2 ml of nonionic contrast
- Check the optimal dispersion of the contrast media in AP and lateral view. The contrast media must "hug" the vertebral body laterally, and not track backwards to the neuroforamen
- Inject 2 ml of phenol 6–10% (not painful)

For radiofrequency (RF):
- Perform sensory and motor stimulation
- At 50 Hz, the sensory stimulation is conducted up to 1 V
- If patient reports stimulation or twitches in the arm or in the chest, the needle needs to be advanced anteriorly
- Inject 2–3 cc of local anesthetic
- Perform the RF lesion (60–90 seconds, 80 °C). Turn the RF needle 180° and perform another lesion

Clinical Pearls

- Notice that the thoracic vertebral bodies are narrower at this level than the lamina, so needle will eventually point medially
- Precise entry point identification is particularly important for ease of procedural performance
- On lateral view, it is often difficult to visualize the anterior borders of the vertebral bodies at T2 and T3 levels because of the shoulder; however, lower levels T4, 5, 6 vertebral bodies show well, allowing "projecting" a line identifying anterior portion of the vertebral bodies at the level of interest
- Collimating the fluoroscopy image helps good visualization of the spine
- Magnifying the image helps visualization, but increases radiation
- If performing radiofrequency ablation procedure, appropriate distance from exiting nerve root and intercostal nerve is crucial (Fig. 11.4c). 0.2 mV in stimulation roughly corresponds to 1 mm distance of nerve. For example, if patient notes intercostal stimulation at 1 mV, needle is about 5 mm distance of nerve
- Affected upper extremity veins will be dilated, and hand will be warm and dry upon successful block, with no sensory or motor block

Unacceptable, Potentially Harmful Needle Placement on Exam

- Rough needle manipulation
- Far lateral entry point, lack of awareness of lung in vicinity
- Not checking lateral view to assess depth of needle
- Compromise of intraspinal space
- Needle too dorsal, compromising exiting nerve root
- Needle advanced too anterior multiple times and not recognized by the candidate
- Any proof of lack of understanding of thoracic anatomy, for example, needle left far posterior behind pedicle line and believing it is in the right place

Unacceptable, But Not Harmful Needle Placement on Exam

- Placing the needle past the anterior third of the vertebral body
- The procedure was abandoned after unsuccessful attempts, but it was clear that the examinee was cognizant of the safety aspects of the procedure, the needle did not compromise vital structures, did not reach the epidural space and there was no cord compromise

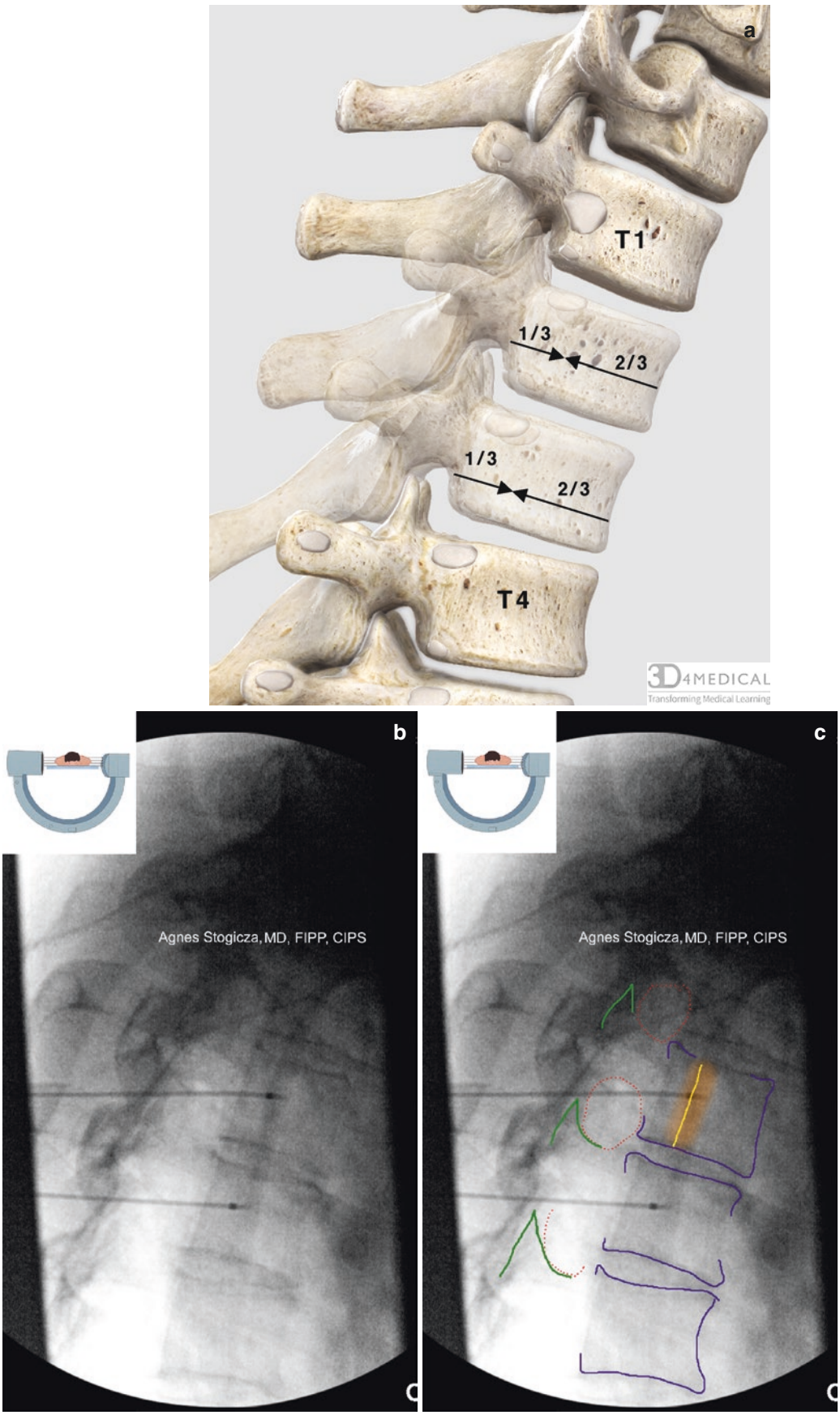

Fig. 11.4 Lateral view of the thoracic spine: Complete Anatomy image (**a**). Needle is positioned on target, at T2 and T3 level at the junction of the posterior one third and anterior two third junction of the vertebral body (**b**). Purple = visible vertebral body contours, green = superior articular process, red dotted = neuroforamen. Yellow line marks the target zone for diagnostic block, orange zone marks the target zone for the active tip for RFA ablation (**c**)

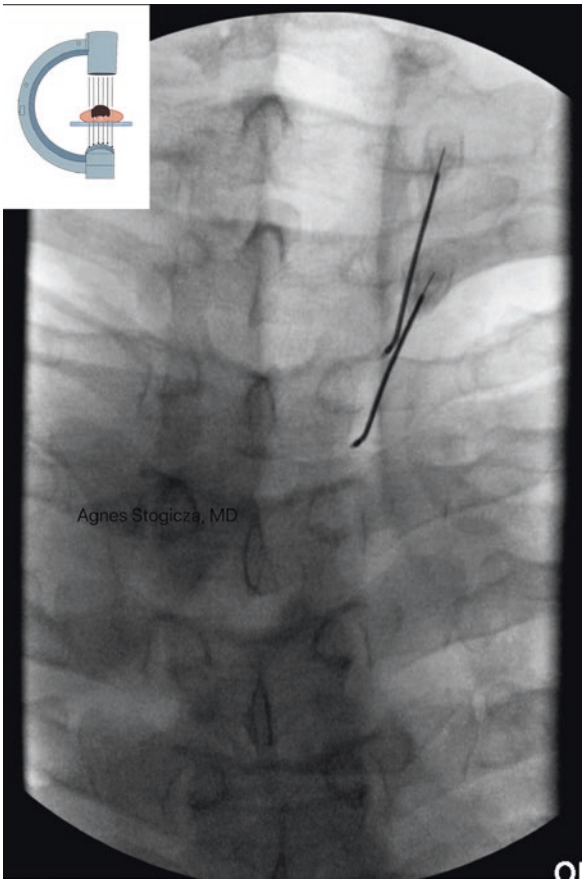

Fig. 11.5 Thoracic sympathetic block (radiofrequency ablation) AP view. Needles are positioned at T2 and T3 levels. Needles are pointing medially, "hugging" the vertebral body

Evidence

Table 11.1 Level of evidence and recommendations by the Benelux section of the World Institute of Pain

These recommendations are based on both a review of the literature in 2015 by an independent third party (Kleijnen Systematic Reviews LTD) and the previous published guidelines published in Pain Practice. The recent literature, the potential risk for complications, and the grade of invasiveness were considered when deciding to upgrade or downgrade the recommendation.

Indication	Procedure	Recommendation 2009[1]	Grade 2015[2]	Recommendation 2018[3,4]
Complex regional pain syndrome	Thoracic sympathetic block (Th2-Th3) with ropivacaine and triamcinolone		Low	Weak

[1]van Eijs F, Stanton-Hicks M, Van Zundert J, Faber CG, Lubenow TR, Mekhail N, et al. Evidence-based interventional pain medicine according to clinical diagnoses. 16. Complex regional pain syndrome. Pain Pract. 2011;11:70–87

[2]Kleijnen Systematic Reviews Ltd.: Search and evaluation of the literature. 2015

[3]Huygen F, Kallewaard JW, van Tulder M, Van Boxem K, Vissers K, van Kleef M, et al. "Evidence-based interventional pain medicine according to clinical diagnoses": update 2018. Pain Pract. 2019;19:664–75

[4]https://www.anesthesiologie.nl/publicaties/praktische-richtlijnen-anesthesiologische-pijnbestrijding

Table 11.2 Level of evidence based on the American Society of Interventional Pain Physicians (ASIPP) review of the literature

Thoracic sympathetic blocks[1]	Evidence
Thoracic sympathetic block for CRPS	Level III

[1]Vydyanathan A, Bryan G, Gritsenko K, Hansen H, Manhikanti L. Cervical and thoracic sympathetic blocks. In: Manchikanti L, Kaye AD, Falco FJE, Hirsch JA, editors. *Essentials of interventional techniques in managing chronic pain*. Springer International Publishing; 2018. p. 531–50.

Suggested Reading

Kim WH, Lee CJ, Kim TH, Shin BS, Sim WS. The optimal oblique angle of fluoroscope for thoracic sympathetic ganglion block. Clin Auton Res. 2011;21(2):89–96.

Skaebuland C, Racz GB. Indications and technique of thoracic(2) and thoracic(3) neurolysis. Curr Rev Pain. 1999;3:400–5.

Skaebuland C, Racz GB. Thoracic (T2-3) ganglion block. In: Diwan S, Staats PS, editors. Atlas of pain medicine procedures. New York: McGraw-Hill Education/Medical; 2014. p. 349–56.

The Thoracic Sympathetic Block and Radiofrequency Ablation chapter was reviewed by Sandra van den Huevel; Miles Day; Pierluigi Manchiaro; Sudhir Diwan; Andrea M. Trescot; Milan Stojanovic; Peter S. Staats; Andre M. Mansano.

Thoracic Facet Joint Block

12

Wael Saleem

Equipment

- Standard ASA monitoring
- Fluoroscopy
- Sterile prep, and drape
- Skin local anesthesia prior to any needle larger than 25G (unless sedation is used)
- Coaxial view is always used to advance needle, unless otherwise specified
- CPR equipment and medications available
- 22–25G, 3.5 inch (90 mm) needle, tip curved to facilitate steering
- Local anesthetic with or without steroid of choice

Anatomy

- Joint space is between the superior articular process (SAP) and inferior articular process (IAP), encased in the facet capsule
- The sagittal facet orientation is 60° at T1, increasing to 70° at T12
- The coronal facet orientation is commonly 20°–40°

Structures to Keep in Mind and Possible Complications

- Lung → pneumothorax
- Exiting nerve roots → nerve injury
- Intraspinal structures → intrathecal, epidural medication administration, high spinal anesthesia, spinal cord injury, paralysis, death
- Intercostal nerves → nerve injury
- Infection
- Bleeding
- Postprocedure pain
- Vasovagal reaction
- Allergic reaction

Fluoroscopy Technique, Target Localization – Non-coaxial Approach

- Prone position
- On anteroposterior (AP) view, identify the level by counting up from T12 or down from T1
- The entry point of the needle should be approximately 1–2 segments below the target joint

Procedure Steps – Non-coaxial Approach

This approach is easier for the upper joints.

- Direct needle to the inferior aspect of the joint (superior articular process (SAP)), not in a coaxial view (Fig. 12.1a–c)
- The needle is advanced into the joint. Usually the needle will reach the most posteroinferior aspect of the joint due to the sharp angle of the joint
- Verify position in lateral view (Fig. 12.2a–c)

Fluoroscopy Technique, Target Localization – Coaxial Approach

- Patient in prone position
- On AP view, identify the level by counting up from T12 or down from T1
- Tilt the C-arm 30–50° caudad from the axial plane (Fig. 12.3a, b)

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A. R. Stogicza et al. (eds.), *Interventional Pain*, https://doi.org/10.1007/978-3-030-31741-6_12

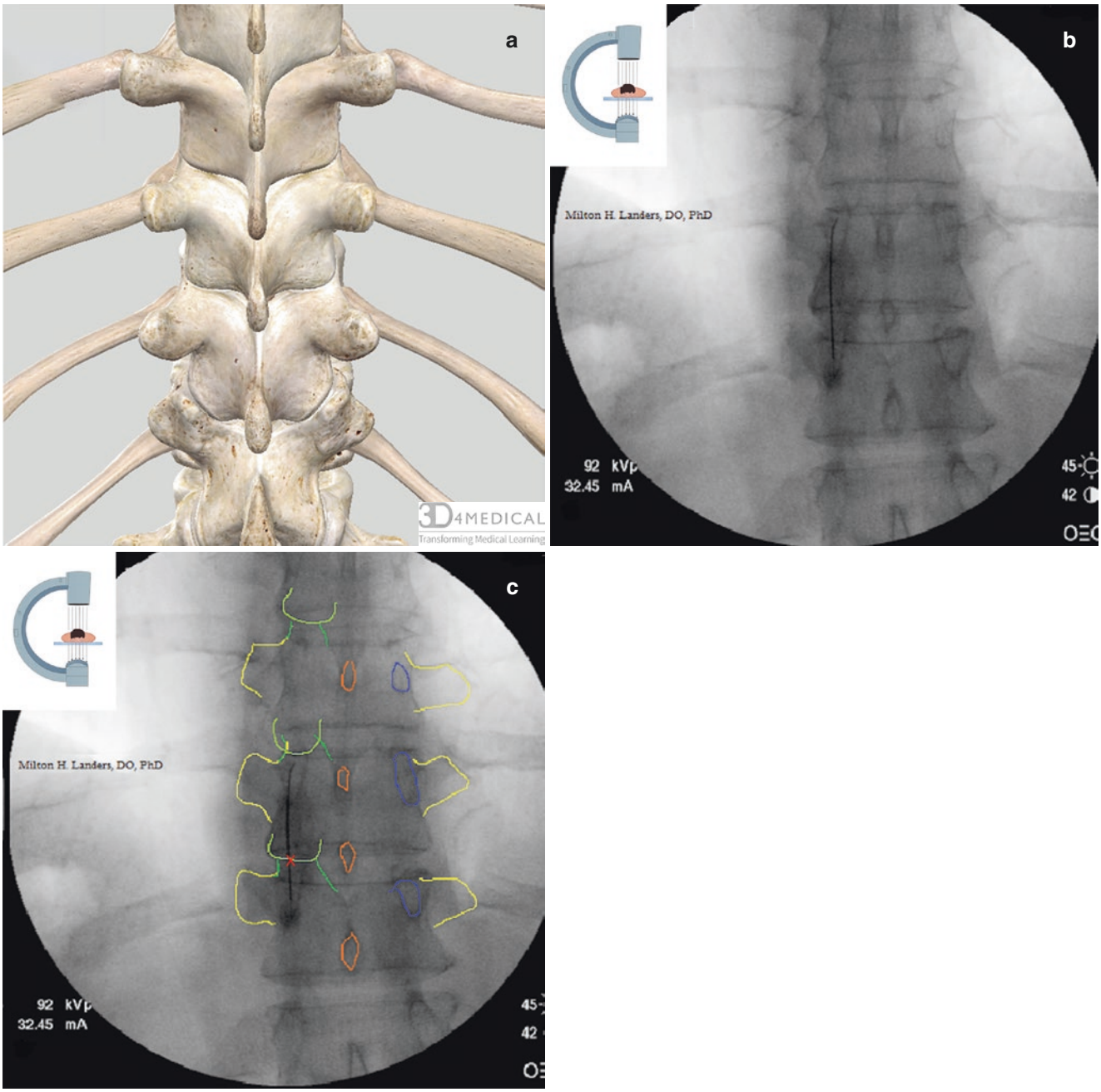

Fig. 12.1 Thoracic facet joint block AP view: Needle skin entry is one segment below the targeted joint (marked with red X). The needle is advanced to the inferior aspect of the SAP. Orange = spinous process; yellow = transverse process; dark green = superior articular process; light green = inferior articular process; dark blue = pedicle. Complete Anatomy image (**a**), native (**b**) and edited fluoroscopy image (**c**)

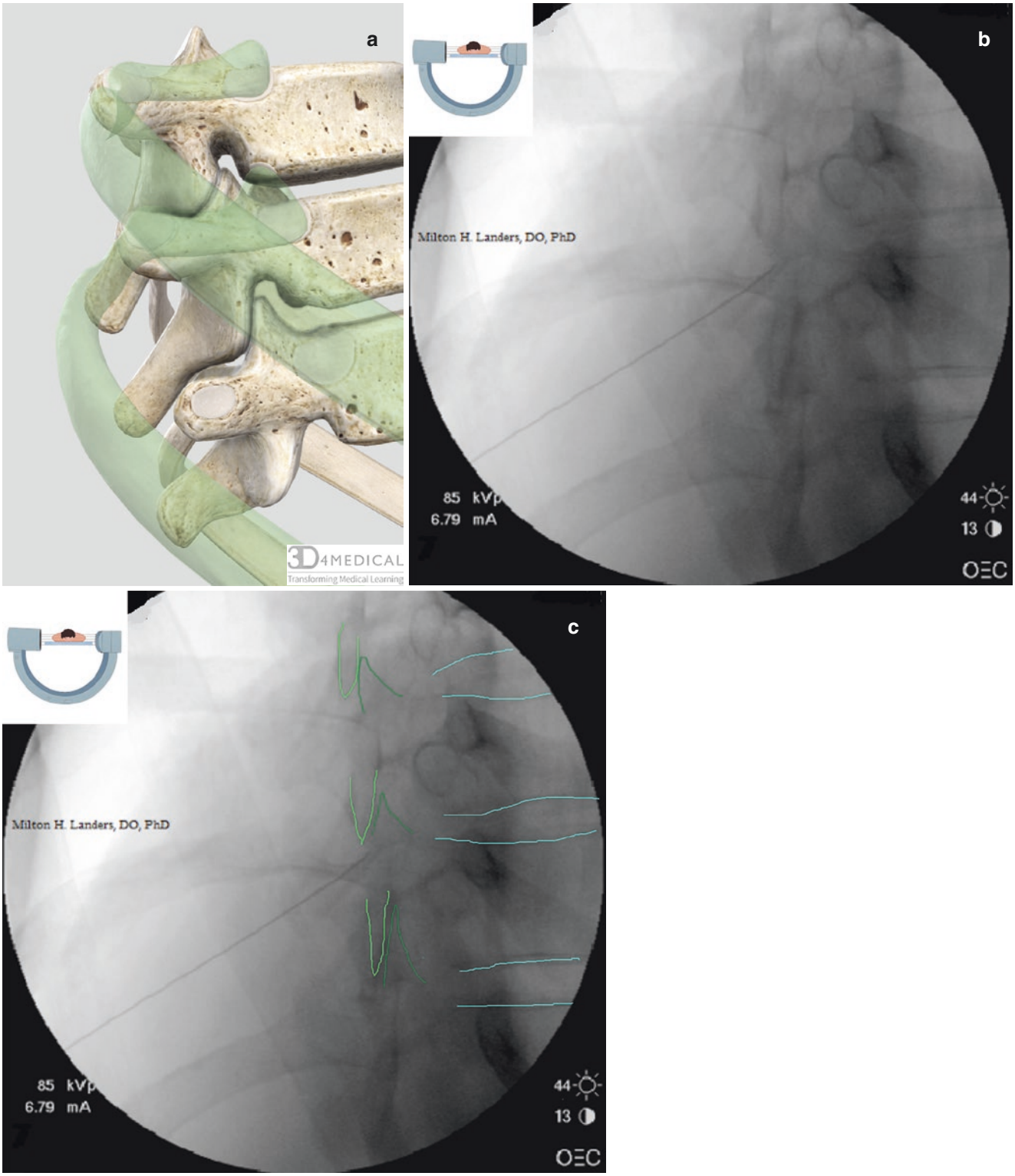

Fig. 12.2 Thoracic facet joint block lateral view: Needle is positioned at the inferior aspect of the SAP. Further advance the needle to enter the capsule of the joint. Light blue = endplate with disc; dark green = superior articular process; light green = inferior articular process. Complete Anatomy image, ribs faded (**a**), native (**b**) and edited fluoroscopy image (**c**)

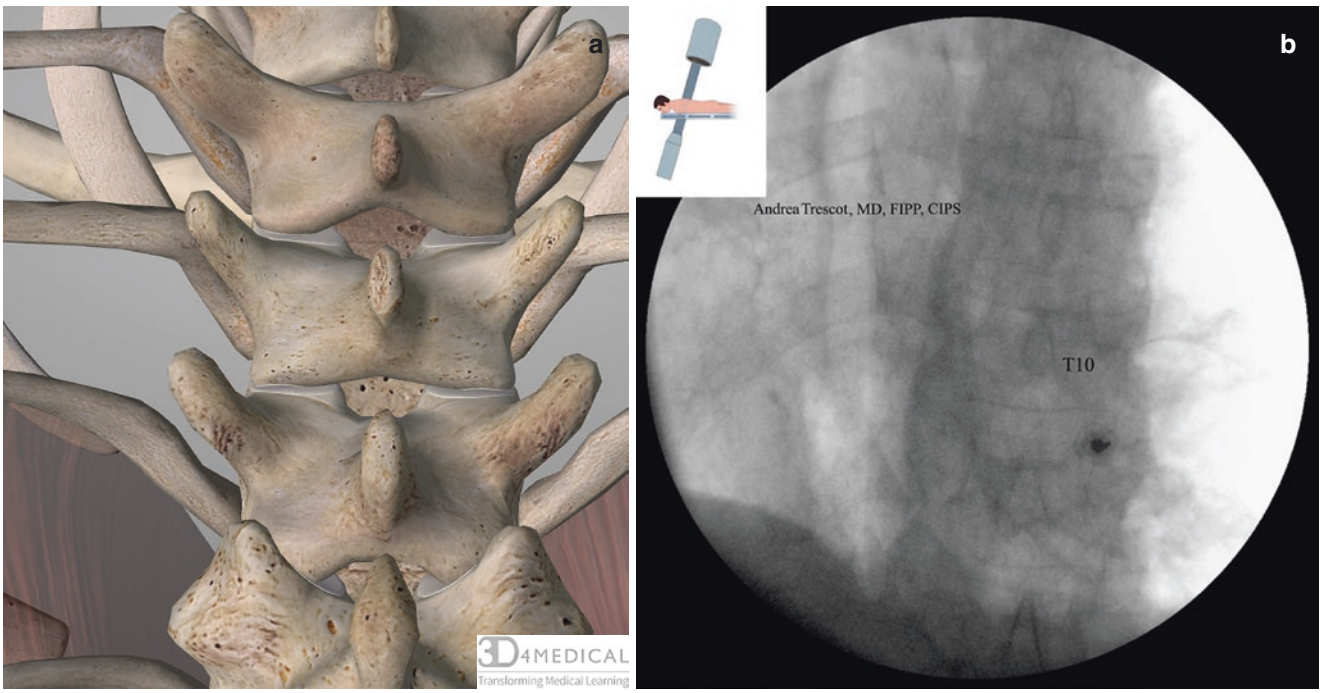

Fig. 12.3 C-arm tilted caudally about 30–50° from the axial plane. Needle placed to the T10–T11 facet joint. Complete Anatomy image (**a**), native (**b**) fluoroscopy image

Procedure Steps – Coaxial Approach

This approach is easier for the lower joints.

- Advance a 22G, 3.5 inch (90 mm) spinal needle in a coaxial view to the inferior aspect of the joint opening (Fig. 12.3b)
- The needle is advanced into the joint, and usually the needle will reach the most posteroinferior aspect of the joint due to the sharp angle of the joint
- Lateral view and contrast injection confirms needle position (Fig. 12.4a, b)

Clinical Pearls

- The needle should remain on a vertical line connecting the midpart of the targeted facet joint to the one below to avoid deviation of the needle to the intraspinal space or the pleura
- To enhance identifying structures on the lateral image, one should make sure that the discs are well visualized. Then, following the lower margin of the disc (Fig. 12.2c) will always lead to the SAP
- Using a curved needle helps to guide the needle in the joint space, despite the steep orientation of the facet joint

Unacceptable, Potentially Harmful Needle Placement on Exam

- Rough needle manipulation
- Compromised intraspinal space
- Compromised lung/pleura
- Not checking lateral view

Unacceptable, But Not Harmful Needle Placement on Exam

- The procedure was abandoned after unsuccessful attempts, but it was clear that the examinee was cognizant of the safety aspects of the procedure, the needle did not compromise vital structures

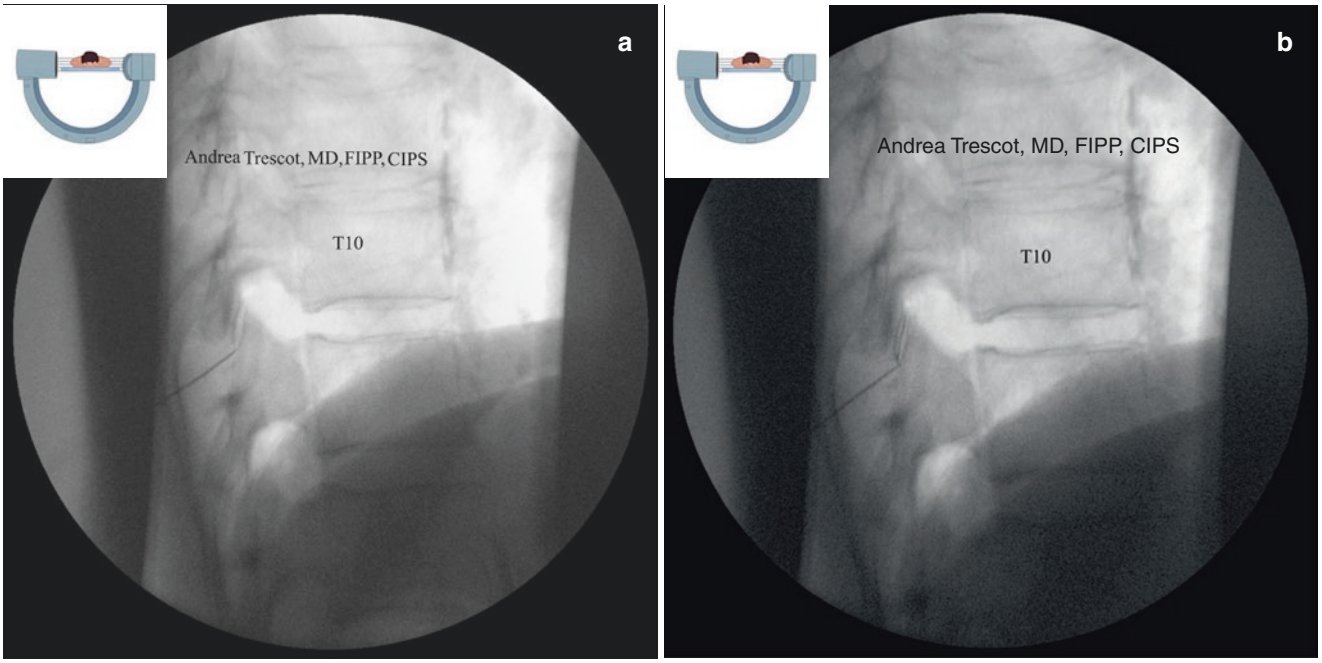

Fig. 12.4 Lateral view and contrast injection confirms needle position. Native fluoroscopy image without (**a**) and with 0.5 ml contrast (**b**)

Evidence

Table 12.1 Level of evidence and recommendations by the Benelux section of the World Institute of Pain

These recommendations are based on both a review of the literature in 2015 by an independent third party (Kleijnen Systematic Reviews LTD) and the previous published guidelines published in Pain Practice. The recent literature, the potential risk for complications, and the grade of invasiveness were considered when deciding to upgrade or downgrade the recommendation.

Indication	Procedure	Recommendation 2009[1]	Grade 2015[2]	Recommendation 2018[3,4]
Thoracic facet joint pain	Local anesthetic block of the thoracic medial branch (ramus medialis of the ramus dorsalis)		Not graded	Not applicable
Thoracic facet joint pain	Addition of corticosteroid to local anesthetic blocks of the thoracic medial branch (ramus medialis of the ramus dorsalis)		High	Moderate against

[1]van Kleef M, Stolker RJ, Lataster A, Geurts J, Benzon HT, Mekhail N. 10. Thoracic pain. Pain Pract. 2010;10:327–38

[2]Kleijnen Systematic Reviews Ltd.: Search and evaluation of the literature. 2015

[3]Huygen F, Kallewaard JW, van Tulder M, Van Boxem K, Vissers K, van Kleef M, et al. "Evidence-based interventional pain medicine according to clinical diagnoses": update 2018. Pain Pract. 2019;19:664–75

[4]https://www.anesthesiologie.nl/publicaties/praktische-richtlijnen-anesthesiologische-pijnbestrijding

Table 12.2 Level of evidence based on the American Society of Interventional Pain Physicians (ASIPP) review of the literature

Thoracic facet joints interventions	Evidence
Therapeutic facet joint nerve block[1]	Level II
Therapeutic facet joint neurotomy	Level IV

[1]Manchikanti L, Schultz DM, Falco FJE, Singh V. Thoracic facet joint interventions. In: Manchikanti L, Kaye AD, Falco FJE, Hirsch JA, editors. Essentials of interventional techniques in managing chronic pain. Springer International Publishing; 2018. p. 369–86.

Suggested Reading

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Lee DG, Ahn SH, Cho YW, Do KH, Kwak SG, Chang MC. Comparison of intra-articular thoracic facet joint steroid injection and thoracic medial branch block for the management of thoracic facet joint pain. Spine (Phila Pa 1976). 2018;43(2):76–80.

Manchikanti KN, et al. An update of evaluation of therapeutic thoracic facet joint interventions. Pain Physician. 2012;15:E463–81.

The Thoracic Facet Joint Block chapter was reviewed by Andrea M. Trescot; Milan Stojanovic; Peter S. Staats; Agnes R. Stogicza; Andre M. Mansano.

Thoracic Medial Branch Block and Denervation

13

Charles A. Oliveira

Equipment and Monitoring

- Standard ASA monitoring
- Fluoroscopy
- Sterile prep, and drape
- Skin local anesthesia prior to any needle larger than 25G (unless sedation is used)
- Coaxial view is always used to advance needle, unless otherwise specified
- CPR equipment and medications available
- 22–25G, 2 inch (50 mm)–3.5 inch (90 mm) needle for diagnostic block
- 18–20G, 10 mm, 5–10 mm active tip radiofrequency cannula for ablation

Anatomy

- T1-T10: Medial branch at the superolateral corner of the transverse process (TP), occasionally not immediately on bone, but rather "floating" in the tissue close to the transverse process
- T11-T12: The medial branches follow a course similar to those in the lumbar regions, more medial and closer to the superior articular process

Structures to Keep in Mind and Possible Complications

- Lung → pneumothorax
- Intrathecal and epidural injection
- Exiting nerve root → nerve damage
- Intercostal nerve → nerve damage
- Infection
- Bleeding
- Postprocedure pain
- Vasovagal reaction
- Allergic reaction

Fluoroscopy Technique, Target Localization

- Patient in prone position
- Anteroposterior (AP) view (Fig. 13.1a–c)
- Identify the target level
- If the TP cannot be identified, move the C-arm 5–10° to the contralateral side so as to distinguish the TP, ribs, laminae, and lung
- Skin entry is at the superolateral part of the TP of interest

Procedure Steps-Diagnostic Block

- Advance needle for diagnostic block to the superior and lateral portion of the TP, until bony contact (Fig. 13.2)
- Obtain a lateral view to confirm the depth of the needles (Fig. 13.4a–c and 13.5c)
- Inject 0.5 ml Lidocaine 1%

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A. R. Stogicza et al. (eds.), *Interventional Pain*, https://doi.org/10.1007/978-3-030-31741-6_13

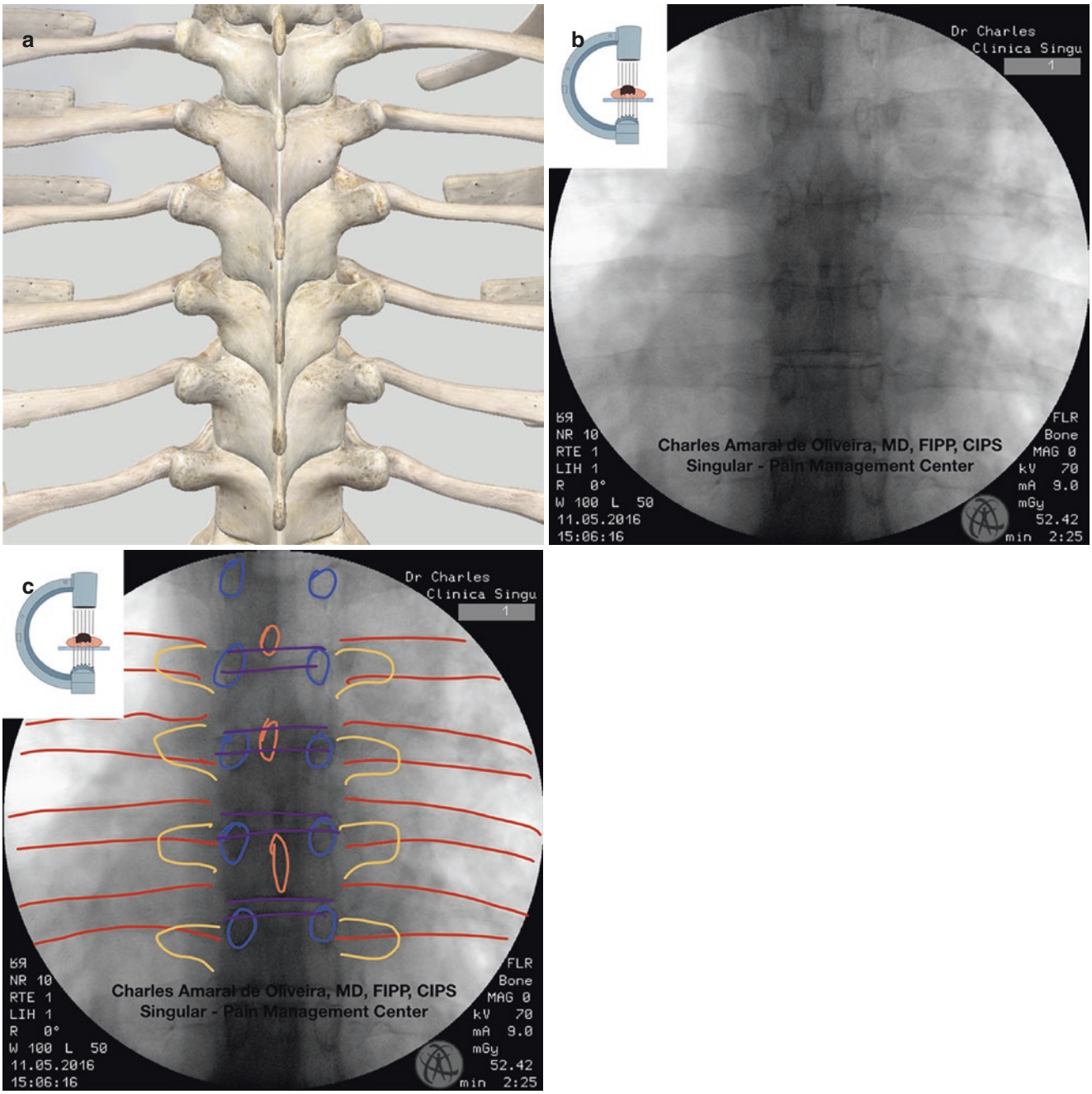

Fig. 13.1 AP view of the thoracic spine. Orange = spinous process; purple = vertebral body endplates; blue = pedicles; yellow = transverse process; red = ribs. Complete Anatomy image (**a**), native (**b**) and edited fluoroscopy image (**c**)

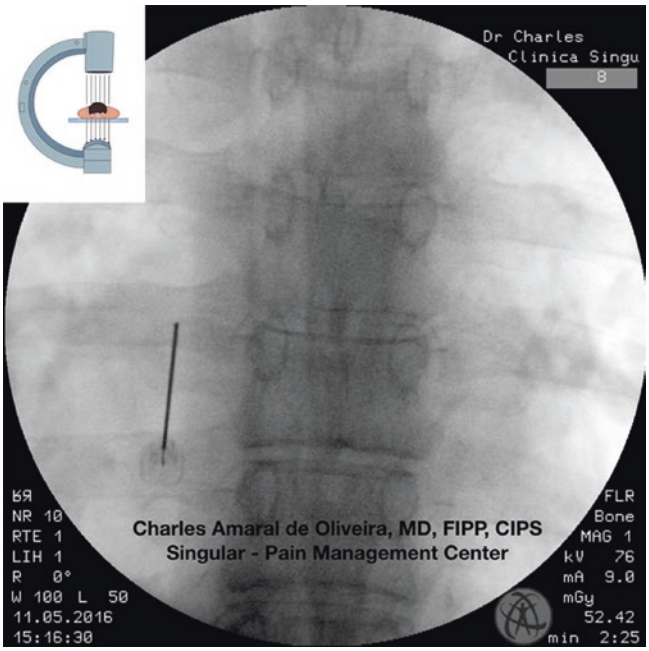

Fig. 13.2 Needle over the superior and lateral aspect of the transverse process

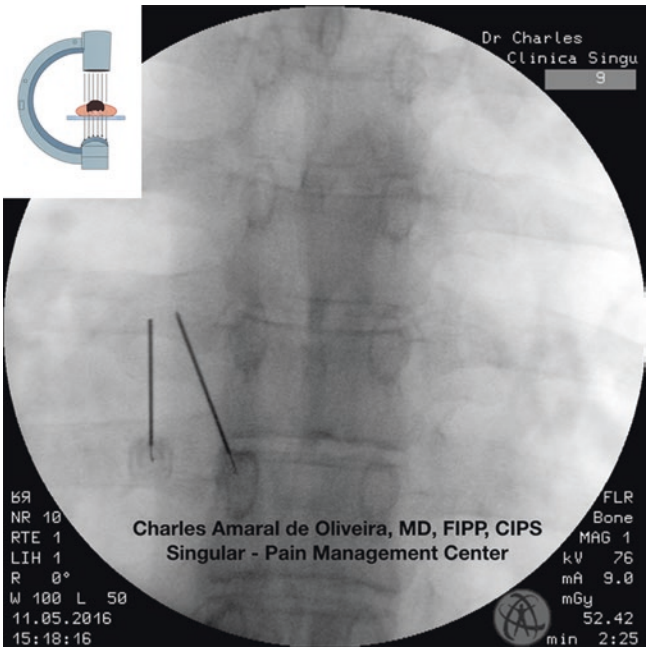

Fig. 13.3 Second needle is placed parallel to the first needle for bipolar RFA. Native fluoroscopy image

Procedure Steps-Radiofrequency (RF) Ablation (Unipolar or Bipolar)

- Advance RF cannula for ablation to the superior and lateral portion of the transverse process, until bony contact (Fig. 13.2)
- A second RF needle may be placed parallel to the first 1 cm medially to create a larger, bipolar lesion (Fig. 13.3)
- Obtain a lateral view to confirm the depth of the needles (Fig. 13.4a–c)
- Apply motor stimulation at 2 Hz at up to 2 V. Twitches of the paravertebral muscles (m. mulitifidus) is expected
- Apply sensory stimulation at 50 Hz up to 0.5 V. Overlapping paresthesia is expected
- Apply local anesthetic followed by unipolar (Fig. 13.5a–c) or bipolar RF ablation, 90 seconds, twice at 80°C

Clinical Pearls

- Magnifying and collimating the image often helps to visualize the TP in cases of challenging anatomy, this however may increase radiation exposure
- If the needle tip is kept posterior to the TP on its approach to the bony surface, pneumothorax is of no concern
- Dysesthesia and sensorial loss may develop at the innervation area of the medial branch
- Transient neuritis and increased pain may develop for 3–4 weeks after RF lesion, which is usually self-limiting

Unacceptable, Potentially Harmful Needle Placement on Exam

- Rough needle manipulation
- Far lateral entry point, lack of awareness of lung in the vicinity
- Not checking lateral view to assess the depth of needle
- Compromise of intraspinal space
- Needle advanced too anterior multiple times and not recognized by the candidate
- Any proof of lack of understanding of thoracic anatomy, for example, needle left far posterior between the spinous processes and believing it is in the right place

Unacceptable, But Not Harmful Needle Placement on Exam

- Placing the needle to the medial part of the TP
- The procedure was abandoned after unsuccessful attempts, but it was clear that the examinee was cognizant of the safety aspects of the procedure, the needle did not compromise vital structures, did not reach the epidural space and there was no lung or spinal cord compromise

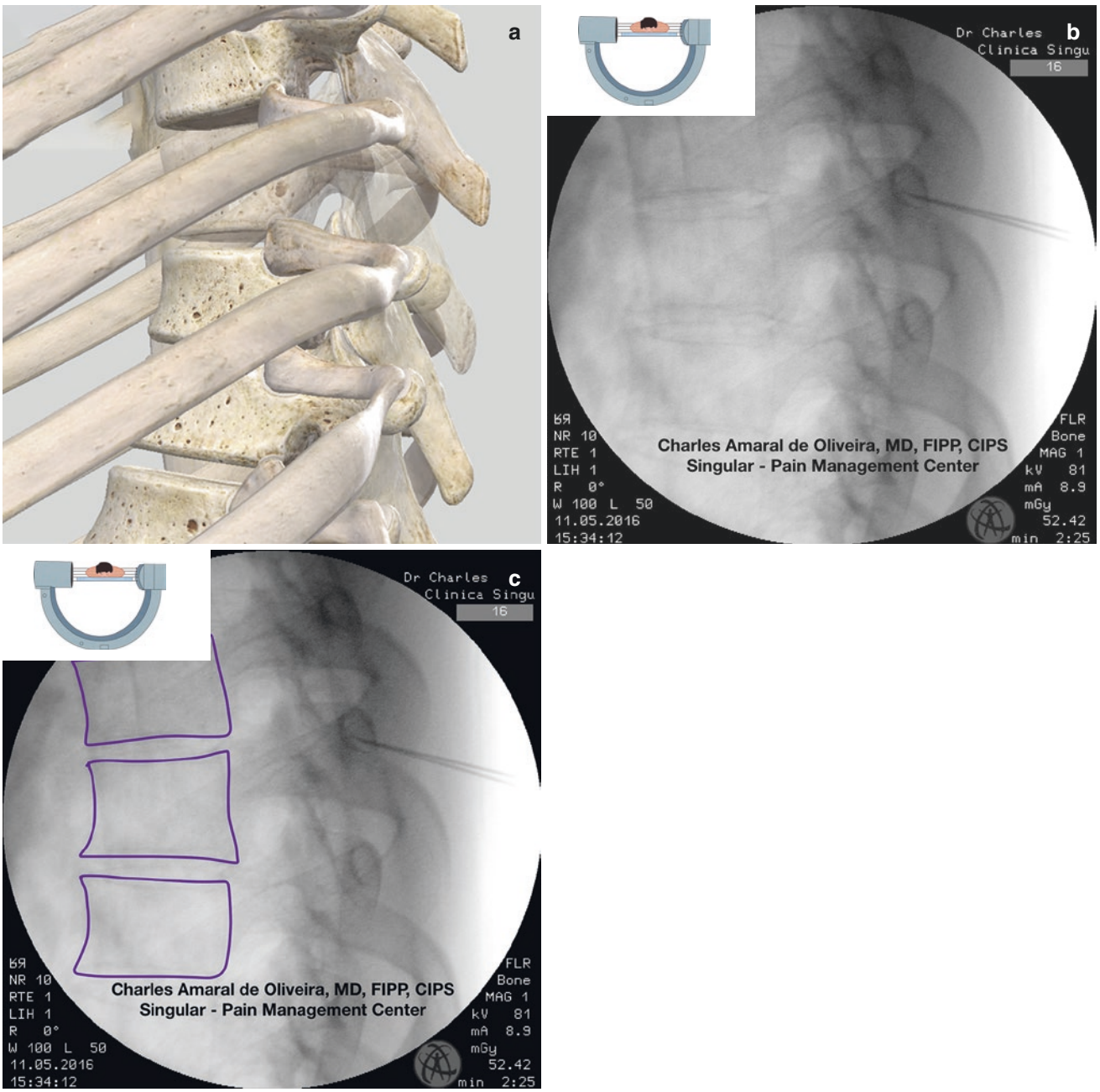

Fig. 13.4 Lateral view of the thoracic spine. Purple = vertebral body. Complete Anatomy image (**a**), native (**b**) and edited fluoroscopy image (**c**)

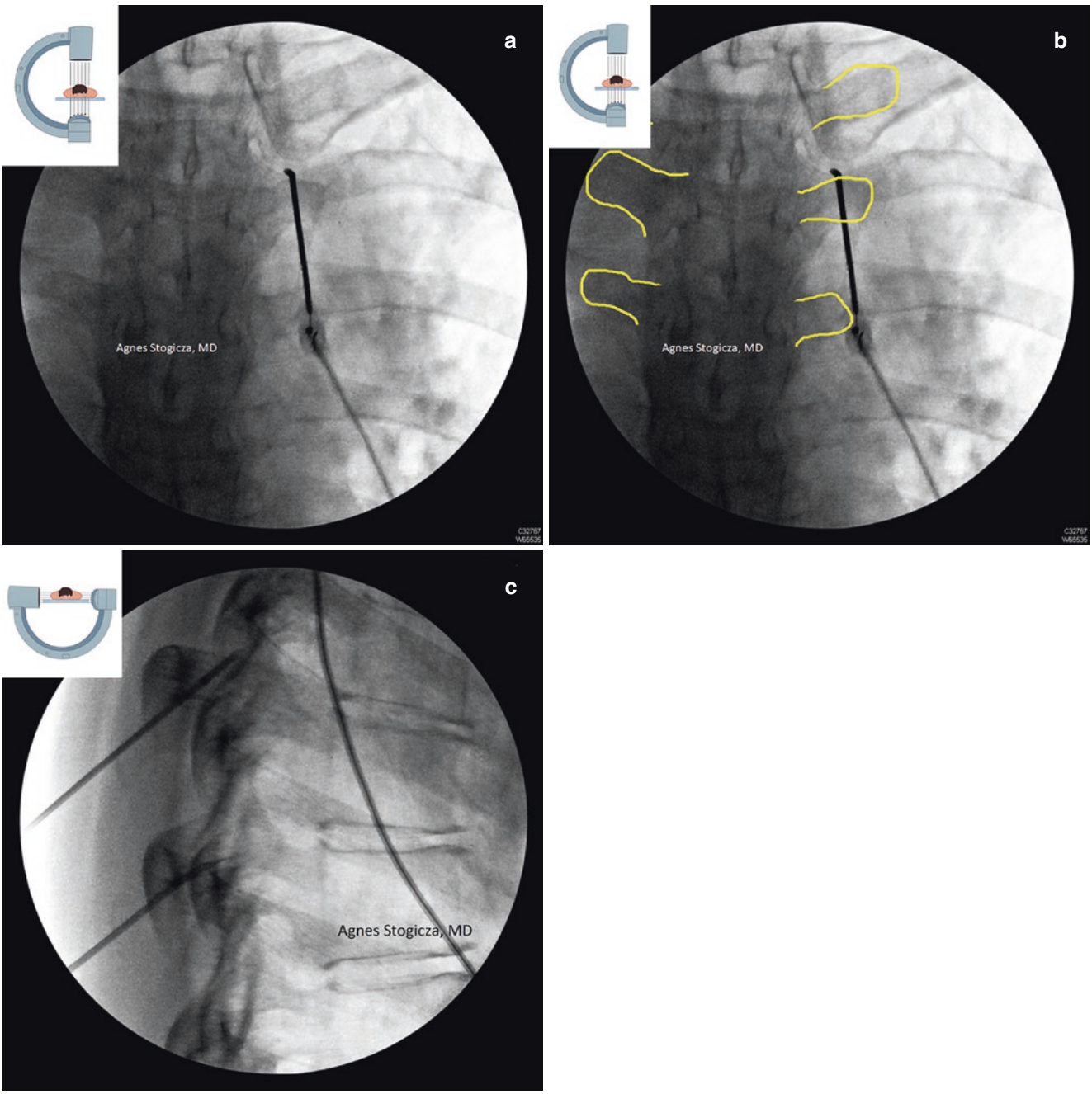

Fig. 13.5 Radiofrequency ablation with 18G cannula. The RFA cannula was slightly advanced from the superolateral margin of the transverse process, to achieve optimal sensory stimulation at <0.4 V. Native (**a**) and edited (**b**) images. Lateral view confirms sufficient distance from the neuroforamen (**c**)

Evidence

Table 13.1 Level of evidence and recommendations by the Benelux section of the World Institute of Pain
These recommendations are based on both a review of the literature in 2015 by an independent third party (Kleijnen Systematic Reviews LTD) and the previous published guidelines published in Pain Practice. The recent literature, the potential risk for complications, and the grade of invasiveness were considered when deciding to upgrade or downgrade the recommendation.

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Thoracic facet joint pain	Addition of corticosteroid to local anesthetic blocks of the thoracic medial branch (ramus medialis of the ramus dorsalis)		High	Moderate against

[1]van Kleef M, Stolker RJ, Lataster A, Geurts J, Benzon HT, Mekhail N. 10. Thoracic pain. Pain Pract. 2010;10:327–38
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[3]Huygen F, Kallewaard JW, van Tulder M, Van Boxem K, Vissers K, van Kleef M, et al. "Evidence-based interventional pain medicine according to clinical diagnoses": update 2018. Pain Pract. 2019;19:664–75
[4]https://www.anesthesiologie.nl/publicaties/praktische-richtlijnen-anesthesiologische-pijnbestrijding

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[1]Manchikanti L, Schultz DM, Falco FJE, Singh V. Thoracic facet joint interventions. In: Manchikanti L, Kaye AD, Falco FJE, Hirsch JA, editors. Essentials of interventional techniques in managing chronic pain. Springer International Publishing; 2018. p. 369–86.

Suggested Reading

Chua WH, Bogduk N. The surgical anatomy of thoracic facet denervation. Acta Neurochir. 1995;136:140–4.
Gaucci C. Thoracic facets. In: Manual of RF techniques. Ridderkerk: CoMedical; 2004. p. 67–78.
Gungor S, Candan B. The efficacy and safety of cooled radiofrequency neurotomy in the treatment of chronic thoracic facet (zygapophyseal) joint pain. Medicine (Baltimore). 2020;99(14):e19711.
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Stolker RJ, Vervest AC, Groen GJ. Percutaneous facet denervation in chronic thoracic spinal pain. Acta Neurochir. 1993;122:82–90.

The Thoracic Medial Branch Radiofrequency Ablation chapter was reviewed by Miles Day; Fabricio Dias Assis; Jan Van Zundert; Charles Gauci; Andrea M. Trescot; Milan Stojanovic; Peter S. Staats; Agnes R. Stogicza; Andre M. Mansano.

Spinal Cord Stimulator

14

Mert Akbas and Agnes R. Stogicza

Equipment and Monitoring

- Standard ASA monitoring
- Fluoroscopy
- Sterile prep, and drape
- Skin local anesthesia prior to any needle larger than 25G (unless sedation is used)
- Coaxial view is always used to advance needle, unless otherwise specified
- CPR equipment and medications available
- IV antibiotics single-dose preoperative is recommended
- 13–15G 3.5 inch (90 mm) to 6 inch (150 mm) straight or Coude epidural needle
- Saline 5–15 ml
- Spinal cord stimulator lead, anchors, tunneling tools, extension cables, and IPG/receiver
- Loss of resistance (LOR) syringe
- 2.0 nylon/vicryl, 2.0 silk, 3.0 vicryl sutures
- Occlusive bandage–if possible silver impregnated
- Bacitracin in saline for wound irrigation

Anatomy

Target is the posterior epidural space, to stimulate the dorsal columns with traditional tonic stimulation

- Back pain
  - Epidural entry level: L2–3 or L3–4
  - Level of top of the lead: T8–11
- Leg pain
  - Epidural entry level: L2–3, L3–4
  - Level of tip of the lead: generally, T9–10
- Foot pain–epidural entry level: L2–3, L3–4
  - Level of tip of lead: T11-L1
- Arm pain
  - Epidural entry level: T2–3 to T5–6
  - Level of tip of the lead: C3–4
- Neck pain
  - Epidural entry level: T4–5, T5–6
  - Level of tip of the lead: C2–3
- Abdominal pain
  - Epidural entry level: L2–3, L1–2
  - Level of tip of the lead: T4–5 to 5–6

The above levels reflect general concepts. The levels of epidural entry and target level for the lead may vary based on patient size, anatomy, previous spinal surgery, pain location, or other circumstances. For traditional tonic stimulation, it is important to overlap the areas of pain with a sensation of paresthesia. More recently, a number of novel waveforms and frequencies that do not require a paresthesia have become clinically available. Placement for these devices tends to have a set anatomic location. Burst and high frequency are placed between T8 and T9 for low back pain and at C2–3 for neck pain with or without radiculopathy.

Structures to Keep in Mind and Possible Complications

- Dura puncture → spinal headache
- Dural puncture and intrathecal medication administration → sudden onset motor block, cardiac/respiratory arrest, death
- Subdural puncture → spinal cord compression, or medication related sudden onset motor block, cardiac/respiratory arrest, death

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- Epidural blood vessels → bleeding, spinal cord compression and epidural hematoma formation, possible onset even after procedure is completed. This can also occur with insertion or removal of the electrodes
- Direct spinal cord damage/injection → loss of bladder/bowel function, various paresthesias, motor loss, depending on injected amount, syrinx formation, quadriplegia, death
- Epidural infection → abscess
- Exiting nerve roots → nerve injury
- Procedure should not be performed while patient is taking certain anticoagulants
- Heavy sedation should be preferably avoided for routine procedures
- Infection
- Bleeding
- Postprocedure pain
- Vasovagal reaction
- Allergic reaction

Fluoroscopy Technique, Target Localization

- Patient in prone position, with pillows under abdomen to decrease lumbar lordosis

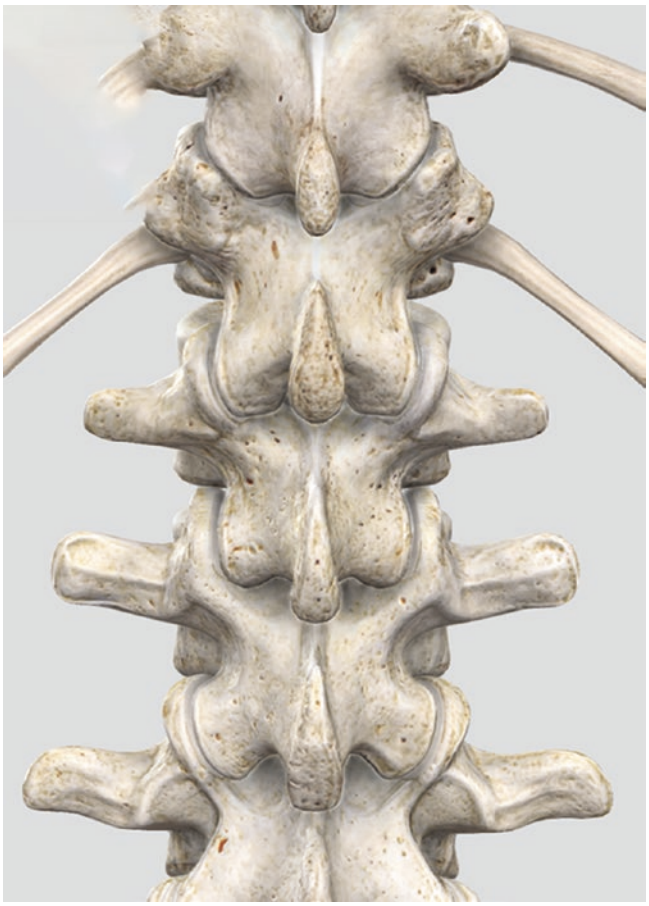

Fig. 14.1 AP image of the thoracolumbar spine, true AP, spinous processes in the midline. Complete Anatomy image

- True anteroposterior (AP) image, spinous processes in midline (Fig. 14.1)
- Slight caudad tilt in difficult cases may facilitate visualizing the interlaminar opening (Fig. 14.2a)
- **Non-coaxial view technique:**
  - Entry 2 vertebral bodies below target interlaminar space, in order to reach epidural space utilizing a shallow angle, entering in the midline. This will facilitate driving the lead midline in the posterior epidural space
- **Coaxial view technique:**
  - 30° caudad tilt of the C-arm
  - Skin entry just paramedian of the spinous process, immediately below the target interlaminar space

Procedure Steps

- Target the lamina caudad from the target interlaminar epidural place, in a paramedian approach (Fig. 14.2b, c)
- Walk needle off the cephalad edge of lamina to engage in ligamentum flavum
- Advance needle with LOR technique
- After LOR, check lateral view to see the depth of the needle tip (Fig. 14.3)
- Thread lead to confirm epidural position (Fig. 14.4a, b)
- Advance electrode cephalad in the posterior epidural space (Fig. 14.5)
- Use a forefinger/thumb "pill rolling" technique as the lead is advanced to maintain lead position as close as possible to the anatomical midline
- After lead placement, for tonic stimulation test, stimulation is performed with the patient awake. For paresthesia stimulation, the leads are left in an anatomic location
- Analgesia/paresthesia is reported by the patient and should cover the painful area for tonic stimulation
- Secure leads to fascia or skin once best pain area coverage is obtained
- When leads are in final position, check and save lateral and AP images (Figs. 14.6, 14.7a, b, and 14.8)
- For cervical levels: Consider using contralateral oblique view (CLO) where the tip of the needle can be advanced to the ventrolaminar line (VILL) without LOR. At interlaminar line, LOR should be employed. Detailed description provided in cervical epidural chapter

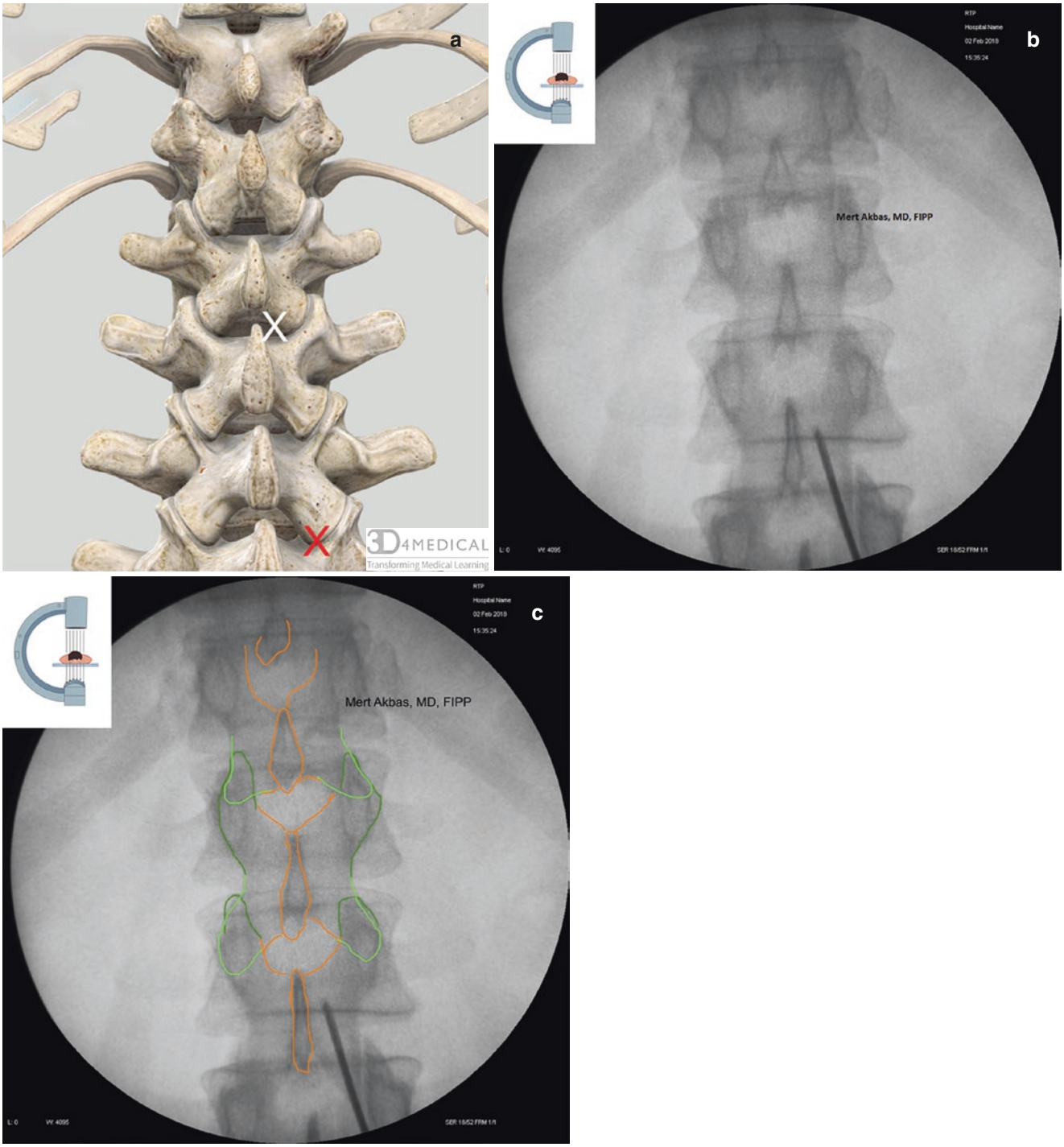

Fig. 14.2 AP image of the thoracolumbar spine, caudad tilt of the C-arm. Skin entry marked with red X, target interlaminar epidural space marked with white X. Needle tip is on the lamina, just below L1–2 interlaminar space. Orange = spinous process and lamina; dark green = superior articular process; light green = inferior articular process. Complete Anatomy image (**a**), native (**b**) and edited fluoroscopy image (**c**)

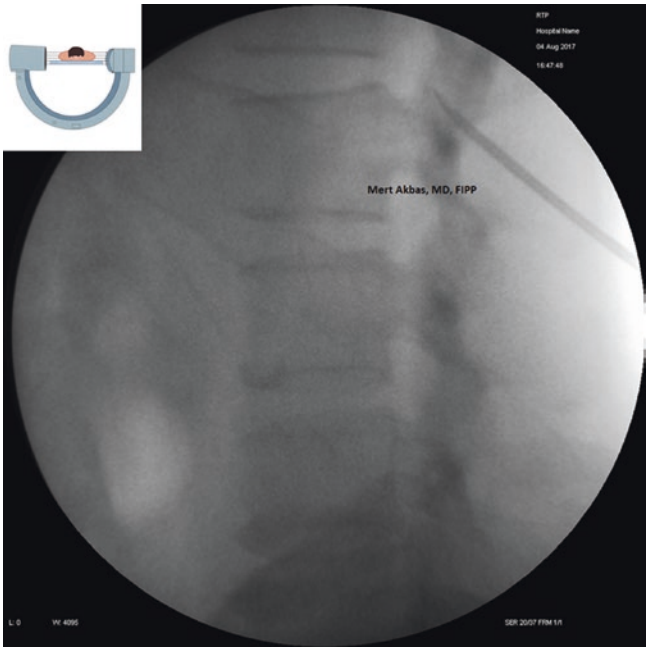

Fig. 14.3 Lateral view of the lumbar spine, needle in L1–2 epidural space after loss of resistance (LOR). Native fluoroscopy image

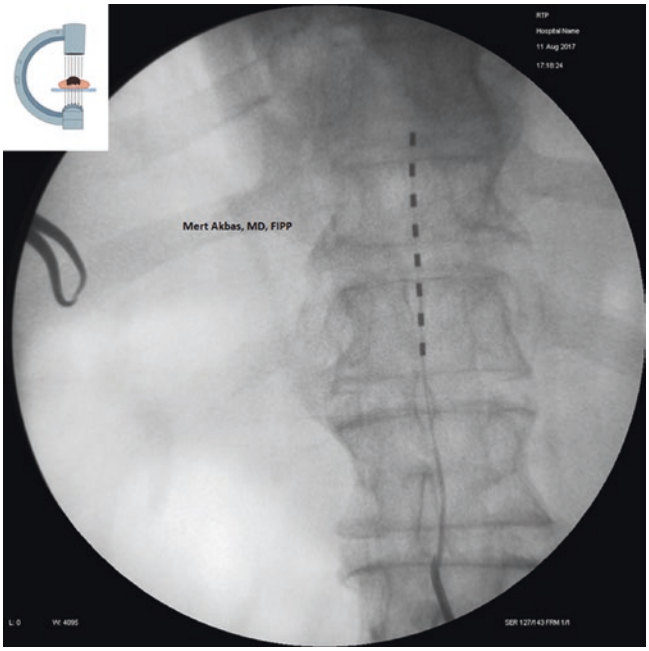

Fig. 14.5 AP image of thoracic spine, SCS lead is at the caudad edge of T10 vertebral body. Native fluoroscopy image

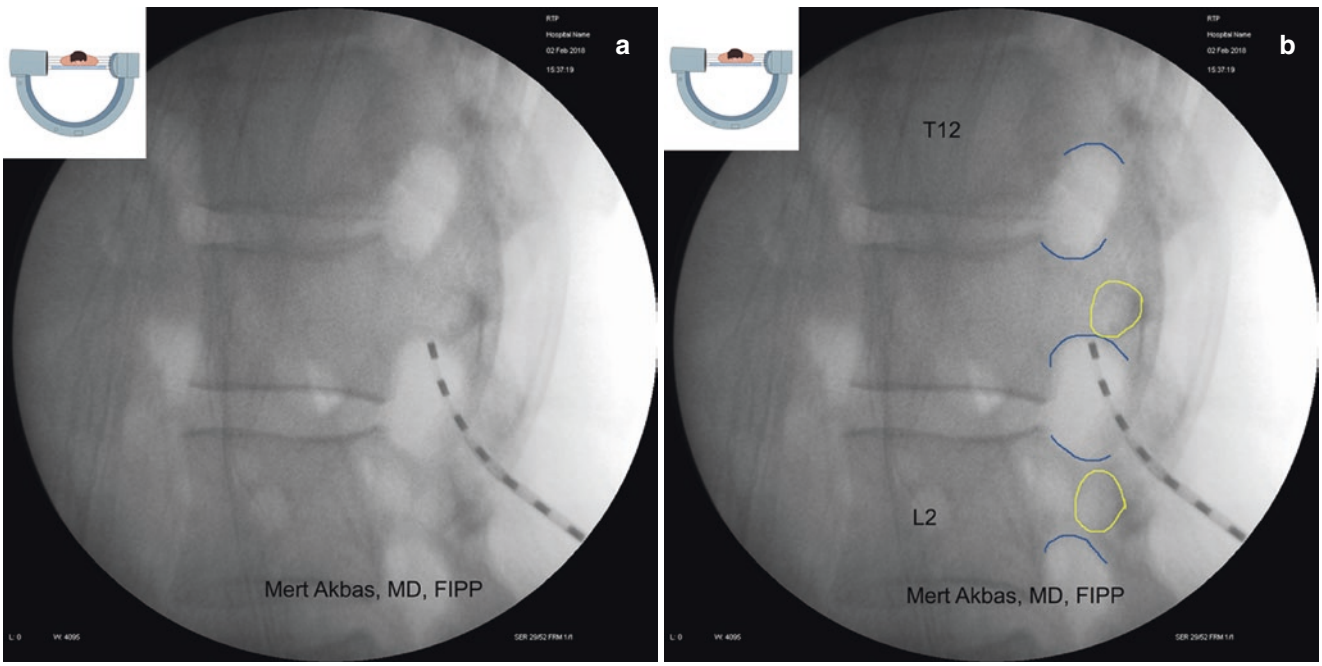

Fig. 14.4 Lateral image of thoracolumbar spine. Needle and lead in the posterior epidural space at L1–2 level. Blue = pedicle; yellow = transverse process. Native (**a**) and edited (**b**) fluoroscopy image

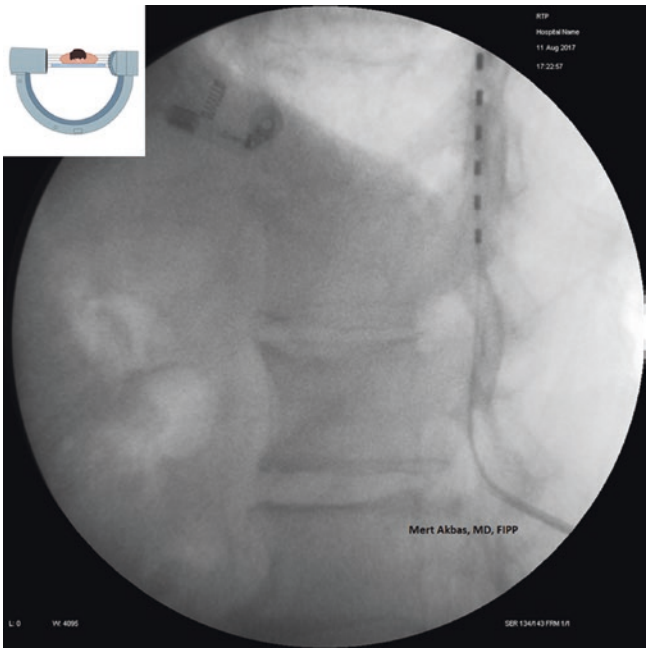

Fig. 14.6 Lateral image of thoracic spine, SCS lead is at the posterior epidural space. Native fluoroscopy image

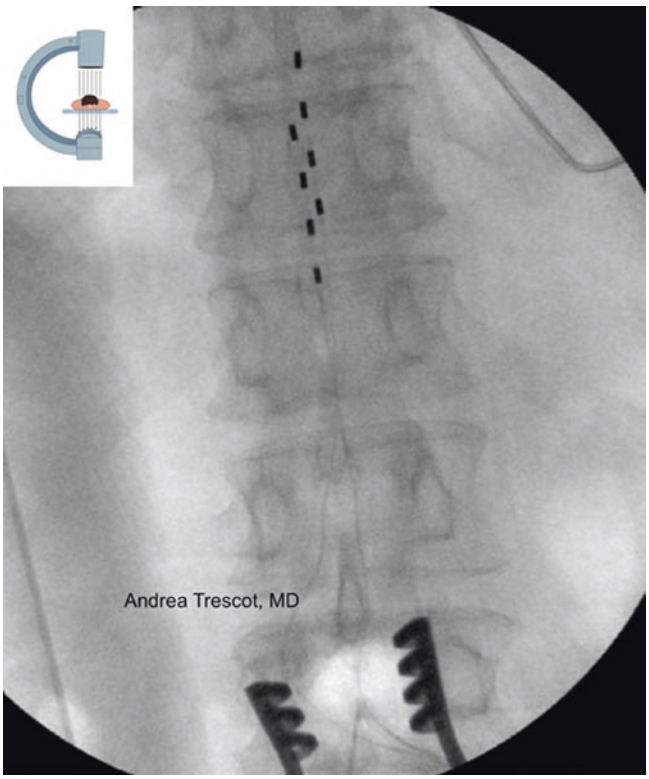

Fig. 14.8 Dual lead placement for better stimulation/coverage. Native fluoroscopy image

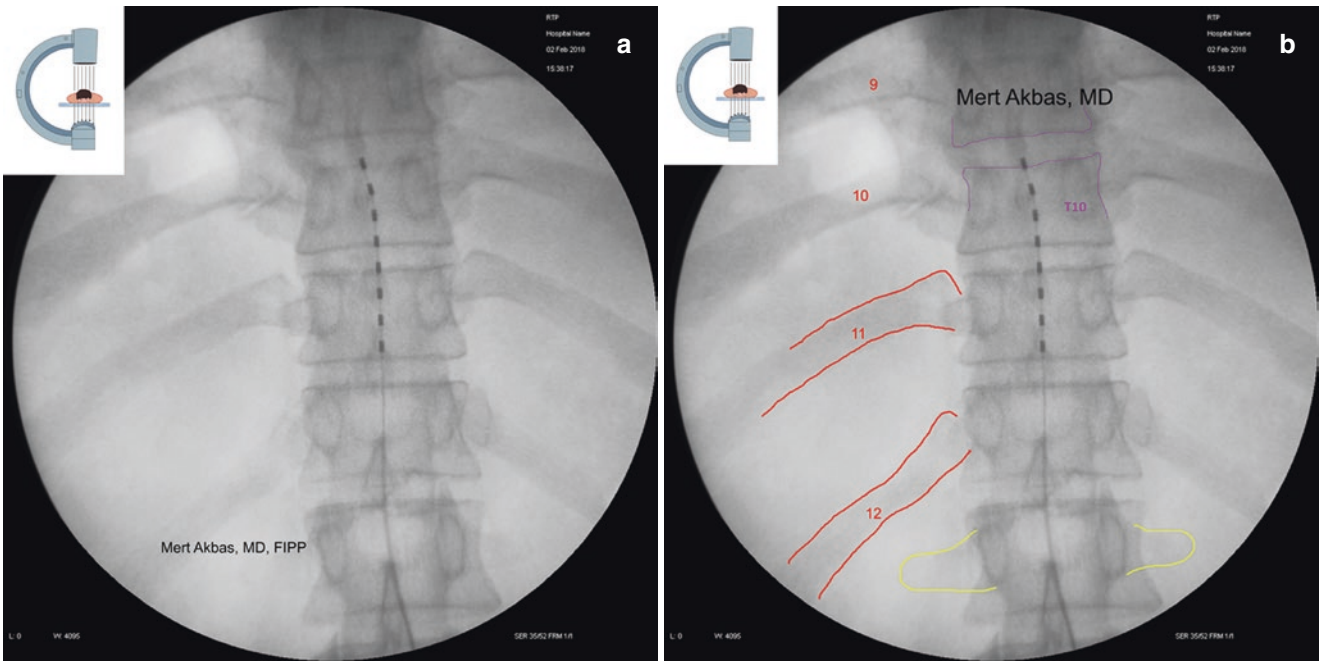

Fig. 14.7 Final lead position, at the cephalad edge of T10 vertebral body. Red = rib; yellow = transverse process. Native (**a**) and edited (**b**) fluoroscopy image

Clinical Pearls

- If the needle angle is too acute at epidural entry, it will be very difficult to keep the lead/s in the posterior epidural space
- Always confirm lead position in lateral view especially if patient experiences motor stimulation. This is done to rule out the possibility of anterior migration of the leads
- Repositioning of leads can be performed with a combination of AP and lateral views at regular intervals
- More than one lead may need to be placed for adequate pain area coverage

Unacceptable, Potentially Harmful Needle Placement on Exam

- Not checking lateral view
- Compromising spinal cord
- Rough needle/catheter manipulation, which may compromise spinal cord
- Obvious signs of lack of understanding thoracic spinal anatomy, for example, placing the lead in the subcutaneous area, posterior to the spinal canal, and believing it is well positioned

Unacceptable, But Not Harmful Needle Placement on Exam

- Not reaching the epidural space, but lateral view and LOR technique was carefully utilized to prevent spinal cord damage
- Lead in anterior epidural space
- Abandoned procedure

Evidence

Table 14.1 Level of evidence and recommendations by the Benelux section of the World Institute of Pain
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Indication	Procedure	Recommendation 2009[1]	Grade 2015[2]	Recommendation 2018[3,4]
Failed back surgery syndrome	Spinal cord stimulation (tonic)	2A+	Moderate	Moderate
Failed back surgery syndrome	Spinal cord stimulation (HF-10)		Not graded	Moderate
Complex regional pain syndrome[5]	Spinal cord stimulation	2B+	Moderate	Moderate
Painful diabetic polyneuropathy[6]	Spinal cord stimulation	2C+	Moderate	Moderate
Ischemic pain of the extremities[7]	Spinal cord stimulation	2B±	High	Moderate
Chronic refractory angina[8]	Spinal cord stimulation	2B+	Low	Weak

[1]Van Boxem K, Cheng J, Patijn J, van Kleef M, Lataster A, Mekhail N, et al. 11. Lumbosacral radicular pain. Pain Pract. 2010;10:339–58
[2]Kleijnen Systematic Reviews Ltd.: Search and evaluation of the literature. 2015.
[3]Huygen F, Kallewaard JW, van Tulder M, Van Boxem K, Vissers K, van Kleef M, et al. Evidence-based interventional pain medicine according to clinical diagnoses: update 2018. Pain Pract. 2019;19:664–75
[4]https://www.anesthesiologie.nl/publicaties/praktische-richtlijnen-anesthesiologische-pijnbestrijding
[5]van Eijs F, Stanton-Hicks M, Van Zundert J, Faber CG, Lubenow TR, Mekhail N, et al. Evidence-based interventional pain medicine according to clinical diagnoses. 16. Complex regional pain syndrome. Pain Pract. 2011;11:70–87
[6]Pluijms W, Huygen F, Cheng J, Mekhail N, van Kleef M, Van Zundert J, et al. Evidence-based interventional pain medicine according to clinical diagnoses. 18. Painful diabetic polyneuropathy. Pain Pract. 2011;11:191–8
[7]Devulder J, van Suijlekom H, van Dongen R, Diwan S, Mekhail N, van Kleef M, et al. 25. Ischemic pain in the extremities and Raynaud's phenomenon. Pain Pract. 2011;11:483–91
[8]van Kleef M, Staats P, Mekhail N, Huygen F. 24. Chronic refractory angina pectoris. Pain Pract. 2011;11:476–82

Table 14.2 Level of evidence based on the American Society of Interventional Pain Physicians (ASIPP) review of the literature

Spinal cord stimulation[1]	Evidence
Failed back surgery syndrome	Level II
Complex regional pain syndromes	Level II
Diabetic neuropathy	Level IV
Abdominal/pelvic pain	Level IV
Ischemic pain syndrome	Level IV

[1]Benyamin RM, Vallejo R, Cedeno DL. Spinal cord stimulation. In: Manchikanti L, Kaye AD, Falco FJE, Hirsch JA, editors. Essentials of interventional techniques in managing chronic pain. Springer International Publishing; 2018. p. 659–670.

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Yampolsky C, Hem S, Bendersky D. Dorsal column stimulator applications. Surg Neurol Int. 2012;3:275.

This chapter was reviewed by Alan Berkman; Fabricio D. Assis; Andrea M. Trescot; Milan Stojanovic; Peter S. Staats; Agnes R. Stogicza; Andre M. Mansano.

Part III

Lumbar Procedures

Lumbar Facet (Intraarticular) Block

15

Sarfaraz M. Khan

Equipment and Monitoring

- Standard ASA monitoring
- Fluoroscopy
- Sterile prep, and drape
- Skin local anesthesia prior to any needle larger than 25G (unless sedation is used)
- Coaxial view is always used to advance the needle, unless otherwise specified
- CPR equipment and medications available
- 22–25G, 3.5 inch (90 mm)–6 inch (150 mm) needle, curved to facilitate steering
- Extension tubing
- Nonionic contrast
- Medication for injection (local anesthetic +/− steroid)

Anatomy

- C-arm AP view for identification of level (count from T12 rib down)
- Superior articular process (SAP) and inferior articular process (IAP) make up the joint, which are held together by the facet capsule
- Ipsilateral oblique for "Scotty dog" appearance of the vertebra
- Target the inferior recess (lower third) of the facet opening, as it has no direct relation with neural elements
- Note that while the T12-L1 facet joint opening faces posteriorly, as we proceed to L5-S1, the opening faces gradually more and more laterally (Fig. 15.1)
- Angle the C-arm ipsilaterally to open the joint

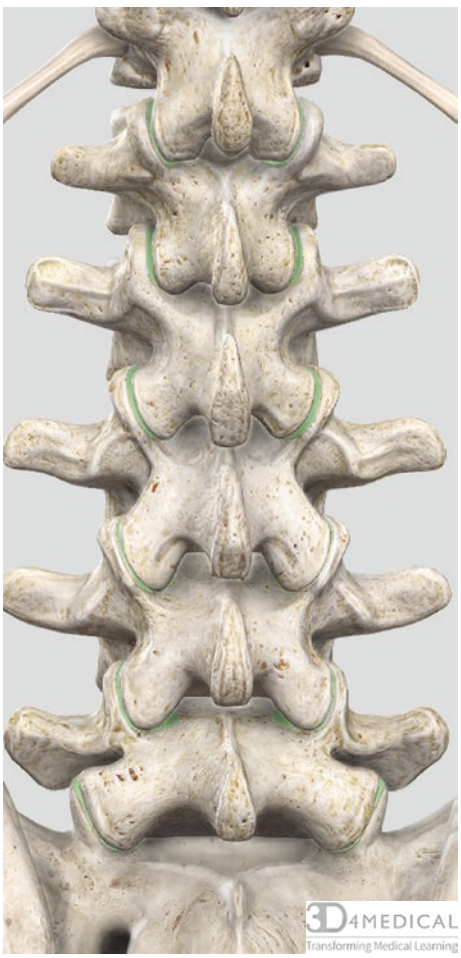

Fig. 15.1 Posterior view of the lumbar spine demonstrates the orientation of the facet joints. Complete Anatomy image

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Structures to Keep in Mind and Possible Complications

- Bony surfaces → bleeding/pain
- Sliding off the superior articular process → possibility of nerve root damage
- Epidural, subdural, intrathecal space → intrathecal, epidural medication administration, high spinal anesthesia, spinal cord injury, paralysis, death
- Infection
- Bleeding
- Postprocedure pain
- Vasovagal reaction
- Allergic reaction

Fluoroscopy Technique, Target Localization

- Patient in prone position
- Anteroposterior (AP) view to identify the spinal level by counting from the T12 vertebra
- Square off vertebra
- Ipsilateral oblique the C-arm until the desired facet joint is opened up (all facet joints may appear at once or in different oblique angles) (Fig. 15.2a–d)
- Skin entry is at the lower third of the facet joint (inferior recess)

Procedure Steps

- Needle entry at the inferior portion of the joint with coaxial technique in ipsilateral oblique view (Fig. 15.2a–d)
- Entry into the facet joint can be felt as a "pop" or a "giving way"
- Confirm intra-articular position with no more than 0.2–0.5 ml contrast material (to prevent rupture) (Figs. 15.2b and 15.3a, b)
- AP and lateral view also confirms optimal (not too anterior) position of the needle (Fig. 15.3a, b)

Clinical Pearls

- Ipsilateral oblique should demonstrate posterior facet joint line; tilting further will demonstrate anterior facet joint line and eventually cause difficulty in needle entry in the joint (upper lumbar levels may require tilting up to 30° and lower lumbar levels up to 60°)
- Minimal contrast volume (0.2–0.5 ml) is recommended to confirm the intra-articular position, to avoid filling the facet joint with contrast (leaving no room for the therapeutic mixture of local anesthetic and steroid)
- Avoid pushing the contrast under pressure/resistance as this may rupture the facet joint capsule, leading to reduced therapeutic effect

Unacceptable, Potentially Harmful Needle Placement on Exam

- Placing needle through the joint into the spinal canal
- Not checking AP/lateral view
- Any proof of lack of understanding of lumbar spine anatomy, for example, the needle placed in the vertebral body or disc and believing it is in the right place

Unacceptable, But Not Harmful Needle Placement on Exam

- The procedure was abandoned after unsuccessful attempts, but it was clear that the examinee was cognizant of the safety aspects of the procedure, the needle did not compromise vital structures
- Rough needle manipulation

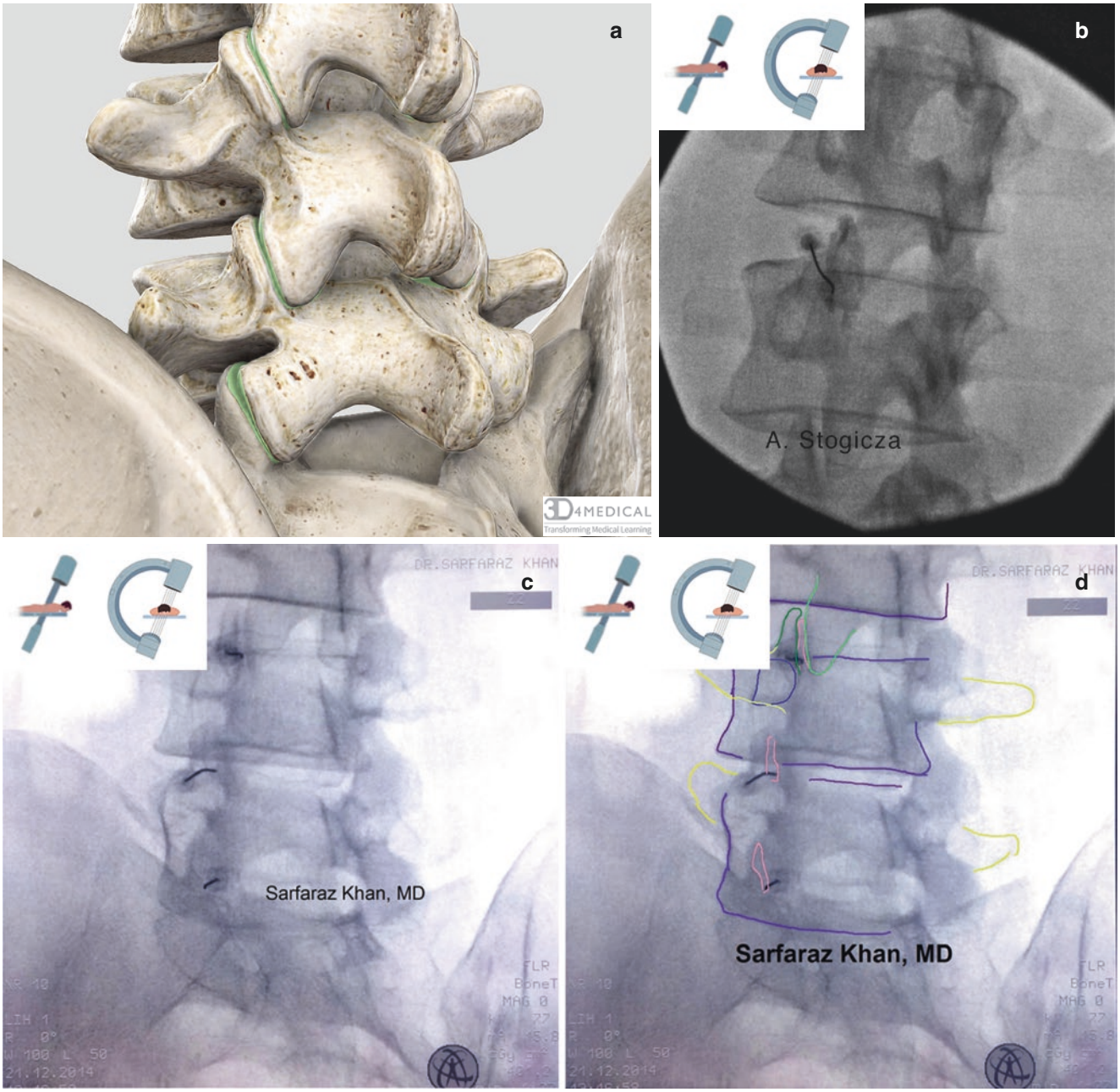

Fig. 15.2 Ipsilateral oblique view showing the facet joint lines, with the needles in the left facet joints. Contrast outlines the L1-2 facet joint (**b**). Yellow = transverse process; dark green = superior articular process; light green = inferior articular process; dark blue = pedicle; purple = vertebral body; pink = facet joint. Complete Anatomy image (**a**), native (**b**, **c**) and edited (**d**) fluoroscopy image, contrast in joint space (**b**)

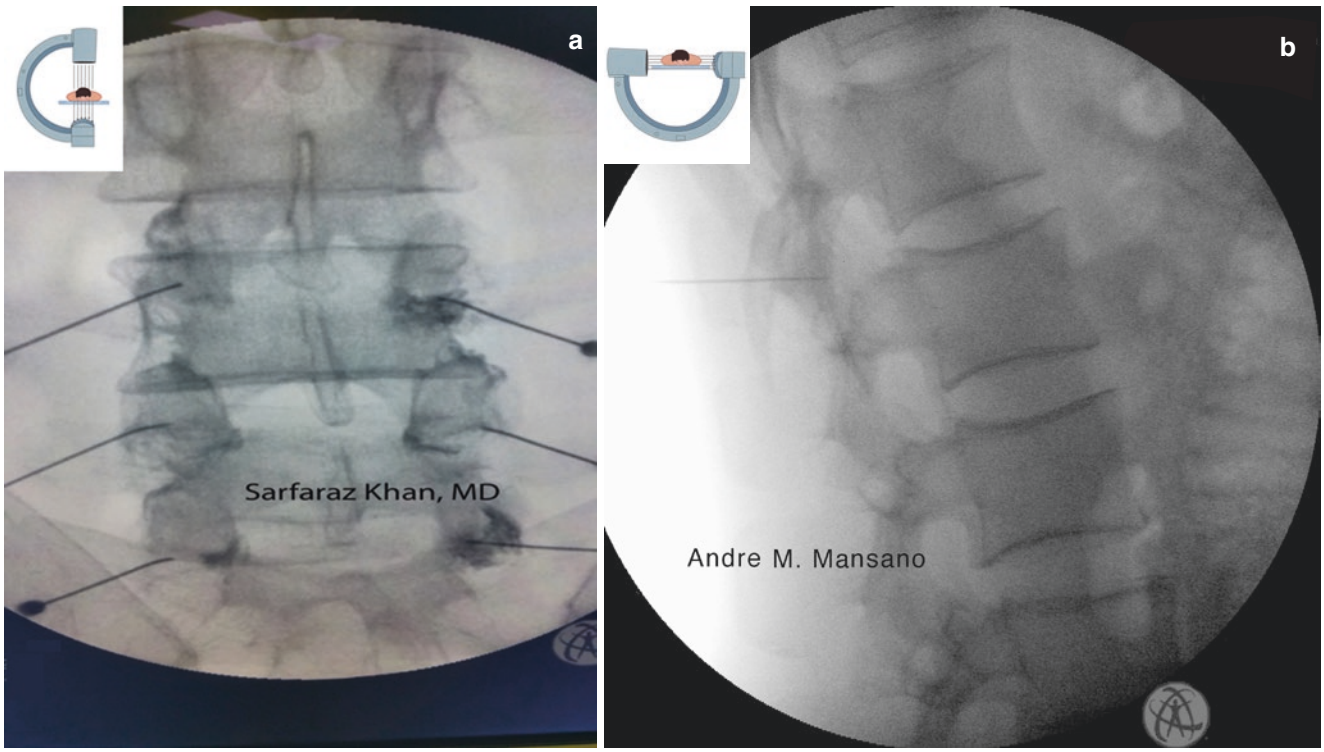

Fig. 15.3 AP fluoroscopy image with needles and contrast in L3–4, L4–5, L5–S1 facet joints bilaterally (**a**). Lateral view also confirms optimal needle position (**b**)

Evidence

Table 15.1 Level of evidence and recommendations by the Benelux section of the World Institute of Pain
These recommendations are based on both a review of the literature in 2015 by an independent third party (Kleijnen Systematic Reviews LTD) and the previous published guidelines published in Pain Practice. The recent literature, the potential risk for complications, and the grade of invasiveness were considered when deciding to upgrade or downgrade the recommendation.

Indication	Procedure	Recommendation 2009[1]	Grade 2015[2]	Recommendation 2018[3,4]
Low back pain originating from the lumbar facet joints	Radiofrequency treatment (ablation) of the lumbar medial branch (ramus medialis of the ramus dorsalis)	1B+	Low	Weak
Low back pain originating from the lumbar facet joints	Pulsed radiofrequency treatment of the lumbar medial branch (ramus medialis of the ramus dorsalis)		Low	Very weak against

[1]van Kleef M, Vanelderen P, Cohen SP, Lataster A, Van Zundert J, Mekhail N. 12. Pain originating from the lumbar facet joints. Pain Pract. 2010;10:459–69
[2]Kleijnen Systematic Reviews Ltd.: Search and evaluation of the literature. 2015
[3]Huygen F, Kallewaard JW, van Tulder M, Van Boxem K, Vissers K, van Kleef M, et al. "Evidence-based interventional pain medicine according to clinical diagnoses": update 2018. Pain Pract. 2019;19:664–75
[4]https://www.anesthesiologie.nl/publicaties/praktische-richtlijnen-anesthesiologische-pijnbestrijding

Table 15.2 Level of evidence based on the American Society of Interventional Pain Physicians (ASIPP) review of the literature

Lumbar facet joint interventions[1]	Evidence
Diagnostic lumbar facet joint nerve blocks	Level I
Therapeutic lumbar facet medial branch blocks	Level II
Therapeutic lumbar facet medial branch neurotomy	Level II

[1]Manchikanti L, Schultz DM, Falco FJE, Singh V. Lumbar facet joint interventions. In: Manchikanti L, Kaye AD, Falco FJE, Hirsch JA, editors. Essentials of interventional techniques in managing chronic pain. Springer International Publishing; 2018. p, 349–368

Suggested Reading

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Cohen SP, Moon JY, et al. Medial branch blocks or intra-articular injections as a prognostic tool before lumbar facet radiofrequency denervation. Regional Anesthesia and Pain Medicine. 40(4):376–383.
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The Lumbar Intra-articular Facet chapter was reviewed by Amitabh Gulati; Andrea M. Trescot; Milan Stojanovic; Peter S. Staats; Agnes R. Stogicza; Andre M. Mansano; Athmaja Thottungal and Raja Reddy.

Lumbar Medial Branch Block and Radiofrequency Ablation

16

Sandra A. S. van den Heuvel, David G. Vivian, and Paul Verrills

Equipment and Monitoring

- Standard ASA monitoring
- Fluoroscopy
- Sterile prep, and drape
- Local anesthesia prior to any needle larger than 25G (unless sedation is used)
- Coaxial view is always used to advance needle, unless otherwise specified
- CPR equipment and medications available

For Diagnostic Block

- 22–25G, 3.5 inch (100 mm) – 6 inch (150 mm) needle, tip curved to facilitate steering 150-mm

For Radiofrequency Ablation (RFA)

- 18–20G RF cannula(s), 10 mm active tip (preferably curved tip), 3.5–5 inch (90–130 mm) depending on body habitus
- RF generator with capacity for unipolar and bipolar lesions
- Local anesthetic
- Grounding pad

Anatomy

- The innervation of each facet joint is via the medial branches of contiguous dorsal rami; because of the additional cervical nerve (C8), each lumbar facet joint innervation is shifted one level cephalic such that, for example, the L4/5 facet joint is innervated by the L3 and L4 medial branches
- Furthermore, the L5/S1 facet joint is innervated from above by the medial branch of the L4 dorsal ramus and the L5 dorsal ramus from below
- The medial branches of the L1–4 dorsal rami, which innervate the facet joints and multifidus, run caudally and dorsally, lying against bone at the junction of the root of the transverse process with the root of the superior articular process from where they pass through a fibro-osseous tissue, covered by the mamillo-accessory ligament. The articular branches arise from this region
- The L5 dorsal ramus passes dorsally over the ala of the sacrum, lying against bone in a groove formed by the junction of the ala with the root of the superior articular process (SAP) of the sacrum. Opposite the caudal aspect of the L5/S1 facet joint, the L5 dorsal ramus divides into a medial and a lateral branch; the medial branch hooks medially around the joint, which it supplies, and then ramifies into the multifidus muscle. The lateral branch runs caudally to communicate with the lateral branch of the S1 dorsal ramus

Structures to Keep in Mind and Possible Complications

- Nerve root → paresthesia, sensory/motor dysfunction, sensory/motor loss
- Disc → discitis
- Dura → postdural puncture headache, spinal cord lesion
- Intravascular injection, bleeding, retroperitoneal hematoma

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- Infection, epidural abscess, vertebral osteomyelitis
- Postprocedure pain
- Vasovagal reaction
- Allergic reaction

Fluoroscopy Technique, Target Localization - Diagnostic Block

Sandra A. S. van den Heuvel

- Prone position; reduce lumbar lordosis with a pillow underneath the lower abdomen
- Anteroposterior (AP) view. Identify level and square off endplates (Fig. 16.1a–c)
- Oblique (approximately 15°), until the joint line between the SAP and inferior articular process (IAP) opens. The C-arm can be turned less oblique (0–10°) for L5 (Fig. 16.2a–c)
- Mark entry point on the skin, which should be at the junction of SAP and the transverse process (TP) or SAP of S1 and sacral ala (SA)

Procedure Steps - Diagnostic Block

- Oblique view: Advance the needle in coaxial view to touch bone at the junction of the SAP and TP (Fig. 16.2a–c)

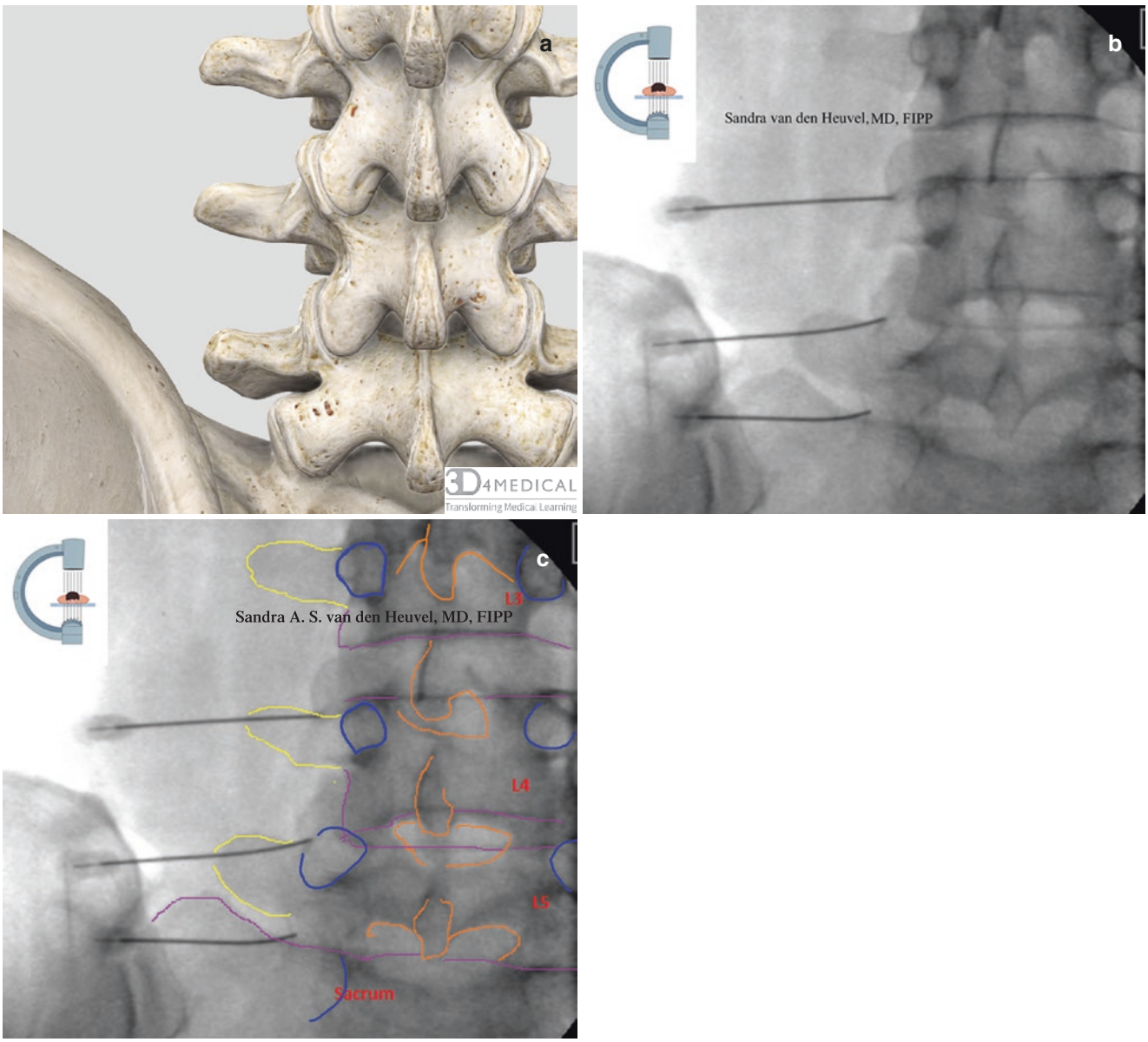

Fig. 16.1 AP view of the lumbar spine. Cannulas are placed at the L3 and L4 medial branches and L5 dorsal ramus for diagnostic medial branch block. Vertebral bodies are squared off at L3–4 level. Orange = spinous process and lamina; purple = vertebral body and sacrum; yellow = transverse process; dark blue = pedicle. Complete Anatomy image (**a**), and native (**b**) and edited fluoroscopy image (**c**)

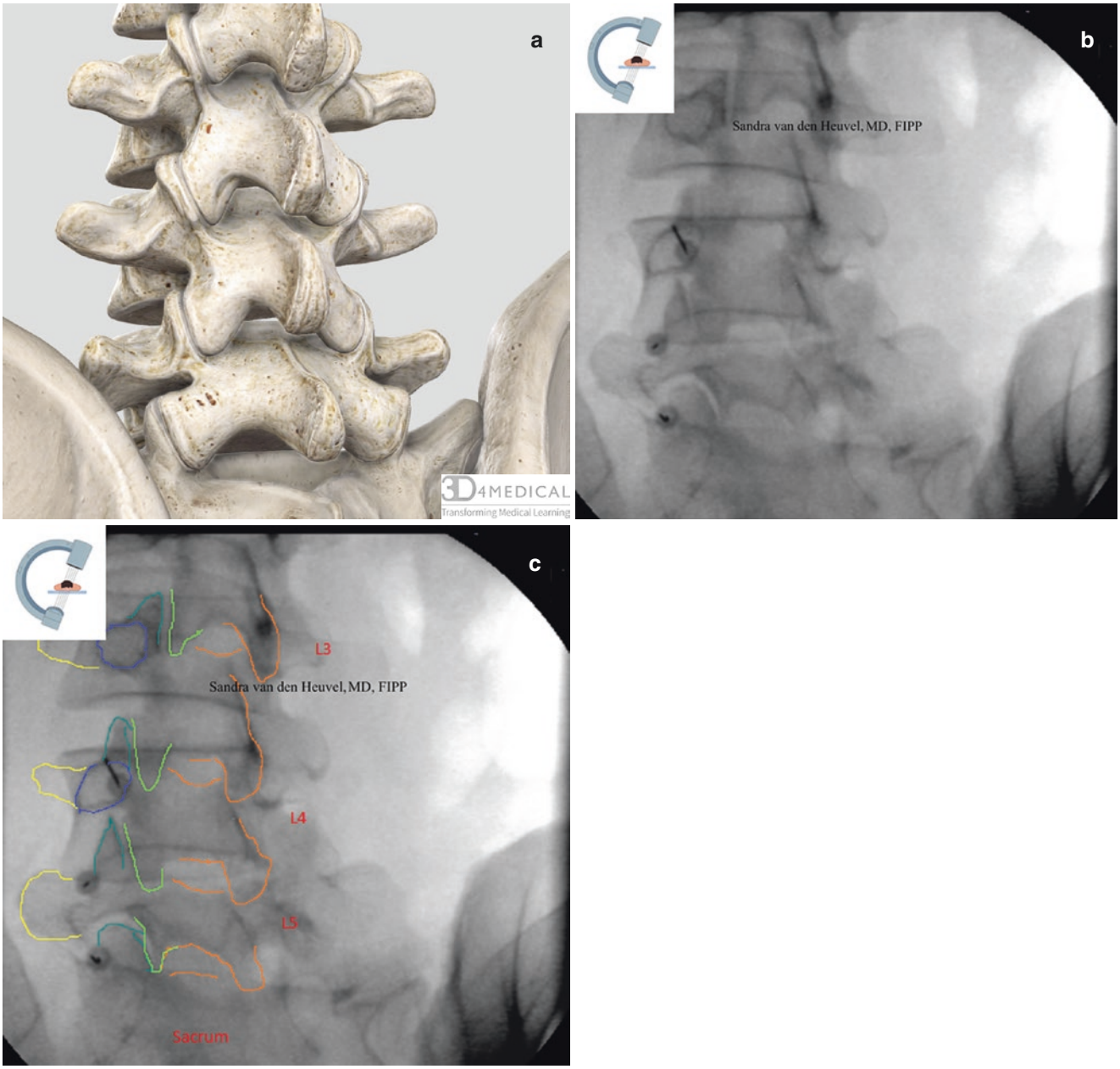

Fig. 16.2 Oblique view of the lumbar spine. Vertebral bodies are squared off at L3–4 level; C-arm is obliqued 20° toward the side of interest. Needles are placed at the L3 and L4 medial branches and L5 dorsal ramus for a diagnostic medial branch block. Orange = spinous process and lamina; yellow = transverse process; dark green = superior articular process; light green = inferior articular process; dark blue = pedicle. Complete Anatomy image (**a**), and native (**b**) and edited fluoroscopy image (**c**)

- Lateral view: The needle should be at the base of the SAP, dorsal to the posterior border intervertebral foramen (Fig. 16.3a–c)
- AP view to confirm needle position: It should touch the SAP (Fig. 16.1a–c)
- Aspiration should be negative. Contrast confirms lack of vascular uptake (Fig. 16.4)
- Limit local anesthetic to 0.5 ml per level

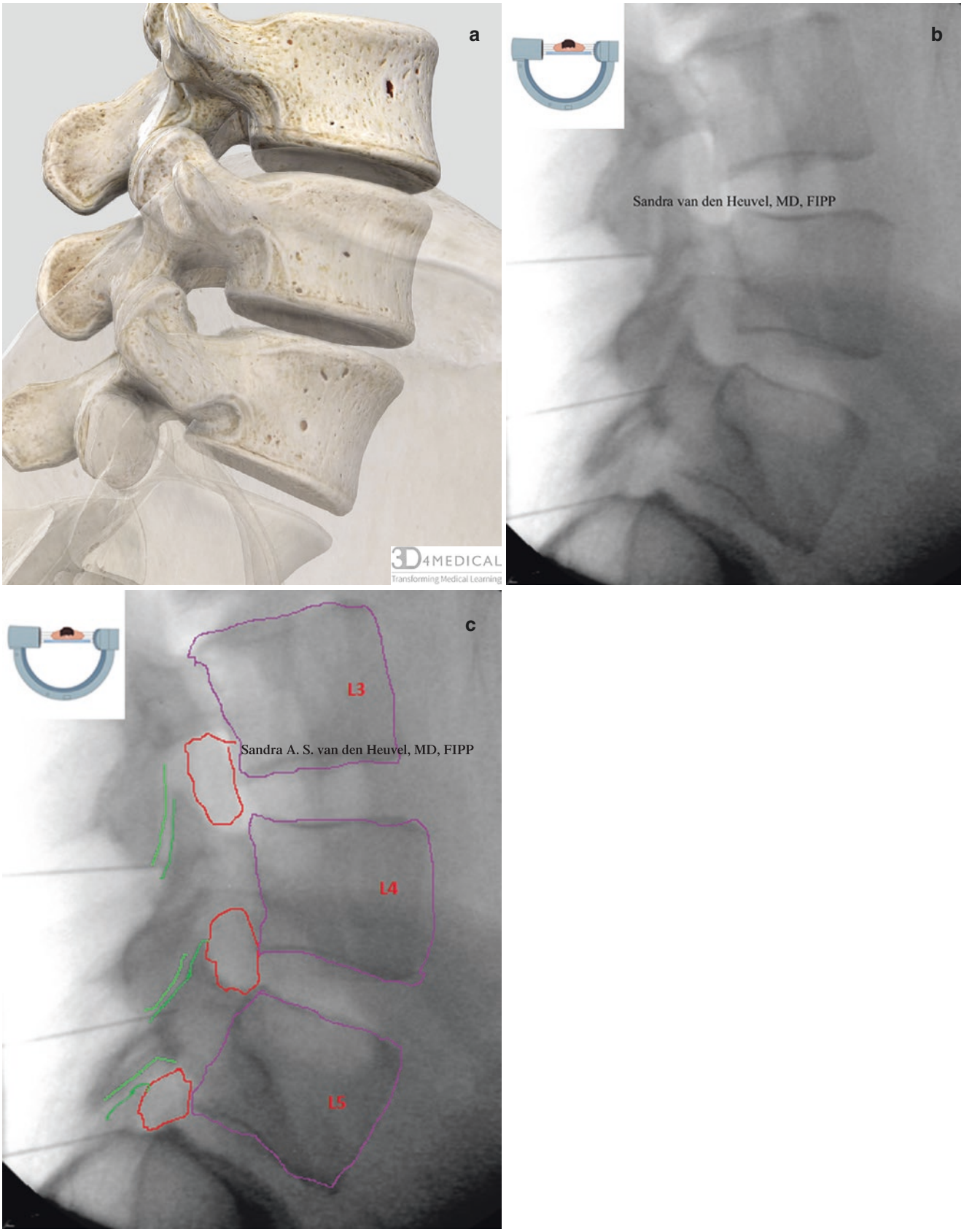

Fig. 16.3 Lateral view of the lumbar spine. Sacrum and ilium faded (**a**). Needles are placed at the L3 and L4 medial branches and L5 dorsal ramus for a diagnostic block. Dark green = superior articular process; light green = inferior articular process; red = intervertebral foramen; purple = vertebral body. Complete Anatomy image (**a**) and native (**b**) and edited (**c**) fluoroscopy images

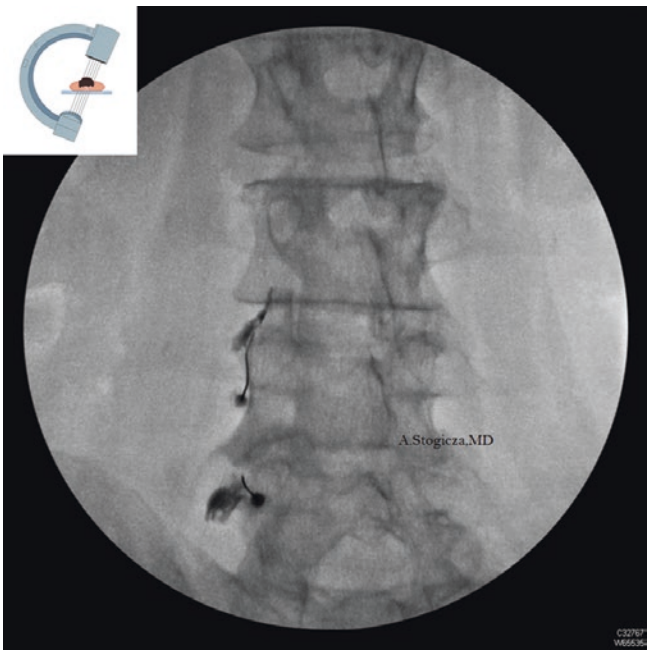

Fig. 16.4 L3 and L4 diagnostic medial branch block. Appropriate contrast spread, no vascular uptake. Native fluoroscopy image

Fluoroscopy Technique, Target Localization - Radiofrequency Ablation

David Vivian and Paul Verrills

L1–4 Medial Branches

- Start as described above for diagnostic block (Figs. 16.1a–c and 16.2a–c)
- Caudad tilt of the C-arm will enable the needle to project from a caudad approach; this is typically about 30° of caudad tilt (Fig. 16.5a–c)

L5 Dorsal Ramus

- One may follow the exact same method as the L1–4 medial branches, bearing in mind that the oblique angle may need a slight adjustment to remove the ilium from needle trajectory

OR

- AP view of the lumbar spine
- Caudad tilt of the C-arm will enable the needle to project from a caudad to the junction of the SAP and SA (sacral ala) of S1; this is typically about 30° of caudad tilt (Fig. 16.6a–c)

Procedure Steps - Radiofrequency Ablation

- Insert cannula and advance it in a coaxial view, aiming at the intended target point: the junction of the SAP and the TP (Figs. 16.5a–c and 16.6a–c)
- Once on bone, and before the cannula advances past the cephalic aspect of the transverse process, assess the anterior position by using a lateral C-arm view (Fig. 16.7a–d)
- True lateral views are identified when the iliopectineal lines are overlapped on lateral imaging (Figs. 16.7a, b and 16.8b)
- Inject local anesthetic and perform lesion
- Bipolar (Fig. 16.8a–c) or unipolar lesions can be performed; the former provides larger lesions
  - If unipolar, place the grounding pad as close to the actual lesion as possible, particularly if metal is present around the site; the closer the pad is to the lesion site, the lower the impedance
  - Try to keep the electrical pathway remote from metal; if there is metallic spinal fusion above the intended target, place the pad below the lesion so that metal is more distant (the metal acts as an electron sink)
- During the lesioning, monitor the temperatures (typically 80–90 °C is required)
- If impedance rises, check machine and leads, and consider injecting saline around the cannula tip
  - Saline can lower impedance and improve the lesion size, and it can be injected as the lesion is performed

Clinical Pearls

- The needle is always directed cephalad and medially from a point caudad to the fluoroscopically optimized vertebra being targeted
- Obtain a true lateral image (iliopectineal lines superimposed) to be able to assess the depth
- Ensure that the trajectory of the needle is kept over bone as it is advanced to ensure that the spinal canal or spinal nerve is not compromised
- Regularly use lateral, oblique, and AP views to ensure safe and accurate needle manipulation
- In older patients, in particular, the anatomy can be difficult to assess; take care and do not perform the procedure if there is any chance of malposition
- As the medial branches are potentially insulated from the RF lesion by the mamillo-accessory ligament, there is an added need for very accurate needle placement

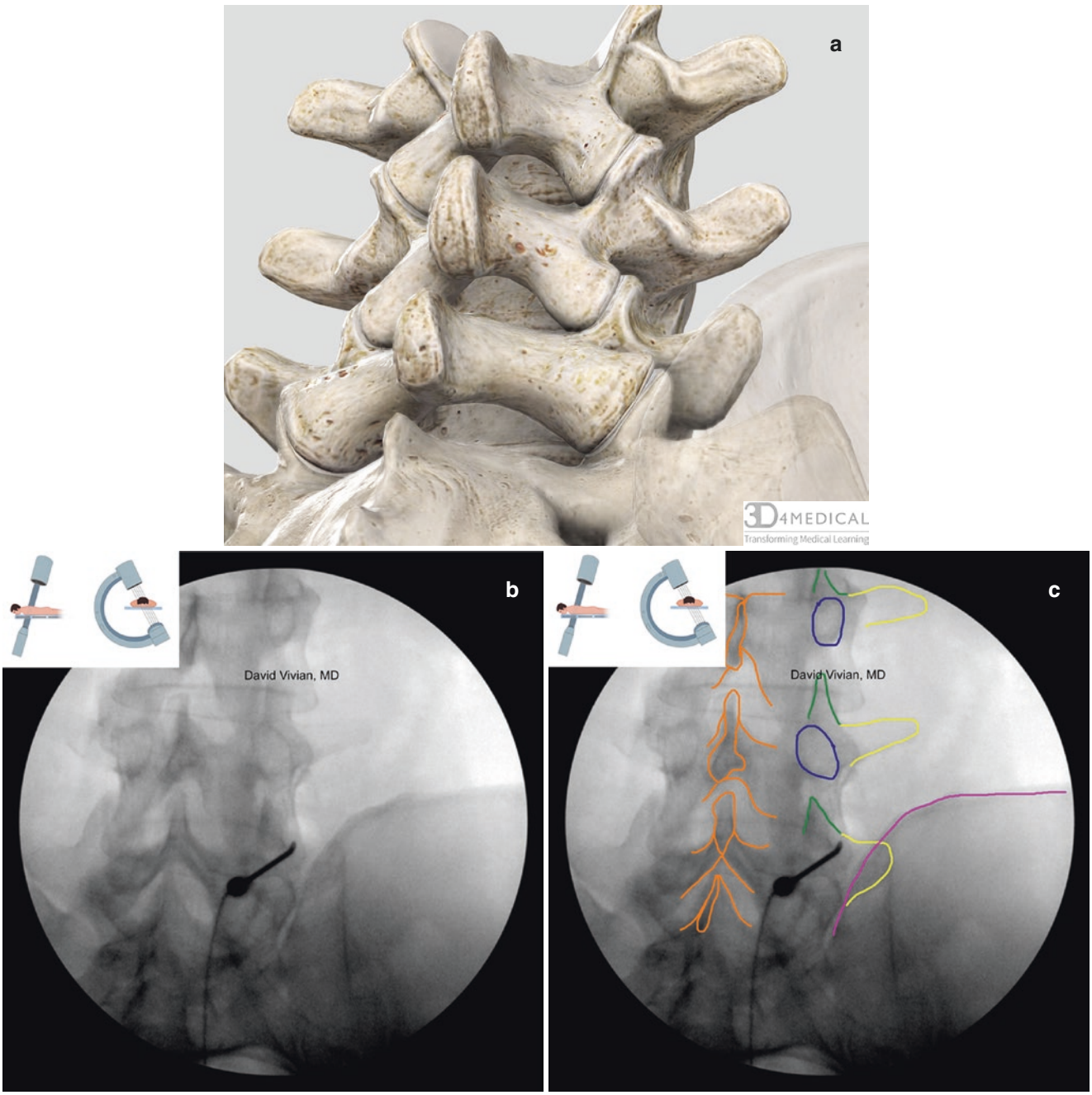

Fig. 16.5 L4 medial branch radiofrequency ablation. C-arm is slightly obliqued to the ipsilateral side, then tilted caudally. Orange = spinous process and lamina; yellow = transverse process; dark green = superior articular process; dark blue = pedicle; pink = ilium. Complete Anatomy image (**a**), native (**b**) and edited fluoroscopy image (**c**)

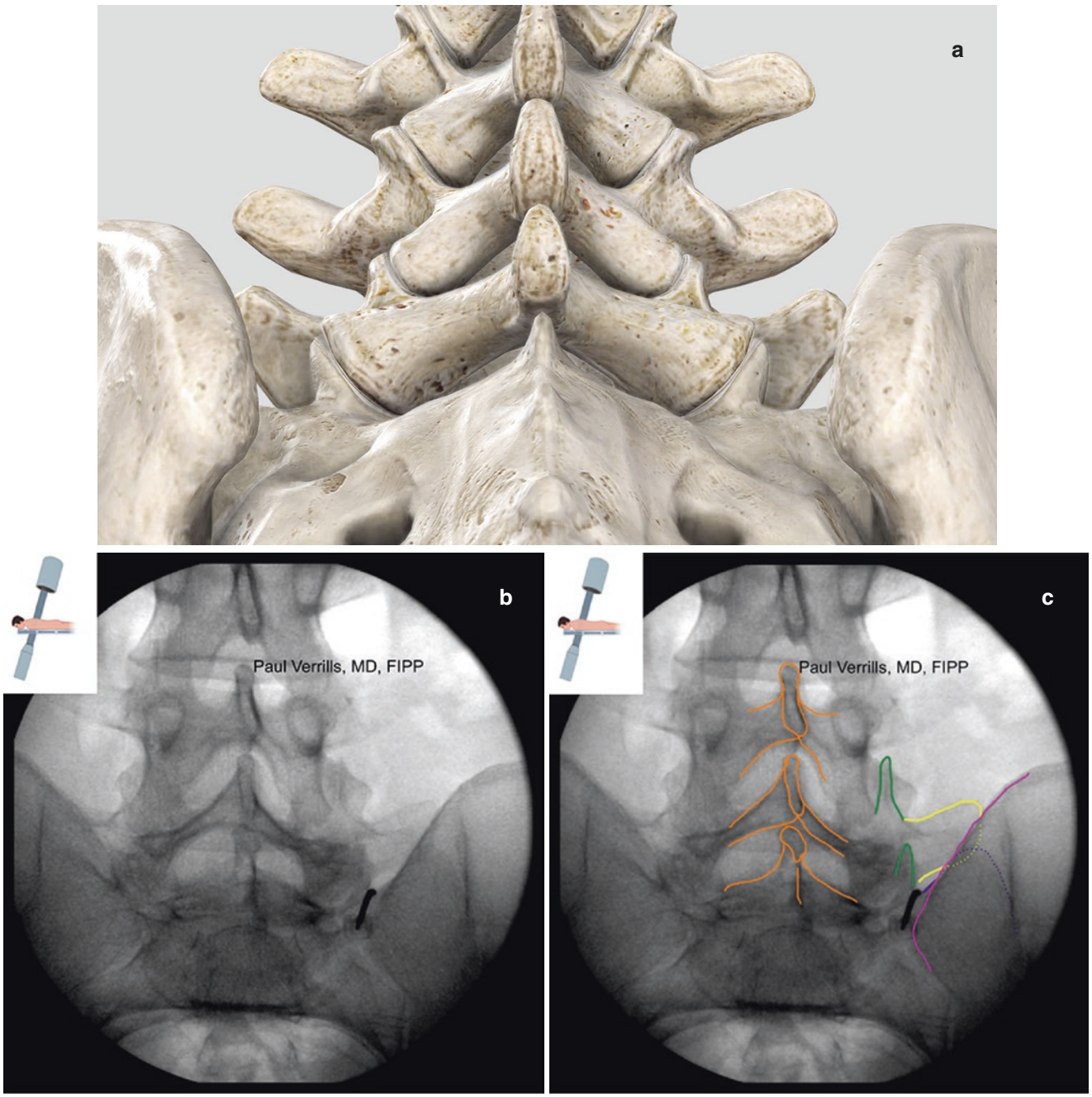

Fig. 16.6 L5 dorsal ramus radiofrequency ablation. C-arm tilted caudally. Needle at the junction of the S1 SAP and SA. Orange = spinous process and lamina; yellow = transverse process; dark green = superior articular process; purple = sacrum; pink = ilium. Complete Anatomy image (**a**), and native (**b**) and edited fluoroscopy image (**c**)

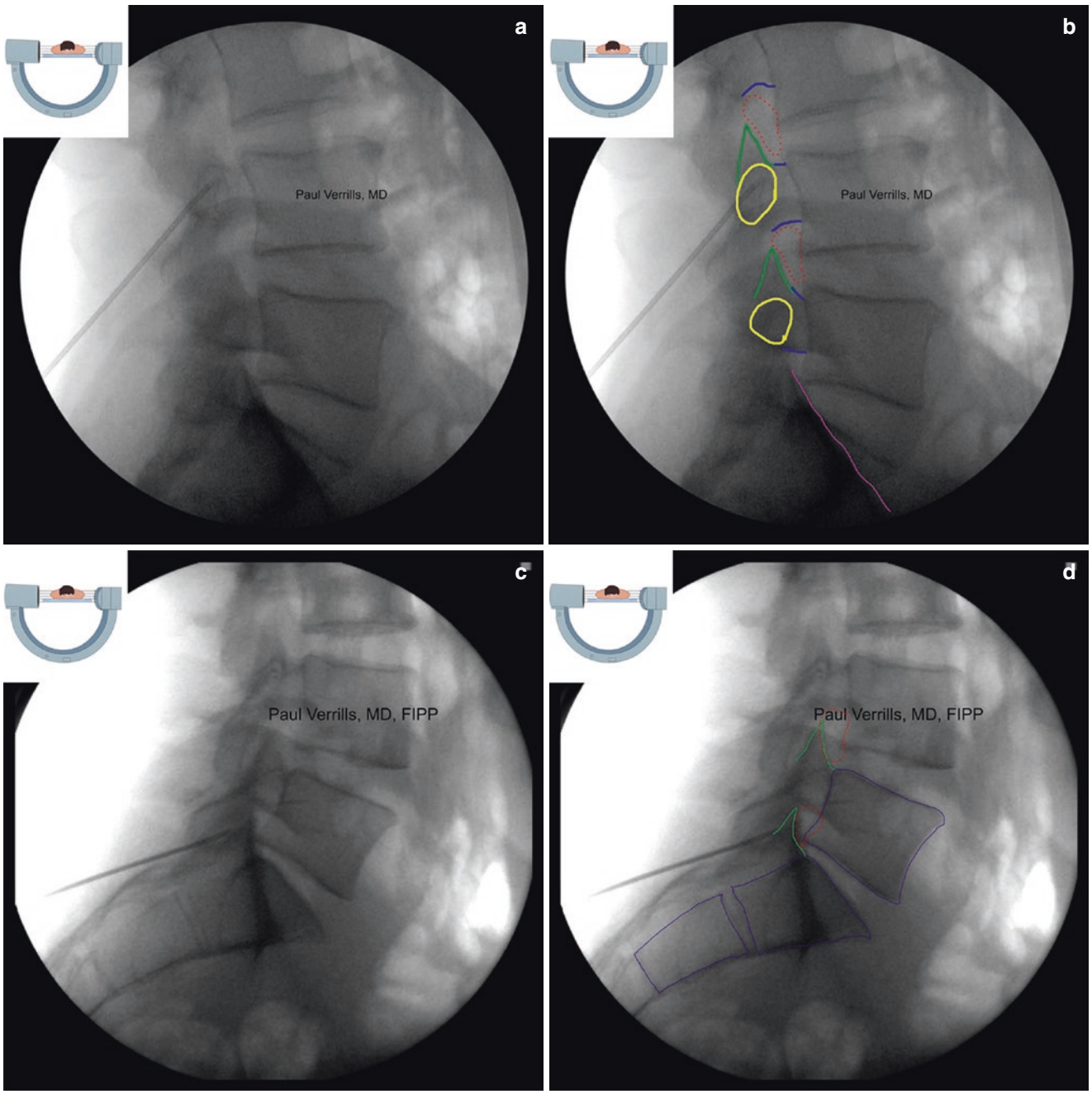

Fig. 16.7 Lateral view of the lumbar spine. Cannulas are placed to the L3 medial branches (**a**, **b**) and L5 dorsal ramus for RFA (**c**, **d**). The iliopectineal lines overlap, showing a true lateral image. Dark green = superior articular process; red = intervertebral foramen; yellow = transverse process, purple = vertebral body; pink = iliopectineal lines. Native (**a**, **c**) and edited (**b**, **d**) fluoroscopy image

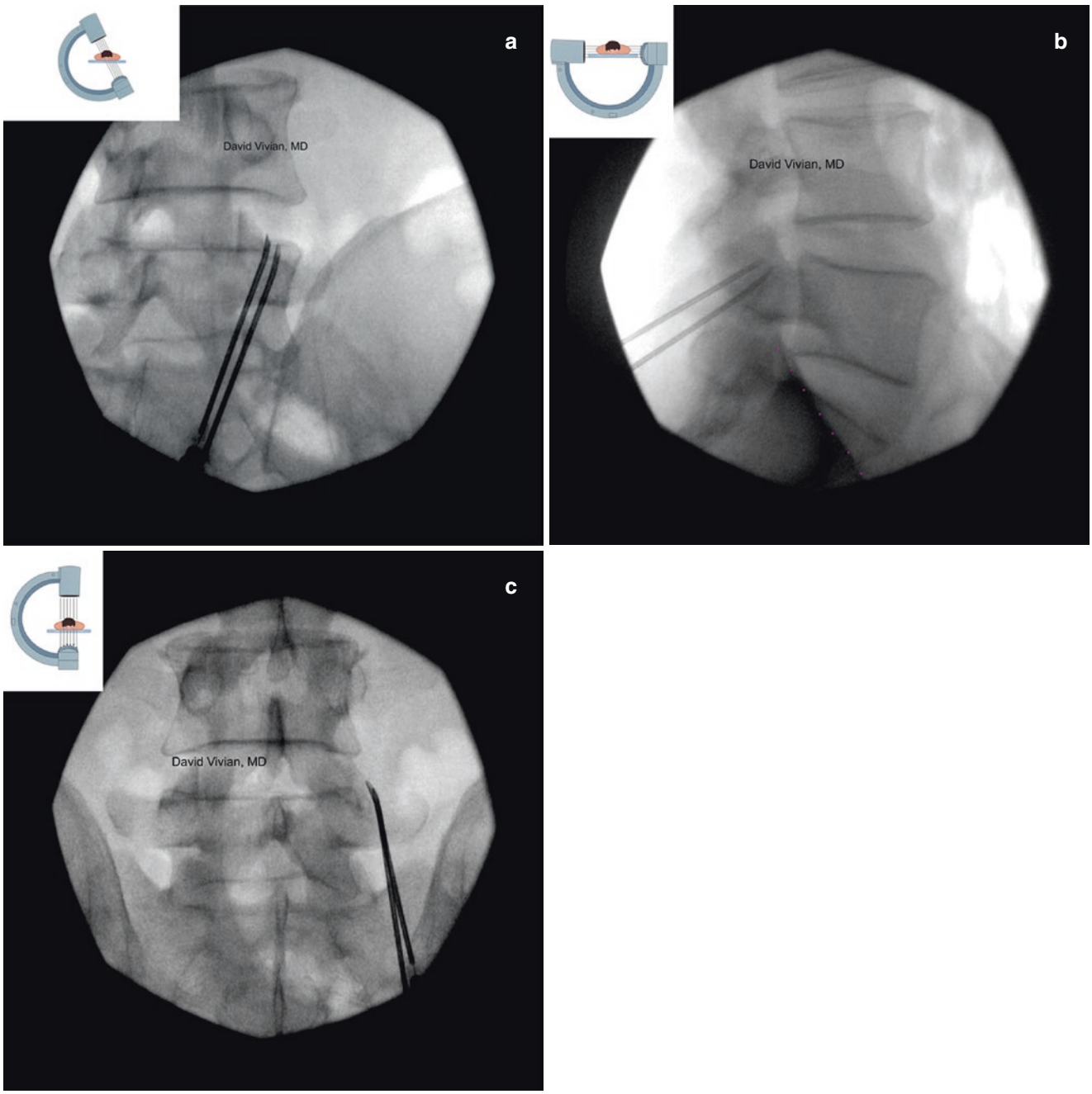

Fig. 16.8 Bipolar L4 medial branch radiofrequency ablation. Oblique (**a**), lateral (**b**), and AP (**c**) fluoroscopy views. Pink dots mark the iliopectineal lines, demonstrating a true lateral view

Unacceptable, Potentially Harmful Needle Placement on Exam

- Failing to check AP and lateral views
- Rough manipulation of the needle
- Needle compromised intraspinal space or exiting nerve root
- Any proof of lack of understanding of lumbar spine anatomy, for example, the needle left far posterior between spinous processes and believing it is in the right place

Unacceptable, But Not Harmful Needle Placement on Exam

- The procedure was abandoned after unsuccessful attempts, but it was clear that the examinee was cognizant of the safety aspects of the procedure, the needle did not compromise vital structures, did not reach the epidural space and there was no cord compromise

Evidence

Table 16.1 Level of evidence and recommendations by the Benelux section of the World Institute of Pain
These recommendations are based on both a review of the literature in 2015 by an independent third party (Kleijnen Systematic Reviews LTD) and the previous published guidelines published in Pain Practice. The recent literature, the potential risk for complications, and the grade of invasiveness were considered when deciding to upgrade or downgrade the recommendation.

Indication	Procedure	Recommendation 2009[1]	Grade 2015[2]	Recommendation 2018[3,4]
Low back pain originating from the lumbar facet joints	Radiofrequency treatment (ablation) of the lumbar medial branch (ramus medialis of the ramus dorsalis)	1B+	Low	Weak
Low back pain originating from the lumbar facet joints	Pulsed radiofrequency treatment of the lumbar medial branch (ramus medialis of the ramus dorsalis)		Low	Very weak against

[1]van Kleef M, Vanelderen P, Cohen SP, Lataster A, Van Zundert J, Mekhail N. 12. Pain originating from the lumbar facet joints. Pain Pract. 2010;10:459–69
[2]Kleijnen Systematic Reviews Ltd.: Search and evaluation of the literature. 2015
[3]Huygen F, Kallewaard JW, van Tulder M, Van Boxem K, Vissers K, van Kleef M, et al. "Evidence-based interventional pain medicine according to clinical diagnoses": update 2018. Pain Pract. 2019;19:664–75
[4]https://www.anesthesiologie.nl/publicaties/praktische-richtlijnen-anesthesiologische-pijnbestrijding

Suggested Reading

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The Lumbar Medial Branch and RFA chapter was reviewed by Athmaja Thottungal; Harvey Finkelstein; Alan Berkman; Amit Gulati; Andrea M. Trescot; Milan Stojanovic; Peter S. Staats; Agnes R. Stogicza; Andre M. Mansano; Athmaja Thottungal and Raja Reddy.

Lumbar Rami Communicantes Block and Radiofrequency Ablation

17

María Luz Padilla del Rey

Equipment and Monitoring

- Standard ASA monitoring
- Fluoroscopy
- Sterile prep, and drape
- Skin local anesthesia prior to any needle larger than 25G (unless sedation is used)
- Coaxial view is always used to advance needle, unless otherwise specified
- CPR equipment and medications available
- 20–22G, 3.5 inch (90 mm) - 6 inch (150 mm) needle, curved tip for diagnostic block
- 18–20G, 3.5 inch (90 mm) - 6 inch (150 mm), 5–10 mm active tip, blunt or sharp, curved radiofrequency cannula for radiofrequency ablation (RFA)
- Nonionic contrast
- Local anesthetic: 1–2 ml 1% lidocaine or 0.5% bupivacaine

Anatomy

- Lumbar ramus communicans arises from the exiting nerve root and connects into the sympathetic chain at the same lumbar level
- Target the mid portion of the vertebral body on lateral view

Structures to Keep in Mind and Possible Complications

- Bowel → pneumoperitoneum/infection/perforation
- Kidney → infection, bleeding
- Segmental artery → Adamkiewicz artery (has been located between T4-lumbar level) — spinal cord ischemia, cord infarction, paralysis
- Abdominal aorta, inferior vena cava → bleeding/intravascular injection
- Exiting nerve roots → inadvertent epidural injection and nerve injury
- Genitofemoral nerve → injury, testicular pain
- Intraspinal structures → intrathecal or epidural injection
- Infection
- Bleeding
- Postprocedure pain
- Vasovagal reaction
- Allergic reaction

Fluoroscopy Technique, Target Localization

- Patient prone
- Anteroposterior (AP) image
- Square off vertebral endplates (Fig. 17.1a–c)
- Turn C-arm obliquely toward ipsilateral side, approximately 30°, until the transverse process overlaps the lateral margin of the vertebral body (Fig. 17.2a–c)
- Entry point is just below the transverse process, in line with the lateral edge of the vertebral body, about 6–7 cm off midline, depending on body habitus

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A. R. Stogicza et al. (eds.), *Interventional Pain*, https://doi.org/10.1007/978-3-030-31741-6_17

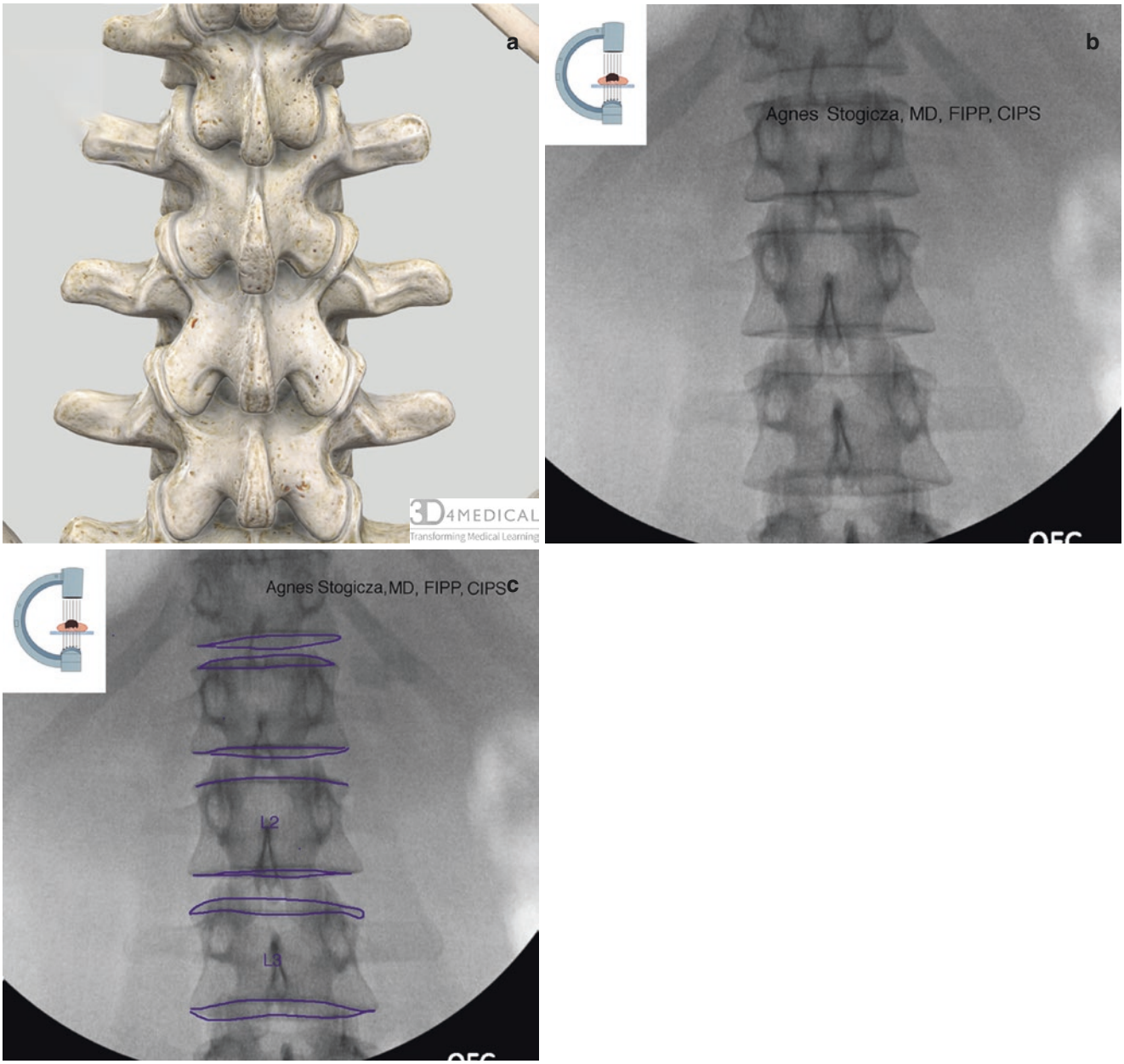

Fig. 17.1 AP view of the lumbar spine. L2 vertebral endplates are lined up with the beam. Purple = vertebral body. Complete Anatomy image (**a**), native (**b**) and edited fluoroscopy image (**c**)

Procedure Steps

- Needle entry at lumbar level chosen
- Coaxial view until bony contact is made with vertebral body (Fig. 17.2a–c)
- Lateral view to confirm needle depth
- Once touched on vertebral body, "wiggle" anteriorly, constantly keeping the needle contacting periosteum with fluoroscopy control to target location
- The tip of the needle is at the middle of the vertebral body on lateral view, not any more anterior, to avoid the sympathetic chain (Fig. 17.3a–c)
- 1 ml contrast injection that should spread beyond the facet line (ensuring that the needle is not in psoas muscle or intravascular)
- AP image to confirm contrast material is lateral to the vertebral body just caudal to the transverse process (Fig. 17.4a, b)
- Inject 3–5 ml local anesthetic
- Needle positioning is identical for RFA ablation. 50 Hz sensory stimulation and 2 Hz motor stimulation to exclude radicular nerve and genitofemoral nerve involvement (with appropriate needle positioning, motor involvement is most unlikely)

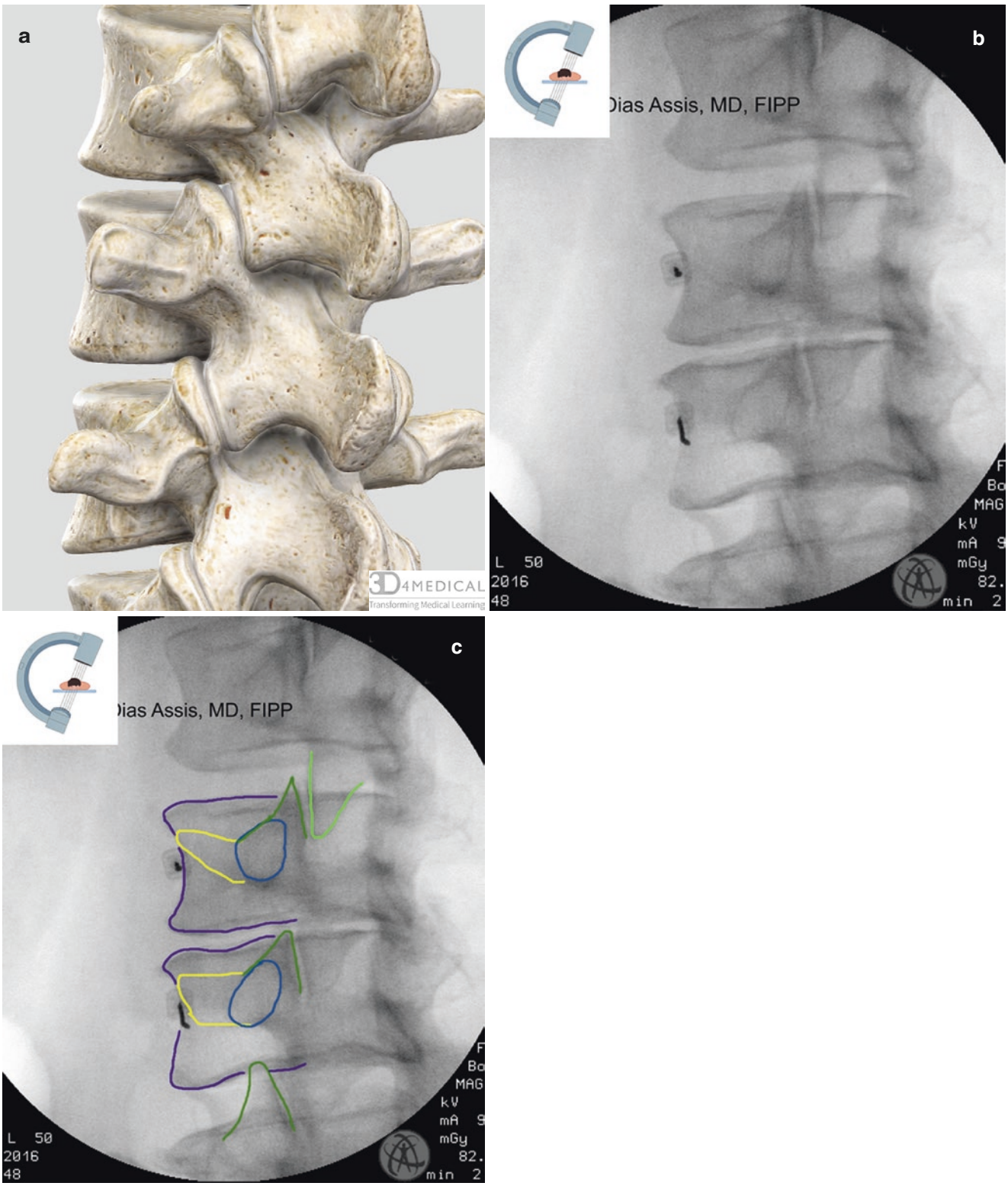

Fig. 17.2 Oblique view (approximately 30°, until the transverse process overlaps the lateral margin of the vertebral body) of the lumbar spine, vertebral endplates squared off, then C-arm tilted to the left. Needles placed in coaxial view onto the vertebral bodies. Yellow = transverse process, green = superior articular process, light green = inferior articular process, blue = pedicle; purple = vertebral body. Complete Anatomy image (**a**), native (**b**) and edited fluoroscopy image (**c**)

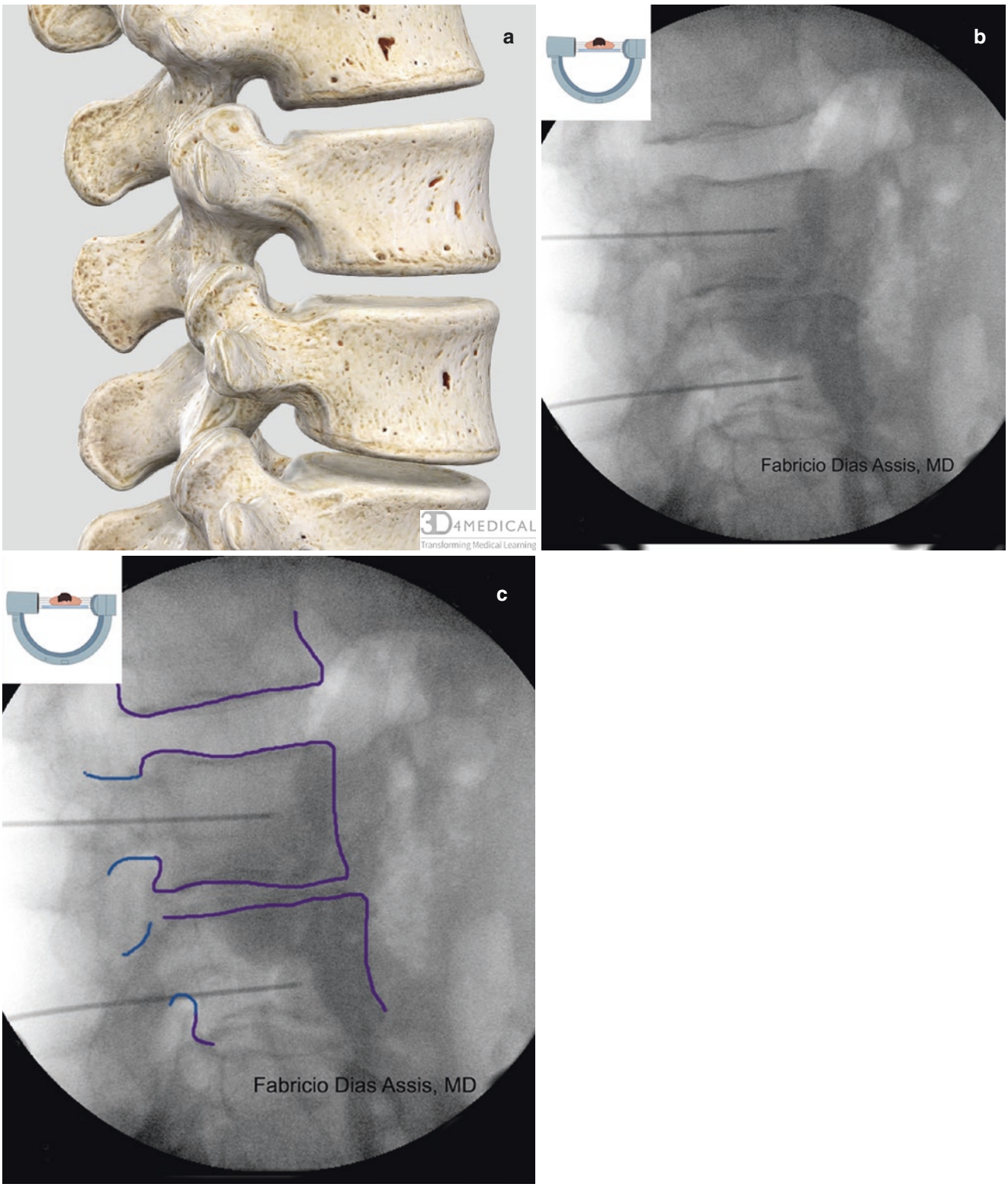

Fig. 17.3 Lateral view of the lumbar spine. Needles on target, at the junction at the mid portion of the vertebral body. Purple = vertebral body, blue = pedicle. Complete Anatomy image (**a**), native (**b**) and edited fluoroscopy image (**c**)

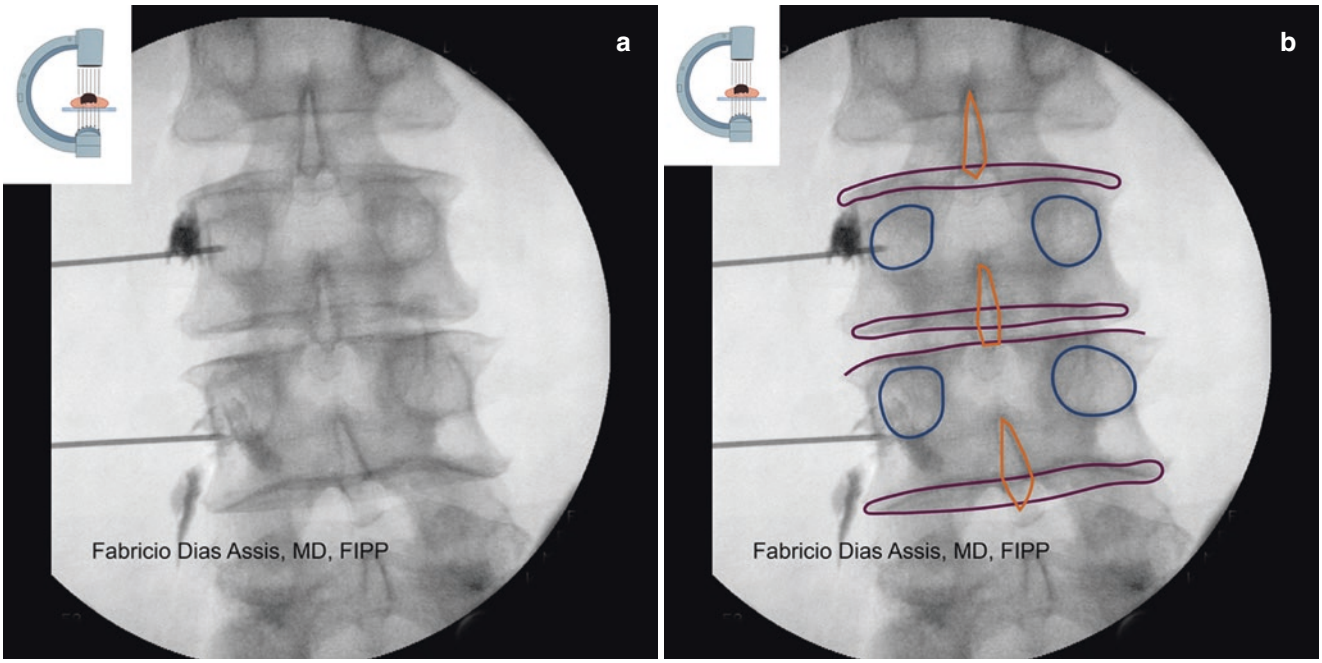

Fig. 17.4 AP view confirms the needle tip at the pedicle line. Orange = spinous process; dark blue = pedicle; purple = vertebral body. Native (**a**) and edited fluoroscopy image (**b**)

Clinical Pearls

- This technique should be done bilaterally
- Precise entry point identification is very important for easy procedural performance
- If performing radiofrequency ablation procedure, appropriate distance from exiting nerve root is crucial
- If pain radiates to the groin at the L2 level during sensory stimulation, close proximity to the genitofemoral nerve is likely and the needle should be repositioned and retested

Unacceptable, Potentially Harmful Needle Placement on Exam

- Rough needle manipulation
- Not checking lateral view to assess depth of needle
- Compromise of intraspinal space
- Needle advanced too anterior multiple times and not recognized by the candidate. Any proof of lack of understanding of lumbar spine anatomy, for example, the needle left far posterior between spinous processes and believing it is in the right place

Unacceptable, But Not Harmful Needle Placement on Exam

- The procedure was abandoned after unsuccessful attempts, but it was clear that the examinee was cognizant of the safety aspects of the procedure, the needle did not compromise vital structures, did not reach the epidural space and there was no cord compromise
- Needle placed too anterior to the sympathetic chain

Evidence

Table 17.1 Level of evidence and recommendations by the Benelux section of the World Institute of Pain
These recommendations are based on both a review of the literature in 2015 by an independent third party (Kleijnen Systematic Reviews LTD) and the previous published guidelines published in Pain Practice. The recent literature, the potential risk for complications, and the grade of invasiveness were considered when deciding to upgrade or downgrade the recommendation.

Indication	Procedure	Recommendation 2009[1]	Grade 2015[2]	Recommendation 2018[3,4]
Discogenic pain	Radiofrequency treatment of the ramus communicans	2B+	Very low	Very weak against

[1]Kallewaard JW, Terheggen MA, Groen GJ, Sluijter ME, Derby R, Kapural L, et al. 15. Discogenic low back pain. Pain Pract. 2010;10:560–79
[2]Kleijnen Systematic Reviews Ltd.: Search and evaluation of the literature. 2015
[3]Huygen F, Kallewaard JW, van Tulder M, Van Boxem K, Vissers K, van Kleef M, et al. "Evidence-based interventional pain medicine according to clinical diagnoses": update 2018. Pain Pract. 2019;19:664–75
[4]https://www.anesthesiologie.nl/publicaties/praktische-richtlijnen-anesthesiologische-pijnbestrijding

Table 17.2 Level of evidence based on the American Society of Interventional Pain Physicians (ASIPP) review of the literature

Lumbar facet joint interventions[1]	Evidence
Diagnostic lumbar facet joint nerve blocks	Level I
Therapeutic lumbar facet joint nerve blocks	Level II
Therapeutic lumbar facet joint nerve radiofrequency treatment ablation	Level II

[1]Manchikanti L, Schultz DM, Falco FJE, Singh V. Lumbar facet joint interventions. In: Manchikanti L, Kaye AD, Falco FJE, Hirsch JA, editors. *Essentials of interventional techniques in managing chronic pain*. Springer International Publishing; 2018. p, 349–368.

Suggested Reading

Oh WS, Shim JC. A randomized controlled trial of radiofrequency denervation of the ramus communicans nerve for chronic discogenic low back pain. Clin J Pain. 2004;20(1):55–60.
Simopoulos TT, Malik AB, Sial KA, Elkersh M, Bajwa ZH. Radiofrequency lesioning of the L2 ramus communicans in managing discogenic low back pain. Pain Physician. 2005;8:61–5.
van Tilburg CWJ, Stronks DL, Groeneweg JG, Huygen FJPM. Randomized sham-controlled, double-blind, multicenter clinical trial on the effect of percutaneous radiofrequency at the ramus communicans for lumbar disc pain. Eur J Pain. 2017;21:520–9.

Lumbar rami communicantes block and radiofrequency ablation chapter was reviewed by Sudhir Diwan; Fabricio D. Assis; Andrea M. Trescot; Milan Stojanovic; Peter S. Staats; Agnes R. Stogicza; Andre M. Mansano.

Lumbar Sympathetic Block and Radiofrequency Ablation

18

André M. Mansano

Equipment and Monitoring

- Standard ASA monitoring
- Fluoroscopy
- Sterile prep, and drape
- Skin local anesthesia prior to any needle larger than 25G (unless sedation is used)
- Coaxial view is always used to advance needle, unless otherwise specified
- CPR equipment and medications available
- 20 – 22G, 5 inch (120 mm) - 7 inch (170 mm) needle, tip curved, for diagnostic injection
- 18 – 20G, 5 inch (120 mm) - 7 inch (170 mm) cannula, 10 mm curved active tip for radiofrequency ablation (RFA)
- Local anesthetics
- Nonionic contrast media
- IV access in case of hypotension
- Peripheral skin temperature monitoring equipment (lower extremity).

Anatomy

- L3 level for single shot or diagnostic block
- L2, L3, and L4 levels for ablation*
- L2 – Junction of the lower 1/3 and upper 2/3 of the L2 vertebral body
- L3 – Junction of the lower 2/3 and upper 1/3 of the L3 vertebral body
- L4 – Variable position
- Target the anterolateral portion of the vertebral body (Fig. 18.1)

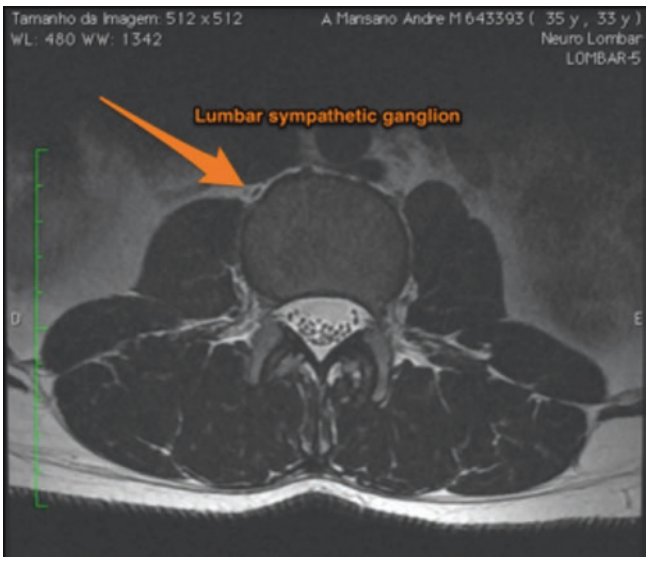

Fig. 18.1 MRI axial view at the L3 level showing the anterolateral position of the lumbar sympathetic ganglion just in front of psoas muscle. Note the inferior cava vein just anterior to the ganglia on the right side

* Although this is the classic technique described in many books, some cadaveric studies show that the number and position of the lumbar sympathetic ganglions are variable (Fig. 18.9)

Structures to Keep in Mind and Possible Complications

- Exiting nerve roots → nerve injury
- Intraspinal structures → spinal, epidural
- Genitofemoral nerve injury
- Intervertebral disc → discitis
- Kidney
- Ureter
- Inferior cava vena, especially at the right side → bleeding, local anesthetic toxicity
- Segmental arteries → bleeding
- Infection
- Postprocedure pain
- Vasovagal reaction
- Allergic reaction

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A. R. Stogicza et al. (eds.), *Interventional Pain*, https://doi.org/10.1007/978-3-030-31741-6_18

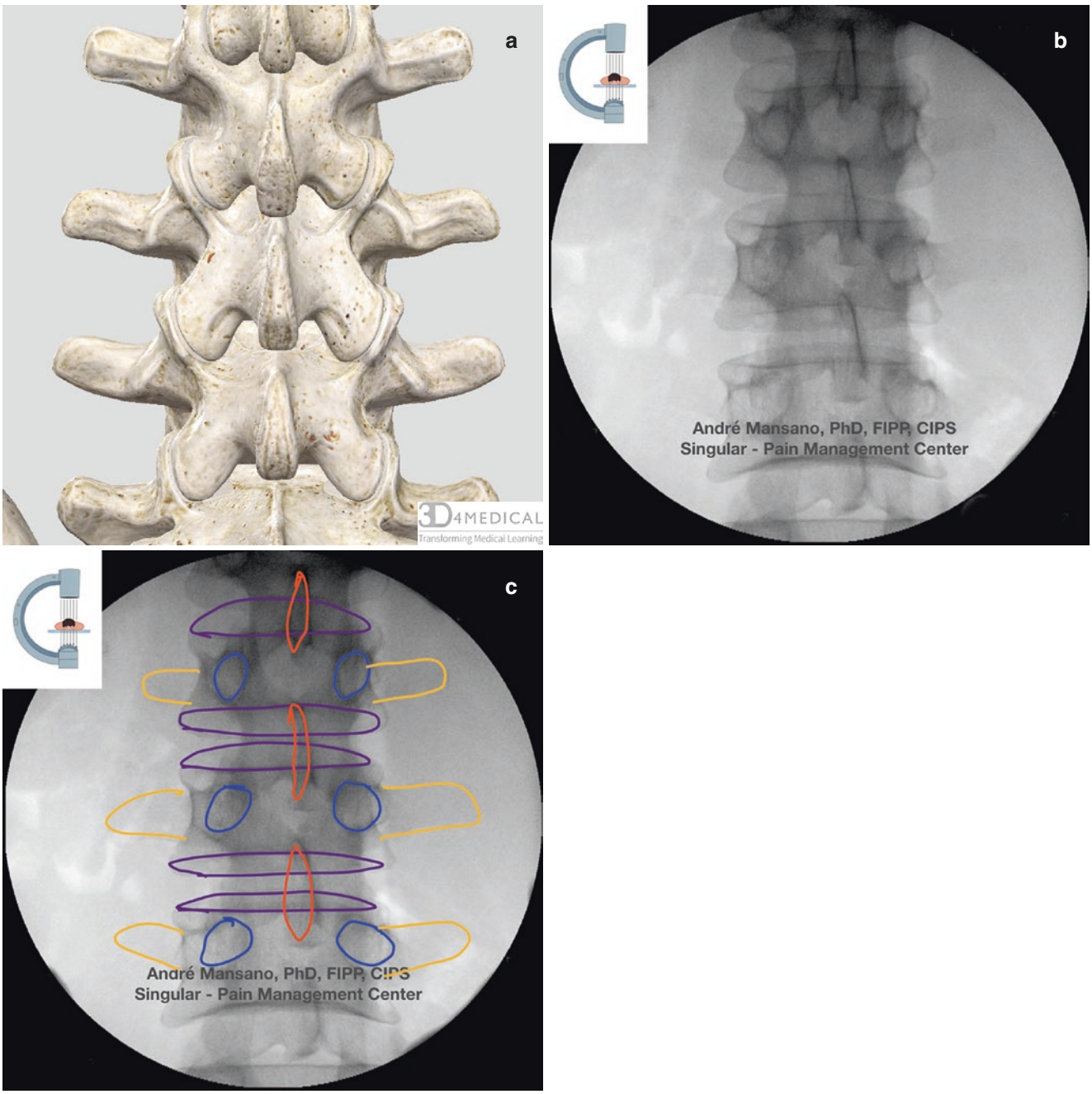

Fig. 18.2 AP view of lumbar spine. Vertebral body endplates are not aligned. Orange = spinous process; purple = vertebral body endplates; blue = pedicles; yellow = transverse process. Complete Anatomy image (**a**), native (**b**) and edited fluoroscopy image (**c**)

Fluoroscopy Technique, Target Localization

- Patient in prone position
- Pillow under the lower abdomen to decrease the lumbar lordosis
- Anteroposterior (AP) image (Fig. 18.2)
- Identify L3 level for single-needle block or L2, L3, and L4 levels for radiofrequency ablation. Count from L1 because of common transitional vertebra (L6)
- Cephalocaudad tilt to square off vertebral body (Fig. 18.3a–c)
- Oblique C-arm to ipsilateral side until the tip of spinous process overlaps the other side of vertebral body ("scotty dog view") . If the transverse process is covering the edge of the vertebral body, the entry point is just above or below the TP, wherever more room is seen for needle guidance. (Fig. 18.4a–c)

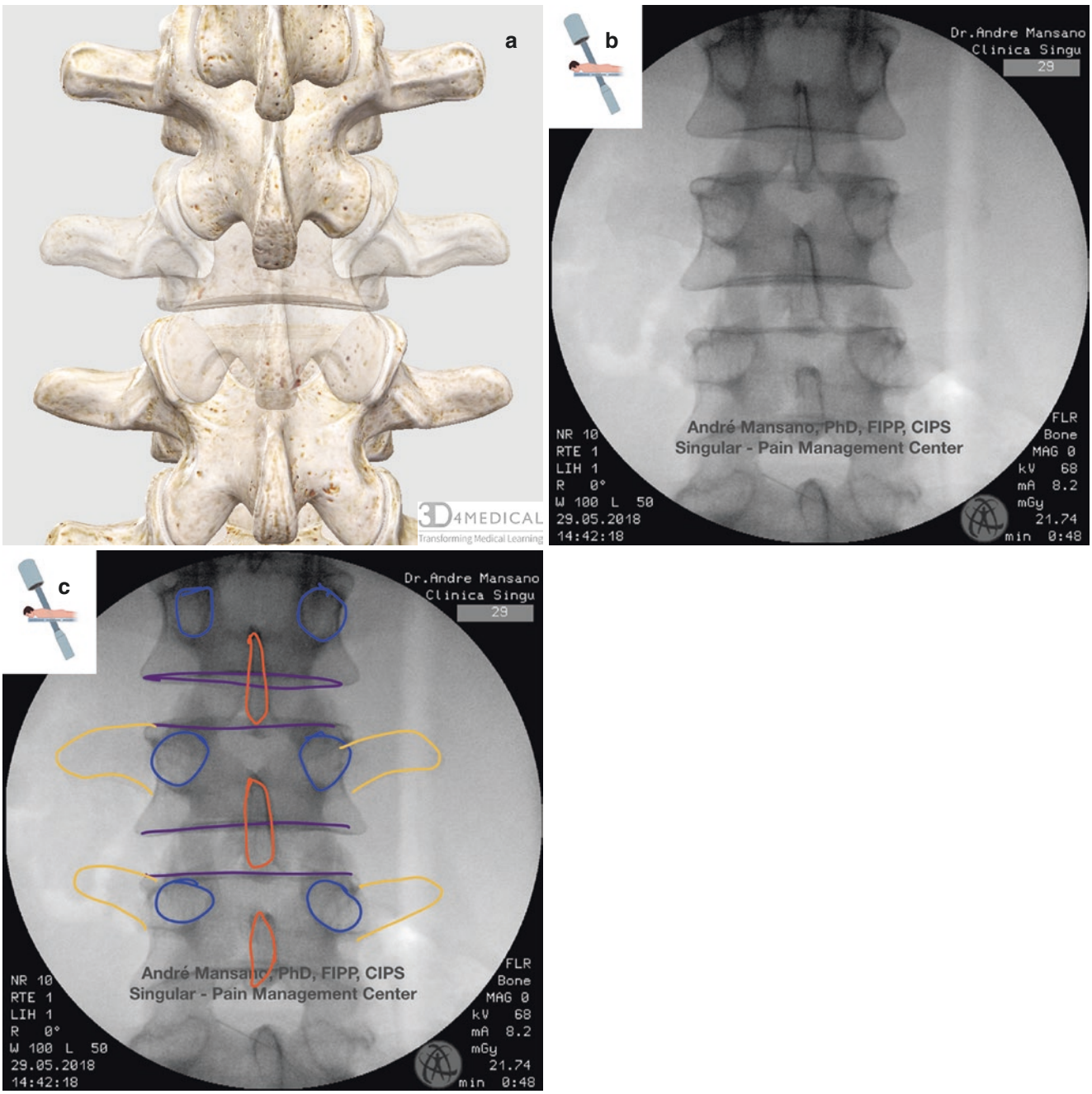

Fig. 18.3 Lumbar spine, true AP view (spinous processes are in the midline) with cephalad tilt of the C-arm. Vertebral body endplates are lined up at the area of interest, which will allow the needle to be placed parallel to the endplates. Orange = spinous process; purple = vertebral body endplates; blue = pedicles; yellow = transverse process. Complete Anatomy image (**a**), native (**b**) and edited fluoroscopy image (**c**)

Procedure Steps – Local Anesthetic Injection or Chemical Ablation

- Entry point should be just lateral to the L3 vertebral body as described above (Fig. 18.4a–c)
- Needle placed in coaxial view until touching the vertebral body (Fig. 18.4a–c)
- Lateral view to control the depth of the needle
- Slip the needle smoothly anteriorly and medially, constantly touching the vertebral body until the tip of the needle reaches the anterior border of the vertebral body (Fig. 18.5a, b)
- Aspirate, in case of blood, reposition the cannula cranial or caudad
- Confirm position with 2–5 ml nonionic contrast (there should be no resistance upon injection)
  - Cranio-caudad spread in lateral view (Fig. 18.6a)
  - Patchy, "retroperitoneal pattern" at the pedicle area in AP view, but no muscular (dense, longitudinal) spread (Fig. 18.6b)
  - No vascular uptake
- Inject 5–7 ml of local anesthetic or 7 ml of 6% phenol

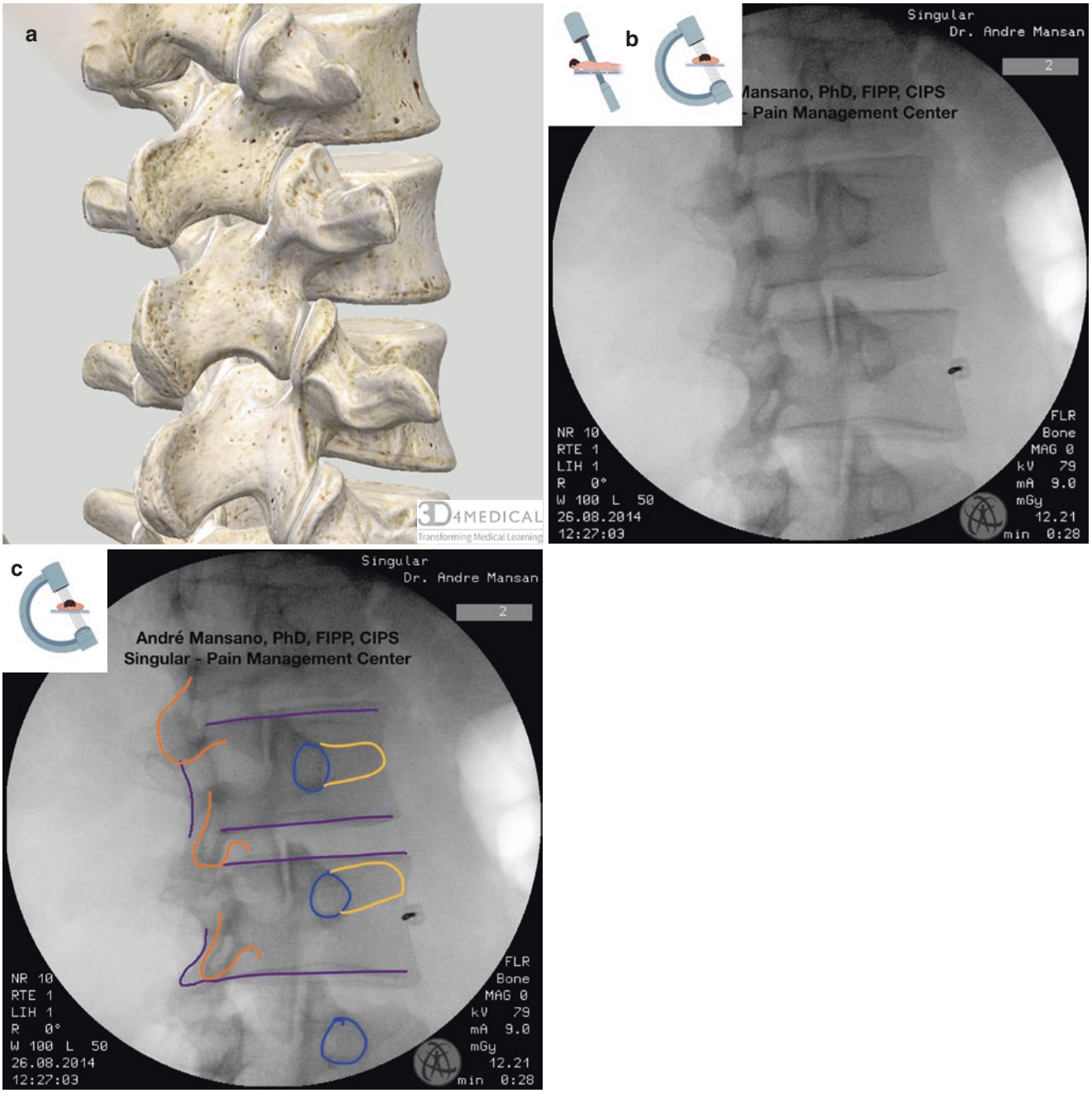

Fig. 18.4 Oblique view of the lumbar spine. The transverse process is hidden behind the vertebral body. The entry point is just lateral to the edge of the vertebral body. Needle is placed in a coaxial view to touch the vertebral body. Orange = spinous process and lamina; purple = vertebral body; blue = pedicle; yellow = transverse process. Complete Anatomy image (**a**), and native (**b**) and edited fluoroscopy image (**c**)

Procedure Steps – Radiofrequency Ablation

- Three levels required (Fig. 18.7a, b and 18.8a, b)
  - L2 – Junction of the lower 1/3 and upper 2/3 of the L2 vertebral body
  - L3 – Junction of the lower 2/3 and upper 1/3 of the L3 vertebral body
  - L4 – Variable position
- Entry point should be just lateral to the L2, L3, L4 vertebral body as described above (Fig. 18.4a–c)
- Needle placement is identical to chemical ablation-as above (Figs. 18.4a–c and 18.5a, b)
- Place all three cannulas (Fig. 18.7a, b), then:
- Sensory stimulation at 50Hz and 1V
  - It can promote a deep ache in the abdomen
  - Avoid paresthesia in the genitofemoral territory. Reposition the cannula if it occurs
- Motor stimulation at 2Hz at 2V
  - Avoid any motor stimulation at lower limb. Reposition the cannula if it occurs
- Inject 1 ml of lidocaine 2% and 3–5 minutes

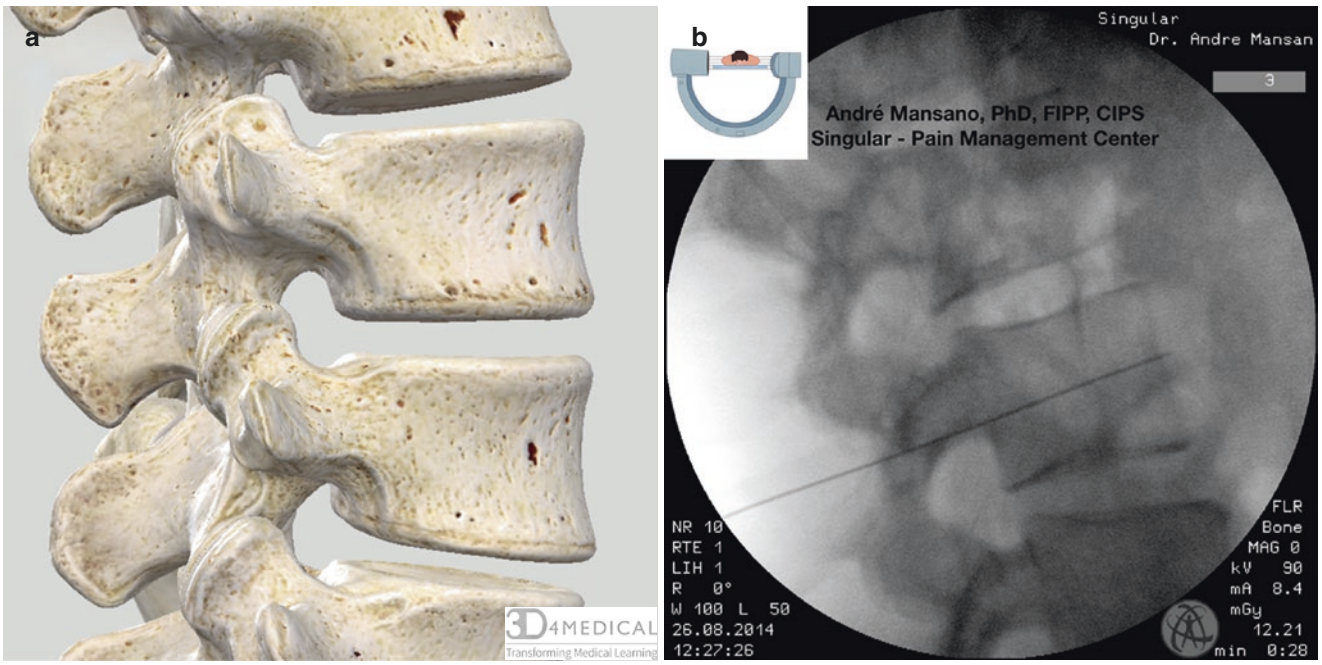

Fig. 18.5 Lateral view of the lumbar spine. The needle is advanced to the anterior border of the vertebral body. Complete Anatomy image (**a**), and native fluoroscopy image (**b**)

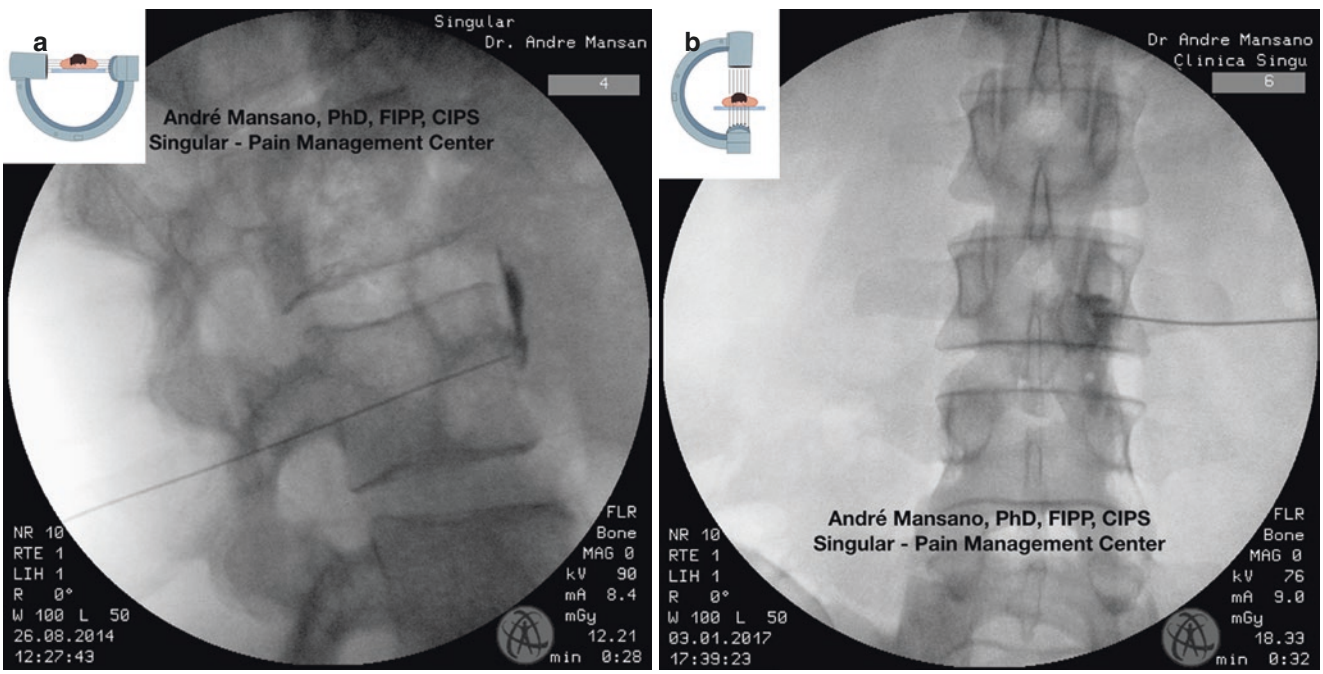

Fig. 18.6 Lateral and AP fluoroscopy images of the lumbar spine. Optimal contrast media dispersion. Cranio-caudad spread in lateral view (**a**) and patchy, "retroperitoneal pattern" at the pedicle area in AP view (**b**)

- Check lower limb temperature elevation at this point (warm, pink, dry on treated side)
- RF lesion at 80 °C for 90 seconds, rotate needle tip to increase lesion size and lesion again
- Some authors advocate a series of three lesions pulling the electrode slightly backwards and rotating the needle 180 degrees to increase lesion size

Clinical Pearls

- Some patients can have large transverse processes, so hiding it behind the vertebral body would prompt a too far lateral approach, potentially putting the kidney at risk. In this case, stop obliquing the C-arm at the "scotty dog" view (tip of spinous process overlaps the other side of vertebral body), and target above or below transverse process. Some cadaveric studies show an almost randomized position of the lumbar sympathetic ganglion (Fig. 18.9)
- The multilevel approach can promote a more efficient sympatholysis
- The lower limb temperature elevation can be monitored, but also look at the change of color and dryness of the skin (less sweating)

Unacceptable, Potentially Harmful Needle Placement on Exam

- Rough needle manipulation close the epidural place
- Needle advanced far anterior multiple times and not recognized by the candidate
- Any proof of lack of understanding of lumbar spine anatomy, for example, needle far lateral to the vertebral body, and believing it is in good final position
- Not checking lateral view to assess the depth of needle

Unacceptable, But Not Harmful Needle Placement on Exam

- Use of short needle, unable to reach the target
- Needle left too posterior
- Advancing needle too far anterior once, but recognized by candidate
- The procedure was abandoned after unsuccessful attempts, but it was clear that the examinee was cognizant of the safety aspects of the procedure, the needle did not compromise vital structures, did not reach the epidural space or was not left in the neuroforamen

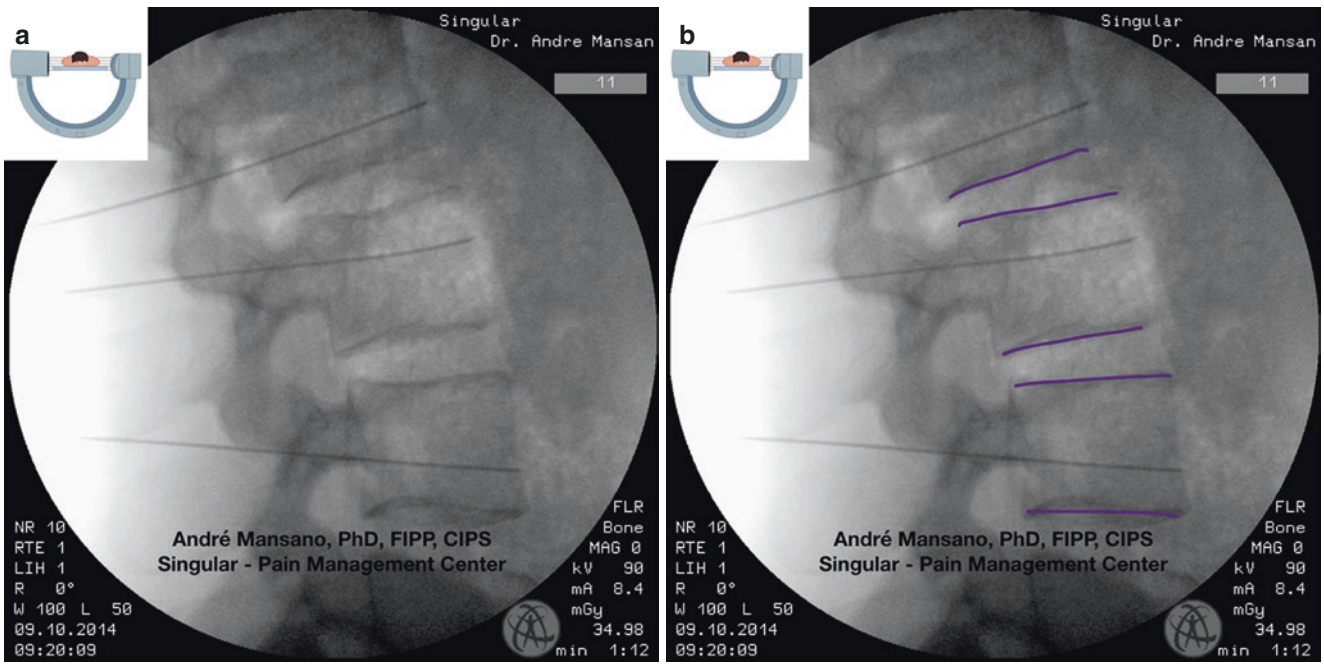

Fig. 18.7 Lateral view of the lumbar spine. Usual positions for RF needles during ablation. Purple = vertebral body endplates. Native (**a**) and edited (**b**) fluoroscopy image

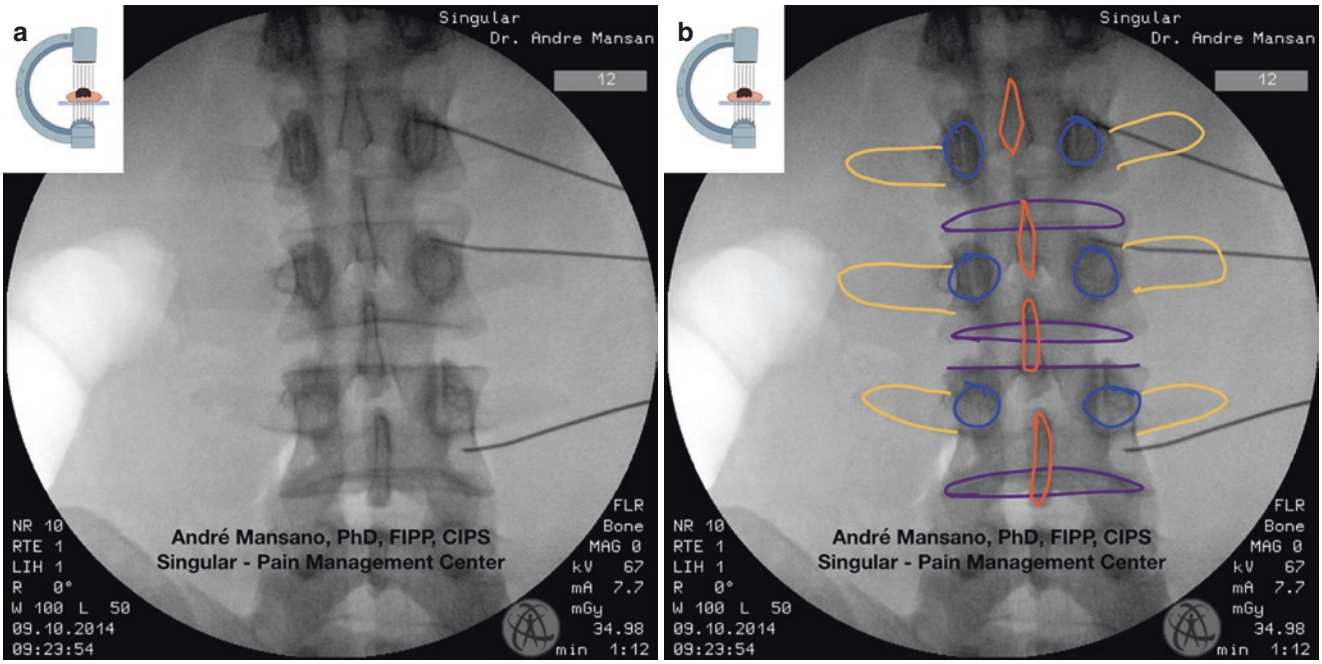

Fig. 18.8 AP view of the lumbar spine. Usual positions for RF needles during ablation. Orange = spinous process; purple = vertebral body endplates; blue = pedicles; yellow = transverse process. Native (**a**) and edited (**b**) fluoroscopy image

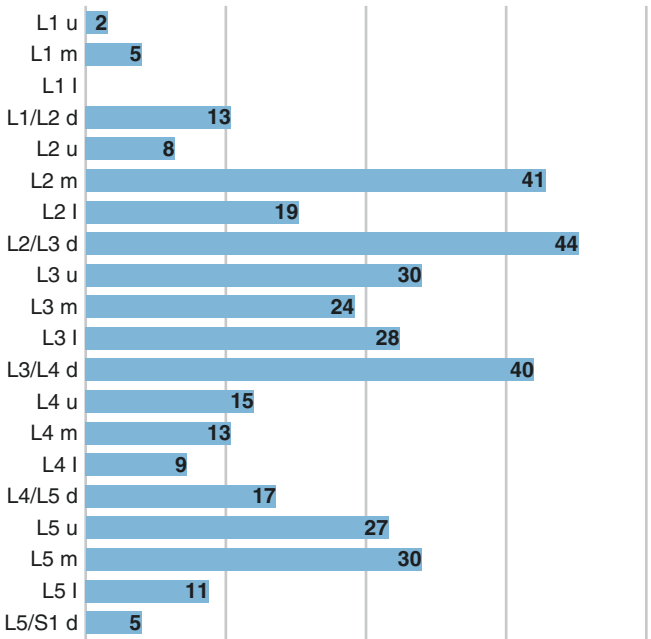

Fig. 18.9 Various positions of sympathetic ganglia in relation to the lumbar vertebrae based on the cadaveric study, by Murata et al. *u* = upper aspect of disc, *m* = middle aspect of disc, *l* = lower aspect of disc, *d* = at disc level

Evidence

Table 18.1 Level of evidence and recommendations by the Benelux section of the World Institute of Pain
These recommendations are based on both a review of the literature in 2015 by an independent third party (Kleijnen Systematic Reviews LTD) and the previous published guidelines published in Pain Practice. The recent literature, the potential risk for complications, and the grade of invasiveness were considered when deciding to upgrade or downgrade the recommendation.

Indication	Procedure	Recommendation 2009	Grade 2015[2]	Recommendation 2018[3,4]
Complex regional pain syndrome[1]	Sympathetic blocks with local anesthetics	2B+	Moderate	Moderate against
Ischemic pain of the extremities[5]	Chemical sympathectomy	2 B±	Not graded	Very weak

[1]van Eijs F, Stanton-Hicks M, Van Zundert J, Faber CG, Lubenow TR, Mekhail N, et al. Evidence-based interventional pain medicine according to clinical diagnoses. 16. Complex regional pain syndrome. Pain Pract. 2011;11:70–87
[2]Kleijnen Systematic Reviews Ltd.: Search and evaluation of the literature. 2015
[3]Huygen F, Kallewaard JW, van Tulder M, Van Boxem K, Vissers K, van Kleef M, et al. "Evidence-based interventional pain medicine according to clinical diagnoses": update 2018. Pain Pract. 2019;19:664–75
[4]https://www.anesthesiologie.nl/publicaties/praktische-richtlijnen-anesthesiologische-pijnbestrijding
[5]Devulder J, van Suijlekom H, van Dongen R, Diwan S, Mekhail N, van Kleef M, et al. 25. Ischemic pain in the extremities and Raynaud's phenomenon. Pain Pract. 2011;11:483–91

Table 18.2 Level of evidence based on the American Society of Interventional Pain Physicians (ASIPP) review of the literature

Lumbar sympathetic interventions	Evidence
Lumbar sympathetic blocks[1]	Level IV

[1]Datta S, Pai UT, Manchikanti L. Lumbar sympathetic block and neurolysis. In: Manchikanti L, Kaye AD, Falco FJE, Hirsch JA, editors. *Essentials of interventional techniques in managing chronic pain*. Springer International Publishing; 2018. p. 551–50.

Suggested Reading

Gandhi KR, Verma VK, Chavan SK, Joshi SD, Joshi SS. The morphology of lumbar sympathetic trunk in humans: a cadaveric study. Folia Morphol (Warsz). 2013;72:217–22.

Hong JH, Oh MJ. Comparison of multilevel with single level injection during lumbar sympathetic ganglion block: efficacy of sympatholysis and incidence of psoas muscle injection. Korean J Pain. 2010;23:131.

Murata Y, et al. Variations in the number and position of human lumbar sympathetic ganglia and rami communicantes. Clin Anat. 2003;16:108–13.

Raj PP. Percutaneous block and lesioning of the lumbar sympathetic ganglia. In: Raj PP, Erdine S, editors. Pain-relieving procedures: the illustrated guide. Chichester: Wiley-Blackwell; 2012. p. 302–8.

The Lumbar Sympathetic Block and Radiofrequency Ablation chapter was reviewed by Micha Sommer; Pierluigi Manchiaro; Olav Rohof, TCT Novy; Ricardo Plancarte; Andrea M. Trescot; Milan Stojanovic; Peter S. Staats; Agnes R. Stogicza.

Lumbar Transforaminal Epidural Injection

19

Cherilyn A. Fenech

Equipment and Monitoring

- Standard ASA monitoring
- Fluoroscopy
- Sterile prep, and drape
- Skin local anesthesia prior to any needle larger than 25G (unless sedation is used)
- Coaxial view is always used to advance needle, unless otherwise specified
- CPR equipment and medications available
- 22–25G 3.5 inch (90 mm)–5 inch (120 mm) sharp needle or blunt tipped needle with introducer
- Nonionic contrast
- Short- and/or long-acting anesthetic
- Steroid, nonparticulate
- Small bore extension tubing
- Peripheral nerve stimulator (optional)

Anatomy

- Target: between the pedicles of the adjacent vertebrae
- Anterior border – intervertebral disc and vertebral bodies
- Posterior border – the articular processes forming the zygapophyseal joint
- Lateral border – fascia and psoas muscle
- Medial border – dural sleeve
- Exiting nerve root is usually located in the caudad part of the foramen, but it may be displaced by anatomic changes (facet arthrosis, cyst, disc, etc.), and therefore encountered at any part of the foramen
- Radicular artery is usually located in the cephalad part of foramen

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Structures to Keep in Mind and Possible Complications

- Dura → subdural/intrathecal injection → hypotension, motor/sensory loss, postdural puncture headache
- Medullary arteries/veins → hematoma
- Radicular artery, possibly feeding into the artery of Adamkiewicz → spinal cord ischemia with quadriplegia/paraplegia
- Dorsal root ganglion/nerve root → direct nerve trauma
- Disc → discitis
- Infection
- Bleeding
- Postprocedure pain
- Vasovagal reaction
- Allergic reaction

Fluoroscopy Technique, Target Localization

- Patient in prone position
- Anteroposterior (AP) image to identify target level
- Square off the vertebra targeted (so the needle will be parallel to the pedicles, allowing for the needle to land at the "rim" and not in the center of the foramen)
- Oblique C-arm by 15–30° until the spinous process projects over the contralateral facet column ("scotty dog" view) (Fig. 19.1a–c))
  - Supraneural = infrapedicular = "safe triangle" approach: the target is caudal to the pedicle and anterosuperior to the DRG (Caution, anterior medullary artery is located in this triangle in 92% cases. "Safe triangle" is a traditional terminology but does not necessarily mean safety.)

A. R. Stogicza et al. (eds.), *Interventional Pain*, https://doi.org/10.1007/978-3-030-31741-6_19

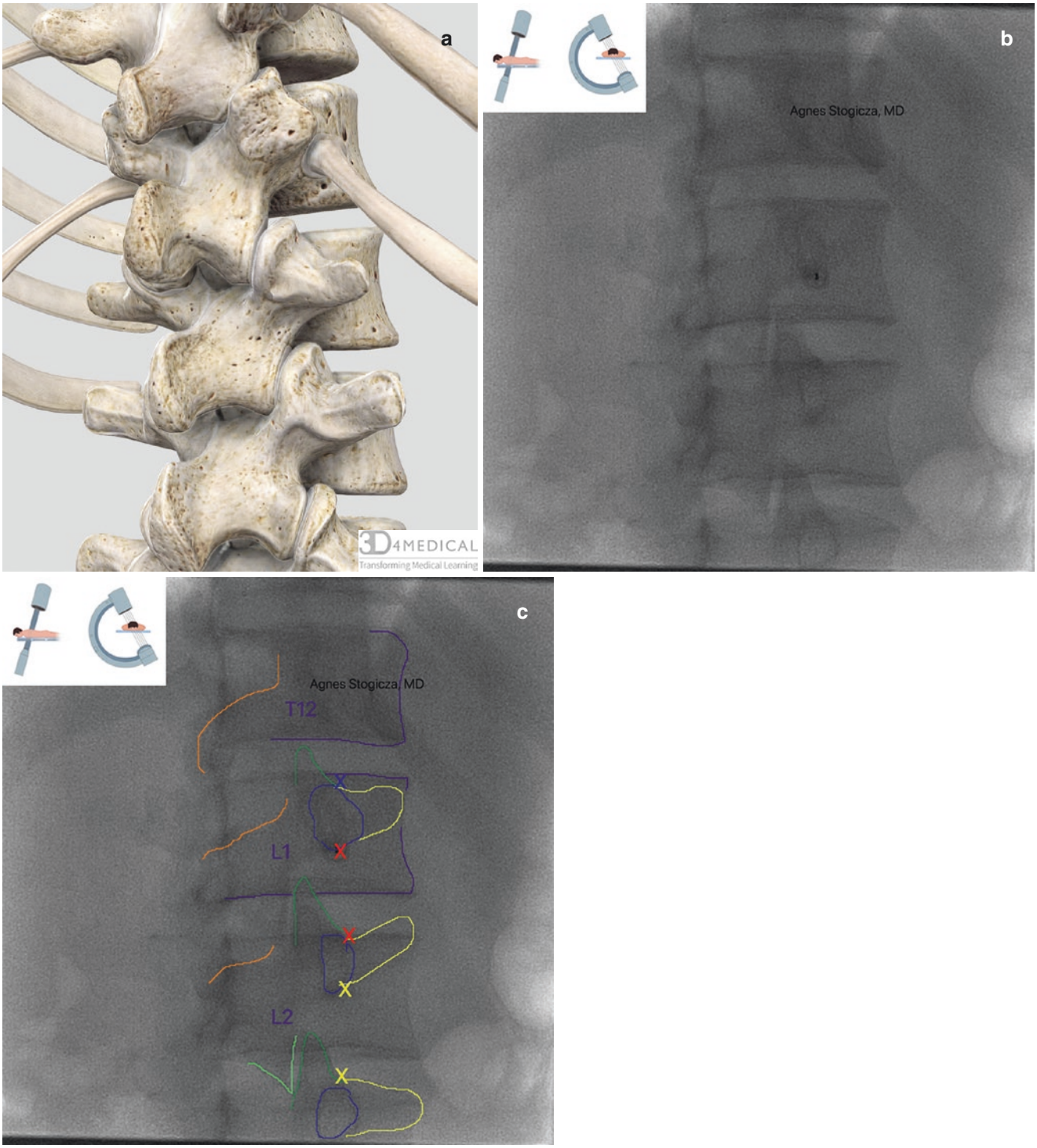

Fig. 19.1 Oblique view of the thoracolumbar spine. L1 vertebral body squared off and C-arm obliqued by about 30° until the spinous process projected over the contralateral facet column ("scotty dog" view). Needle entry options and targets to touch on bone marked with red X for L1, yellow X for L2, and blue X for T12 nerve root. Orange = spinous process and lamina; yellow = transverse process; dark green = superior articular process; light green = inferior articular process; dark blue = pedicle; purple = vertebral body. Complete Anatomy image (**a**), native (**b**) and edited fluoroscopy image (**c**)

  - Infraneural = suprapedicular = Kambin triangle approach: cephalad border is the exiting nerve; caudal border is the caudad vertebral body; and the medial border is the traversing nerve root
- If performing a L5-S1 transforaminal injection, tilt the C-arm cephalad, until the iliac crest is removed from needle path (Fig. 19.2a–e)

Procedure Steps

- Needle entry just above or below the pedicle. Entering above the pedicle will lead the needle to the caudad portion of the upper foramen. Entering below the pedicle will lead the needle to the cephalad portion of the lower foramen
- Coaxial approach to touch upper or lower edge of pedicle (Fig. 19.1a–c)
- Rotate needle tip toward target foramen and slide into foramen
- Lateral view to confirm depth and see the needle entering the foramen (Fig. 19.3a, b)
- A slight loss of resistance, a "pop" is usually felt on entering the epidural space
- AP image confirms needle in the mid pedicular line (Fig. 19.4a, b)
- Contrast administered using extension tubing under live fluoroscopy or DSA to exclude intravascular spread
- Contrast outlines the exiting nerve root and shows epidural spread, best seen on AP image (Fig. 19.4c), but lateral views should be checked as well
- Consider test dose of local anesthetics

Clinical Pearls

- Precise entry point identification and a coaxial needle approach are very important for easy procedural performance
- Curved needle aids needle guidance and decreases necessary needle manipulation
- If patient reports shooting pain to the lower extremity with needle placement, different needle positioning is needed (change needle angle or access from the other side of foramen)
- If unsure about needle location, do not inject contrast, as it will obscure further images; instead, check a different fluoroscopic image

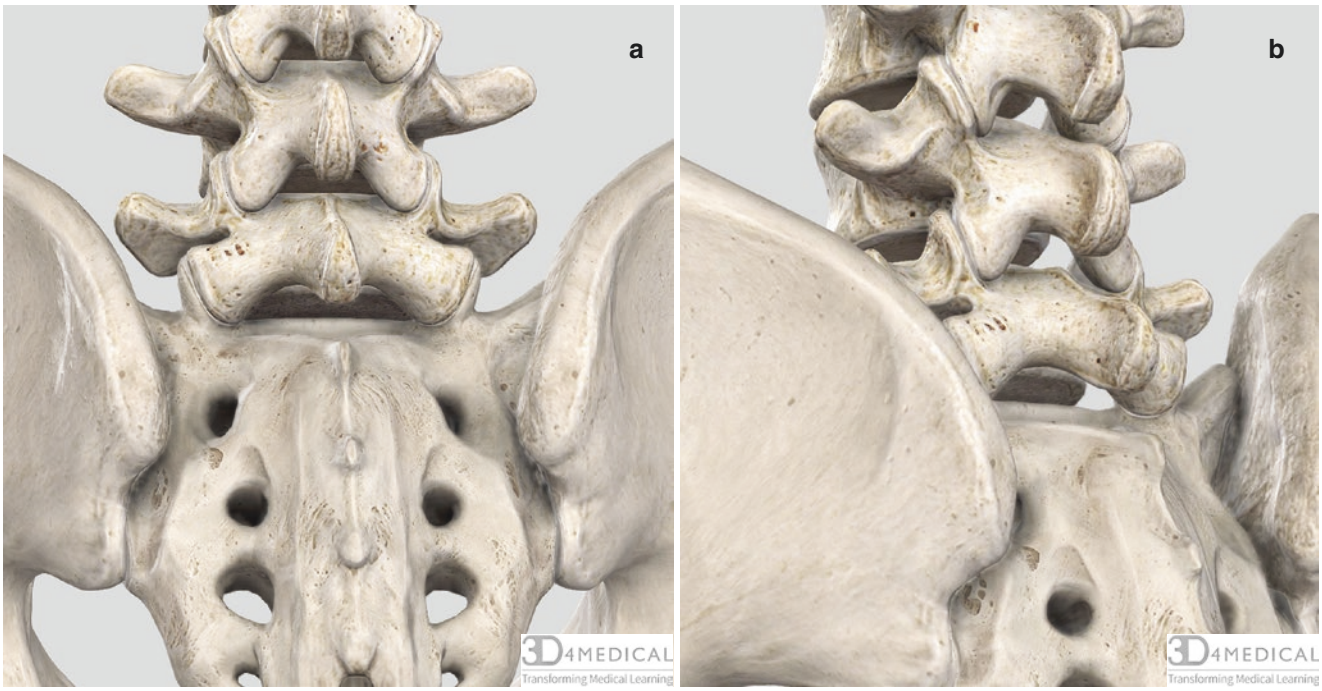

Fig. 19.2 Relevant views of the lumbar spine to achieve ideal view of transforaminal access at L5 exiting nerve root. AP view (**a**) followed by ipsilateral oblique tilt of the C-arm (L5 spinous process overlaps the other side of L5 vertebral body) (**b**), followed by cephalad tilt of C-arm to remove the iliac crest from the view (**c**). L5-S1 transforaminal needle placement (**d**). Complete Anatomy (**a**, **b**, **c**), native (**d**) and edited fluoroscopy image (**e**)

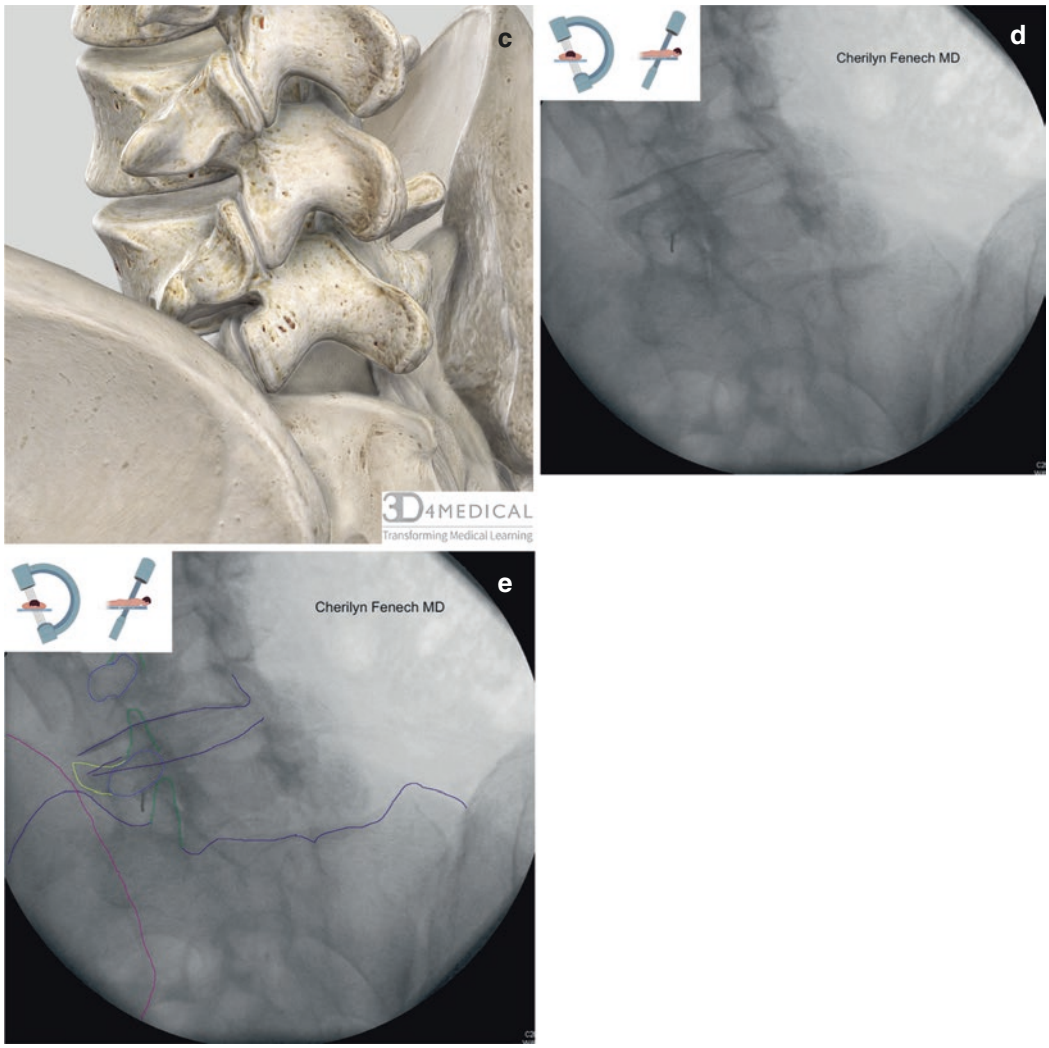

Fig. 19.2 (continued)

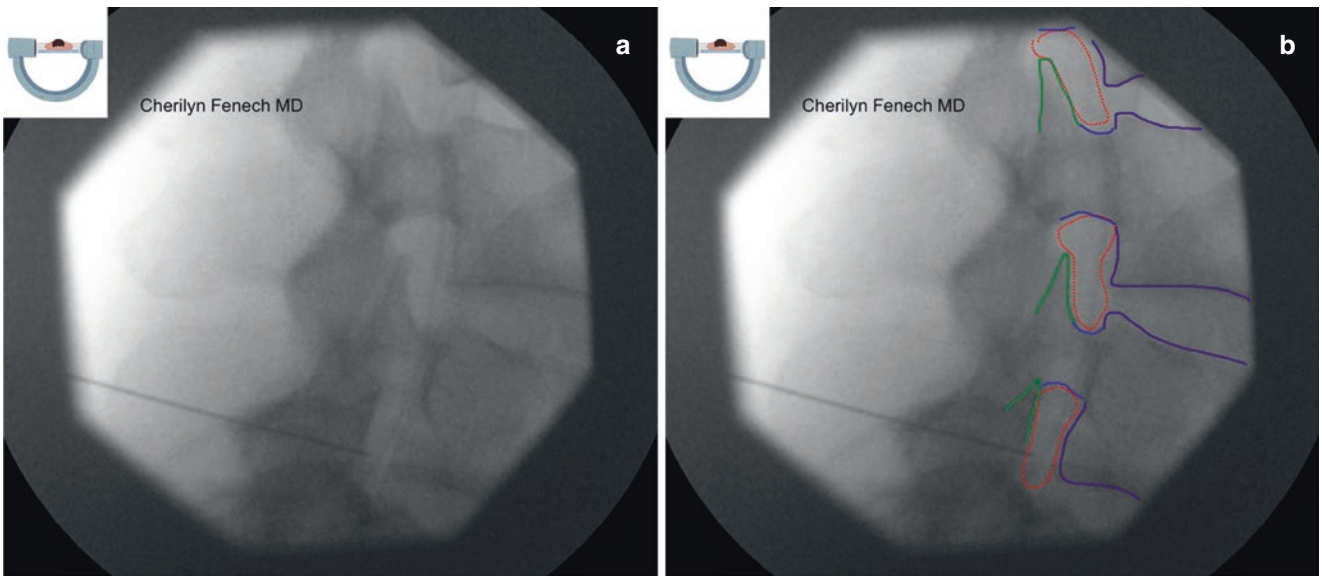

Fig. 19.3 Suprapedicular approach. Lateral view is used to confirm needle depth and to visualize the needle entering the L5-S1 foramen. Needle is positioned into the posterior aspect of the foramen. Spread of contrast can be seen in the anterior epidural space, at injected level and ascending upwards. Dark green = superior articular process; red = intervertebral foramen; dark blue = pedicle; purple = vertebral body. Native (**a**) and edited (**b**) fluoroscopy image

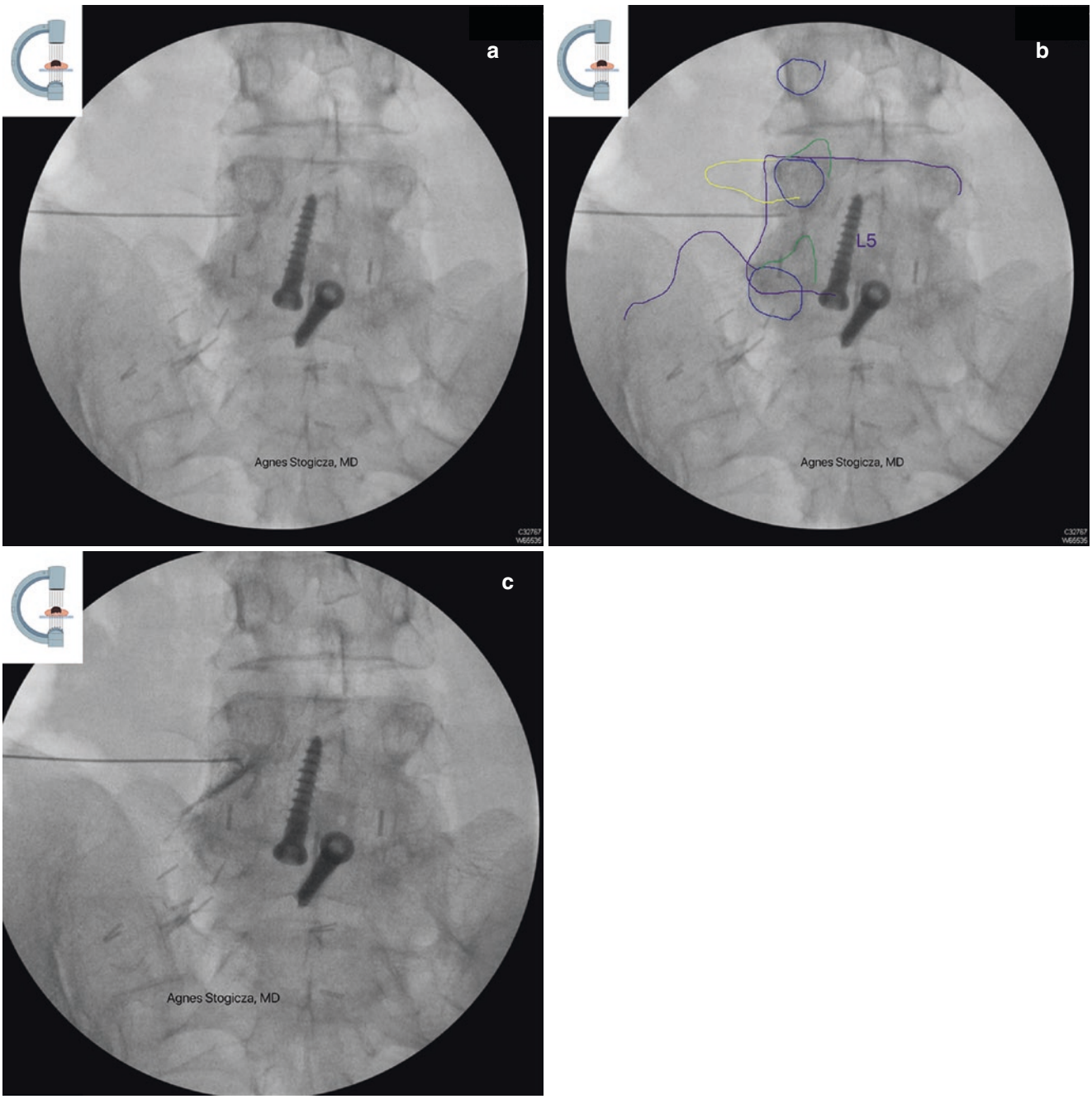

Fig. 19.4 AP image confirms needle in the mid pedicle line. Infrapedicular approach. Blue = pedicle; yellow = transverse process; dark green = superior articular process; purple = vertebral body and sacrum. Native (**a**) and edited fluoroscopy image (**b**), contrast outlines the exiting nerve root (**c**)

Unacceptable, Potentially Harmful Needle Placement on Exam

- Rough needle manipulation
- Not checking lateral and AP view to assess depth of needle
- Unnecessarily large needle (18G or larger)
- Needle in the center of foramen
- Needle placed intradiscally
- Any proof of lack of understanding of lumbar spine anatomy, for example, the needle left far lateral in the quadratus lumborum muscle and believing it is in the right place

Unacceptable, But Not Harmful Needle Placement on Exam

- Needle posterior to neural foramen
- The procedure was abandoned after unsuccessful attempts, but it was clear that the examinee was cognizant of the safety aspects of the procedure, the needle did not compromise vital structures

Evidence

Table 19.1 Level of evidence and recommendations by the Benelux section of the World Institute of Pain

These recommendations are based on both a review of the literature in 2015 by an independent third party (Kleijnen Systematic Reviews LTD) and the previous published guidelines published in Pain Practice. The recent literature, the potential risk for complications, and the grade of invasiveness were considered when deciding to upgrade or downgrade the recommendation.

Indication	Procedure	Recommendation 2009[1]	Grade 2015[2]	Recommendation 2018[3,4]
Lumbosacral radicular pain	Epidural corticosteroid administration	2B+/–	Moderate	Weak

[1]Van Boxem K, Cheng J, Patijn J, van Kleef M, Lataster A, Mekhail N, et al. 11. Lumbosacral radicular pain. Pain Pract. 2010;10:339–58
[2]Kleijnen Systematic Reviews Ltd.: Search and evaluation of the literature. 2015
[3]Huygen F, Kallewaard JW, van Tulder M, Van Boxem K, Vissers K, van Kleef M, et al. "Evidence-based interventional pain medicine according to clinical diagnoses": update 2018. Pain Pract. 2019;19:664–75
[4]https://www.anesthesiologie.nl/publicaties/praktische-richtlijnen-anesthesiologische-pijnbestrijding

Table 19.2 Level of evidence based on the American Society of Interventional Pain Physicians (ASIPP) review of the literature

Lumbar epidural injections[1]	Evidence
Disc herniation	Level I
Discogenic pain	Level III
Central spinal stenosis	Level III
Post-lumbar surgery syndrome	Level IV

[1]Manchikanti L, Schultz DM, Atluri SL, Glaser SE, Falco FJE. Lumbar epidural injections. In: Manchikanti L, Kaye AD, Falco FJE, Hirsch JA, editors. Essentials of interventional techniques in managing chronic pain. Springer International Publishing; 2018, p. 141–86

Suggested Reading

Clark C Smith, Zachary L McCormick, Ryan Mattie, John MacVicar, Belinda Duszynski, Milan P Stojanovic, (2020) The Effectiveness of Lumbar Transforaminal Injection of Steroid for the Treatment of Radicular Pain: A Comprehensive Review of the Published Data. Pain Medicine 21 (3):472–87.

Darrell Vydra, Alexander Hynes, Nate Clements, Ameet Nagpal, Jonathon Julia, Byron J Schneider, Timothy P Maus, Daniel M Cushman, Zachary L McCormick, (2019) Current Practice Trends in Image Guidance During Lumbar and Cervical Transforaminal Epidural Steroid Injections. Pain Medicine 20 (11):2327–9.

Eduard Verheijen, Alexander G. Munts, Oscar van Haagen, Dirk de Vries, Olaf Dekkers, Wilbert van den Hout, Carmen Vleggeert-Lankamp, (2019) Transforaminal epidural injection versus continued conservative care in acute sciatica (TEIAS trial): study protocol for a randomized controlled trial. BMC Neurology 19 (1).

Goodman BS, Posecion LWF, Mallempati S, Bayazitoglu M. Complications and pitfalls of lumbar interlaminar and transforaminal epidural injections. Curr Rev Musculoskelet Med. 2008;1:212–22.

Rathmell JP, et al. Safeguards to prevent neurologic complications after epidural steroid injections. Anesthesiology. 2015;122:974–84.

The Lumbar Transforaminal chapter was reviewed by Andrea M. Trescot; Milan Stojanovic; Peter S. Staats; Agnes R. Stogicza; Andre M. Mansano; Edit Racz and Raja Reddy.

Lumbar Discography

20

Carolina B. Hernández-Porras

Equipment and Monitoring

- Standard ASA monitoring
- Fluoroscopy
- Sterile prep, and drape
- Gown, mask, cap
- Skin local anesthesia prior to any needle larger than 25G (unless sedation is used)
- Coaxial view is always used to advance needle, unless otherwise specified
- CPR equipment and medications available
- 18–20G introducer needle with 22G, 3.5 inch (90 mm)–7 inch (180 mm) curved Chiba needle, or 22G introducer with 25G Quinke (dual needle use preferred to reduce infection risk)
- Manometry
- Nonionic contrast
- IV antibiotic preop

Anatomy

- Target: center, nucleus pulposus of the disc. Needle to aim to reach the sagittal plain and be in the center of the disc in cephalo-caudad and anteroposterior direction.

Structures to Keep in Mind and Possible Complications

- Spinal nerve injury
- Radicular artery → possible cord ischemia
- Spinal, epidural space → spinal, epidural spread of local anesthetic
- Paraspinal muscles → hematoma, pain
- Aorta, iliac arteries (if needles advanced too anteriorly)
- Infection
- Bleeding
- Postprocedure pain
- Vasovagal reaction
- Allergic reaction

Fluoroscopy Technique, Target Localization

- Patient in prone position
- Anteroposterior (AP) image, identify target level
- Square off vertebral bodies at the level of interest (Fig. 20.1a–c)
- Oblique C-arm until the spinous process overlaps the other side of the vertebral body (Figs. 20.2a–c and 20.3a–c)
- Entry point is just lateral to the superior articular process (SAP)
- For the L5-S1 disc, the oblique often needs to be decreased slightly, as the iliac crest can cover needle trajectory. A slight cephalad tilt of the C-arm may also help removing the iliac crest from the view (Fig. 20.3a–c)

Procedure Steps

- Advance the needle in coaxial view to the disc, just anterolateral to the SAP (Figs. 20.2a–c and 20.3c)
- When the needle tip contacts the surface of the disc, verify appropriate position in AP and lateral view before entering the disc
- Lateral view is used to confirm depth as the needle is advanced to the center of the disc (Fig. 20.4a, b)
- AP view to confirm that the needle is in the center of the disc
- Once the needle is in proper position, inject nonionic contrast in 0.5–1 ml increments (<1.5 ml), while pressure of the injection and patient's response is recorded (Fig. 20.5a, b)

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A. R. Stogicza et al. (eds.), *Interventional Pain*, https://doi.org/10.1007/978-3-030-31741-6_20

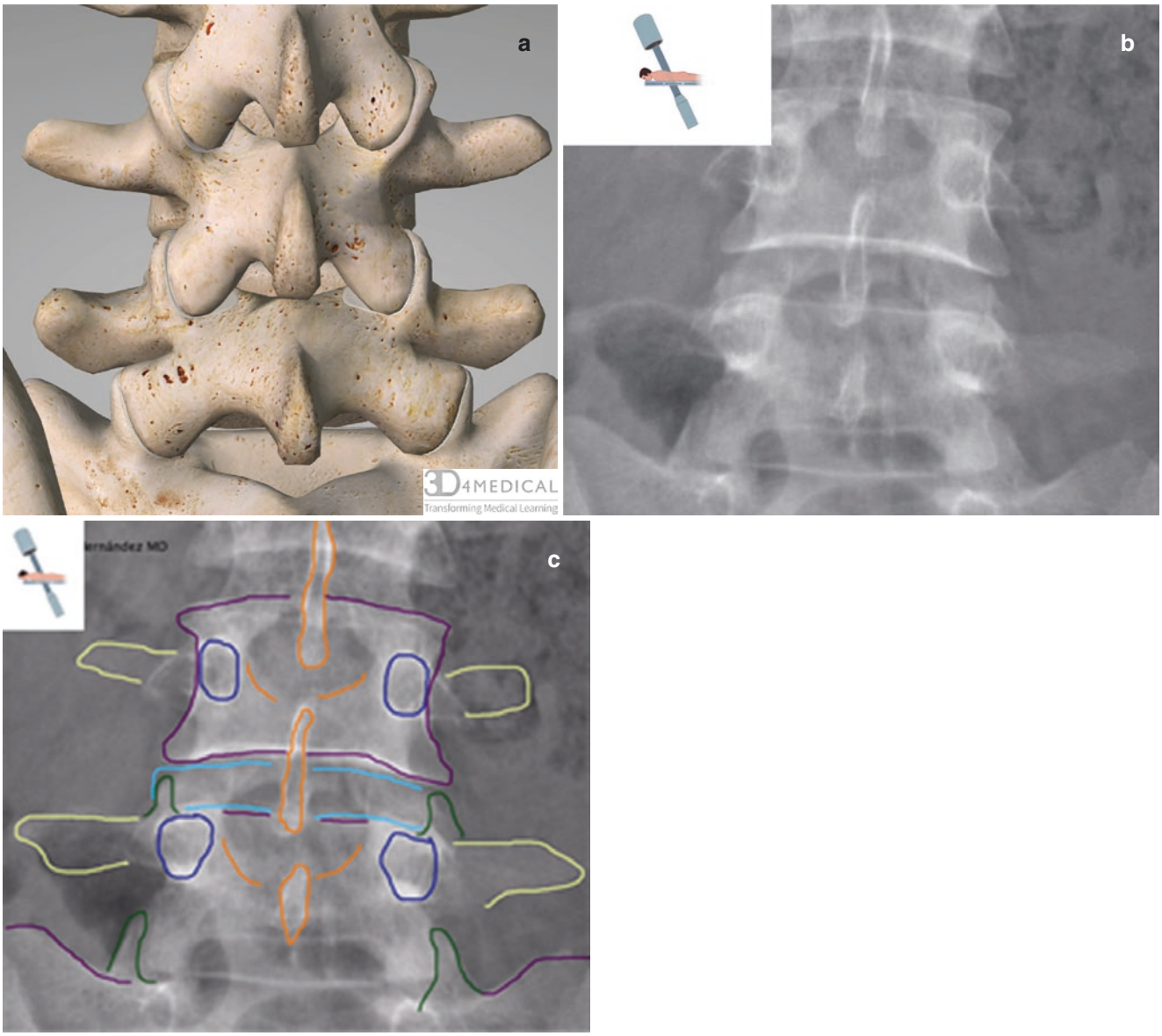

Fig. 20.1 AP image with L4–5 endplates squared off. Orange = spinous process and lamina; yellow = transverse process; dark green = superior articular process; dark blue = pedicle; purple = vertebral body and sacrum; light blue = disc. Complete Anatomy image (**a**), native (**b**) and edited (**c**) fluoroscopy image

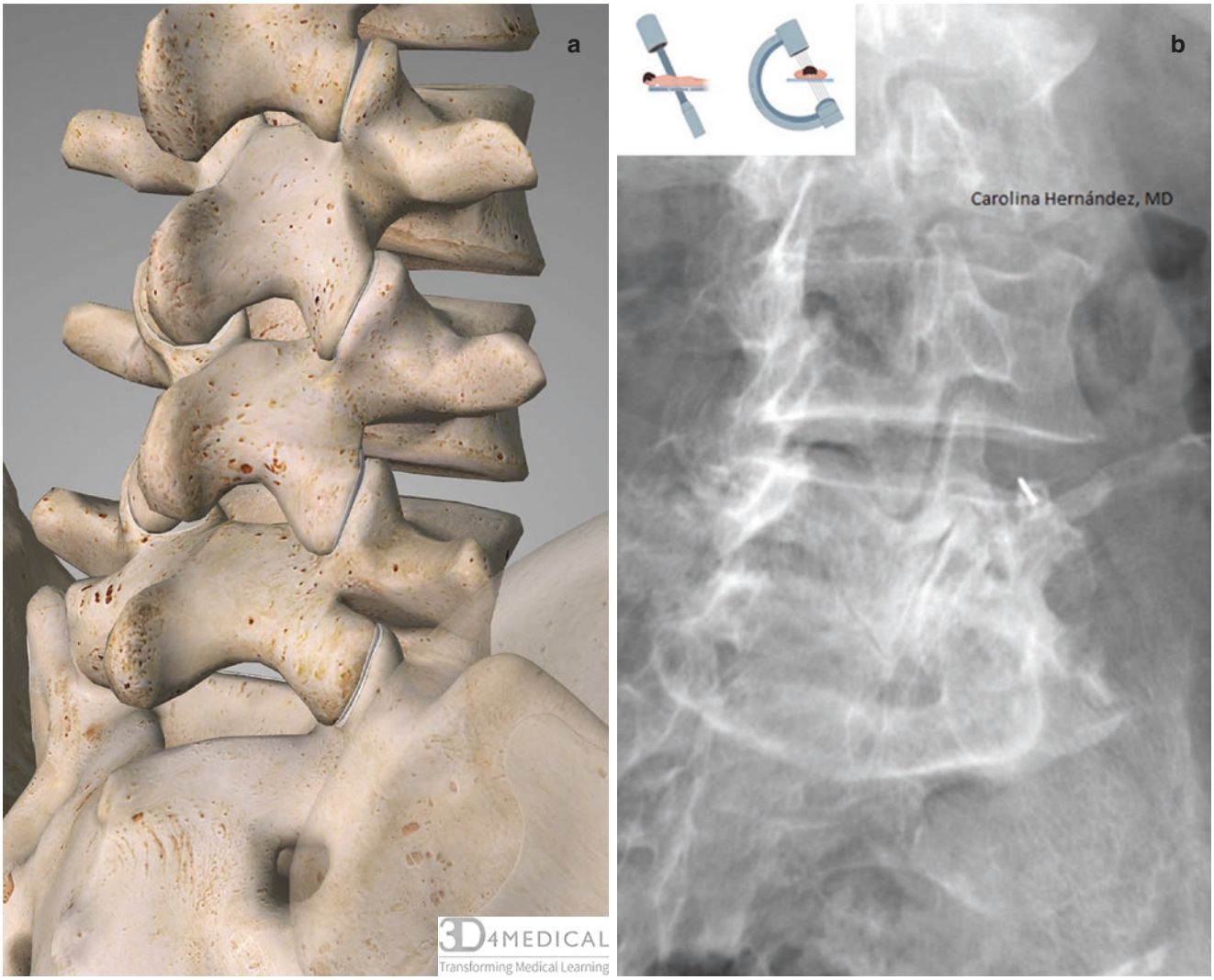

Fig. 20.2 Oblique view of the lumbar spine, needle placed in L4–5 disc in coaxial view. Yellow = transverse process; dark green = superior articular process; light green = inferior articular process; dark blue = pedicle; purple = vertebral body and sacrum; light blue = disc, pink = iliac crest. Complete Anatomy (**a**), native (**b**) and edited fluoroscopy image (**c**)

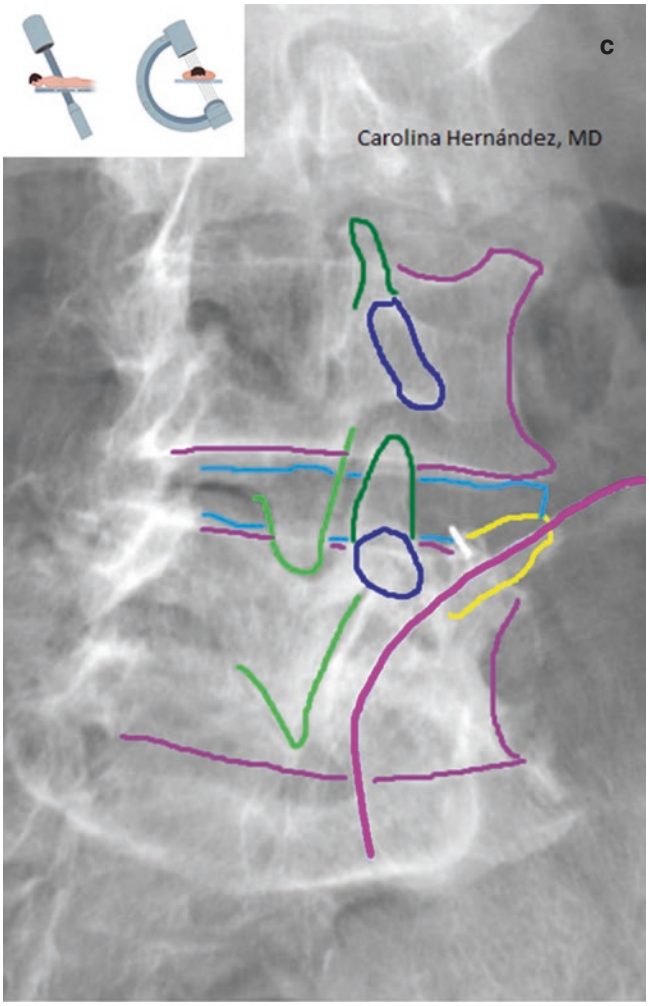

Fig. 20.2 (continued)

- Injection into the disc should be performed using a pressure-controlled injection (disc manometry)
- The recorded pressure of first visualization of contrast medium in the disc is defined as "opening" pressure
- During injection, monitor opening pressure and final pressure defined as maximum pressure above (or in addition to) the opening pressure – not to exceed 50 psi
- For discography to be interpreted positive, all of the following criteria need to be satisfied: a) concordant pain; b) pain intensity of ≥7/10 NRS; c) final pressure ≤ 50 psi above opening pressure; d) annular tear of grade 3; e) negative control disc level; f) maximum volume of 3 ml
- A concordant pain is the pain that matches patient's spontaneous pain in terms of location, quantity and intensity (back or leg pain)

Clinical Pearls

- A curved needle allows easier navigation within the disc, to fine-tune cephalo-caudad and AP positioning of the needle tip.
- Rotate the C-arm 25–35° obliquely and centered on the disc space to be studied.
- L3–4 disc often does not require angulation to align the vertebral endplates, L4–5 disc requires 0–15° of cephalad angulation, and L5-S1 disc requires 25–35° of cephalad angulation.
- 50–100 mg of cefazolin (or clindamycin alternative if allergic reaction) can be mixed with contrast medium.
- At the conclusion of the test, the patient may be sent for a post-procedure non-contrast CT scan. This allows the evaluating physician to better appreciate disc morphology as compared to fluoroscopy alone.

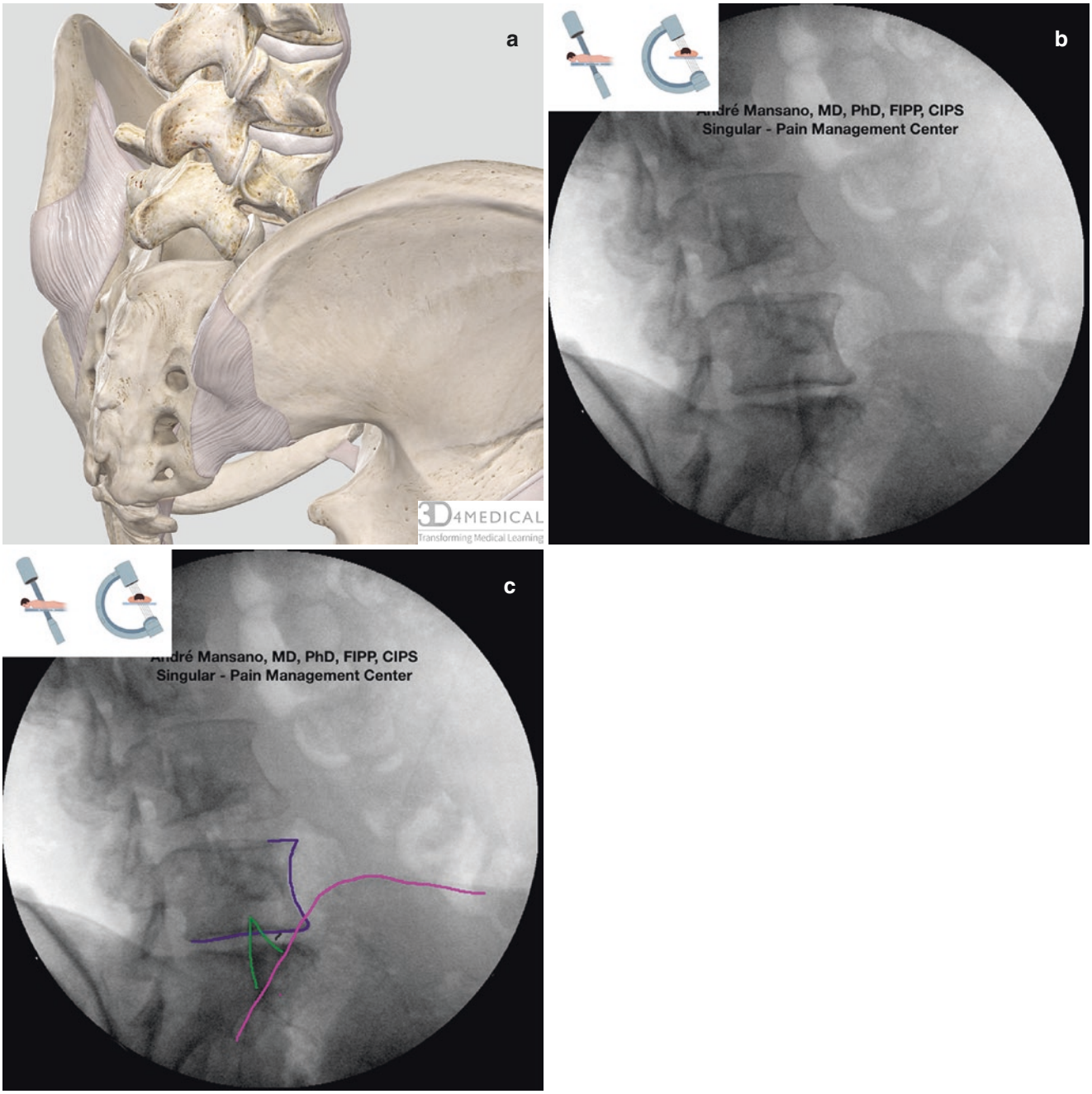

Fig. 20.3 Oblique view of the lumbar spine. Needle placed in L5-S1 disc. Dark green = superior articular process; purple = vertebral body; pink = ilium. Complete Anatomy (**a**), native (**b**) and edited fluoroscopy image (**c**)

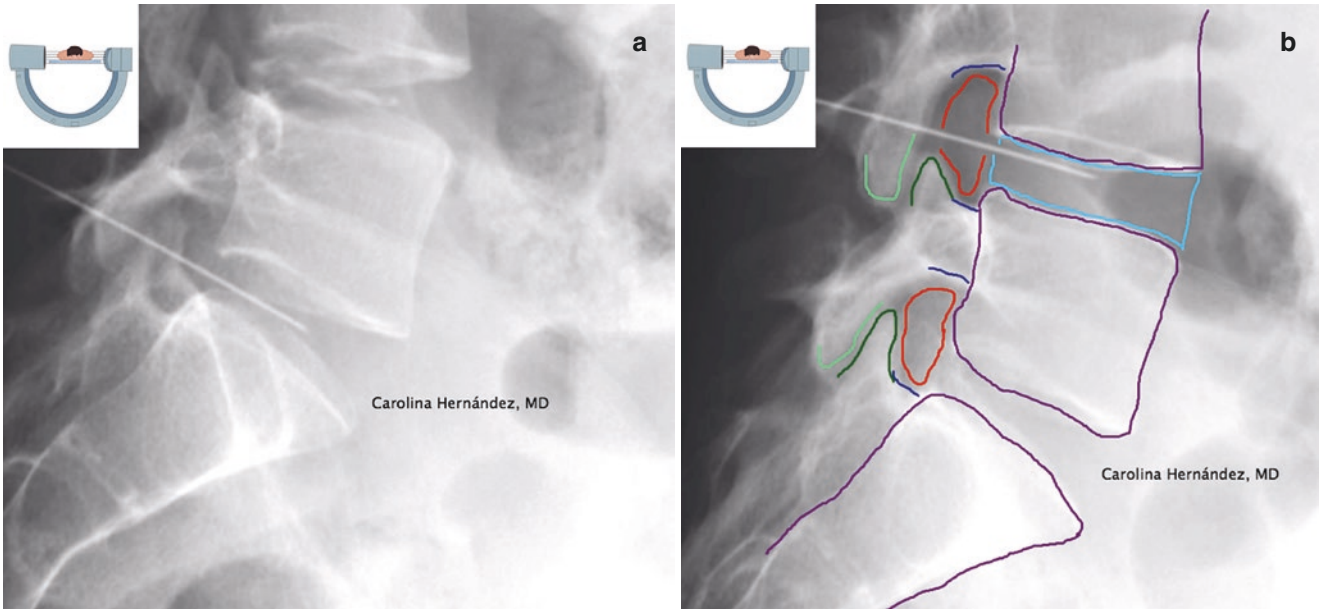

Fig. 20.4 Lateral view of the lumbar spine. Needle in L5-S1 and L4–5 disc. Dark green = superior articular process; light green = inferior articular process; red = intervertebral foramen; dark blue = pedicle; purple = vertebral body and sacrum; light blue = disc. Native (**a**) and edited (**b**) fluoroscopy image

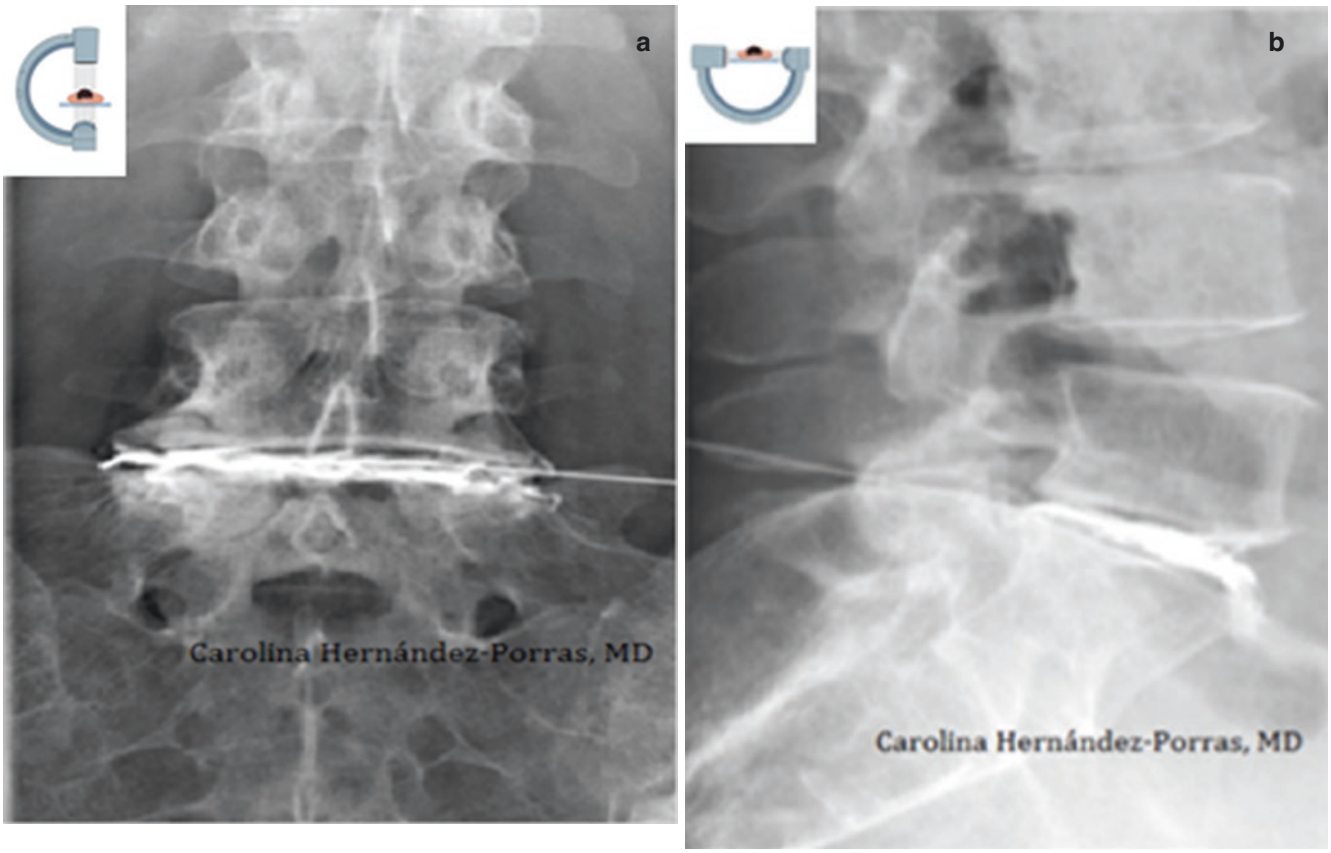

Fig. 20.5 AP (**a**) and lateral (**b**) view of the lumbar spine following L5-S1 discography. Disc height is reduced and the discogram shows diffuse linear spread of the dye to the outer layers of the annulus fibrosus on both sides. Dye also extends to the annulus anteriorly with "candle drip" morphology of the disc

Unacceptable, Potentially Harmful Needle Placement on Exam

- Not checking lateral and AP view to assess depth of needle
- Unnecessarily large needle (18G or larger)
- Multiple needle passes in and out of the disc
- Rough needle manipulation
- Any proof of lack of understanding of lumbar spine anatomy, for example, the needle left far lateral in the quadratus lumborum muscle and believing it is in the right place

Unacceptable, But Not Harmful Needle Placement on Exam

- Needle too anterior: in the anterior fourth of disc or outside the disc
- Needle too posterior: in the posterior fourth of disc
- Needle too cephalad or caudad: touching the vertebral endplates
- Needle too cranial in the intervertebral space could damage the exiting nerve root
- The procedure was abandoned after unsuccessful attempts, but it was clear that the examinee was cognizant of the safety aspects of the procedure, and the needle did not compromise intraspinal space

Evidence

WIP Benelux group only assessed treatments and not a diagnostic test, therefore there is no evidence for discography recommendation available.

Table 20.1 Level of evidence based on the American Society of Interventional Pain Physicians (ASIPP) review of the literature

Lumbar discography	Evidence
Diagnostic lumbar provocation discography[1]	Level III

[1]Manchikanti L, Falco FJE, Singh V, Hirsch JA. Discography. In: Manchikanti L, Kaye AD, Falco FJE, Hirsch JA, editors. Essentials of interventional techniques in managing chronic pain. Springer International Publishing; 2018. p. 273–300.

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Huygen F, et al. "Evidence-based interventional pain medicine according to clinical diagnoses": update 2018. Pain Pract. papr. 12786. 2019; https://doi.org/10.1111/papr.12786.

Vanharanta H, Sachs BL, Spivey MA, Guyer RD, Hochschuler SH, Rashbaum RF, Johnson RG, Ohnmeiss D, Mooney V. The relationship of pain provocation to lumbar disc deterioration as seen by CT/discography. Spine (Phila Pa 1976). 1987;12(3):295–8.

Raj PP. Intervertebral Disc: Anatomy-Physiology-Pathophysiology-Treatment. Pain Pract. 2008;8(1):18–44.

Brinjikji W, Luetmer PH, Comstock B, Bresnahan BW, Chen LE, Deyo RA, Halabi S, Turner JA, Avins AL, James K, Wald JT, Kallmes DF, and Jarvik JG. Systematic literature review of imaging features of spinal degeneration in asymptomatic populations. Am J Neuroradiol. 2015;36(4):811–6.

The Lumbar Discography chapter was reviewed by Micha Sommer; Andrea M. Trescot; Milan Stojanovic; Peter S. Staats; Agnes R. Stogicza; Andre M. Mansano; Massimo Barbieri

Part IV

Sacral/Pelvic Procedures

Neuroplasty (Caudal, Transgrade and Transforaminal approach)

21

Edit Racz and Agnes R. Stogicza

Equipment and Monitoring

- Standard ASA monitoring
- Fluoroscopy
- Sterile prep, and drape
- Sterile gown and mask
- Skin local anesthesia prior to any needle larger than 25G (unless sedation is used)
- CPR equipment and medications available
- IV access
- 16G RX-Coude needle
- Steerable epidurolysis catheter
- Nonionic contrast
- Preservative-free Lidocaine 1%
- Hyaluronidase 1500 units or Hylenex 150 units/10 ml of saline
- Preservative-free Bupivacaine 0.25%
- Triamcinolone 40 mg or methylprednisolone 40 mg
- Hypertonic saline, NaCl 10%, 10 ml
- Preoperative antibiotic

Anatomy

- Neural foramen, exiting nerve root, bordered by disc and vertebral bodies anteriorly, pedicles above and below, and the superior and inferior articular process posteriorly
- The target is to place the catheter to the anterior part of the foramen. The affected nerve root is confirmed by matching:
  - Clinical symptoms (before the procedure)
  - Physical exam (before the procedure)
  - MRI (before the procedure)
  - Epidurogram (during the procedure)

Structures to Keep in Mind and Possible Complications

- Local anesthetic in subdural space → delayed "spinal anesthesia", with numbness, weakness, blood pressure changes
- Intrathecal space:
  - Local anesthetic → total spinal
  - Hypertonic saline → subdural osmotic expansion and secondary ischemia from pressure
- Dura ends at S1, but may extend down to S2 or S3 level → allowing intrathecal needle or catheter placement
- Epidural venous plexus and arteries → intravascular injection, epidural bleeding, cauda equina syndrome
- Exiting nerve roots → nerve damage
- Hypertonic saline can lead to chronic bowel or bladder incontinence if it enters the subdural space
- Infection
- Bleeding
- Postprocedure pain
- Vasovagal reaction
- Allergic reaction

Fluoroscopy Technique, Target Localization—Caudal Approach

- Patient in prone position with a pillow under the lower abdomen to decrease lumbar lordosis. This is particularly important to ease catheter navigation
- Identify sacral hiatus by palpation just distal to the two sacral cornua and also with fluoroscopy, lateral view
- The target is the compromised/compressed/irritated exiting nerve root; catheter tip should be navigated to the ventral lateral aspect of the foramen (midline or posterior catheter placement has no benefit over regular interlaminar steroid injection, and it is not recommended)

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Procedure Steps—Caudal Approach

- This procedure is not performed in a coaxial view
- Sacrum, lateral view to identify opening of the caudal canal (Fig. 21.1a)
- Skin entry is 3 cm caudal and 2 cm off midline contralateral to the targeted side
- Place RX Coudé needle in the caudal hiatus, keeping 2–3 cm of the needle tunneled under the skin (to decrease risk of infection, as catheter stays 12–24h)

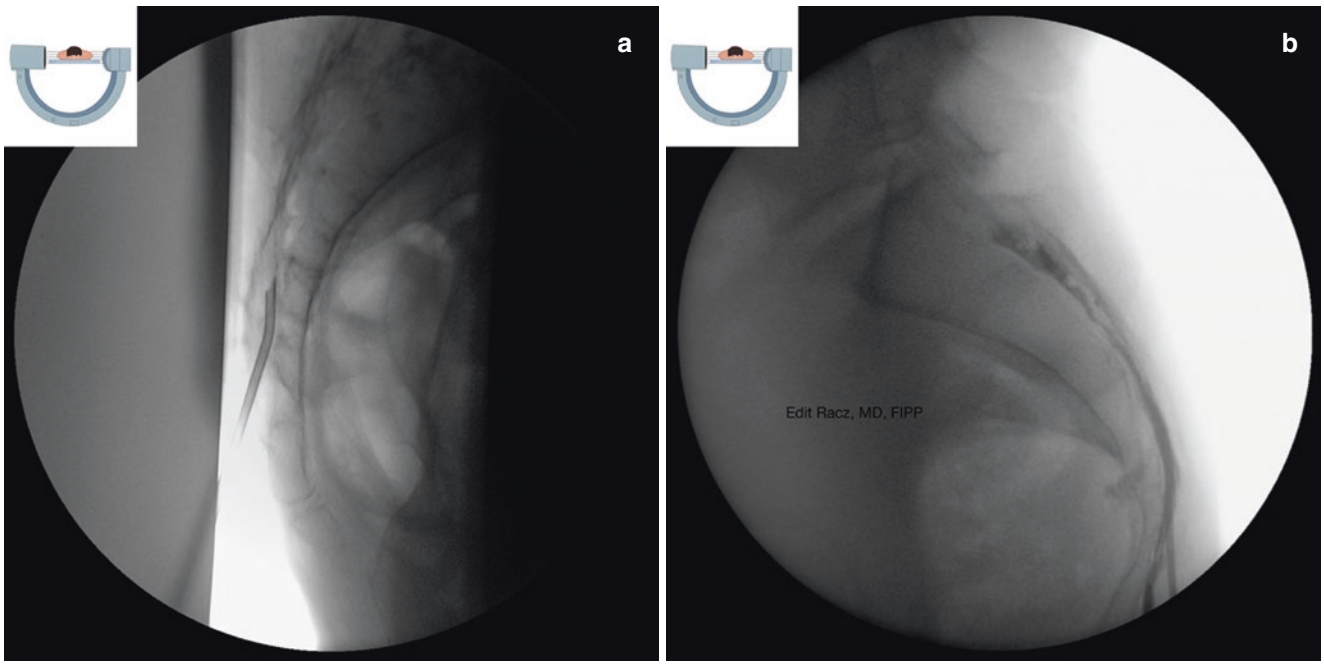

Fig. 21.1 Lateral image of the sacrum, needle placed through the caudal hiatus (**a**). 1–3 ml contrast medium confirms epidural position (**b**)

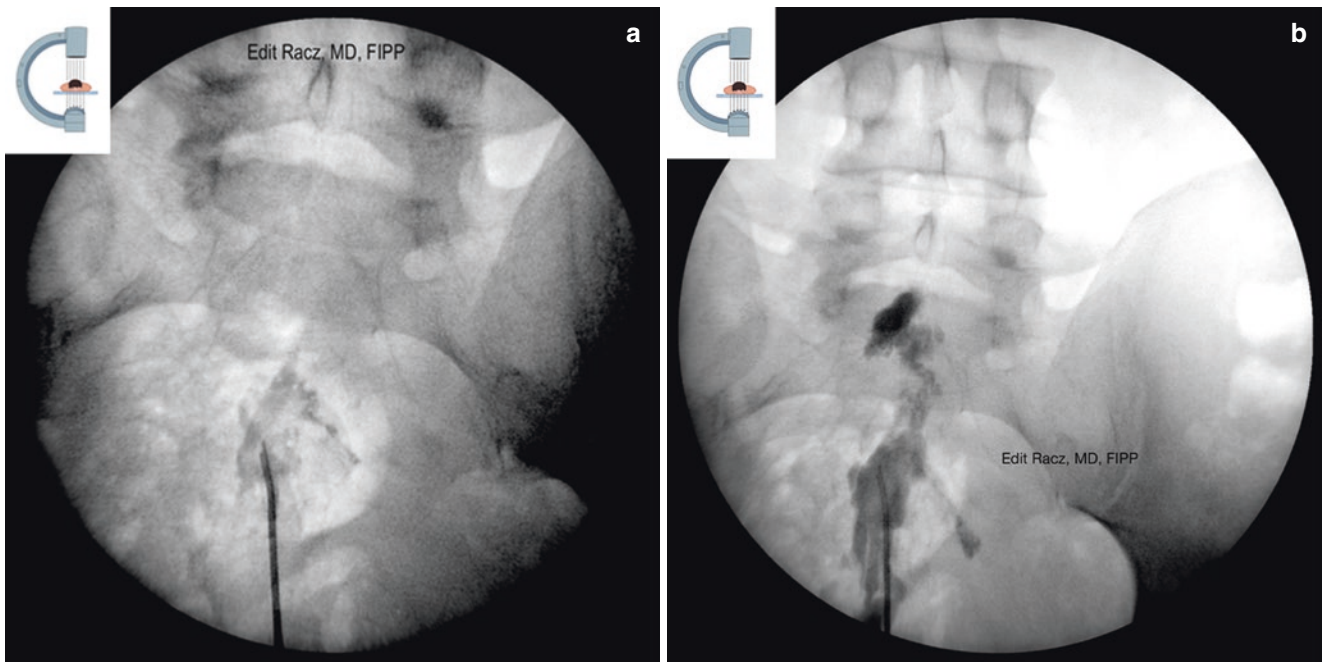

Fig. 21.2 AP fluoroscopy images of the lumbosacral spine. Epidurogram, with 3 ml (**a**), 5 ml (**b**), and 10 ml of contrast medium (**c**). Filling defect at left L5 foramen is obvious on (**c**) native and (**d**) edited images. Yellow = contrast outlining the exiting nerve roots; blue = pedicle; red = filling defect at left L5

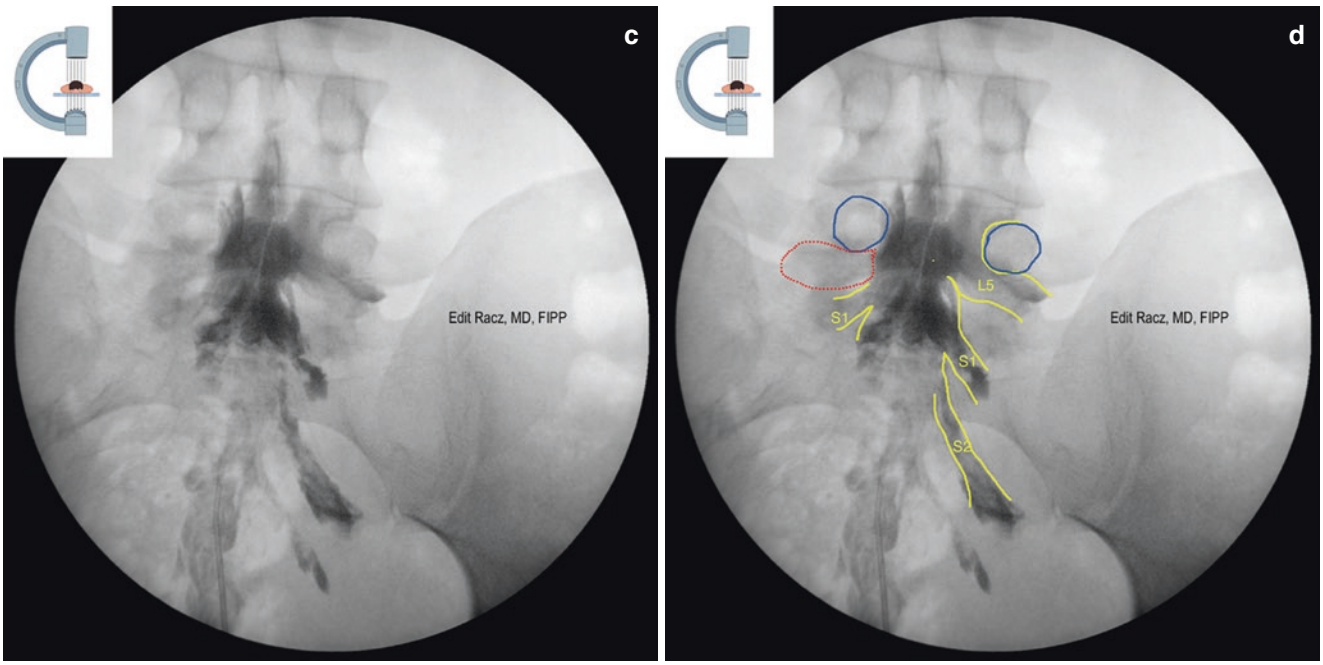

Fig. 21.2 (continued)

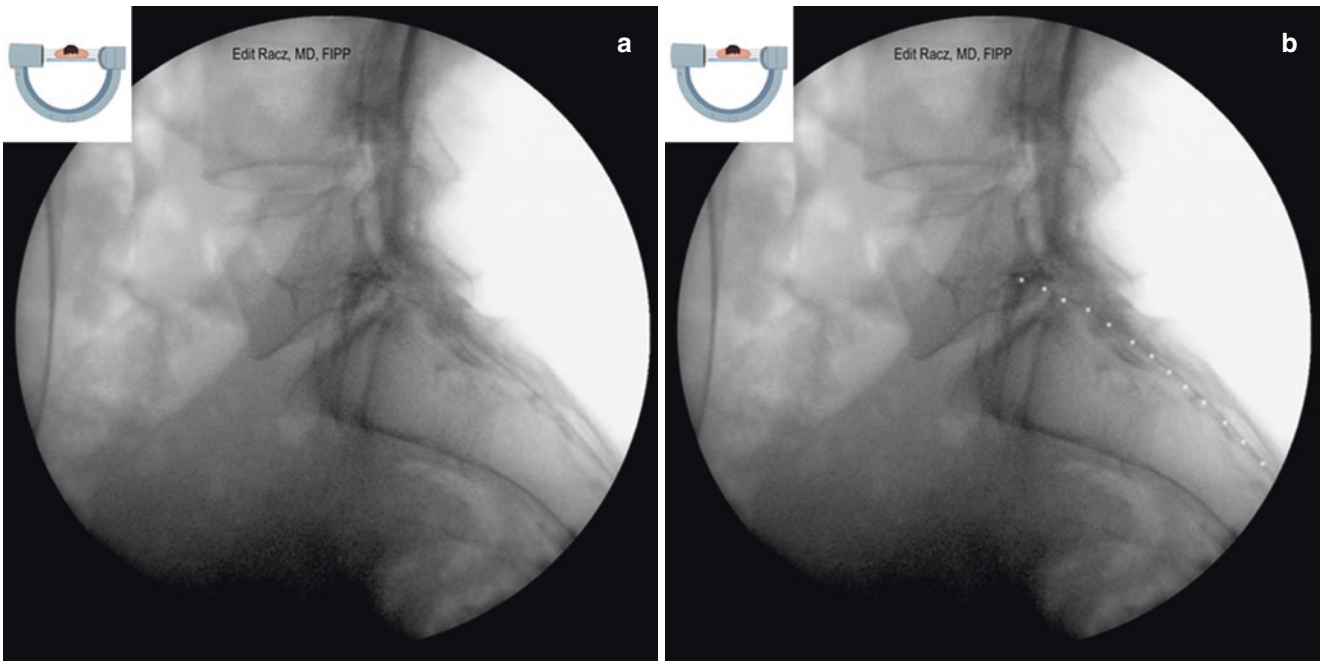

Fig. 21.3 Lateral images of the lumbosacral spine. Ideal positioning, the catheter is located in the anterior part of the L5 foramen. (**a**) Catheter outlined in white dots (**b**)

- Confirm epidural position with 1–2 ml contrast material (Fig. 21.1b)
- Anteroposterior (AP) view to inject 10 ml of contrast to perform epidurogram. Filling defect confirms previous assumptions of affected nerve root (Fig. 21.2a–d)
- 10 ml of lidocaine 1%
- Navigate catheter to the desired foramen in the anterior epidural space
- Inject contrast to confirm position
- Check if catheter in the anterior epidural space (Fig. 21.3a, b)
- Inject hyaluronidase in 10 ml of saline
- Repeat epidurogram with 2–5 ml contrast to confirm good spread in the foramen, outlining the exiting nerve root (Fig. 21.4)
- Secure catheter to the skin

- Inject bupivacaine 0.25%, 10 ml mixed with triamcinolone 40 mg
- Wait 20 minutes (this is very important, otherwise the NaCl 10% will cause unbearable pain. It also ensures that no subdural block has occurred.)
- Place patient in a lateral position with the affected side down
- Infuse 10 ml of hypertonic saline (NaCl 10%) over 20 minutes or NaCl 10% in lidocaine 0.6%, inject 0.5 cc increments over 3–4 minutes
- Flush catheter with 2 ml of lidocaine
- Repeat the infusion of bupivacaine 0.25%, 10 ml/NaCl 10%, 10 ml, after previous motor block is gone (1 or 2 times)
- Remove catheter

Clinical Pearls

- Navigating the catheter to the lateral part of the epidural space early on (latest at S2 level) facilitates keeping the catheter in the anterior epidural space
- Allowing the catheter to stay midline (which is the catheter's natural tendency) while threading toward target contributes to dural puncture and limits the success of reaching the foramen
- Be careful when pulling catheter back to prevent shearing it (manipulation of needle helps)
- NaCl 10% is very painful if the area is not anesthetized. Waiting 20 minutes after bupivacaine injection is important to prevent pain on hypertonic saline injection and also to verify that there is no motor block (which would represent a subdural spread). If the infusion is still painful, stop, add 5 ml more Lidocaine 1%, and wait 5 minutes before restarting infusion
- Flushing the catheter after the completion of first infusion is important, so at the next infusion, the content of the catheter is not NaCl 10%, as it gets flushed onto the nerve root first
- Be prepared – some patients develop significant weakness with the infusions for a few hours, so be careful to prevent falls.
- Occasionally threading the catheter to the desired foramen is too challenging from the caudal approach. In these cases transgrade (Figs. 21.5, 21.6, 21.7, 21.8 and 21.9) or transforaminal (Figs. 21.10, 21.11, 21.12 and 21.13) approach can be utilized

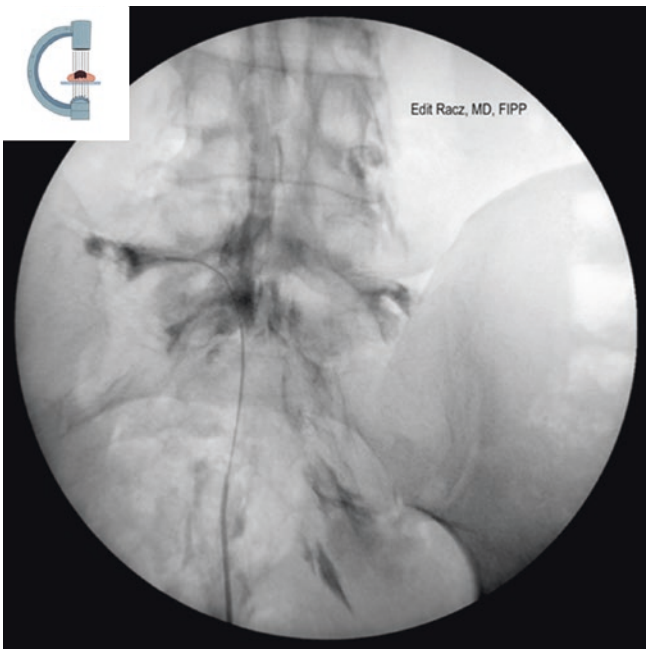

Fig. 21.4 AP image of the lumbosacral spine. Catheter is threaded to the left L5 foramen. It is reinjected with hyaluronidase, and then with 3 more cc of contrast medium. Good contrast flow at previously adhesed nerve root noted on (Fig. 21.2c, d)

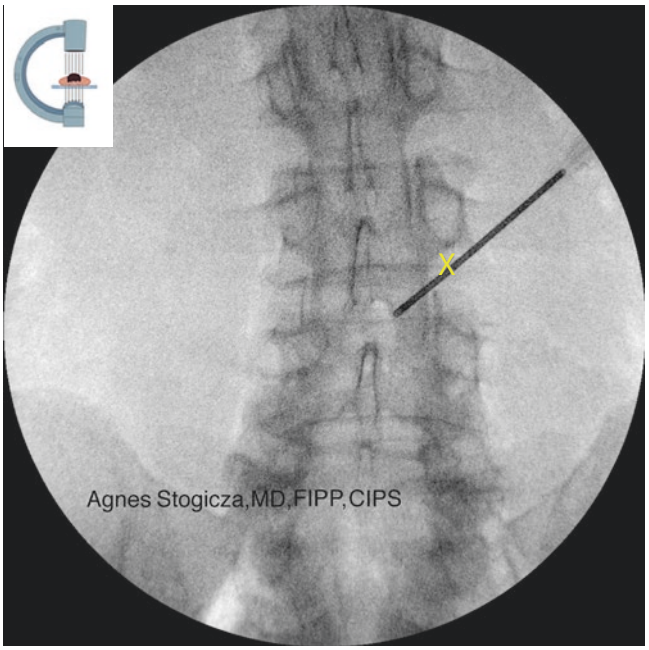

Fig. 21.5 Transgrade epidurolysis, AP view. Skin entry (just below the facet joint above on average size patient) is marked with "X". 16G RX Coude needle is placed on the caudad edge of L3 lamina. Needle is placed without the use of coaxial view

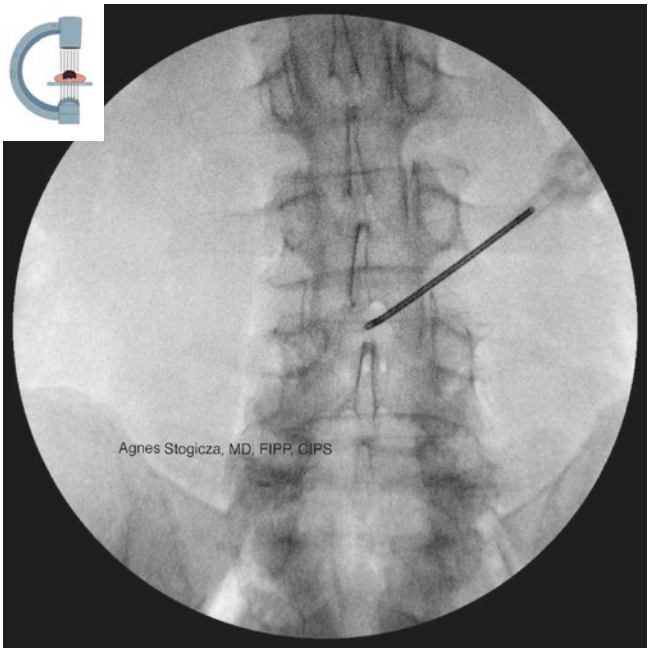

Fig. 21.6 Transgrade epidurolysis, AP view. Needle is in the epidural space after loss of resistance

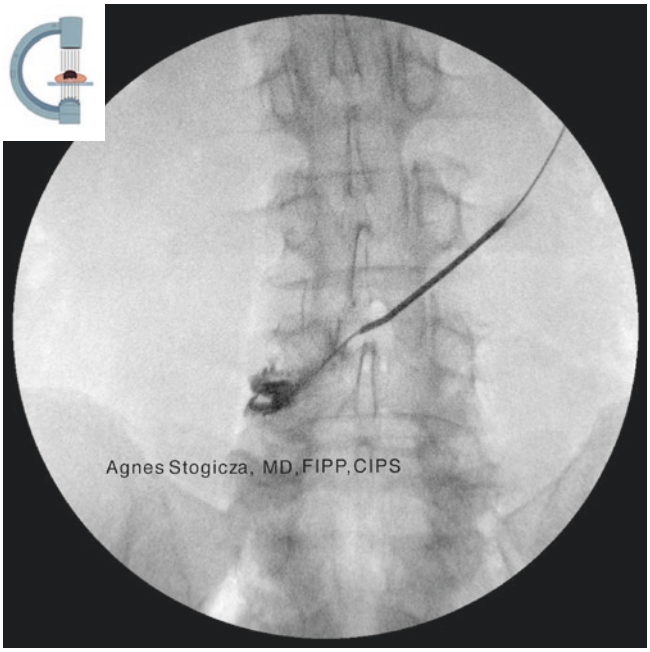

Fig. 21.8 Transgrade epidurolysis, AP view. Contrast is in the L4 foramen, outlining the pedicle

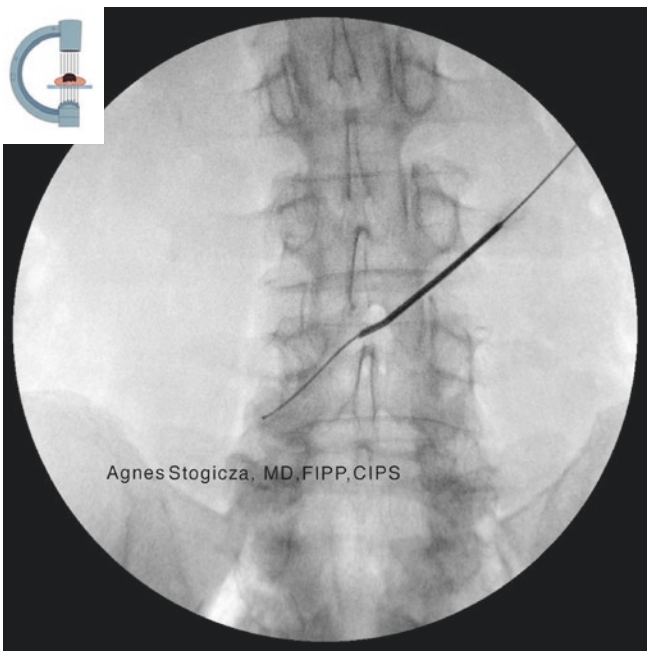

Fig. 21.7 Transgrade epidurolysis, AP view. Catheter threaded to the L4 foramen

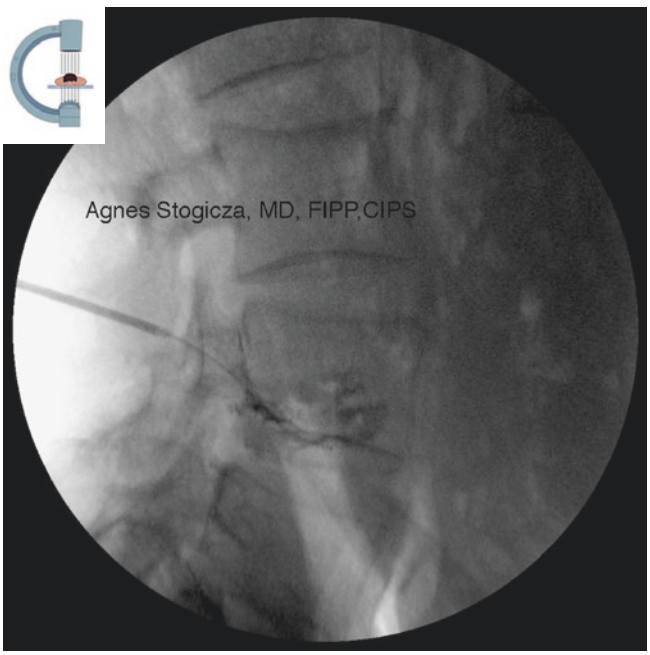

Fig. 21.9 Transgrade epidurolysis, lateral view. Contrast is in the anterior and posterior epidural space, outlining the exiting nerve root

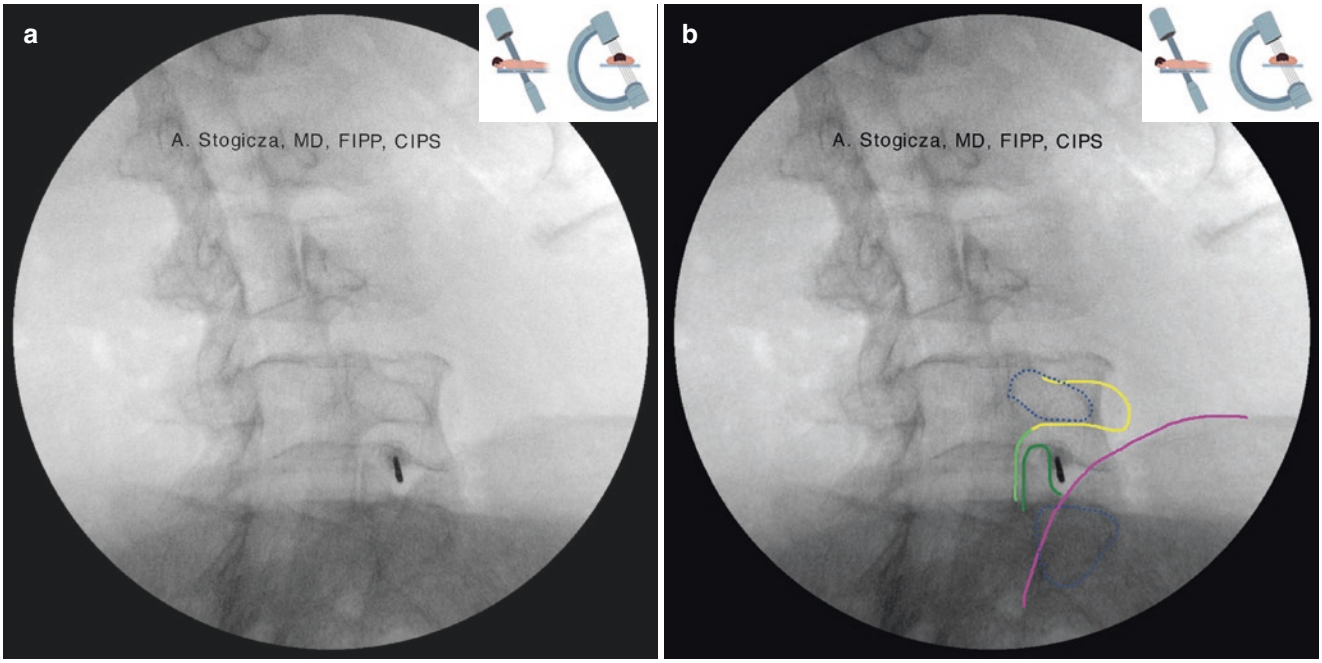

Fig. 21.10 Transforaminal epidurolysis, Oblique view. Vertebral endplates are squared off, then C-arm is obliqued until L5 spinous process overlapped the other side of the vertebral body. Needle is placed in a coaxial view into the foramen. Dark green = superior articular process; light green = inferior articular process; blue = pedicle; yellow = transverse process; pink = iliac crest. Native (**a**) and edited (**b**) fluoroscopy image

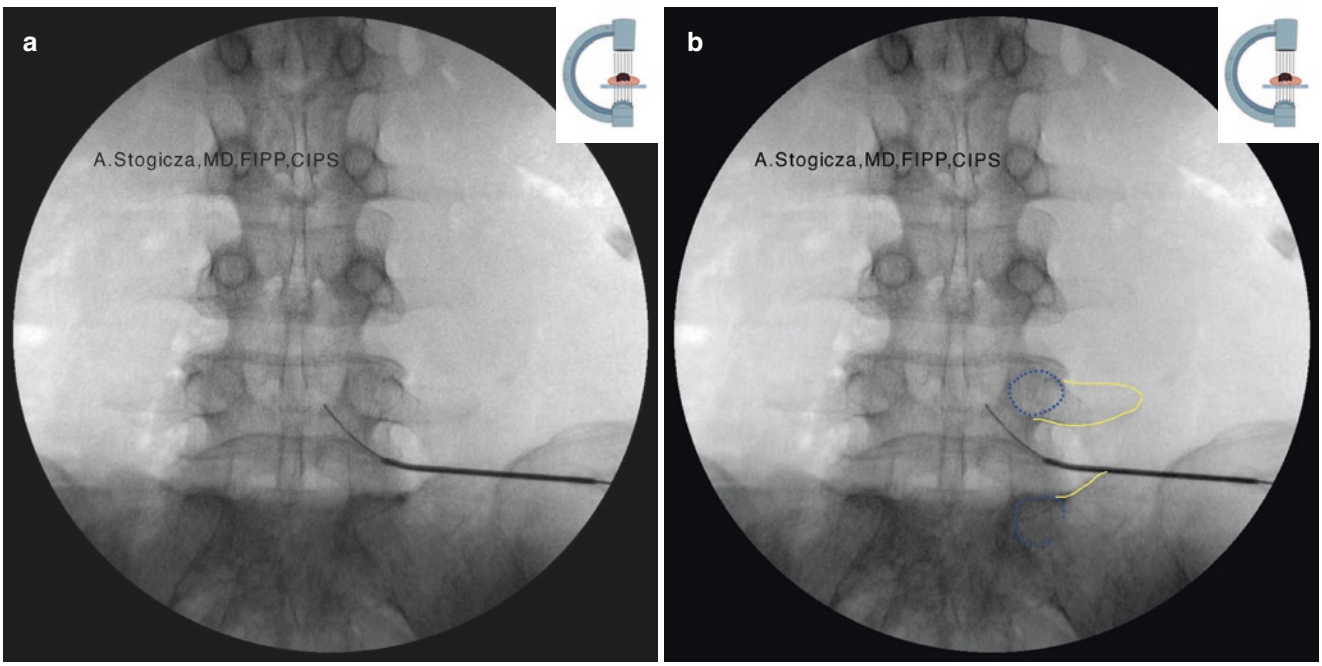

Fig. 21.11 Transforaminal epidurolysis, AP view. The catheter is in the epidural space. Blue = pedicle; yellow = transverse process. Native (**a**) and edited (**b**) fluoroscopy image

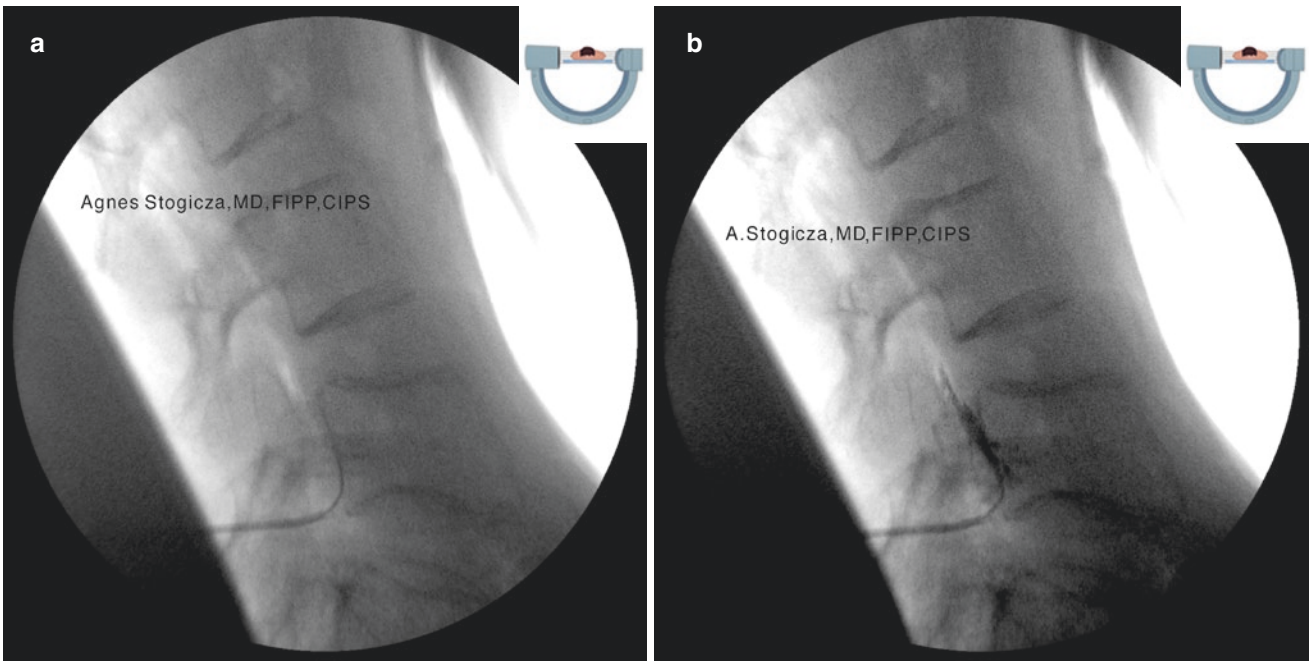

Fig. 21.12 Transforaminal epidurolysis, lateral view. Catheter in the anterior epidural space. Without (**a**) and with contrast (**b**) injected

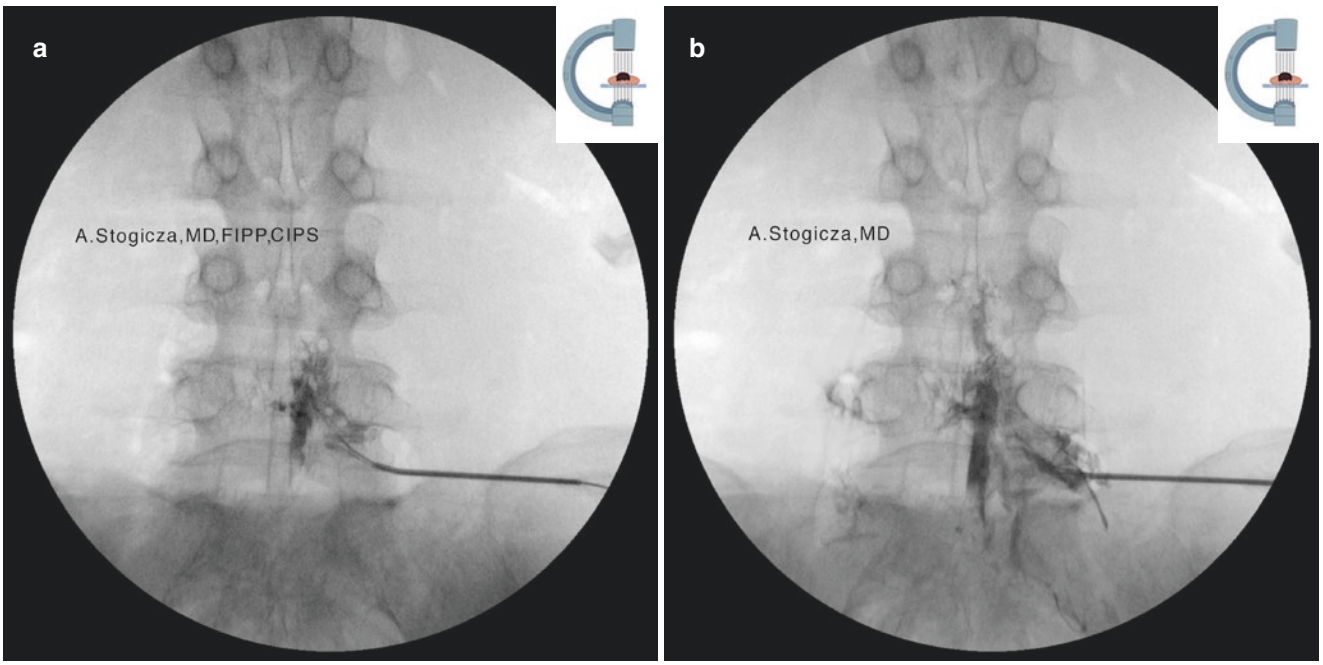

Fig. 21.13 Transforaminal epidurolysis, AP view. 3 ml contrast in the epidural space (**a**), 6 ml contrast outlines the exiting L5 nerve root (**b**).

Unacceptable, Potentially Harmful Needle Placement on Exam

- Not checking multiple fluoroscopy views (AP and lateral)
- Rough needle manipulation
- Catheter shearing
- Any proof of lack of understanding of lumbosacral and pelvic anatomy, for example, the needle placed into the sacrum, of far anterior to it, into the rectum

Unacceptable, But Not Harmful Needle Placement on Exam

- Not accessing the caudal epidural space
- Not threading the catheter into the foramen
- Not threading the catheter to the ventrolateral position in the foramen
- The procedure was abandoned after unsuccessful attempts, but it was clear that the examinee was cognizant of the safety aspects of the procedure

Evidence

Table 21.1 Level of evidence and recommendations by the Benelux section of the World Institute of Pain
These recommendations are based on both a review of the literature in 2015 by an independent third party (Kleijnen Systematic Reviews LTD) and the previous published guidelines published in Pain Practice. The recent literature, the potential risk for complications, and the grade of invasiveness were considered when deciding to upgrade or downgrade the recommendation.

Indication	Procedure	Recommendation 2009[1]	Grade 2015[2]	Recommendation 2018[3,4]
Failed back surgery syndrome	Adhesiolysis	2B+/−	Very low	Very weak

[1]Van Boxem K, Cheng J, Patijn J, van Kleef M, Lataster A, Mekhail N, et al. 11. Lumbosacral radicular pain. Pain Pract. 2010;10:339–58
[2]Kleijnen Systematic Reviews Ltd.: Search and evaluation of the literature. 2015
[3]Huygen F, Kallewaard JW, van Tulder M, Van Boxem K, Vissers K, van Kleef M, et al. Evidence-based interventional pain medicine according to clinical diagnoses: update 2018. Pain Pract. 2019;19:664–75
[4]https://www.anesthesiologie.nl/publicaties/praktische-richtlijnen-anesthesiologische-pijnbestrijding

Table 21.2 Level of evidence based on the American Society of Interventional Pain Physicians (ASIPP) review of the literature

Caudal neuroplasty[1]	Evidence
Post-surgery syndrome	Level II
Central spinal stenosis	Level II
Disc herniation	Level II

[1]Manchikanti L, Heavner JE, Racz GB. Percutaneous adhesiolysis. In: Manchikanti L, Kaye AD, Falco FJE, Hirsch JA, editors. Essentials of interventional techniques in managing chronic pain. Springer International Publishing; 2018. p. 241–72.

Suggested Reading

Gerdesmeyer L, Wagenpfeil S, Birkenmaier C, Veihelmann A, Hauschild M, Wagner K, Muderis MA, Gollwitzer H, Diehl P, Toepfer A. Percutaneous epidural lysis of adhesions in chronic lumbar radicular pain: a randomized, double-blind, placebo-controlled trial. Pain Physician. 2013;16(3):185–96.
Racz GB, Heavner JE, Smith JP, Noe CE, Al-Kaisy A, Matsumoto T, Sang Chul L, Nagy L. Epidural lysis of adhesions and percutaneous neuroplasty. InTechOpen. 2014.
Manchikanti L, Manchikanti KN, Gharibo CG, Kaye AD. Efficacy of percutaneous adhesiolysis in the treatment of lumbar post surgery syndrome. Anesth Pain Med. 2015;5(3).

The Caudal Neuroplasty chapter was reviewed by Gabor Racz; Miles Day; Rafael Justiz; Fabricio D. Assis; Massimo Barbieri; Andrea M. Trescot; Milan Stojanovic; Peter S. Staats; Andre M. Mansano.

Superior Hypogastric Plexus Block – Posterolateral Approach, Coaxial View (Non-transdiscal Approach)

22

Agnes R. Stogicza

Equipment and Monitoring

- Standard ASA monitoring
- Fluoroscopy
- Sterile prep and drape
- Skin local anesthesia prior to any needle larger than 25G (unless sedation is used)
- Coaxial view is used to advance needle, unless otherwise specified
- CPR equipment and medications available
- 20–22G, 5 inch (130 mm)–7 inch (180 mm) needle, tip curved to facilitate steering
- Nonionic contrast material
- Lidocaine 1% or Bupivacaine 0.25% or phenol 6–7%

Anatomy

- Target: anterior to the L5-S1 disc, and/or lower part of the L5 vertebral body and/or upper part of the sacrum
- The aorta and inferior vena cava splits into the common iliac arteries and veins anterior to the L4 and L5 vertebral bodies
- Anterior to the aorta bifurcation lays the intermesenteric plexus, which continues caudally as superior hypogastric plexus
- The superior hypogastric plexus connects to the inferior hypogastric plexus via the left and right hypogastric nerves, that are just anterior to the S1 (Fig. 22.1a, b)

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Structures to Keep in Mind and Possible Complications

- L4 and L5 exiting nerve root, depending on needle entry level → nerve injury
- L5-S1 disc → discitis, disc degeneration, pain
- Common iliac arteries and veins → bleeding, intravascular injection
- Intrathecal, epidural advancement of needles
- Ureter
- Infection
- Bleeding
- Postprocedure pain
- Vasovagal reaction
- Allergic reaction

Fluoroscopy Technique, Target Localization

Goal: To obtain an unobstructed view of the anterolateral portion of the L5-S1 disc. This can be achieved by:

- Patient in prone position
- Anteroposterior (AP) view of the L-S spine (Fig. 22.2a–c)
- Oblique tilt of the C-arm so the spinous process of L5 overlaps the contralateral facet line ("scotty dog view") (Fig. 22.3a–c)
- Cephalad tilt of the C-arm in order to the move the iliac crest out of view (Fig. 22.4a–c)

A step-by-step, oblique-cephalad tilt usually allows finding an unobstructed view and allows the needle to be passed in a coaxial view.

A. R. Stogicza et al. (eds.), *Interventional Pain*, https://doi.org/10.1007/978-3-030-31741-6_22

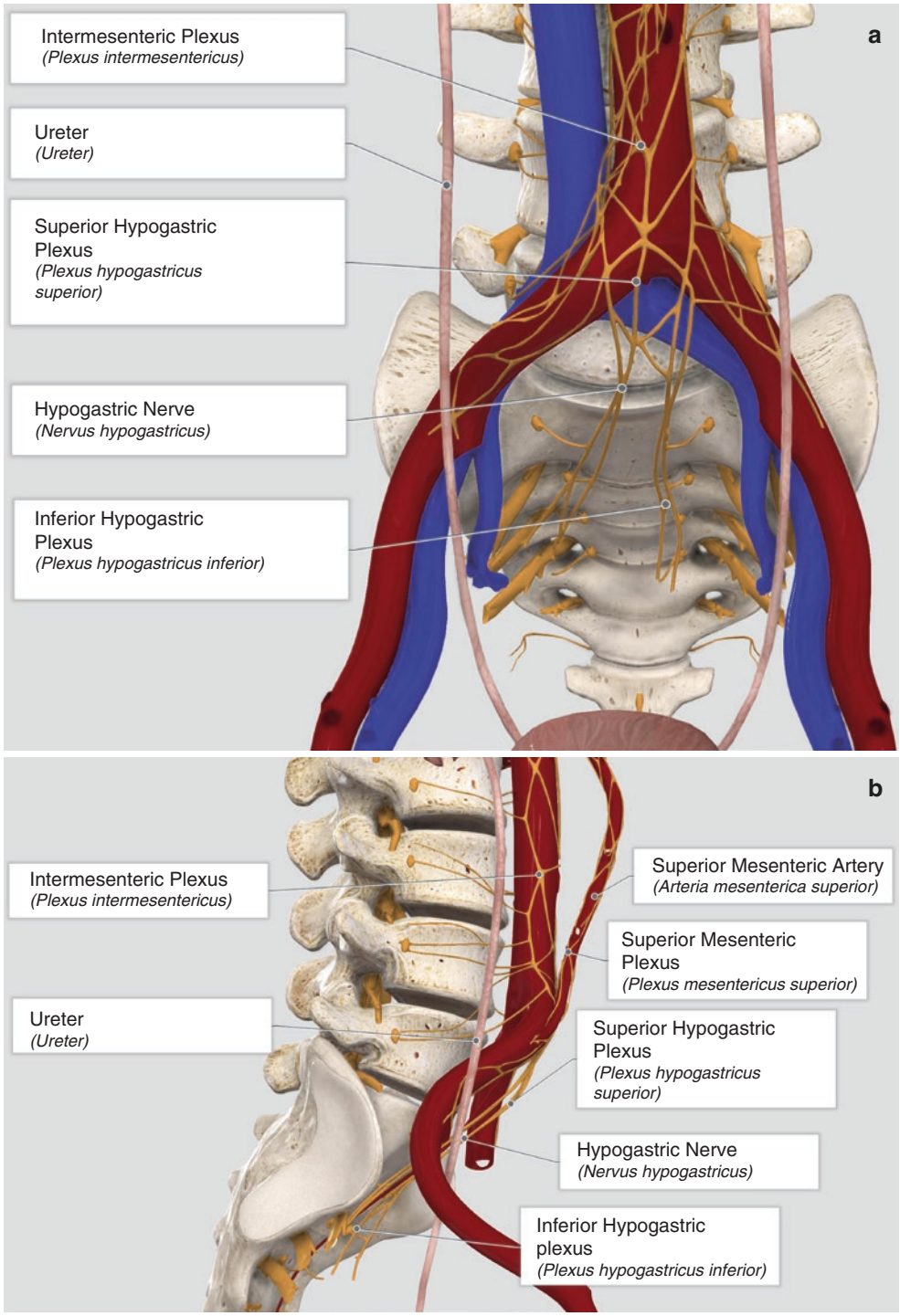

Fig. 22.1 The superior hypogastric plexus connects to the inferior hypogastric plexus via the left and right hypogastric nerves, that are just anterior to the lower part of L5 vertebral body, the L5-S1 disc and the upper part of S1. Complete Anatomy image, anterior (**a**) and lateral view (**b**)

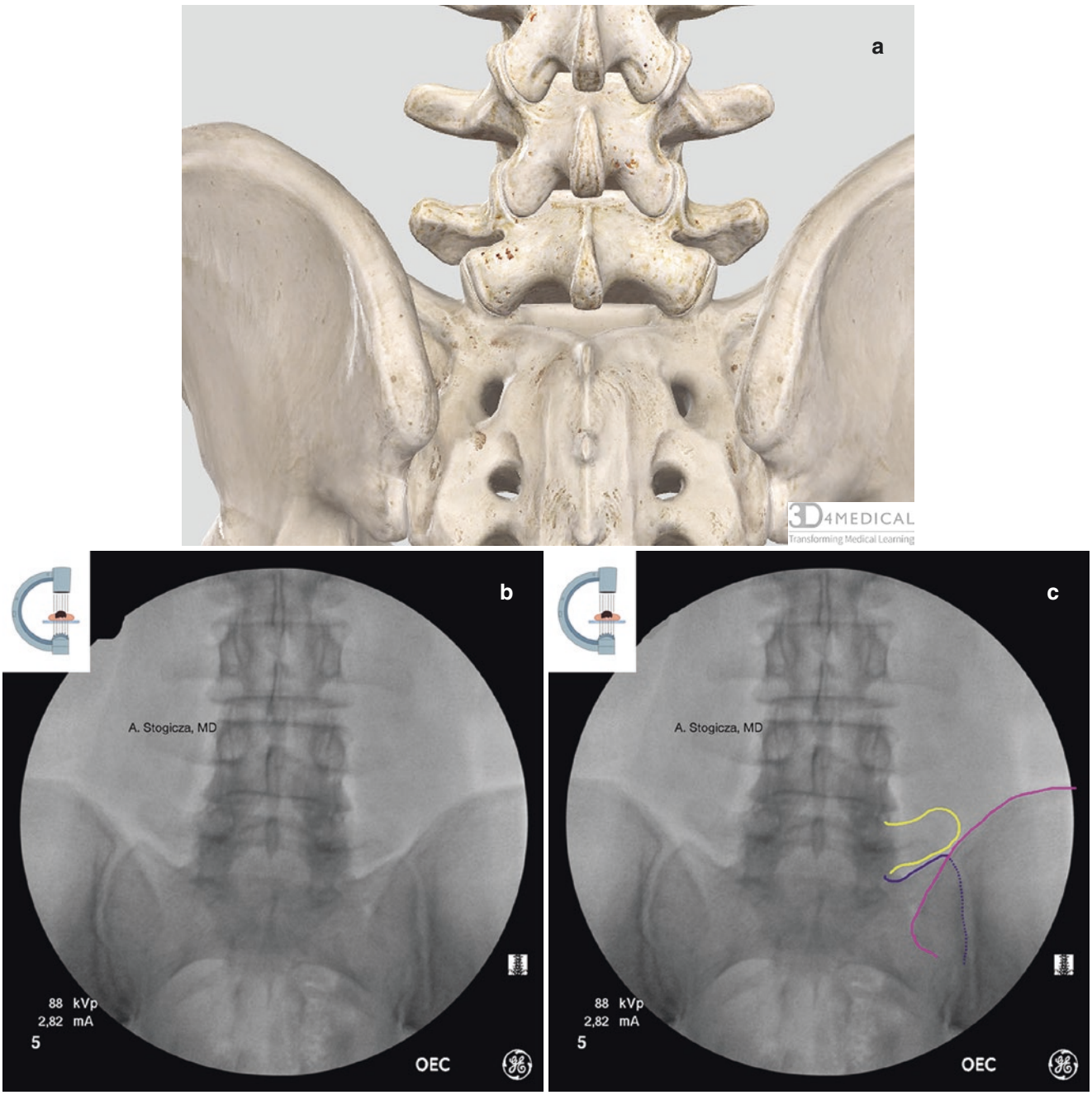

Fig. 22.2 AP image of the L5-S1 region. Pink = iliac crest; purple = sacrum; yellow = transverse process. Complete Anatomy image (**a**), native (**b**) and edited fluoroscopy image (**c**)

On this view, the needle entry point is anterolateral to the lower part of the L5 vertebral body, just cephalad to the iliac crest (Fig. 22.4a–c).

Procedure Steps

- Needle entry point is lateral to the lower part of the L5 vertebral body, just cephalad to the iliac crest, with the above fluoroscopy setting
- Coaxial approach to touch lower portion of L5 vertebral body or L5-S1 disc (Fig. 22.5)
- Check lateral view
- "Wiggle" the needle anteriorly in lateral view until it is just slightly anterior to L5-S1 disc
- Check AP view; needle is usually at the midpoint or at the junction of the lateral and mid third of the vertebral body
- Contrast injection shows spread anterior to the L5-S1 disc (Fig. 22.6a, b)

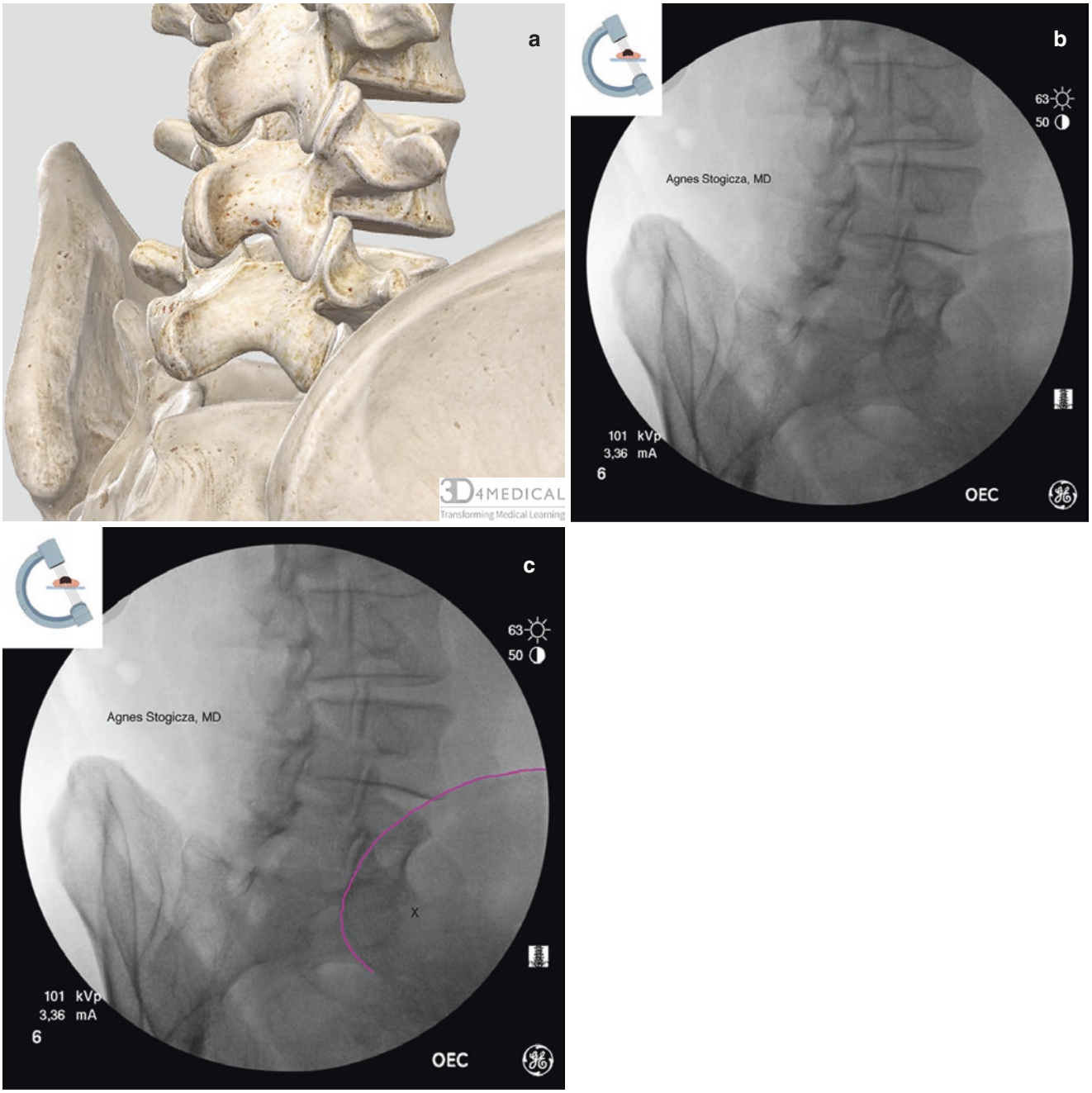

Fig. 22.3 Oblique, "scotty dog" view of the L5 vertebra. The target (X) is obstructed by the iliac crest. Pink = iliac crest. Complete Anatomy image (**a**), native (**b**) and edited fluoroscopy image (**c**)

- If contrast shows bilateral spread on the AP view, inject 15 ml Bupivacaine 0.25% or 15 ml Phenol 6%, and procedure is completed. If the contrast only shows unilateral spread, then the procedure is repeated from the opposite side (Fig. 22.7a–c). 10 ml is then injected on each side

Clinical Pearls

- Men usually have a higher riding crest, requiring much more cephalad C-arm tilt

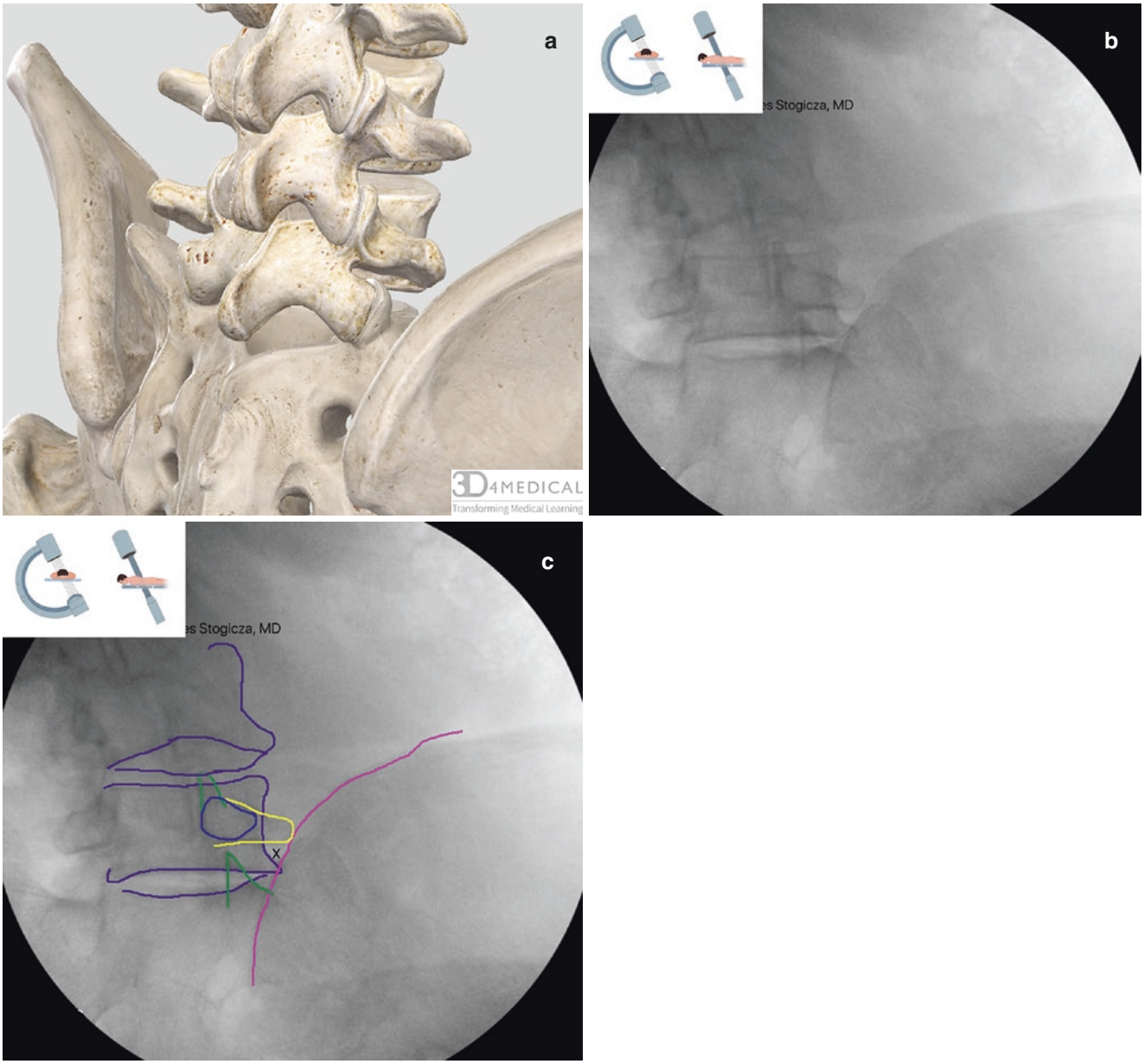

Fig. 22.4 C-arm is obliqued ipsilaterally (to "scotty dog" view, like Fig. 22.3), then tilted cephalad, so the iliac crest is no longer obstructing the view at the entry point. Needle entry point is lateral to the lower part of the L5 vertebral body or L5-S1 disc, just cephalad to the iliac crest. Purple = vertebral body; dark blue = pedicle; yellow = transverse process; pink = iliac crest; dark green = superior articular process. Complete Anatomy image (**a**), native (**b**) and edited fluoroscopy image (**c**)

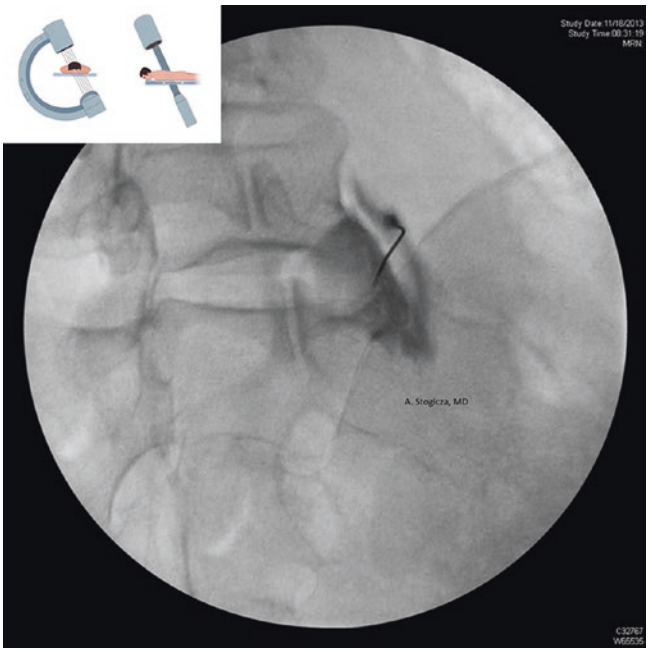

Fig. 22.5 C-arm is obliqued ipsilaterally (to "scotty dog" view, like Fig. 22.3), then tilted cephalad. Needle is advanced to just anterior to the L5-S1 disc. Contrast also shown on this image

- Very rarely the combination of high riding iliac crest and very arthritic L4–5 and L5-S1 facet joint makes the "unobstructed view" hard to find, so that transdiscal or anterior approach is easier than the coaxial view.

Unacceptable, Potentially Harmful Needle Placement on Exam

- Rough needle manipulation, needle forced into/through iliac crest
- Violation of the epidural space
- Not checking either lateral or AP view to assess depth of needle
- Any proof of lack of understanding of lumbosacral spine anatomy, compromising patient safety

Unacceptable, But Not Harmful Needle Placement on Exam

- Unnecessarily large needle, 18G or larger
- The procedure was abandoned after unsuccessful attempts, but it was clear that the examinee was cognizant of the safety aspects of the procedure, the needle did not compromise vital structures

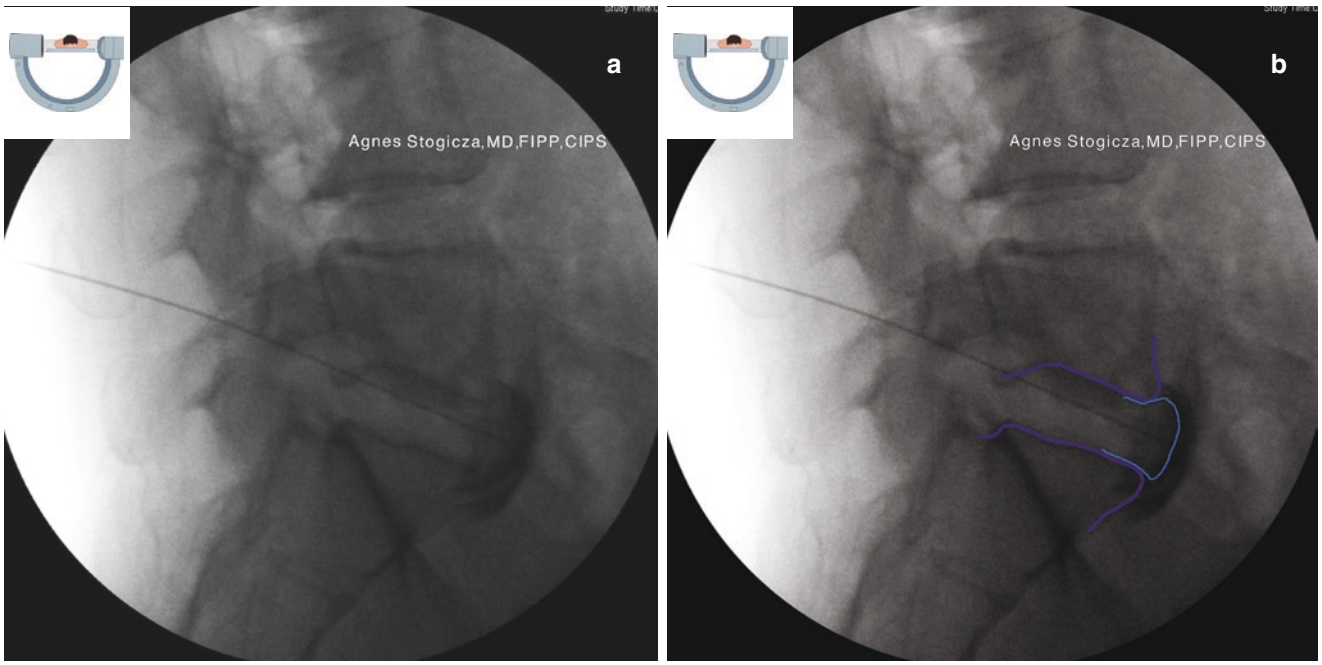

Fig. 22.6 Lateral view shows needle tip and contrast spread anterior to the L5-S1 disc. Purple = vertebral body and sacrum; light blue = disc

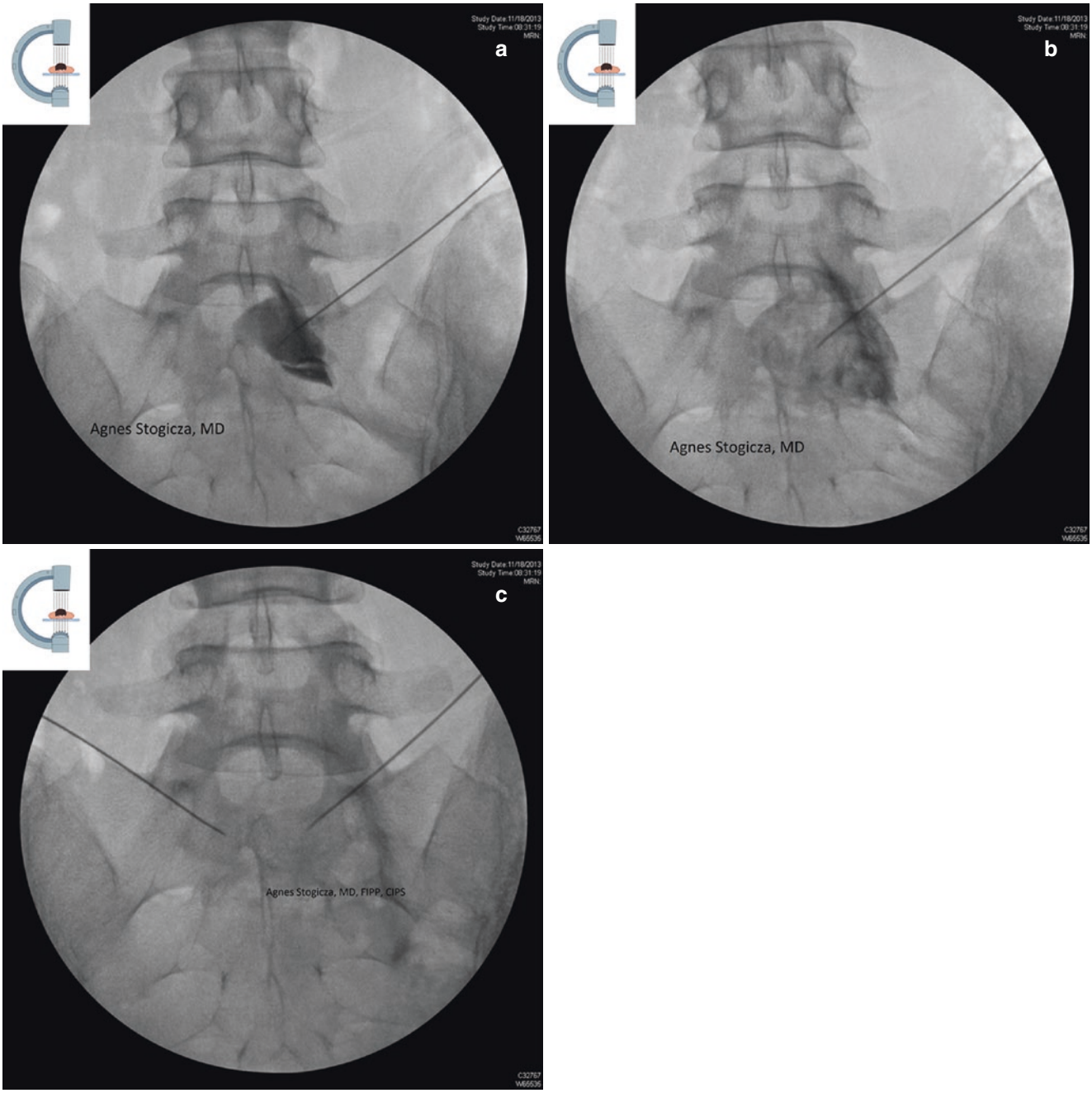

Fig. 22.7 AP image shows mostly unilateral contrast spread (**a**) even after 10 ml Bupivacaine 0.25% is injected (**b**). A second needle is placed anterior to the L5-S1 disc from the other side (**c**)

Evidence

Table 22.1 Level of evidence and recommendations by the Benelux section of the World Institute of Pain
These recommendations are based on both a review of the literature in 2015 by an independent third party (Kleijnen Systematic Reviews LTD) and the previous published guidelines published in Pain Practice. The recent literature, the potential risk for complications, and the grade of invasiveness were considered when deciding to upgrade or downgrade the recommendation.

Indication	Procedure	Recommendation 2009[1]	Grade 2015[2]	Recommendation 2018[3,4]
Cancer-related pelvic pain	Neurolytic superior hypogastric plexus block	2C+	Low	Weak

[1]Vissers KC, Besse K, Wagemans M, Zuurmond W, Giezeman MJ, Lataster A, et al. 23. Pain in patients with cancer. Pain Pract. 2011;11:453–75
[2]Kleijnen Systematic Reviews Ltd.: Search and evaluation of the literature. 2015
[3]Huygen F, Kallewaard JW, van Tulder M, Van Boxem K, Vissers K, van Kleef M, et al. Evidence-based interventional pain medicine according to clinical diagnoses: update 2018. Pain Pract. 2019;19:664–75
[4]https://www.anesthesiologie.nl/publicaties/praktische-richtlijnen-anesthesiologische-pijnbestrijding

Table 22.2 Level of evidence based on the American Society of Interventional Pain Physicians (ASIPP) review of the literature

Superior hypogastric plexus block[1]	Evidence
Cancer related pelvic pain	Level III

[1]Fronk B, Doulatram GR. Hypogastric plexus block. In: Manchikanti L, Kaye AD, Falco FJE, Hirsch JA, editors Essentials of interventional techniques in managing chronic pain. Springer International Publishing; 2018. p. 573–80.

Suggested Reading

Plancarte R, Amescua C, Patt RB, Aldrete JA. Superior Hypogastric Plexus Block for Pelvic Cancer Pain. Anesthesiology. 73 (2):236–9.
Plancarte R, de Leon-Casasola OA, El-Helaly M, Allende S, Lema MJ. Neurolytic superior hypogastric plexus block for chronic pelvic pain associated with cancer. Reg Anesth. 1997;22(6):562–8.
Stogicza A. Hypogastric plexus block. In: Diwan S, Staats PS, editors. Atlas of pain medicine procedures. New York: McGraw-Hill; 2015; p. 1918–60.

The Superior Hypogastric chapter was reviewed by Sudhir Diwan; Andrea M. Trescot; Milan Stojanovic; Peter S. Staats; Andre M. Mansan; Miles Day; Jan Van Zundert; Ricardo Plancarte; Athmaja Thottungal.

Superior Hypogastric Plexus Block – Transdiscal Approach

23

Agnes R. Stogicza

Equipment and Monitoring

- Standard ASA monitoring
- Fluoroscopy
- Sterile prep, and drape
- Skin local anesthesia prior to any needle larger than 25G (unless sedation is used)
- Coaxial view is used to advance needle, unless otherwise specified
- CPR equipment and medications available
- 20–22G, 5 inch (150 mm) –7 inch (180 mm) needle, tip curved to facilitate steering
- Gown and mask, similar to discogram
- Pre-procedure antibiotic
- Nonionic contrast
- Lidocaine 1% or Bupivacaine 0.25% or phenol 6–7%, 10 ml for each side

Anatomy

- Target: sympathetic chain, just anterior to the L5-S1 disc, and/or lower part of the L5 vertebral body and/or upper part of the sacrum
- The aorta and inferior vena cava splits into the common iliac arteries and veins anterior to the L4 and L5 vertebral bodies
- Anterior to the aorta bifurcation lays the intermesenteric plexus, which continues caudally as superior hypogastric plexus
- The superior hypogastric plexus connects to the inferior hypogastric plexus via the left and right hypogastric nerves, that are just anterior to the S1 (Fig. 23.1a, b)

Structures to Keep in Mind and Possible Complications

- L5 exiting nerve root, depending on needle entry level → nerve injury
- L5-S1 disc → discitis, disc degeneration, pain
- Common iliac arteries and veins → bleeding, intravascular injection
- Intrathecal, epidural advancement of needles
- Ureter (quite anterior and lateral to normal needle trajectory)
- Infection
- Bleeding
- Postprocedure pain
- Vasovagal reaction
- Allergic reaction

Fluoroscopy Technique, Target Localization

Goal: obtain a nonobstructed view of the anterolateral portion of the L5-S1 disc, so the needle will pass through the disc without entering the nucleus pulposus. This can be achieved by:

- Prone position, pillow under abdomen to decrease lumbar lordosis
- Anteroposterior (AP) view
- Square off the lower L5 and upper S1 endplates (Fig. 23.2)
  - Oblique C-arm until S1 SAP (superior articular process) and lamina is removed from the needle path (usually about 20°) (Fig. 23.3a–c)
  - Entry point just lateral to the S1 SAP. Too much oblique will lead to needle passing through the nucleus pulposus, and also to the iliac crest covering the entry point

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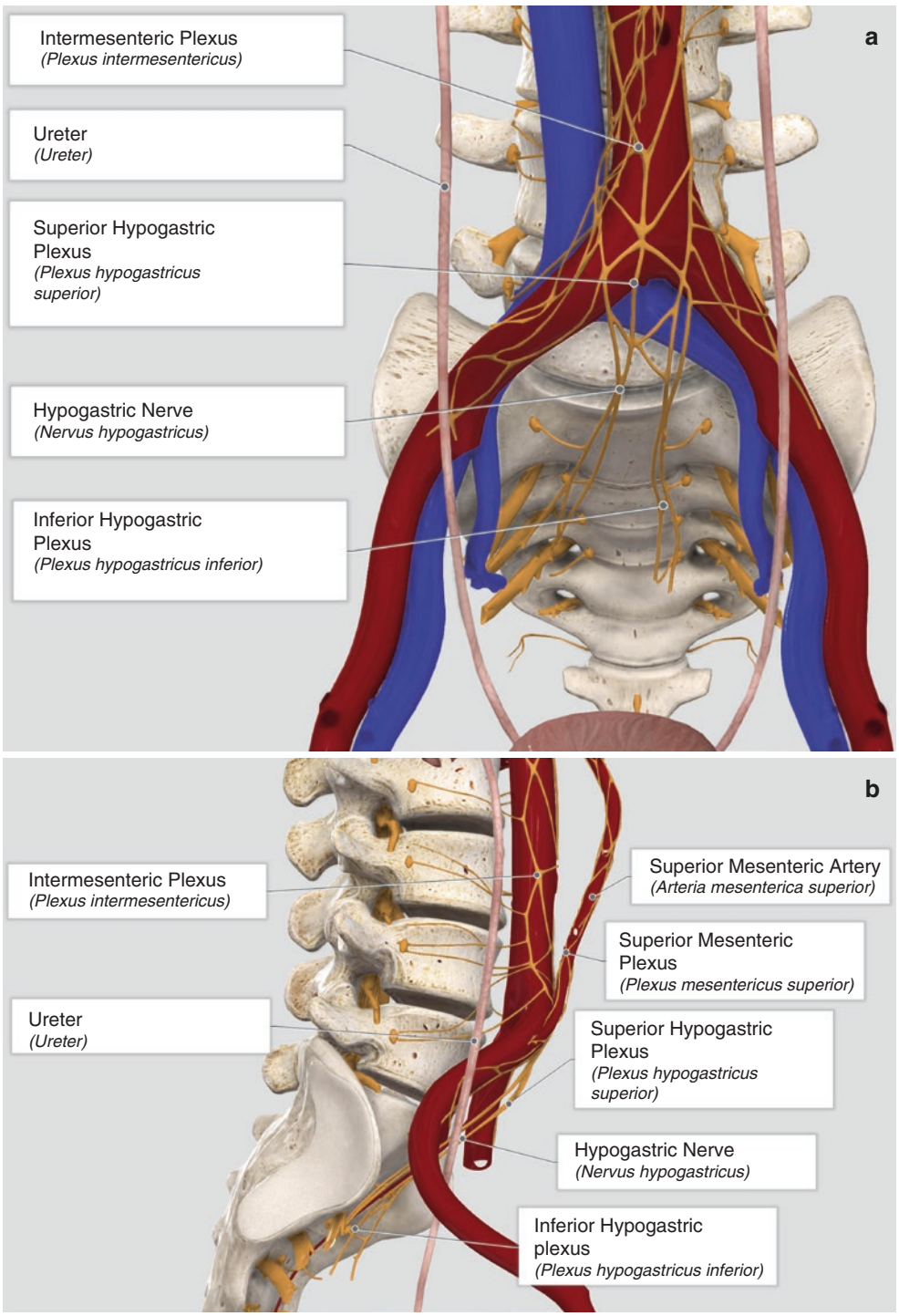

Fig. 23.1 The superior hypogastric plexus connects to the inferior hypogastric plexus via the left and right hypogastric nerves, that are just anterior to the lower part of L5 vertebral body, the L5-S1 disc and the upper part of S1. Complete Anatomy image, anterior (**a**) and lateral view (**b**)

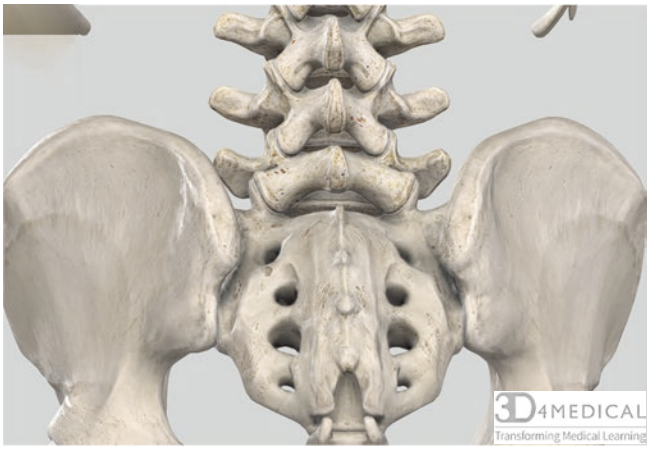

Fig. 23.2 Lumbar spine AP view, L5-S1 endplates squared off with cephalad tilt. (Complete Anatomy image)

Procedure Steps

- Coaxial view to touch the posterolateral aspect of the disc (Fig. 23.3a–c)
- Check AP and lateral view to assess appropriate needle trajectory (needle will have to travel the same distance anteriorly as medially to reach target position)
- Needle will pass at the lateral third of the disc
- Pass needle through disc just to reach anterior to disc
- Loss of resistance confirms needle reaching past the disc (Fig. 23.4a–c)
- Contrast injection shows spread anterior to the L5-S1 disc
- If contrast shows bilateral spread on the AP view, inject 15 ml Bupivacaine 0.25% or 15 ml Phenol 6%, then procedure is completed. If the contrast only shows unilateral spread, then the procedure is repeated from the opposite side, and 10 ml is injected on each side (Fig. 23.5a, b)

Clinical Pearls

- Disc can be often painful from degenerative disc disease
- Preprocedure IV antibiotic may decrease chance of discitis
- Intraoperative intradiscal antibiotics at a low-dose 100 mg cefazolin may be an alternative
- Consider double-needle technique to reduce the risk of discitis (e.g., 18G introducer and 22G, 5 or 7 inch (130–180 mm) needle or 20G introducer and 25G, 5 or 7 inch (130–180 mm) needle)

Unacceptable, Potentially Harmful Needle Placement on Exam

- Violation of the epidural space
- Not checking either lateral or AP view to assess depth of needle
- Rough needle manipulation, multiple passes through the disc, or needle forced into/ through iliac crest
- Needle passed too anterior multiple times, likely to have penetrated bowels
- Any proof of lack of understanding of lumbosacral spine anatomy, compromising patient safety

Unacceptable, But Not Harmful Needle Placement on Exam

- Unnecessarily large needle, 18G or larger
- The procedure was abandoned after unsuccessful attempts, but it was clear that the examinee was cognizant of the safety aspects of the procedure, the needle did not compromise vital structures
- Lack of understanding of the bony structures that might obscure the view, but no patient harm

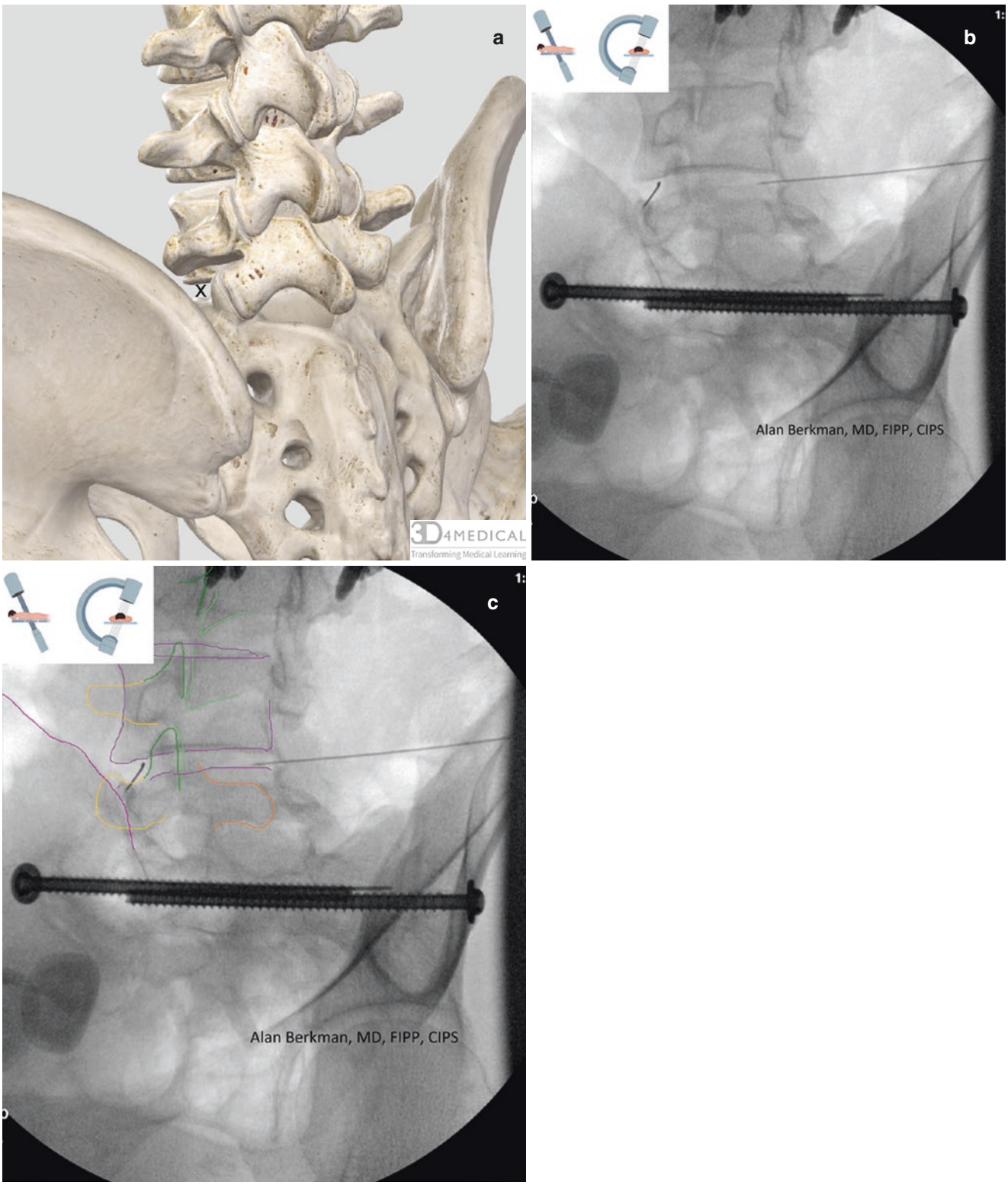

Fig. 23.3 After the cephalad tilt, oblique the C-arm toward the ipsilateral side (15–25°). Needle is then advanced through the L5-S1 disc. Needle was placed previously on the right side. Previous sacroiliac joint fixation. Orange = spinous process and lamina; yellow = transverse process; dark green = superior articular process; purple = vertebral body; pink = ilium; X marks the needle entry point on the Complete Anatomy image (**a**); native (**b**) and edited (**c**) fluoroscopy image

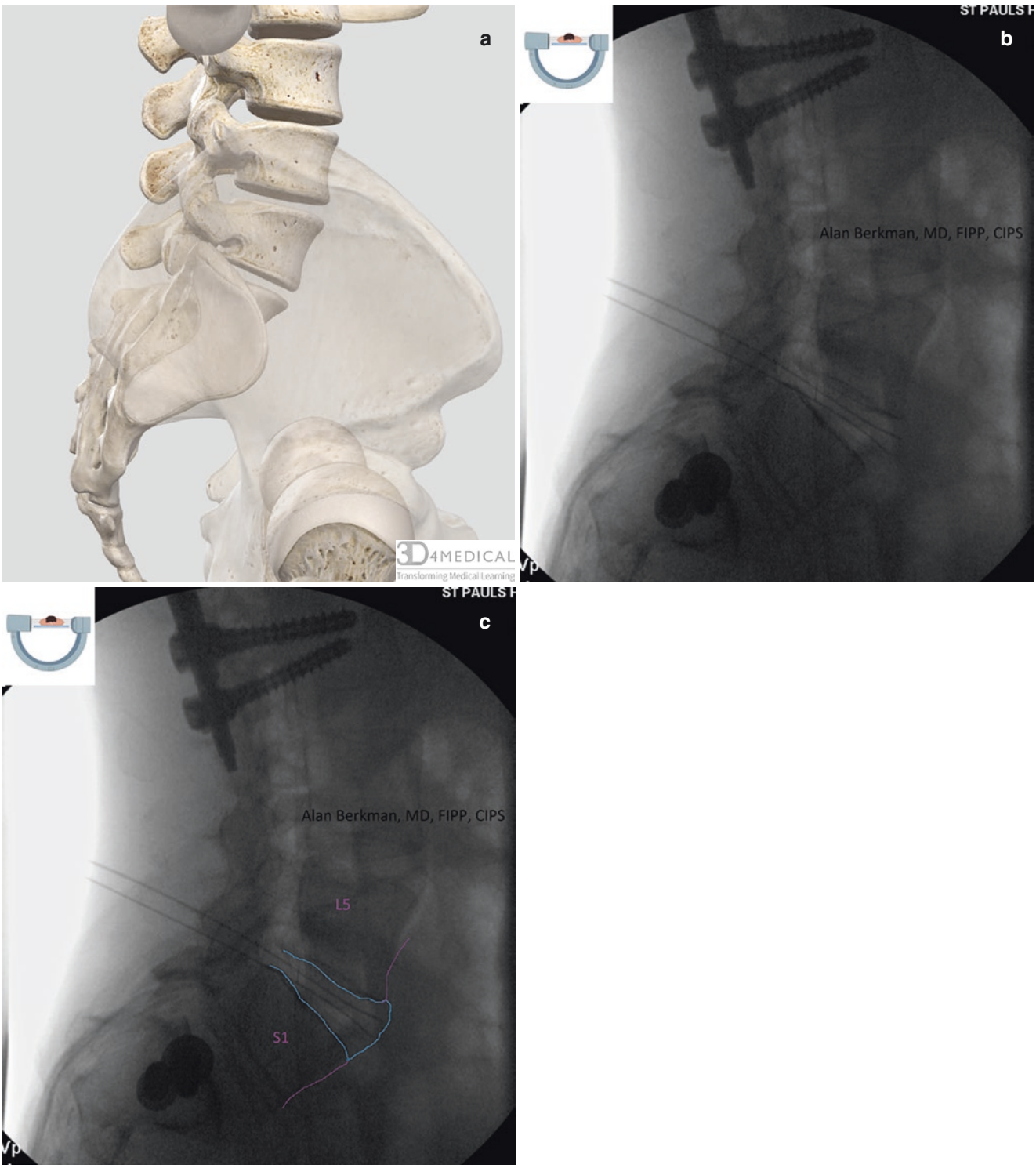

Fig. 23.4 Lumbosacral spine, lateral view. Two needles in place, tips just anterior to the L5-S1 disc. Purple = vertebral body and sacrum; light blue = disc. Pelvic fixation. Complete Anatomy image (**a**) and native (**b**) and edited (**c**) fluoroscopy image

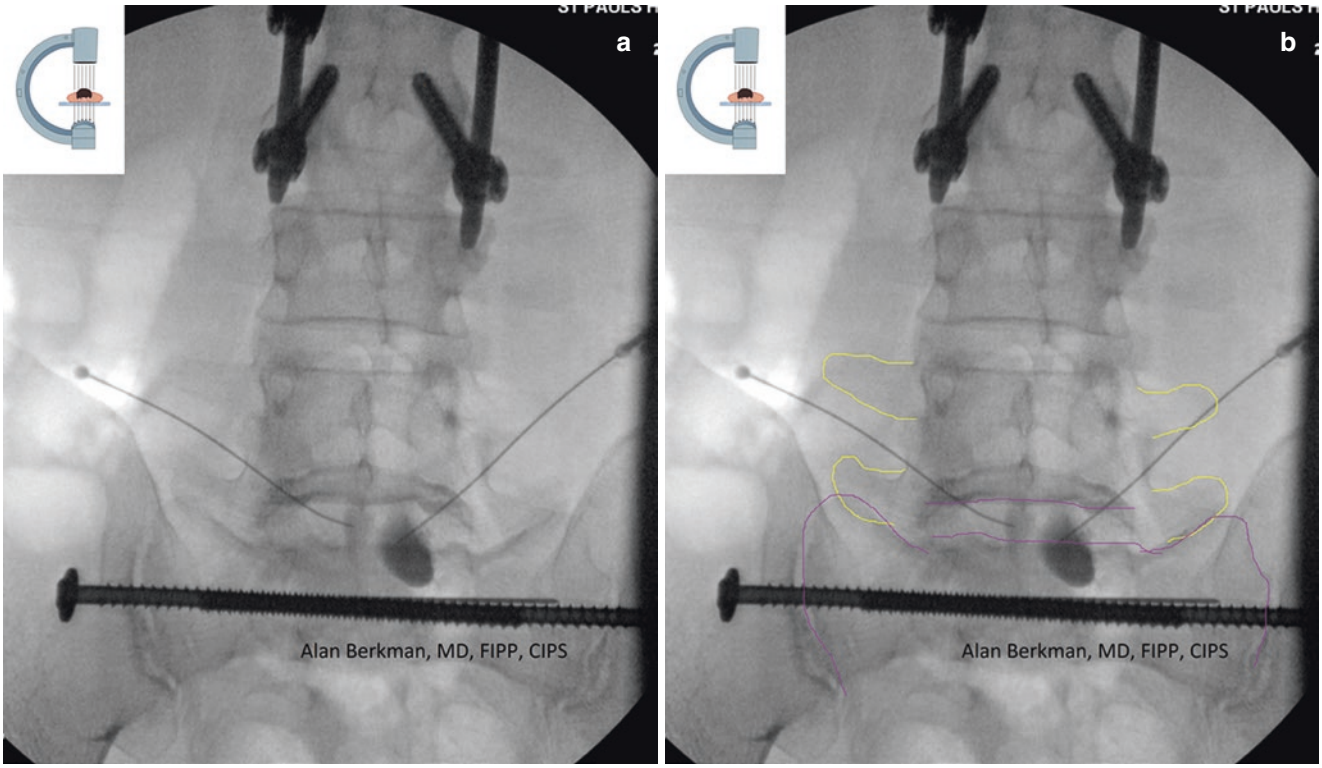

Fig. 23.5 Lumbosacral spine, AP image with needles in place. Pelvic fixation. Contrast injected through the needle on the right. Yellow = transverse process; purple = vertebral body and sacrum. Native (**a**) and edited (**b**) fluoroscopy images

Evidence

Table 23.1 Level of evidence and recommendations by the Benelux section of the World Institute of Pains

These recommendations are based on both a review of the literature in 2015 by an independent third party (Kleijnen Systematic Reviews LTD) and the previous published guidelines published in Pain Practice. The recent literature, the potential risk for complications, and the grade of invasiveness were considered when deciding to upgrade or downgrade the recommendation.

Indication	Procedure	Recommendation 2009[1]	Grade 2015[2]	Recommendation 2018[3,4]
Cancer-related pelvic pain	Neurolytic superior hypogastric plexus block	2C+	Low	Weak

[1]Vissers KC, Besse K, Wagemans M, Zuurmond W, Giezeman MJ, Lataster A, et al. 23. Pain in patients with cancer. Pain Pract. 2011;11:453–75

[2]Kleijnen Systematic Reviews Ltd.: Search and evaluation of the literature. 2015

[3]Huygen F, Kallewaard JW, van Tulder M, Van Boxem K, Vissers K, van Kleef M, et al. "Evidence-based interventional pain medicine according to clinical diagnoses": update 2018. Pain Pract. 2019;19:664–75

[4]https://www.anesthesiologie.nl/publicaties/praktische-richtlijnen-anesthesiologische-pijnbestrijding

Table 23.2 Level of evidence based on the American Society of Interventional Pain Physicians (ASIPP) review of the literature

Superior hypogastric plexus block[1]	Evidence
Cancer related pelvic pain	Level III

[1]Fronk B, Doulatram GR. Hypogastric plexus block. In: Manchikanti L, Kaye AD, Falco FJE, Hirsch JA, editors Essentials of interventional techniques in managing chronic pain. Springer International Publishing; 2018. p. 573–80.

Suggested Reading

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Gamal G, Helaly M, Labib YM. Superior hypogastric block: transdiscal versus classic posterior approach in pelvic cancer pain. Clin J Pain. 2006;22:544–7.

Stogicza A. Hypogastric plexus block. In: Diwan S, Staats PS, editors. Atlas of pain medicine procedures. New York: McGraw-Hill. 2015;1918–60.

The Superior Hypogastric chapter was reviewed by Sudhir Diwan; Miles Days; Andrea M. Trescot; Milan Stojanovic; Peter S. Staats; Andre M. Mansano; Ricardo Plancarte; Athmaja Thottungal.

Superior Hypogastric Plexus Block – Anterior Approach

24

Agnes R. Stogicza

Equipment and Monitoring

- Standard ASA monitoring
- Fluoroscopy
- Sterile prep, and drape
- Skin local anesthesia prior to any needle larger than 25G (unless sedation is used)
- Coaxial view is used to advance needle, unless otherwise specified
- CPR equipment and medications available
- IV access
- 22–25G, 3.5 inch (90 mm) –7 inch (180 mm) needle, tip curved to facilitate steering
- Nonionic contrast material
- Lidocaine 1% or bupivicaine 0.25% or phenol 6–7%, 20 ml
- Preoperative IV antibiotics

Anatomy

- Target: anterior to the L5-S1 disc, and/or lower part of the L5 vertebral body and/or upper part of the sacrum
- The aorta and inferior vena cava splits into the common iliac arteries and veins anterior to the L4 and L5 vertebral bodies
- Anterior to the aorta bifurcation lays the intermesenteric plexus, which continues caudally as superior hypogastric plexus
- The superior hypogastric plexus connects to the inferior hypogastric plexus via the left and right hypogastric nerves, that are just anterior to the S1 (Fig. 24.1a–c)

Structures to Keep in Mind and Possible Complications

- Small intestines → injury, infection
- Large intestines → injury, infection
- Ureter/bladder → injury, infection
- L5-S1 disc → discitis, disc degeneration, pain
- Iliac arteries and veins → bleeding, intravascular injection
- Infection
- Bleeding
- Postprocedure pain
- Vasovagal reaction
- Allergic reaction

Fluoroscopy Technique, Target Localization

- Supine patient
- Posteroanterior (PA) view
  - Caudad tilt of C-arm to line up L5 and S1 vertebral endplates
- Needle entry at the mid portion of the L5-S1 disc

Procedure Steps

- Coaxial view to touch upper part of S1 vertebral body or L5-S1 disc or lower part of L5 vertebral body (Fig. 24.2a–c)
- Check lateral view (Fig. 24.3a, b)
- Contrast injection shows spread anterior to the L5-S1disc
- Inject 15 ml Bupivacaine 0.25% or 15 ml Phenol 6% after negative aspiration, then procedure is completed

Clinical Pearls

- Larger gauge needle and multiple needle passes may increase risk of injury of the bowels and infection
- Anterior approach is only recommended in special cases, such as tumor in the needle trajectory for transdiscal or posterolateral approach, or L4-L5-S1 fusion with large calcification, sacralized L5 obstructing needle access, or patient unable to lie prone because of colostomy

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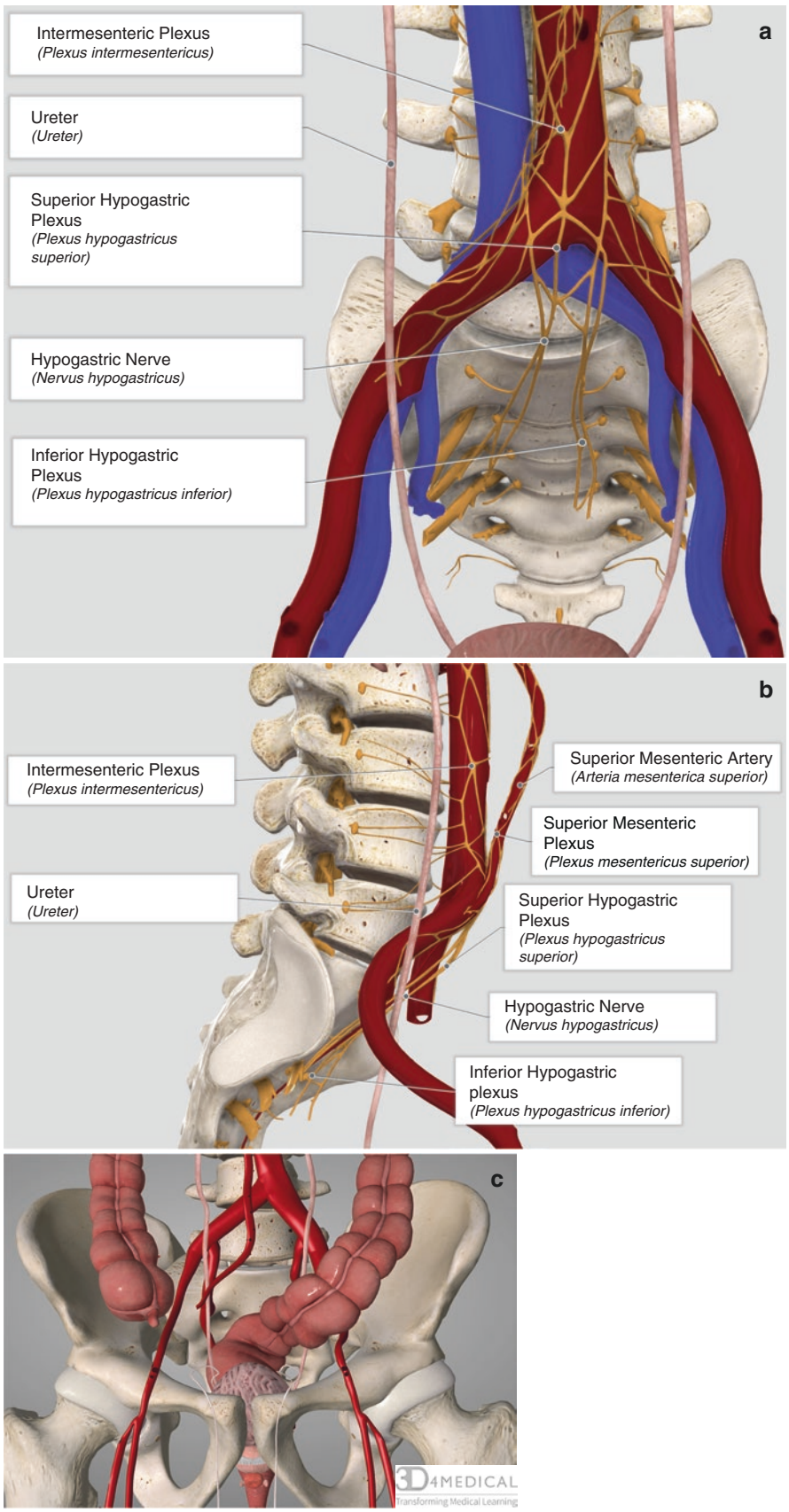

Fig. 24.1 Anatomy of the hypogastric plexus. Anterior (**a**), lateral (**b**) view of the hypogastric plexus and the relationship between target and pelvic organs. Omentum and small intestines removed (**c**). Complete Anatomy image

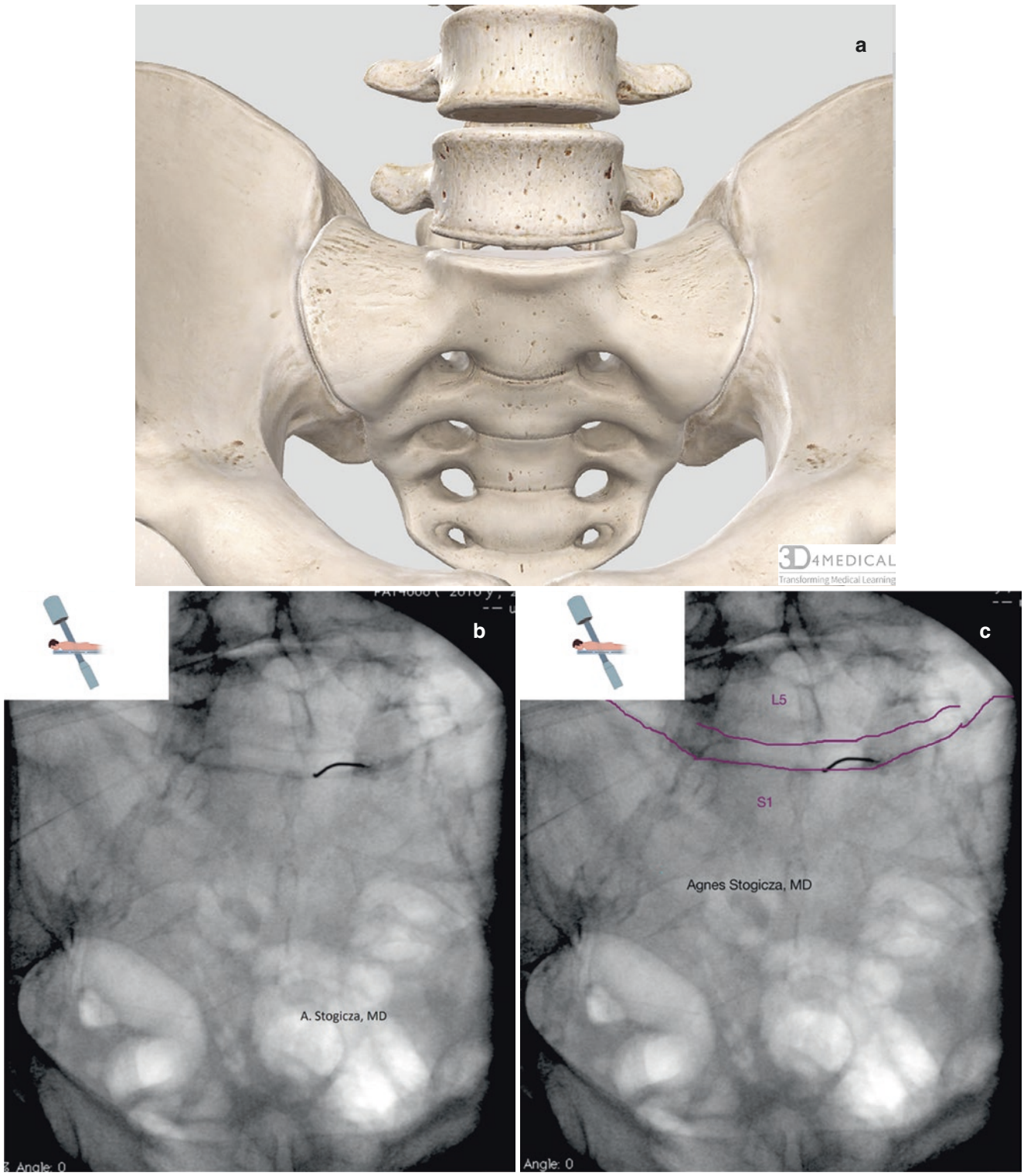

Fig. 24.2 PA view of lumbosacral spine, C-arm in caudad tilt to view L5 and S1 vertebral endplate and identify anterior portion of L5-S1 disc. Needle placed just anterior to L5-S1 in coaxial view. Purple = vertebral body and sacrum. Complete Anatomy image (**a**), native (**b**) and edited fluoroscopy image (**c**)

Unacceptable, Potentially Harmful Needle Placement on Exam

- Rough needle manipulation, multiple passes through bowels/bladder
- Larger than 22G needle
- Entering the disc
- Any evidence of lack of understanding of pelvic/lower abdominal anatomy

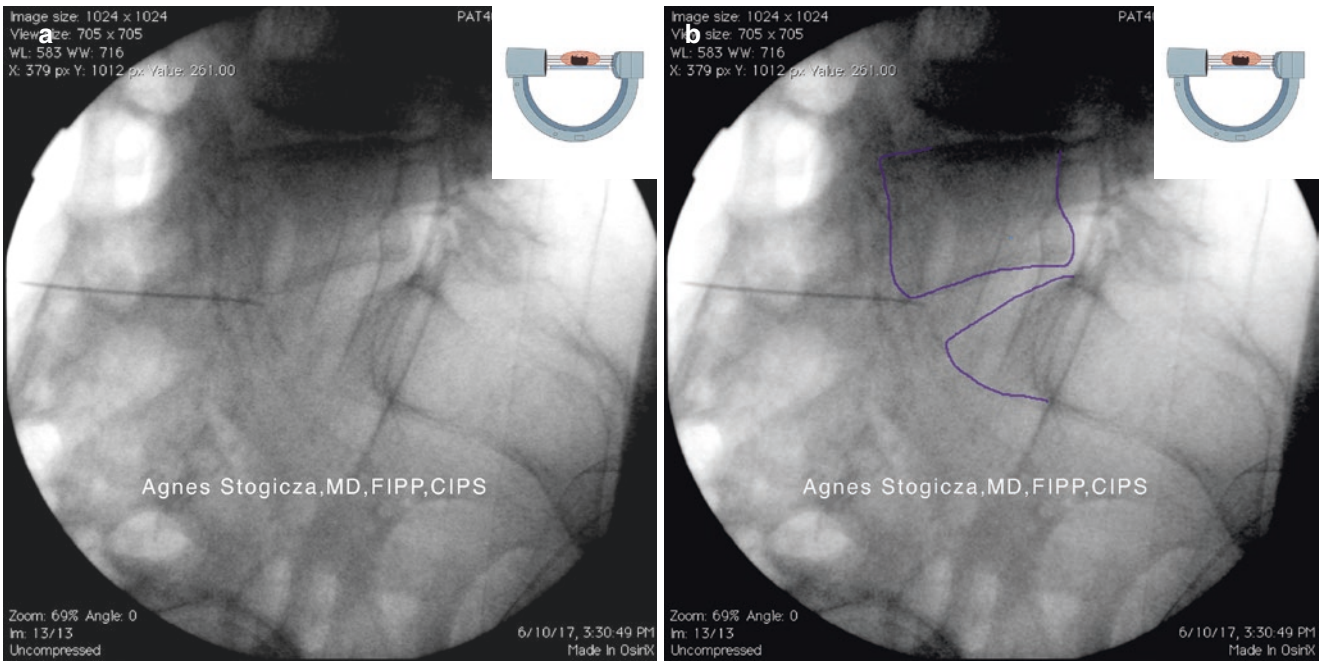

Fig. 24.3 Lateral view confirms needle tip placed immediately anterior to L5-S1 disc. Purple = vertebral body and sacrum. Native (**a**) and edited (**b**) fluoroscopy image

Unacceptable, But Not Harmful Needle Placement on Exam

- Needle off target
- The procedure was abandoned after unsuccessful attempts, but it was clear that the examinee was cognizant of the safety aspects of the procedure, the needle did not compromise vital structures

Evidence

Table 24.1 Level of evidence and recommendations by the Benelux section of the World Institute of Pain
These recommendations are based on both a review of the literature in 2015 by an independent third party (Kleijnen Systematic Reviews LTD) and the previous published guidelines published in Pain Practice. The recent literature, the potential risk for complications, and the grade of invasiveness were considered when deciding to upgrade or downgrade the recommendation.

Indication	Procedure	Recommendation 2009[1]	Grade 2015[2]	Recommendation 2018[3,4]
Cancer-related pelvic pain	Neurolytic superior hypogastric plexus block	2C+	Low	Weak

[1]Vissers KC, Besse K, Wagemans M, Zuurmond W, Giezeman MJ, Lataster A, et al. 23. Pain in patients with cancer. Pain Pract. 2011;11:453–75
[2]Kleijnen Systematic Reviews Ltd.: Search and evaluation of the literature. 2015.
[3]Huygen F, Kallewaard JW, van Tulder M, Van Boxem K, Vissers K, van Kleef M, et al. Evidence-based interventional pain medicine according to clinical diagnoses: update 2018. Pain Pract. 2019;19:664–75
[4]https://www.anesthesiologie.nl/publicaties/praktische-richtlijnen-anesthesiologische-pijnbestrijding

Table 24.2 Level of evidence based on the American Society of Interventional Pain Physicians (ASIPP) review of the literature

Superior hypogastric plexus block[1]	Evidence
Cancer related pelvic pain	Level III

[1]Fronk B, Doulatram GR. Hypogastric plexus block. In: Manchikanti L, Kaye AD, Falco FJE, Hirsch JA, editors *Essentials of interventional techniques in managing chronic pain*. Springer International Publishing; 2018. p. 573–80.

Suggested Reading

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Kanazi G, Perkins F, Thakur R, Dotson E. New technique for superior hypogastric plexus block. Reg Anesth Pain Med. 1999;24(5):473–6.
Michalek P, Dutka J. Computed tomography-guided anterior approach to the superior hypogastric plexus for noncancer pelvic pain: a report of two cases. Clin J Pain. 2005;21:553–6.
Stogicza A. Hypogastric plexus block. In: Diwan S, Staats PS, editors. Atlas of pain medicine procedures. New York: McGraw-Hill; 2015:1918–60.

The superior hypogastric chapter was reviewed by Ricardo Plancarte; Sudhir Diwan; Miles Day; Andrea M. Trescot; Milan Stojanovic; Peter S. Staats; Andre M. Mansano; Alan Berkman; Athmaja Thottungal.

Sacral Transforaminal Epidural Injection (Selective Nerve Root Block)

25

Erich E. Mansfeld

Equipment and Monitoring

- Standard ASA monitoring
- Fluoroscopy
- Sterile prep, and drape
- Skin local anesthesia prior to any needle larger than 25G (unless sedation is used)
- Coaxial view is always used to advance needle, unless otherwise specified
- CPR equipment and medications available
- 20–25G, 3.5 inch (90 mm) – 5 inch (130 mm) needle (consider blunt tipped needle with introducer)
- Nonionic contrast
- Local anesthetic and steroid (Non-particulate)

Anatomy

- S1-S4 anterior rami form the sacral plexus
- S1 fibers contribute to the common peroneal, tibial, gluteal and obturator nerves
- S2 fibers contribute to the common peroneal, tibial, obturator, posterior femoral cutaneous and pudendal nerves
- S3 fibers contribute to the tibial, obturator, posterior femoral cutaneous and pudendal nerves
- S4 fibers contribute to the pudendal nerves
- Access the epidural space via S1, S2, or S3 posterior foramen of the sacrum (Fig. 25.1a, b)
- It may be difficult to distinguish posterior and anterior sacral foramina. The posterior foramina are small and round, while the anterior foramina are larger and semilunar shaped

Structures to Keep in Mind and Possible Complications

- Anterior nerve roots (to sacral plexus) → nerve damage
- Dura to S1, but occasionally to S3 → inadvertent intrathecal injection
- It is possible to access the pelvic organs through the posterior and then anterior foramina → rectum: retroperitoneal or epidural infection
- Periosteum → pain
- Infection
- Bleeding
- Postprocedure pain
- Vasovagal reaction
- Allergic reaction

Fluoroscopy Technique, Target Localization

- Patient in prone position
- Anteroposterior (AP) view
- Identify anterior and posterior foramina (Fig. 25.1a–e)
- Cranial (for S1) or caudal (S3) fluoroscopic tilt is occasionally needed to better visualize neuroforamina
- Occasionally the needle is directed to the foramen of interest based on the location of the contralateral foramen, if better visible

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Procedure Steps

- Advance needle through posterior foramen
- There is a "give" when passing through the posterior opening
- Check lateral view; needle tip should be just inside, but not through, the spinal canal
- Administer contrast medium using live fluoroscopy and extension tubing to exclude intravascular spread
- Inject 1–2 ml of contrast to confirm spread along the nerve root and into the sacral epidural space (Figs. 25.2a, b and 25.3a–c)

Clinical Pearls

- Good fluoroscopic view is critical. Rotate or tilt fluoroscopic unit until clear view of the "desired" neuroforamina is obtained
- Use gentle movement and, if need be, change fluoroscopic views often
- Best is to just enter the neuroforamina near bone edge (to avoid direct nerve infiltration). A bent needle tip can be walked off the neuroforaminal bony edge
- If foramen does not show well, visualizing the foramina on the contralateral side helps to understand the target on side of interest

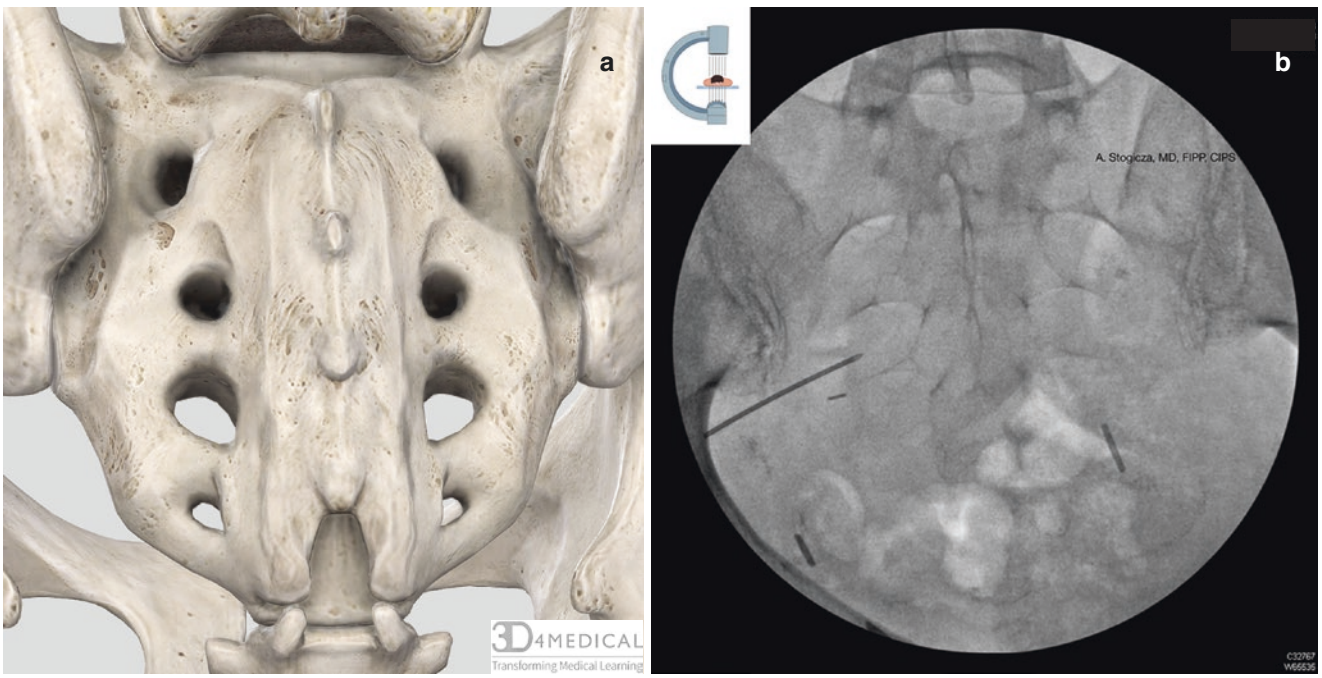

Fig. 25.1 Posterior view of the sacrum. Complete Anatomy image (**a**). Native (**b**) fluoroscopy image. Posterior, small, round foramina marked with purple. Needle is pointing at skin entry site (**c**). Anterior view of the sacrum. Complete Anatomy image (**d**), anterior, large, semilunar foramina marked with pink (**e**)

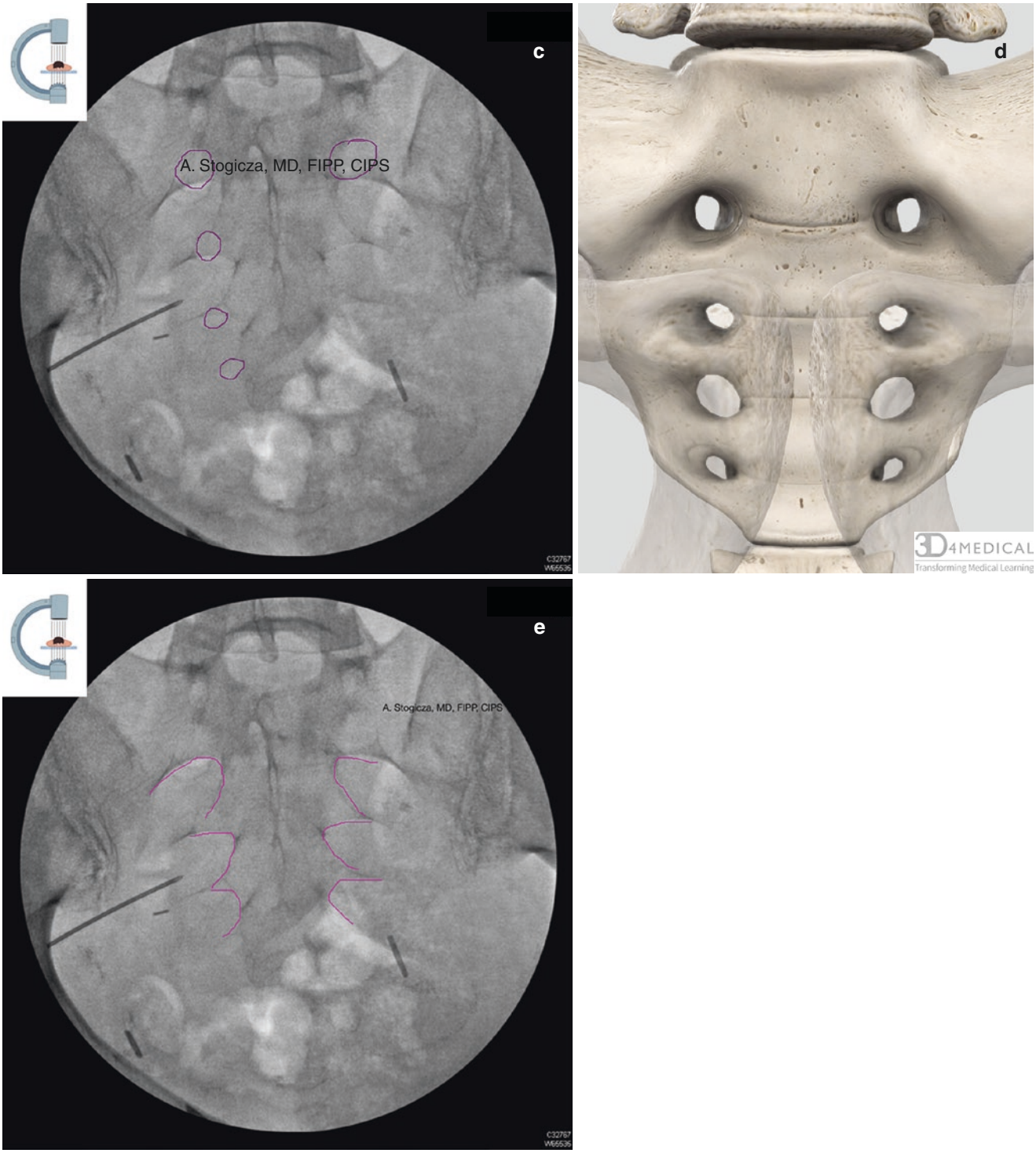

Fig. 25.1 (continued)

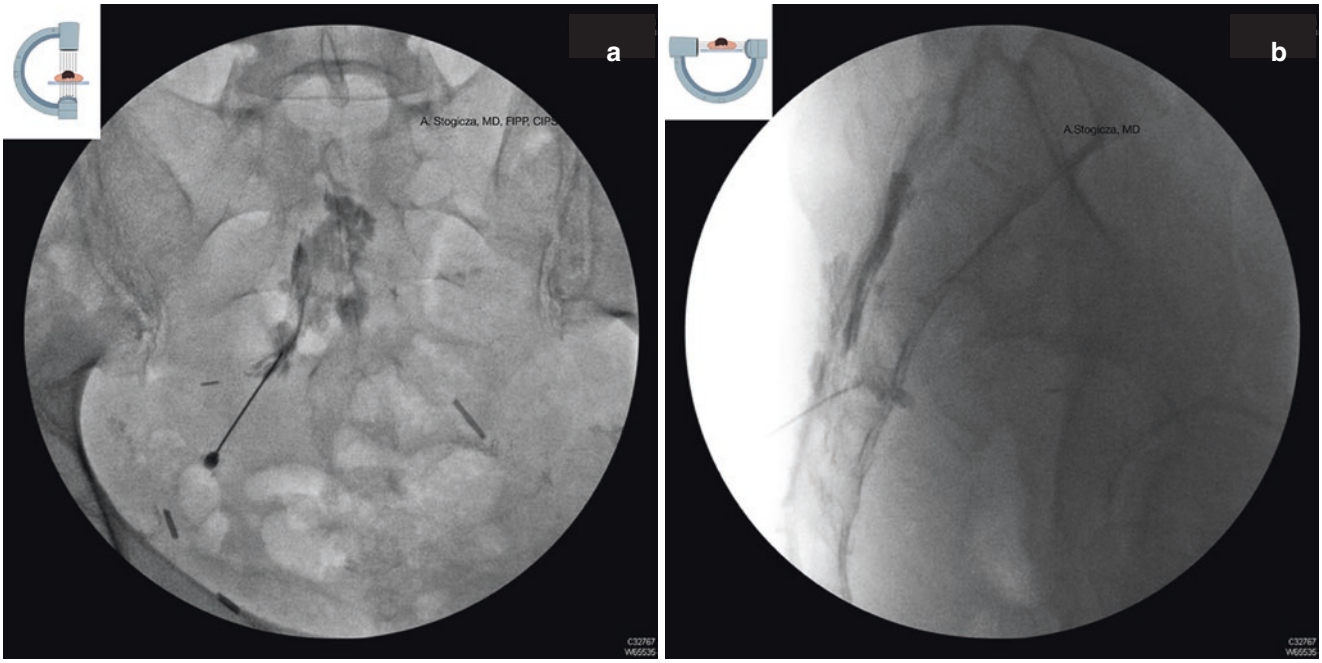

Fig. 25.2 AP (**a**) and lateral (**b**) image of the sacrum, needle in the S3 foramen, contrast in the epidural space and outlines S3 nerve root

- The foramen is always below the pedicle
- Procedure done correctly has few complications, but, if done haphazardly, will result in morbid complications (e.g., bowel perforation with fecal contamination and sepsis)
- Use only a tiny amount of contrast to check position (less than 0.5 ml at a time). If using too much contrast when needle placement is incorrect, it will obscure any chance of finding the correct neuroforamina again during subsequent attempt
- Contrast spread or lack thereof can indicate vascular uptake of the contrast (Fig. 25.4a, b)

Unacceptable, Potentially Harmful Needle Placement on Exam

- Rough needle manipulation
- Passing anterior to the sacrum via anterior foramen
- Not checking lateral view to assess depth of needle
- Any proof of lack of understanding of lumbosacral and pelvis anatomy, for example needle repeatedly forced through the iliac crest

Unacceptable, But Not Harmful Needle Placement on Exam

- Needle past midway between sacral line and anterior sacrum
- The examinee abandoned the procedure after unsuccessful attempts, but it was clear that the examinee was cognizant of the safety aspects of the procedure

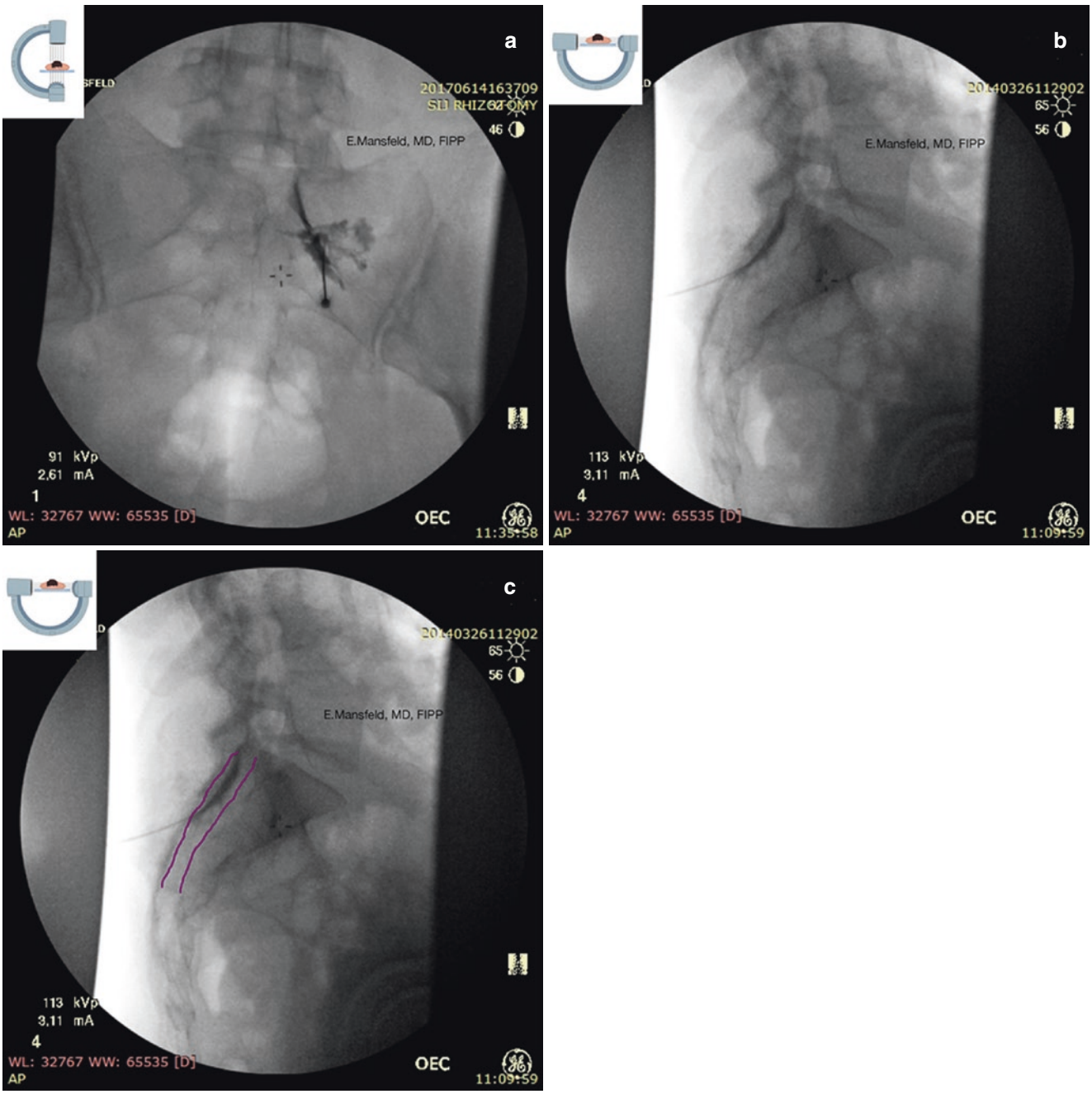

Fig. 25.3 AP and lateral image of the sacrum, needle in S1 foramen, contrast in epidural space. Epidural space is marked with pink. Native (**a**, **b**) and edited (**c**) fluoroscopy image

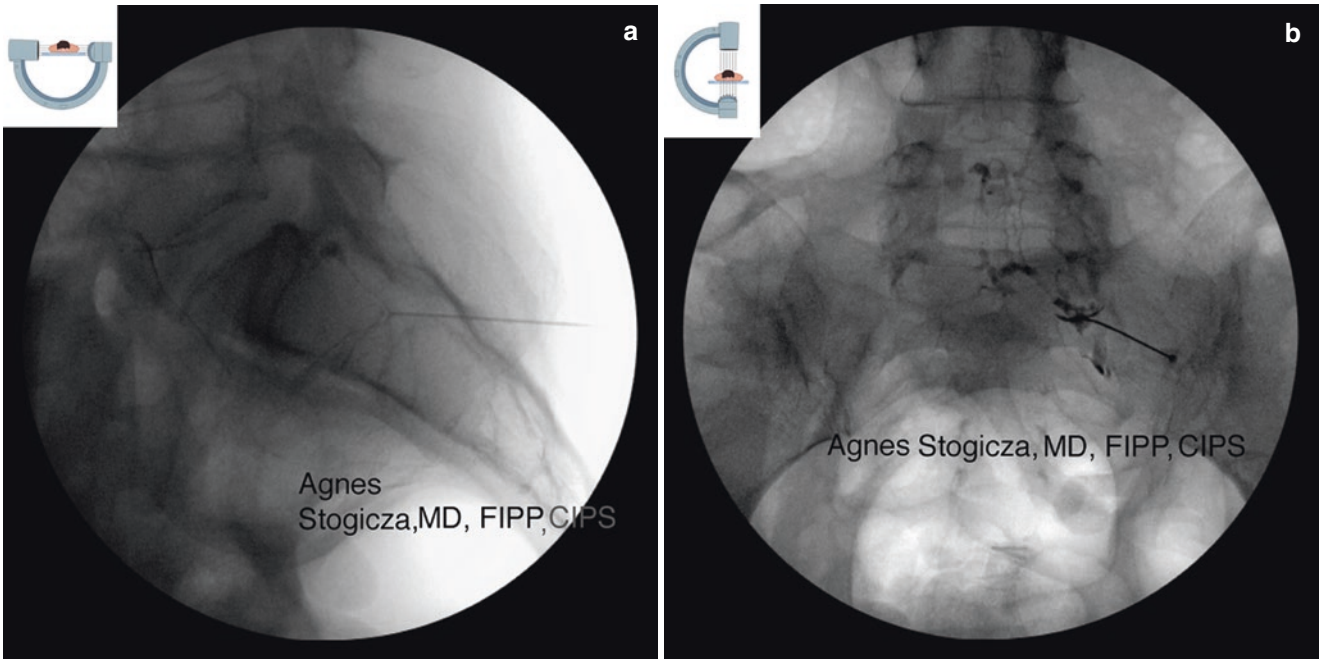

Fig. 25.4 Vascular uptake. Lateral view, 1 ml contrast injection (**a**), AP view, 3 ml contrast injection clearly shows the epidural venous plexus filled with contrast (**b**)

Evidence

Table 25.1 Level of evidence and recommendations by the Benelux section of the World Institute of Pain
These recommendations are based on both a review of the literature in 2015 by an independent third party (Kleijnen Systematic Reviews LTD) and the previous published guidelines published in Pain Practice. The recent literature, the potential risk for complications, and the grade of invasiveness were considered when deciding to upgrade or downgrade the recommendation.

Indication	Procedure	Recommendation 2009[1]	Grade 2015[2]	Recommendation 2018[3,4]
Lumbosacral radicular pain	Epidural corticosteroid administration	2B+/−	Moderate	Weak

[1]Van Boxem K, Cheng J, Patijn J, van Kleef M, Lataster A, Mekhail N, et al. 11. Lumbosacral radicular pain. Pain Pract. 2010;10:339–58
[2]Kleijnen Systematic Reviews Ltd.: Search and evaluation of the literature. 2015
[3]Huygen F, Kallewaard JW, van Tulder M, Van Boxem K, Vissers K, van Kleef M, et al. "Evidence-based interventional pain medicine according to clinical diagnoses": update 2018. Pain Pract. 2019;19:664–75
[4]https://www.anesthesiologie.nl/publicaties/praktische-richtlijnen-anesthesiologische-pijnbestrijding

Table 25.2 Level of evidence based on the American Society of Interventional Pain Physicians (ASIPP) review of the literature

Lumbar epidural injections[1]	Evidence
Disc herniation	Level I
Discogenic pain	Level III
Central spinal stenosis	Level III
Post-lumbar surgery syndrome	Level IV

[1]Manchikanti L, Schultz DM, Atluri SL, Glaser SE, Falco FJE. Lumbar epidural injections. In: Manchikanti L, Kaye AD, Falco FJE, Hirsch JA, editors. Essentials of interventional techniques in managing chronic pain. Springer International Publishing; 2018, p. 141–86

Suggested Reading

Burnett C, Anderson J. Sacral injections. In: Sackheim K, editor. Pain management and palliative care. New York/Heidelberg/Dordrecht/London: Springer; 2015. p. 315–23.

Huygen F, et al. "Evidence-based interventional pain medicine according to clinical diagnoses": update 2018. Pain Pract. papr.12786. 2019; https://doi.org/10.1111/papr.12786.

Racz GB, Noe C. Pelvic spinal neuroaxial procedures. In: Raj P, Erdine S, Staats PS, Waldman S, Gabor R, editors. Interventional pain management: image-guided procedures. Philadelphia: Saunders Elsevier; 2008. p. 420–3.

Rathmell JP, et al. Safeguards to prevent neurologic complications after epidural steroid injections. Anesthesiology. 2015;122:974–84.

The Sacral Nerve Root Block chapter was reviewed by Mert Akbas; Sudhir Diwan; Agnes Stogicza; Milan Stojanovic; Andrea Trescot; and Peter S Staats, Athmaja Thottungal, Einar Ottestad.

Sacroiliac Joint Injection

26

Zakari A. Suleiman and Agnes R. Stogicza

Equipment and Monitoring

- Standard ASA monitoring
- Fluoroscopy
- Sterile prep, and drape
- Skin local anesthesia prior to any needle larger than 25G (unless sedation is used)
- Coaxial view is used to advance needle, unless otherwise specified
- CPR equipment and medications available
- 22–25G, 3.5 inch (90 mm) needle
- Nonionic contrast medium
- Local anesthetic
- Deposteroid

Anatomy

- Junction between the articular surfaces of the sacrum and iliac bones at the pelvis
- The SI joint has significant irregularities in articular surface topography and it may be difficult to visualize in fluoroscopic images
- It is important to identify anterior and posterior margins of the joint. In AP fluoroscopic views, the anterior margins are usually located more laterally
- The average joint volume is 1.5 ml with maximum joint volume being 2.5 ml
- Sacral cartilage is thick (3 mm), white, shiny, and smooth, while iliac cartilage is thin (0.5 mm), bluish, dull, and rough
- The nerve supply to the sacroiliac joint is dual: anterior and posterior
- Blocking posterior supply to the SI joint ligaments (medial branches L4 and L5 and S1 to S4 lateral branches) will block the nociception from posterior sacroiliac complex ligaments, but not from the SI joint itself

Structures to Keep in Mind and Possible Complications

- Sciatic nerve, immediately caudad to joint line → nerve injury, unwanted lower extremity weakness from local anesthetic
- Posterior sacral foramen → possible entry into epidural space/anterior nerve roots
- Soft periosteum in elderly patient → needle advances easily into the bone marrow
- Intraosseous injection → postprocedure pain, infection
- Infection
- Bleeding
- Postprocedure pain
- Vasovagal reaction
- Allergic reaction

Fluoroscopic Technique, Target Localization

- Inferior approach is the most recommended approach to the SI joint (SIJ)
- Patient in prone position
- Anteroposterior (AP) view to identify posterior and anterior joint margins
- Observe the Posterior Superior Iliac Spine (PSIS) as it covers the cephalad two-thirds of the SIJ (Fig. 26.1a–c)
- Contralateral oblique tilt of the C-arm is needed to overlap anterior and posterior joint margins, and "peak under" ilium and PSIS that covers the joint opening (Figs. 26.2 and 26.4)

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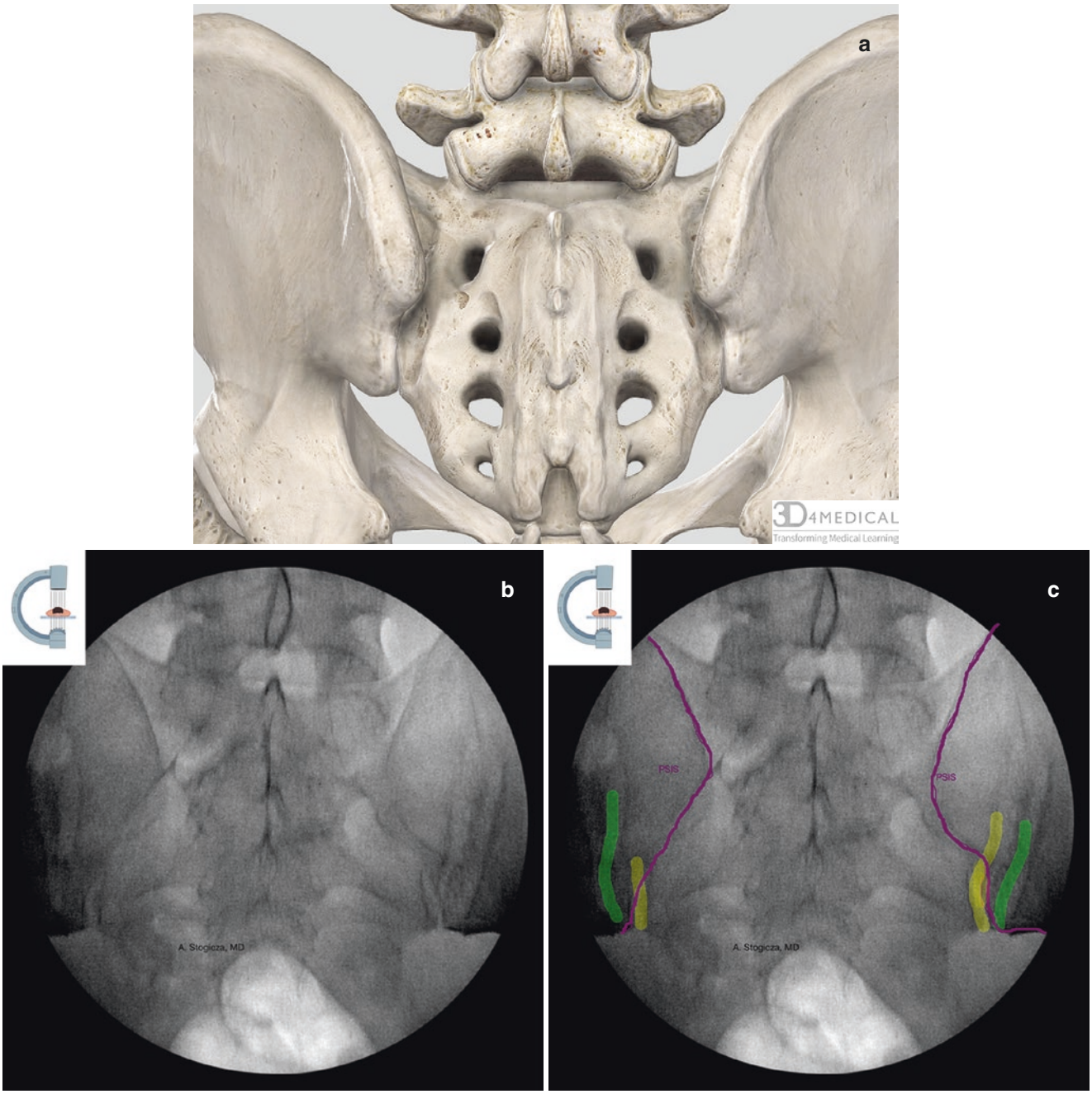

Fig. 26.1 Sacroiliac joint. The PSIS and posterior part of the ilium (purple) covers the upper two-thirds of the posterior joint opening (yellow, medial line). Green line: anterior, more laterally located SI joint opening. Complete Anatomy image (**a**), native (**b**) and edited fluoroscopy image (**c**)

- The anterior SIJ margins are more lateral and also usually more clearly visible than the posterior opening (Fig. 26.2).
- With this in mind, one can identify posterior joint margin and access the joint space without any oblique C-arm tilt in some cases
- Occasionally, a caudad tilt is needed to further help remove the ilium and PSIS covering the lower portion of posterior joint margin
- Needle entry point is at the caudal edge (1 cm) of the joint

Procedure Steps

- Coaxial approach to enter joint space at the caudad third of the joint (Fig. 26.3a, b)
- Needle usually engages as it slides in the cartilaginous part of the joint
- Confirm position with very small amount (0.3 ml) of contrast medium in AP view (Fig. 26.4)

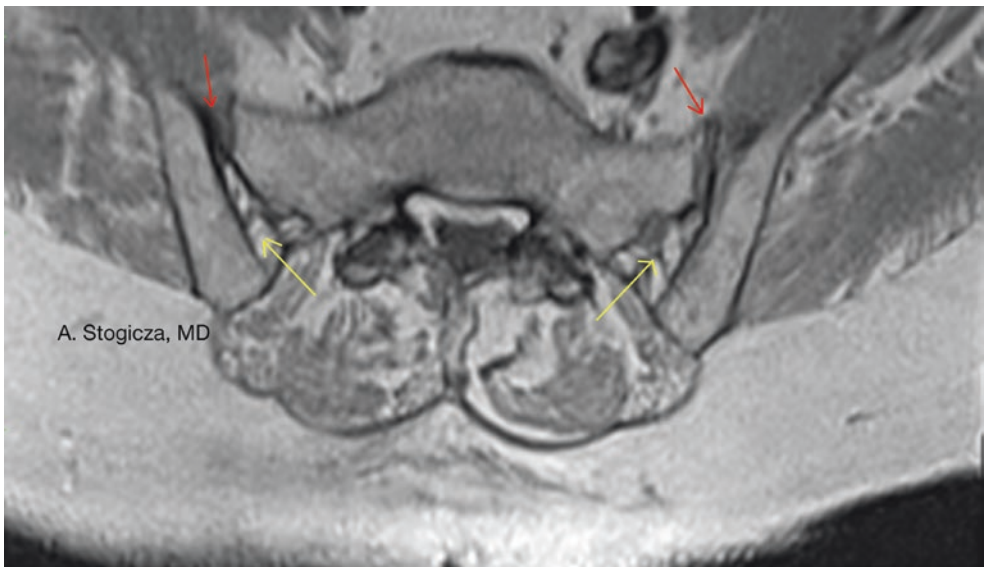

Fig. 26.2 MRI of the pelvis. Posterior sacroiliac joint opening (yellow arrow) is medial compared to the anterior (red arrow)

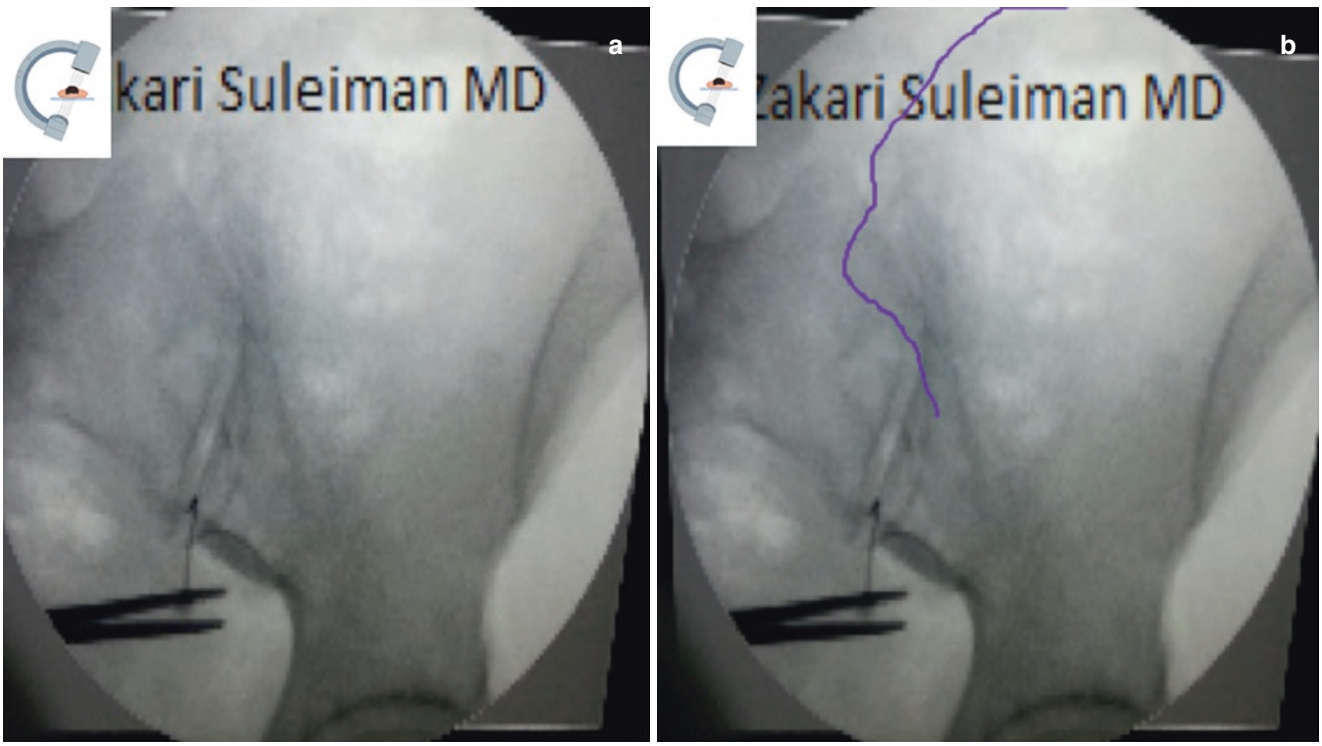

Fig. 26.3 Needle in SI joint. Purple line: PSIS and iliac crest. The SI joint is accessible caudad from the purple line. Native (**a**) and edited fluoroscopy image (**b**)

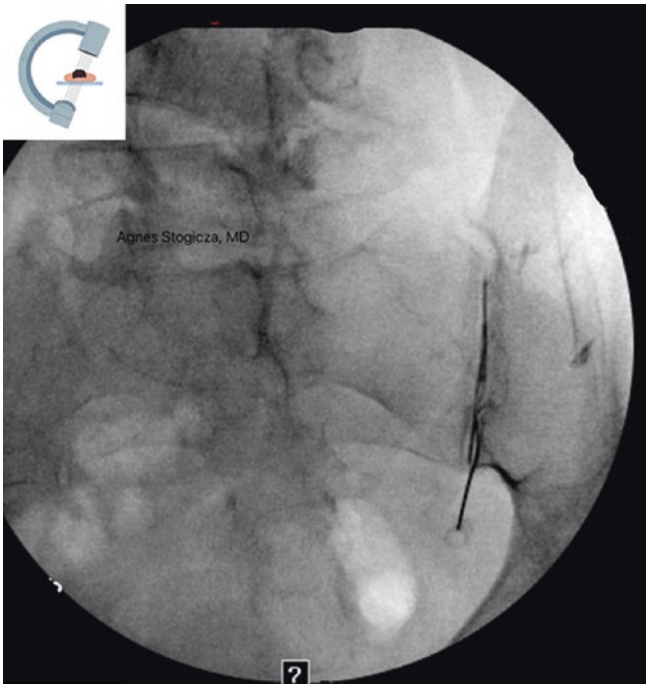

Fig. 26.4 Contrast spread in the SI joint space. Native fluoroscopy image, contralateral oblique view

- Check lateral view: needle to be posterior to the anterior sacral surface (Fig. 26.5a–c)
- Inject 1.5 ml of local anesthetics and steroids (maximum reported volume is 2.5 ml)

Clinical Pearls

- When the needle is engaged in the joint, an "opening pressure" is often felt at the beginning of the injection (difficult to inject initially)
- If it is too easy to inject contrast medium, check the lateral view – it is possible that contrast may leak anteriorly through the ruptured capsule
- If contrast spread is inadequate after several attempts, consider superior approach to the SI joint

Unacceptable, Potentially Harmful Needle Placement on Exam

- Needle far too anterior, in the pelvis, injuring pelvic structures (Note: the anterior part of the joint is not always as easy to see as on Fig. 26.5)
- Needle too caudad, past the joint line, potentially injuring sciatic nerve

Unacceptable, But Not Harmful Needle Placement on Exam

- Unnecessarily large bore needle
- Rough needle manipulation
- Proof of lack of understanding of SI anatomy
- The procedure was abandoned after unsuccessful attempts, but it was clear that the examinee was cognizant of the safety aspects of the procedure

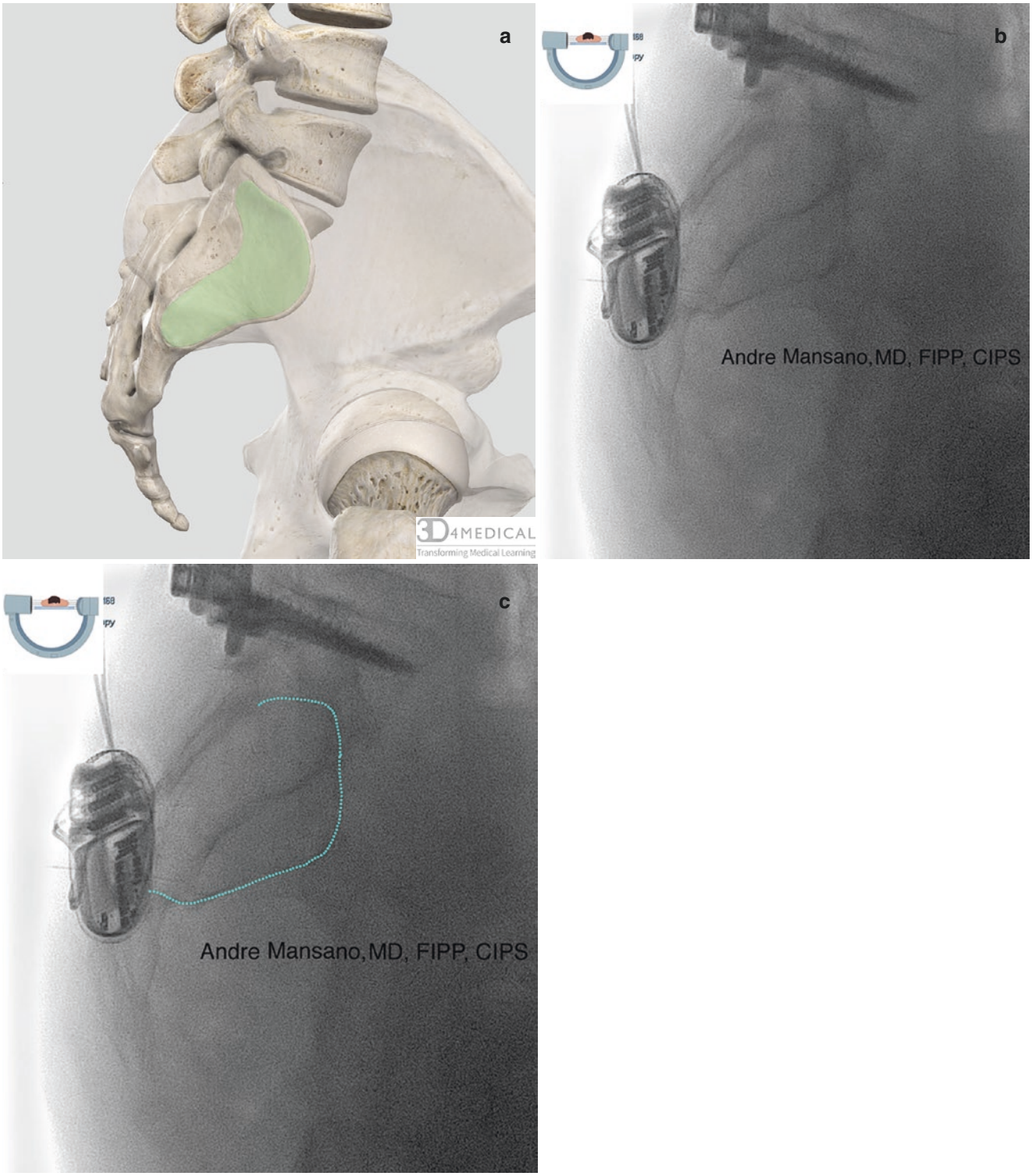

Fig. 26.5 Lateral view of the sacrum. Ilium faded, SI joint surface highlighted in green (**a**), needle tip in the SI joint and contrast outlines the joint space (blue), Complete Anatomy image (**a**), native (**b**) and edited fluoroscopy image (**c**)

Evidence

Table 26.1 Level of evidence and recommendations by the Benelux section of the World Institute of Pain
These recommendations are based on both a review of the literature in 2015 by an independent third party (Kleijnen Systematic Reviews LTD) and the previous guidelines published in *Pain Practice*. The recent literature, the potential risk for complications, and the grade of invasiveness were considered when deciding to upgrade or downgrade the recommendation.

Indication	Procedure	Recommendation 2009[1]	Grade 2015[2]	Recommendation 2018[3,4]
Sacroiliac joint pain	Intra-articular corticosteroid injections	1B+	Low	Weak

[1]Vanelderen P, Szadek K, Cohen SP, De Witte J, Lataster A, Patijn J, et al. 13. Sacroiliac joint pain. Pain Pract. 2010;10:470–8
[2]Kleijnen Systematic Reviews Ltd.: Search and evaluation of the literature. 2015
[3]Huygen F, Kallewaard JW, van Tulder M, Van Boxem K, Vissers K, van Kleef M, et al. Evidence-based interventional pain medicine according to clinical diagnoses: update 2018. Pain Pract. 2019;19:664–75
[4]https://www.anesthesiologie.nl/publicaties/praktische-richtlijnen-anesthesiologische-pijnbestrijding

Table 26.2 Level of evidence based on the American Society of Interventional Pain Physicians (ASIPP) review of the literature

Sacroiliac joint interventions[1]	Evidence
Intra-articular and periarticular steroid injections	Limited to poor evidence

[1]Jani S, Simopoulos TT. Sacroiliac joint interventions. In: Manchikanti L, Kaye AD, Falco FJE, Hirsch JA, editors. Essentials of interventional techniques in managing chronic pain. Springer International Publishing; 2018. p. 337–348

Suggested Reading

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Dreyfuss P, Henning T, Malladi N, Goldstein B, Bogduk N. The ability of multi-site, multi-depth sacral lateral branch blocks to anesthetize the sacroiliac joint complex. Pain Med. 2009;10:679–88.

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The Sacroiliac Joint Block chapter was reviewed by Sudhir Diwan, Andrea M. Trescot; Milan Stojanovic; Peter S. Staats; Agnes R. Stogicza; Andre M. Mansano; Raja Reddy, Massimo Barbieri.

Sacroiliac Joint Radiofrequency Ablation (Bipolar Palisade Technique)

27

Javier De Andrés Ares

Equipment and Monitoring

- Standard ASA monitoring
- Fluoroscopy
- Sterile prep, and drape
- Skin local anesthesia prior to any needle larger than 25G (unless sedation is used)
- Coaxial view is used to advance needle, unless otherwise specified
- CPR equipment and medications available
- Radiofrequency generator and electrodes
- Grounding pad
- Six or seven 18–20G, 3.5 inch (90 mm) needle, 10 mm or 5 mm active tip radiofrequency cannula (depending on patient body habitus)
- Extension tubing
- 1% Lidocaine, 0.75% Ropivacaine or 0.5% bupivacaine
- Corticosteroid
- Nonionic contrast

Anatomy

Sacroiliac joint radiofrequency neurotomy (SIJRN) is performed after a positive diagnostic sacroiliac joint block or sacral lateral branches block. The ventral portion of the sacroiliac joint (SIJ) is probably innervated by the posterior rami of L1–S2, with possible additional innervation from the obturator nerve, superior gluteal nerve, and lumbosacral trunk, while the dorsal portion of the SIJ is believed to be innervated by the posterior rami of L5–S3 (some authors also include L4). Only dorsal denervation is described. So, the targets for SIJRN are L5 dorsal ramus and the lateral branches of S1–S3.

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There are many ways of performing the neurotomy; the following is the bipolar radiofrequency palisade technique.

Bipolar thermal radiofrequency (RF) drives electric current between two nearby electrode tips, without using a grounding pad, to make strip lesions between the two tips (the size of the bipolar lesion is greater than those from monopolar lesions alone).

- Target:
  - L5 Dorsal Ramus: junction of the Sacral Ala (SA) and the base of SAP of S1
  - Lateral branches of S1, S2, and S3

Structures to Keep in Mind and Possible Complications

- Dorsal sacral foramina and exiting nerve roots-nerve injury, epidural injection (if cannula goes far too anterior)
- Soft tissues → hematoma, infection, and pain
- Infection
- Bleeding
- Postprocedure pain
- Vasovagal reaction
- Allergic reaction

Fluoroscopy Technique, Target Localization - S1–S3 Lateral Branches

- Prone patient
- Anteroposterior (AP) image (Fig. 27.1a, b)
- Identify bony landmarks: SIJ and dorsal sacral foramina at different levels. Notice that the larger, semilunar foramina correspond to the ventral, not the dorsal foramina (Fig. 27.1c)

A. R. Stogicza et al. (eds.), *Interventional Pain*, https://doi.org/10.1007/978-3-030-31741-6_27

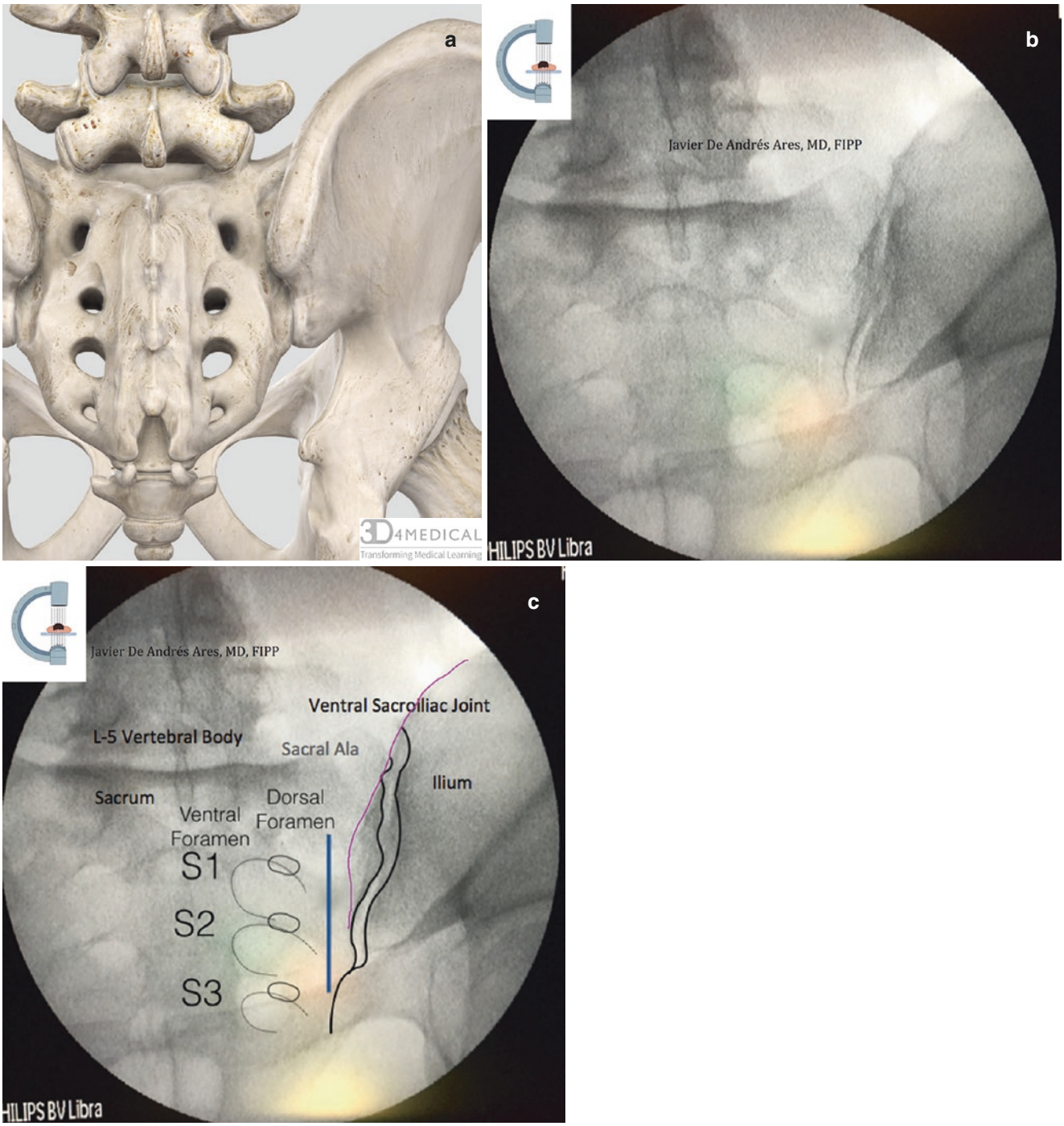

Fig. 27.1 AP view of the sacrum and pelvis with slight cranio-caudad tilt. Blue line drawn just lateral to the dorsal sacral foramina, pink marks the iliac crest. Complete Anatomy image (**a**), native (**b**) and edited fluoroscopy image (**c**)

- Cranio-caudal inclination of C-Arm. Inclination so that the radiofrequency cannula in lateral view is 90° with sacral surface
- Purpose: To place the cannulas perpendicular to sacrum (sometimes difficult because of sacral curvature)
- Entry point of first cannula superior to S1. Space cannulae 10 mm apart, the last cannula inferior to S3, just to the lateral rim of the posterior foramina

Procedure Steps - S1–S3 Lateral Branches

- Coaxial view is used to advance needle to bony contact at the sacral surface (Fig. 27.2)
- Check lateral views in order to avoid entering the dorsal sacral foramen (Fig. 27.3a–c)
- AP view and lateral view: Confirm that cannulas are parallel to each other, separated no more than 1 cm and perpendicular to sacrum (Fig. 27.3 and 27.4)
- Inject 0.3 ml of nonionic contrast under direct vision to exclude vascular uptake or abnormal spread
- If there is vascular uptake or dye spreading to nerve root or epidural space, reposition needle
- If no vascular uptake or epidural or intrathecal dye spread, perform the following:
- Motor stimulation (2Hz). No contraction should be felt
- Leapfrog two electrodes along six needles
- Anesthetize with 2 ml of lidocaine 1%

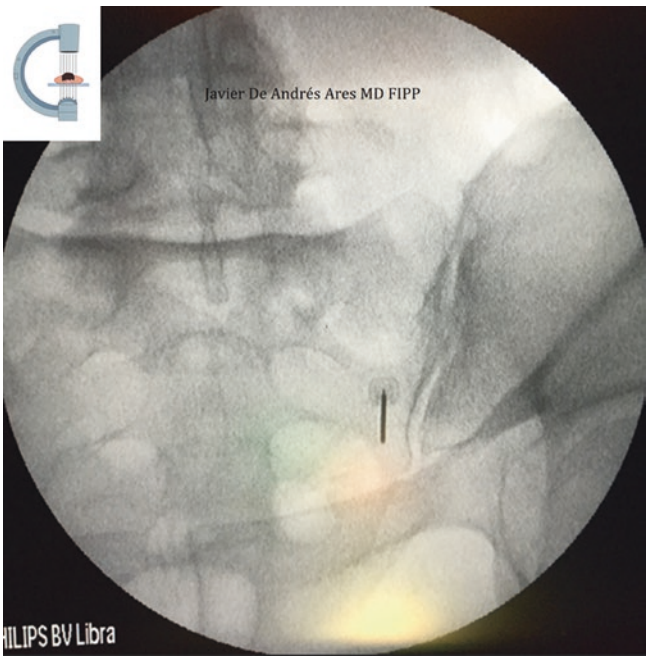

Fig. 27.2 AP view of the sacrum and pelvis with slight cranio-caudad tilt. First cannula is inserted until bony contact (Native fluoroscopy image)

- Wait 2–3 minutes
- Perform radiofrequency lesion 180 seconds 90ºC
- Leapfrog electrodes and lesions along palisade cannulae

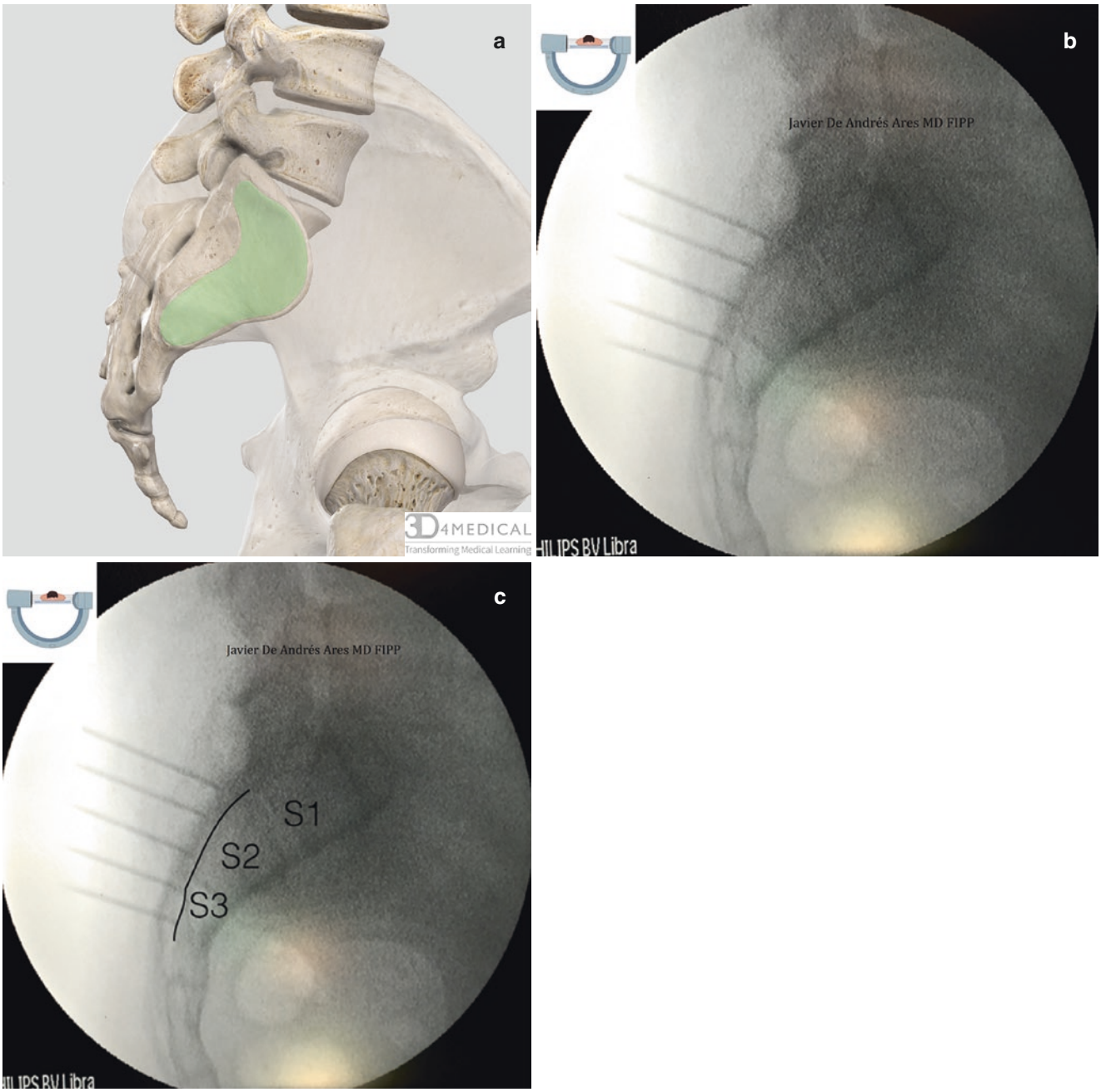

Fig. 27.3 Lateral view of the sacrum and pelvis. Cannulas are placed parallel to each other, touching the posterior surface of the sacrum and they do not reach the epidural space, marked by black line (**c**). Complete Anatomy image (**a**), native (**b**) and edited fluoroscopy image (**c**)

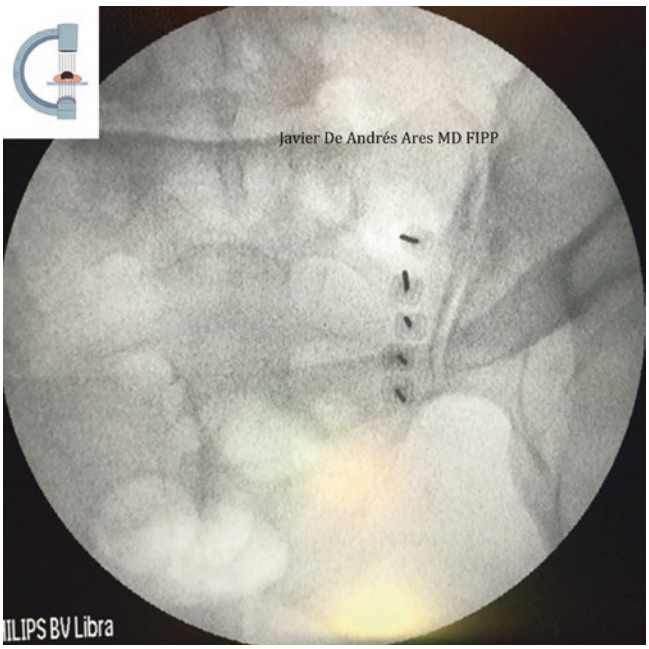

Fig. 27.4 AP view of the sacrum and pelvis, with slight cranial tilt, 5 cannulas placed parallel to each other. Native fluoroscopy image

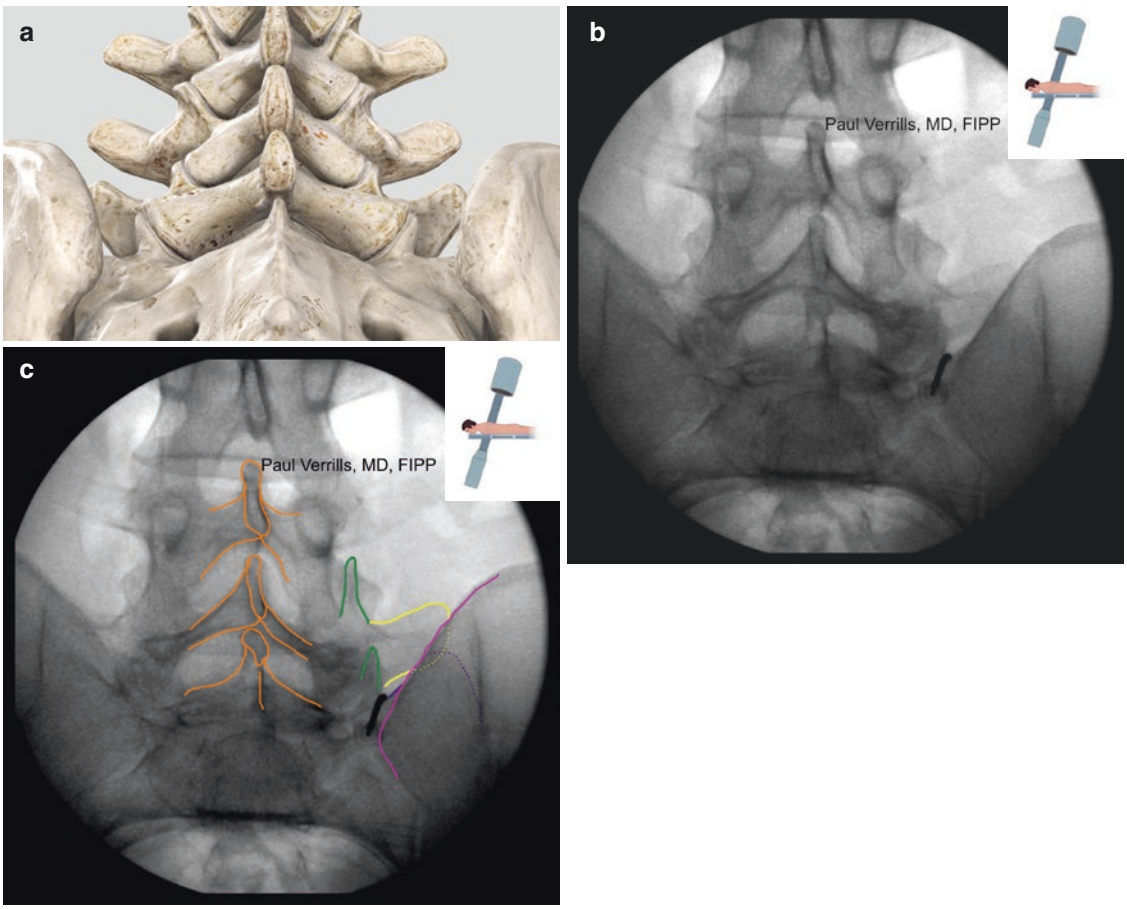

Fig. 27.5 L5 dorsal ramus radiofrequency ablation. C-arm tilted caudally. Needle at the junction of the S1 SAP and SA. Orange = spinous process and lamina; yellow = transverse process; dark green = superior articular process; purple = sacrum; pink = ilium. Complete Anatomy image (**a**), and native (**b**) and edited fluoroscopy image (**c**)

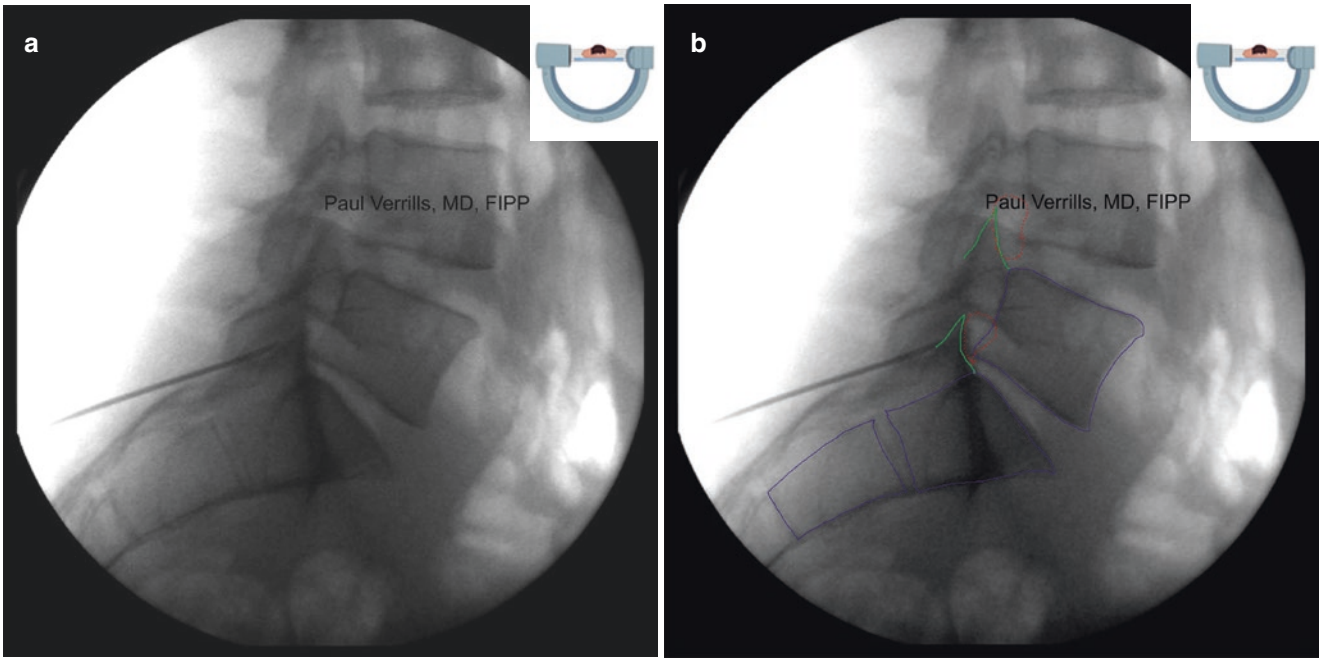

Fig. 27.6 Lateral view of the lumbar spine. Cannula is placed to the L5 dorsal ramus for RFA. The iliopectineal lines overlap, showing a true lateral image. Dark green = superior articular process; red = intervertebral foramen; purple = vertebral body. Native (**a**) and edited (**b**) fluoroscopy image

Fluoroscopy Technique, Target Localization L5 Dorsal Ramus

- AP view of the lumbar spine, identify the junction of the superior articular process (SAP) of S1 and the S1 sacral ala (SA)
- Caudad tilt of the C-arm will enable the needle to project from a caudad approach; this is typically about 30° of caudad tilt (Fig. 27.5a–c)

Procedure Steps, L5 Dorsal Ramus

- Insert cannula and advance it in a coaxial view, aiming at the junction of the SAP and the SA (Fig. 27.5a–c)
- Once on bone, assess the anterior position by using a lateral C-arm view (Fig. 27.6a, b)
- Inject local anesthetic and perform lesion

L5 dorsal ramus RFA is part of the SIJ denervation

Clinical Pearls

- True lateral is achieved with aligned intercristal lines, which helps in assessing needle depth
- Do not use general anesthesia or heavy sedation
- Notice that in bipolar radiofrequency neurotomy, the cannulas must be parallel to each other and separated no more than 10 mm
- Always obtain at least two image views at final needle position
- Inform the patient that he will probably have more pain 7–10 days after the procedure. Prescribe analgesics if needed
- A palm size patch of skin numbness over the lower part of the sacrum is expected

Unacceptable, Potentially Harmful Needle Placement on Exam

- Not checking multiple fluoroscopy views (AP and lateral)
- Rough needle manipulation
- Multiple passes through epidural space

Unacceptable, But Not Harmful Needle Placement on Exam

- Needle off target
- The procedure was abandoned after unsuccessful attempts, but it was clear that the examinee was cognizant of the safety aspects of the procedure

Evidence

Table 27.1 Level of evidence and recommendations by the Benelux section of the World Institute of Pain
These recommendations are based on both a review of the literature in 2015 by an independent third party (Kleijnen Systematic Reviews LTD) and the previous published guidelines published in Pain Practice. The recent literature, the potential risk for complications, and the grade of invasiveness were considered when deciding to upgrade or downgrade the recommendation.

Indication	Procedure	Recommendation 2009[1]	Grade 2015[2]	Recommendation 2018[3,4]
Sacroiliac joint pain	Radiofrequency treatment (ablation) of the dorsal and lateral branches (rami dorsalis and lateralis) (palisade technique)	2C+	Very low	Very weak
Sacroiliac joint pain due to ankylosis spondylitis	Radiofrequency treatment (ablation) of the dorsal and lateral branches (rami dorsalis and lateralis) (palisade technique)		Moderate	Moderate
Sacroiliac joint pain	Radiofrequency treatment (ablation) of the dorsal and lateral branches (rami dorsalis and lateralis) (Simplicity technique)		Not graded	Moderate against
Sacroiliac joint pain	Radiofrequency treatment (ablation) of the dorsal ramus (rami dorsalis) of L4–L5 **and** cooled radiofrequency treatment (ablation) of the lateral branches (rami lateralis) of S1–S3	2B+	Low	Weak
Sacroiliac joint pain	Cooled radiofrequency treatment (ablation) of the dorsal ramus (rami dorsalis) of L5 and of the lateral branches (rami lateralis) of S1–S3		Moderate	Moderate

[1]Vanelderen P, Szadek K, Cohen SP, De Witte J, Lataster A, Patijn J, et al. 13. Sacroiliac joint pain. Pain Pract. 2010;10:470–8
[2]Kleijnen Systematic Reviews Ltd.: Search and evaluation of the literature. 2015
[3]Huygen F, Kallewaard JW, van Tulder M, Van Boxem K, Vissers K, van Kleef M, et al. Evidence-based interventional pain medicine according to clinical diagnoses: update 2018. Pain Pract. 2019;19:664–75
[4]https://www.anesthesiologie.nl/publicaties/praktische-richtlijnen-anesthesiologische-pijnbestrijding

Table 27.2 Level of evidence based on the American Society of Interventional Pain Physicians (ASIPP) review of the literature

Sacroiliac joint interventions[1]	Evidence
Conventional radiofrequency neurotomy	Limited to poor evidence
Cooled radiofrequency neurotomy	Fair evidence
Pulsed radiofrequency neurotomy	Limited to poor evidence

[1]Jani S, Simopoulos TT. Sacroiliac joint interventions. In: Manchikanti L, Kaye AD, Falco FJE, Hirsch JA, editors. Essentials of interventional techniques in managing chronic pain. Springer International Publishing; 2018. p. 337–48.

Suggested Reading

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