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GRAND ROUNDS

Percutaneous cement discoplasty for the treatment of advanced degenerative disk disease in elderly patients

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Abstract

Purpose The authors describe a percutaneous technique to treat advanced degenerative disk disease in elderly patients.
Method A step-by-step technical description based on our experience in selected cases.
Result Postoperative imaging results are presented as well as indications and recommendations.
Conclusion Percutaneous discoplasty can result as an alternative minimal invasive strategy for the treatment of advanced degenerative disk disease.

Keywords Percutaneous discoplasty · Cement bone spacer · Minimally invasive technique

Case presentation

A 78 year old female who complains of chronic low back pain. The pain started 1 year ago, increases with standing activities and is relieved by resting in bed, is indicated with 7 out of 10 in intensity without radiation. The patient refers that the pain is not getting worse, but she cannot perform activities of daily living as she was able to do before. Physical examination shows pain at the middle and lower lumbar spine; flexion and extension of lumbar spine are mildly restricted and painful especially during flexion. There is no motor weakness or sensory deficit in extremities. Imaging studies (X-rays, CT scan and MRI) were requested (see

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Fig. 1) showing degenerative scoliosis with multiple pneumodisk at the lumbar spine.

Diagnostic imaging section

See Fig. 1.

Historical review, epidemiology, diagnosis, pathology and differential diagnosis

Low back pain (LBP) is a common problem observed in elderly population [1].

One of the main challenges for the spine surgeon is to identify the source of pain. Even when the pain source can be determined, age-related comorbidities such as osteoporosis, deformity or clinical problems restrain the surgical options. In cases of severe deformity or degenerative-related spinal instability, the conventional open or even minimal invasive techniques are associated with high morbidity [2–4] such as wound infection and non-union. Associated comorbidities such as cardiorespiratory, advanced rheumatic diseases, diabetes or osteoporosis increase those rates [5]. Minimally invasive surgery has emerged to decrease surgical time, intraoperative blood loss, infection rates, hospital length of stay and cost [6–8]. Those minimal invasive techniques have become an acceptable treatment option [9]; however, complications have been described such as neurological injury, vertebral fracture or implant subsidence, especially in spinal deformities that require treating multiple levels [10, 11].

Percutaneous Cement Discoplasty (PCD), a minimally invasive technique, was first developed by Varga et al. [12] using polymethylmethacrylate (PMMA) as an intervertebral spacer. This procedure was proposed as an alternative interbody spacer option. The objectives of this technical note are to describe the percutaneous discoplasty technique as it is performed in our institution, its indications and contraindications as well as some pearls and pitfalls of the procedure, nor previously described by Varga et al. In addition, the *accordion phenomenon,* the main imaging finding to be considered in this technique, is described below.

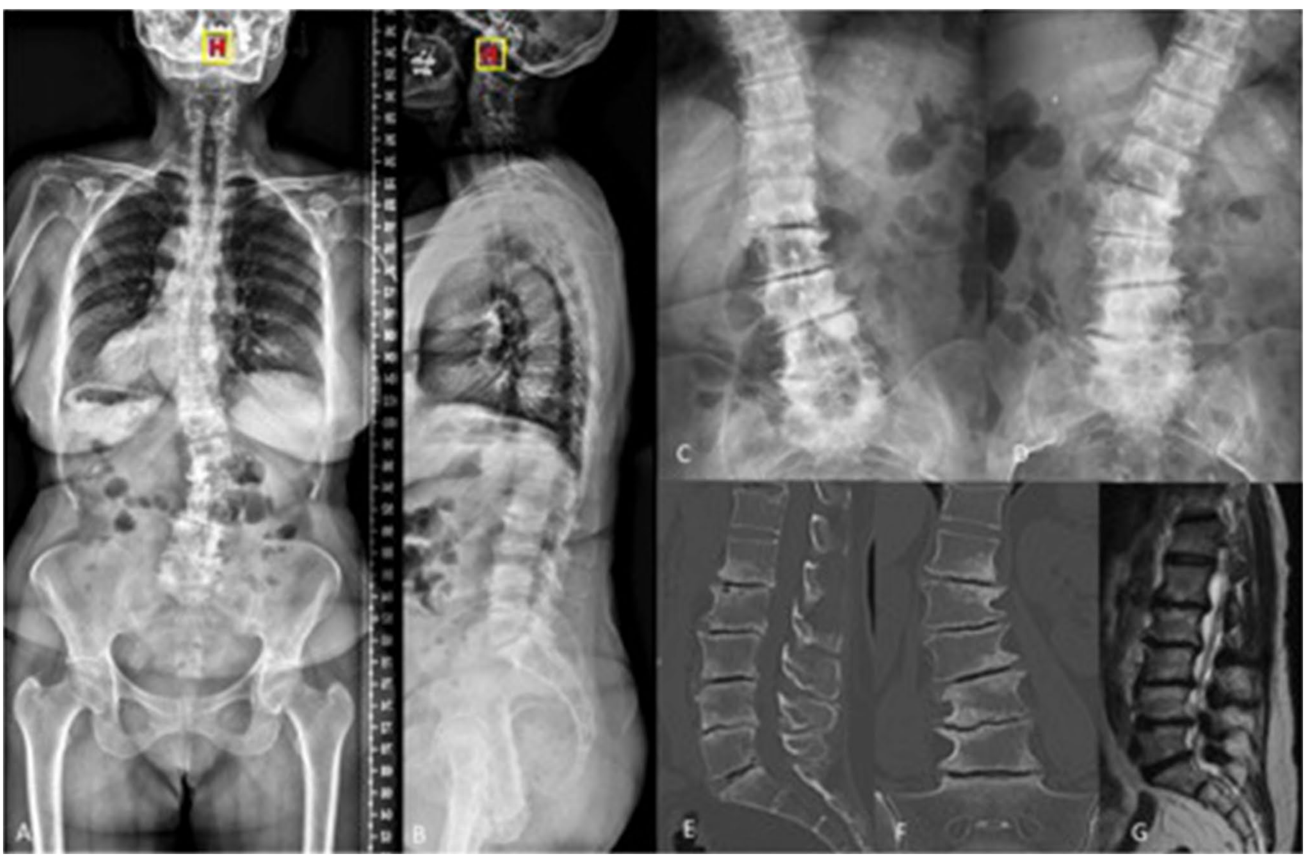

Fig. 1 **a**, **b** Stand AP view showing degenerative scoliosis. **c**, **d** Right and left lumbar bending X-rays showing intervertebral pneumodisk movement. **e**, **f** Lateral and AP CT scan with multiple pneumodisk spaces in lumbar spine, observe the difference between stand X-rays and horizontal CT scan (*accordion phenomenon*). **g** Sagittal MR without nerve root compression

Patient selection

Candidates for PCD are elderly patients, usually older than 75 years, with typical mechanical LBP (exacerbated in standing position that diminish utilizing a brace or laying in bed) as the main clinical complain. Radiating pain is not a contraindication if it is considered secondary to dynamic instability.

Patients require both clinical examination and imaging studies including X-ray (standing and dynamics), computed tomography (CT) and magnetic resonance (MR).

Dynamic X-rays usually show modifications of the disk space height in standing and prone position; this vertical collapse can also be observed in AP view comparing standing X-ray with AP (anterior–posterior) CT scan and is considered an equivalent of axial instability (Fig. 1a–d). CT scan examination is also important to study the interbody surface anatomy (presence of sclerotic subchondral bone, osteophytes) (Fig. 1e, f). MRI is mandatory to rule out other pathologies (metastases, infection or fracture) (Fig. 1g).

The vacuum phenomenon [13, 14], described as the presence of gas involving the intervertebral disk, is a degenerative sign, usually observed in lateral X-rays and CT scan and it is considered an important finding required to perform this procedure, whose objective is to fill this space with PMMA (Fig. 1e, f). However, the only presence of the vacuum phenomenon should not be considered itself as an indication of discoplasty; as in many cases, it is asymptomatic. Nevertheless, the *accordion phenomenon* (Fig. 2), that is, a disk vertical height variation between the standing and supine X-ray or between standing X-ray and CT scan due to disk collapse in the presence of vacuum phenomenon should be considered a sign of instability. This is an important finding related to segmental intervertebral movement and, based on our experience, is essential to indicate this technique.

Indications

The following situations are prone to be considered indications for discoplasty:

Typical situations are elderly patients with mechanical low back pain and vacuum phenomenon associated with variation in intervertebral disk height on dynamics X-rays, stand and horizontal X-rays, or stand X-ray and CT-scan (*accordion phenomenon*). One or multiple levels associated with spinal deformity or degenerative spondylolisthesis in which open surgery is not indicated due to high risk of complications can be treated.

Contraindications

Severe osteoporosis is a relative contraindication for this procedure, as it could increase the rate of adjacent vertebral compression fracture. It is strongly recommended to perform preoperative medical treatment for osteoporosis in order to decrease the rate of vertebral fracture. Another relative contraindication is the presence of severe deformity, as this procedure is not primarily intended to restore severe coronal or sagittal balance; obesity is a relative contraindication as it might decrease the quality of the intraoperative images. Absolute contraindications include active infection and tumor.

Operative procedure

Operative room preparation

The patient is placed in prone position under general anesthesia in a radiolucent table with two air-filled rolls (25 cm diameter) both located under the thoracic and pelvic regions, leaving the abdominal wall free of pressure. Another roll is positioned under both knees and should be insufflated in order to open the disk spaces by increasing lumbar lordosis (Fig. 3). According to our technical description, we consider this step important to increase the lumbar lordosis and to optimize the PMMA filling the space in this position. Resistant Scotch Tape is required to fix both pelvis and thorax to the radiolucent table. Radioscopic control is performed under X-ray image intensifier (C-arm brand, origin).

Entry point placement

The access to the disk space can be performed through pedicle (transpedicular access) or parallel to the superior lateral pedicle edge to avoid the nerve root, which passes through the medial and inferior corner of the superior pedicle (extra-pedicular access, Fig. 4) similar to a discography technique [15].

The extra-pedicular access is preferred for all levels except for L5–S1 level in which we use and recommend that a transpedicular S1 access is performed, with violation of the superior sacral endplate (Fig. 5).

Both anterior–posterior and lateral images are necessary to identify pedicles and vertebral end plates. It is crucial to observe the superior and inferior end plates parallel to the intensifier in the lateral view as well as the pedicles in the anterior–posterior view; bad quality images may difficult proper needle placement and can increase the rate of neurovascular injury.

Unilateral entry point is usually recommended; in cases of scoliosis, it is recommended to access the intervertebral

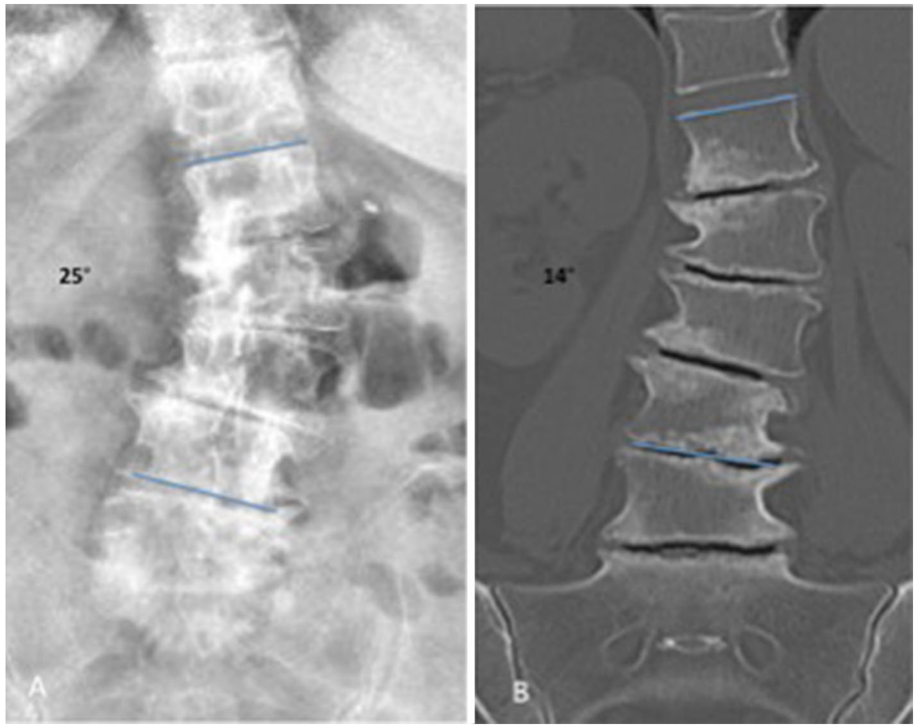

Fig. 2 Illustration of the *accordion phenomenon*. **a** AP standing X-ray. **b** Supine CT scan, note the different angulation due to the intervertebral collapse (25° and 14°, respectively)

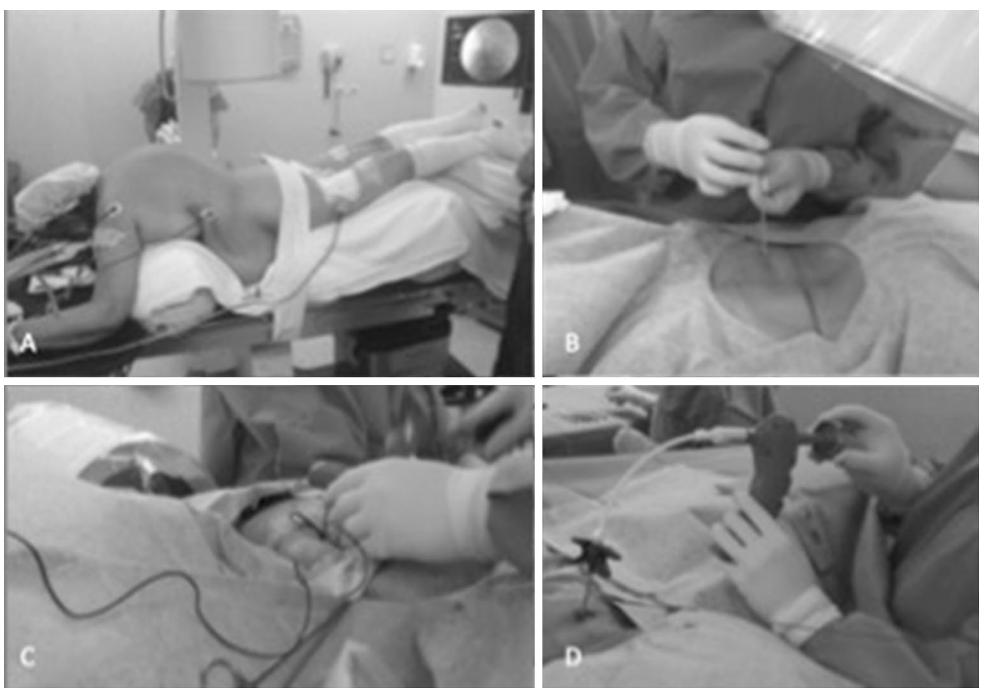

Fig. 3 **a** Prone operative position with hip extension in order to increase lumbar lordosis and open the disk spaces. **b** Percutaneous Jamshidi needle placement under C-arm radioscopy. **c** Free run and triggered EMG during needle placement and injection. **d** Slow bone cement injection

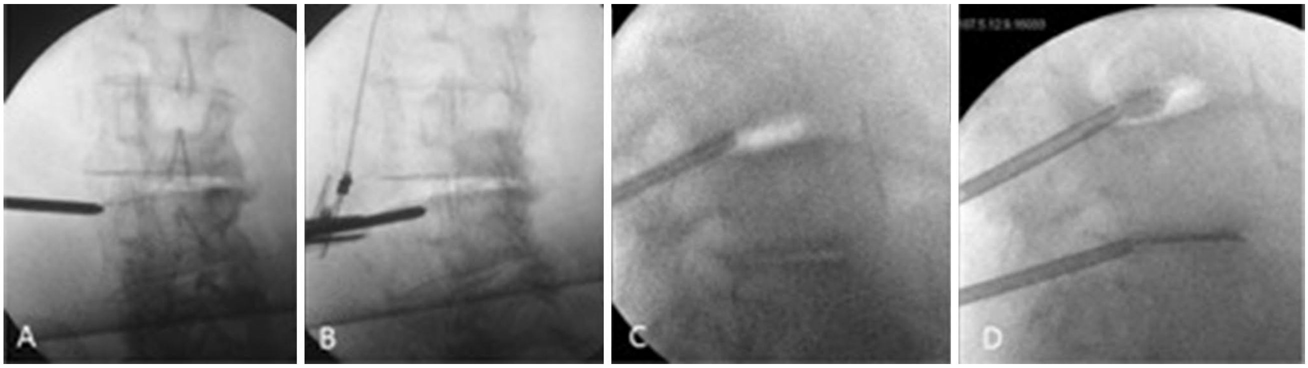

Fig. 4 Extrapedicular access entry point. **a**, **b** (Front and oblique view) with radioscopic guidance the cannulated needle (Jamshidi) is placed in the intersection of the transverse process and the superior facet. **c** Lateral view showing needle position inside the disc. **d** Cement injection is performed under strict C-arm radioscopic control

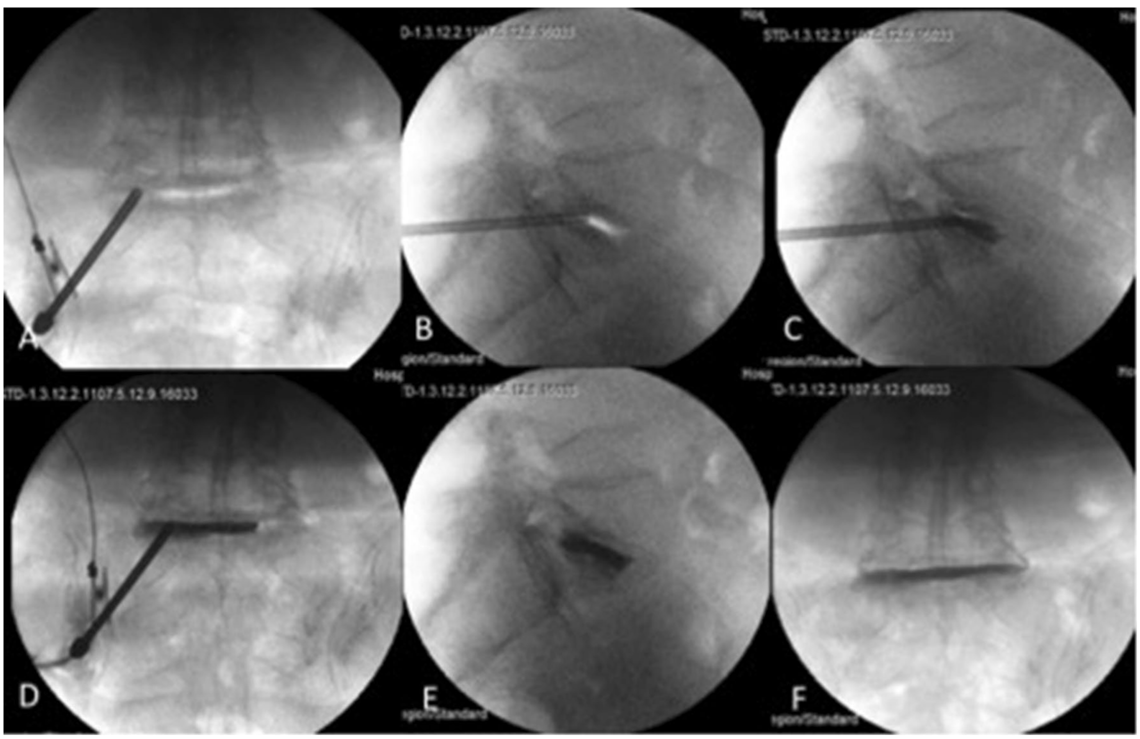

Fig. 5 **a**, **b** Pedicular access to the fifth intervertebral disk from another similar case. **c**, **d** After correct guide positioning bone cement is injected slowly and intermittently, at this point care should be placed on the posterior disk space, posterior and lateral cement leakage can cause compression. **e**, **f** Postoperative lateral and AP control

space in the convexity of the curve to reduce the risk of nerve root damage due to the longer interpedicular space; however, according to the air distribution observed in CT scan, some cases are required to be treated in the concavity of the curve.

Intraoperative neuromonitoring

All the steps are guided by intraoperative neurophysiological monitoring, something not suggested by Varga et al. The anesthetic protocol is defined by the requirement for EMG and MEP monitoring, employing total intravenous anesthesia. Muscle relaxants are used only for intubation and then avoided for the remainder of the surgical procedure.

Small monopolar needle electrodes are placed in target muscles dependent upon the spinal region being operated.

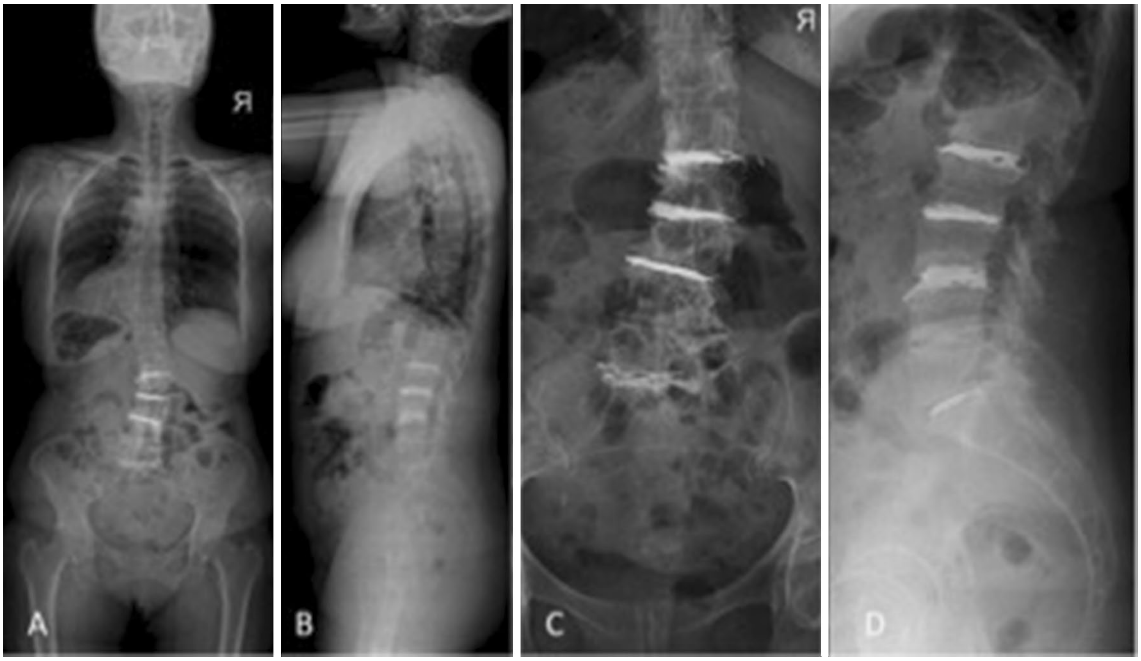

Fig. 6 Postoperative control of the case from Fig. 1, partial correction of the AP curve is observed as well as improvement of lumbar lordosis

Additional recording electrodes are placed in the Abductor hallucis, for the train-of-4 stimulation over the tibialis nerve, to determine the level of muscle relaxants after positioning the patient and before the beginning of the procedure.

Reference and return electrodes are placed on the patient's upper thigh and near the surgical site, respectively.

Free-run electromyography (EMG) is conducted during the whole procedure, employing multiple simultaneous channels of an NIM Eclipse® neuromonitoring system (Medtronic).

Continuous stimulation through the Jamshidi needle is performed, employing a clamp stimulator, with a maximum intensity of 20 mA (with transpedicular approaches) or 10 mA (with extra pedicular ones), looking for a neural response indicating radicular proximity.

During the injection of the cement, motor evoked potentials are performed, to monitor central motor pathway function and to detect unnoticed cement spills into the spinal canal.

To avoid neural complications associated with this approach, as in most percutaneous procedures, is recommended to add neurophysiological monitoring with free-run and triggered EMG and transcranial motor evoked potentials. Free-run EMG registers real-time muscle activity during the whole procedure. Mechanical stimulation of a nerve root leads to complex repetitive discharges in the EMG. Discrete threshold, triggered EMG provides real-time feedback of the proximity of the roots, as measured by the threshold required to depolarize them to elicit a response. Worth mentioning that chronically compressed nerve roots may have a higher stimulation threshold than uncompressed ones.

Cement preparation and injection

After the cannulated needle is placed in the disk space, cement (KYPHON® HV-R® Bone Cement) is prepared by mixing the components, then, after 4 or 5 min cement is slowly injected through the cannula (1 cc in 30 s approximately). Usually 5 or 6 cc of cement are usually required to fill the disk space, but it depends on the amount of air, which is usually analyzed preoperatively. It is important to control the cement leakage to the epidural space or outside the foramen, lateral to the spine.

The cement must be completely set before the removal of the trocars to avoid leakage; usually 15 min are recommended to obtain enough cement induration to remove the Jamshidi needle.

Rationale for treatment

The principle of discoplasty is based on the intervertebral segment instability in which the neuroforamen area is compromised on standing position, reducing its area and decompressed in decubitus position. As the disc collapses, one of the vertebras slips forwards or backwards and facet osteophytes protrude into the foramen. In the present case, we decided to perform this procedure based on the increased rate of postoperative complications related to standard surgical treatment such

Fig. 7 Multiple level discoplasty in a patient with degenerative scoliosis observing the accordion phenomenon and partial correction of the AP curve (10°) and lumbar lordosis from another similar case

Table 1 Pearls and pitfalls

Pearls	Pitfalls
Insufflate the knee roll to open the disk space in order to increase lumbar lordosis[a]	Avoid excessive hip hyperextension that can cause femoral artery compression at inguinal crease[a]
Check the endplates to be parallel with C-arm	Do not insert the needle before control both endplates to be parallel
Monitor time of cement preparation	Avoid premature or late cement injection
Stop the procedure when cement reaches the posterior intervertebral margin or any change in neuromonitoring[a]	Excessive cement volume could increase the risk of cement leakage, nerve root compression and adjacent vertebral fracture
Pedicular access is recommended for L5–S1 level[a]	PCD at L5–S1 level is difficult especially in obese patients[a]

PCD percutaneous cement discoplasty

[a]Additional steps that we consider important to add to the original description of PCD

as posterior lumbar arthrodesis. Surgical treatment in elderly patient is associated with higher rate of complication such as postoperative infection, non-union, pneumonia, thrombosis or urinary tract infection [16, 17]. Carreon et al. [18] found a 79.6% complication rate in patients greater than 65 years of age who underwent posterior decompression and fusion. 21.4% had major complications and 50% had 2 or more complications. The complication rate increased with age, blood

Table 2 Advantages and disadvantages

Advantages	Disadvantages
Less surgical time	Increase X-ray exposure
Minimal blood loss	Difficult visualization in obese patients or L5–S1 space
Shorter length of hospital stay	

loss, operative time, and the number of levels fused [3]. Minimal invasive surgery has been developed to decrease blood loss, operative time and complications but usually with high cost and not exempt of complications [19].

Procedure imaging section

See Figs. 3, 4 and 5.

Clinical outcome

Postoperative management

After the procedure, the patient was able to stand up and walk; it is preferred a 24 h hospital admission for clinical control. Upright spine X-rays were performed postoperatively (Fig. 6). Postoperative CT scan also can be performed specially in multiple level discoplasties to evaluate cement disk filling or leakage (Fig. 7). Our patient improved from 7/10 to 2/10 in visual analog scale of pain. The improvement was observed after the procedure and is maintained after 1 year of treatment.

Tables 1 and 2 show Pearls and pitfalls as well as some advantages and disadvantages of this technique.

Conclusion

The objective of this technical note was to describe the technique, indications, contraindication as well as some pearls and pitfalls. The *accordion phenomenon* is described and is considered important; to our knowledge, this imaging finding associated with mechanical low back pain is considered an indication for this technique. This percutaneous technique could represent an alternative option for the treatment of severe discopathy in elderly patients in which open procedures are associated with more risk than benefits. Clinical studies are required to standardize this technique as a reliable treatment option.

Compliance with ethical standards

Conflict of interest The authors declare no competing financial interest.

References

1. Hoy D, Bain C, Williams G et al (2012) A systematic review of the global prevalence of low back pain. Arthritis Rheum 64:2028–2037. https://doi.org/10.1002/art.34347
2. Puvanesarajah V, Nourbakhsh A, Hassanzadeh H et al (2016) Readmission rates, reasons, and risk factors in elderly patients treated with lumbar fusion for degenerative pathology. Spine (Phila Pa 1976) 41:1933–1938. https://doi.org/10.1097/brs.0000000000001631
3. Puvanesarajah V, Cancienne JM, Werner BC et al (2018) Perioperative complications associated with posterolateral spine fusions: a study of elderly medicare beneficiaries. Spine (Phila Pa 1976) 43:16–21. https://doi.org/10.1097/brs.0000000000001771
4. Mihailidis HG, Manners S, Churilov L, Quan GMY (2017) Is spinal surgery safe in octogenarians? ANZ J Surg 87:605–609. https://doi.org/10.1111/ans.13885
5. Passias PG, Klineberg EO, Jalai CM et al (2016) Hospital readmission within 2 years following adult thoracolumbar spinal deformity surgery: prevalence, predictors, and effect on patient-derived outcome measures. Spine (Phila Pa 1976) 41:1355–1364. https://doi.org/10.1097/brs.0000000000001552
6. Rodgers WB, Gerber EJ, Rodgers JA (2010) Lumbar fusion in octogenarians. Spine (Phila Pa 1976) 35:S355–S360. https://doi.org/10.1097/brs.0b013e3182023796
7. Isaacs RE, Hyde J, Goodrich JA et al (2010) A prospective, nonrandomized, multicenter evaluation of extreme lateral interbody fusion for the treatment of adult degenerative scoliosis. Spine (Phila Pa 1976) 35:S322–S330. https://doi.org/10.1097/brs.0b013e3182022e04
8. Uddin OM, Haque R, Sugrue PA et al (2015) Cost minimization in treatment of adult degenerative scoliosis. J Neurosurg Spine 23:798–806. https://doi.org/10.3171/2015.3.SPINE14560
9. Phillips FM, Isaacs RE, Rodgers WB et al (2013) Adult degenerative scoliosis treated with XLIF: clinical and radiographical results of a prospective multicenter study with 24-month follow-up. Spine (Phila Pa 1976) 38:1853–1861. https://doi.org/10.1097/brs.0b013e3182a43f0b
10. Knight RQ, Schwaegler P, Hanscom D, Roh J (2009) Direct lateral lumbar interbody fusion for degenerative conditions: early complication profile. J Spinal Disord Tech 22:34–37. https://doi.org/10.1097/BSD.0b013e3181679b8a
11. Cummock MD, Vanni S, Levi AD et al (2011) An analysis of postoperative thigh symptoms after minimally invasive transpsoas lumbar interbody fusion. J Neurosurg Spine 15:11–18. https://doi.org/10.3171/2011.2.SPINE10374
12. Varga PP, Jakab G, Bors IB et al (2015) Experiences with PMMA cement as a stand-alone intervertebral spacer. Orthopade 44:1–8. https://doi.org/10.1007/s00132-014-3060-1
13. D'Anastasi M, Birkenmaier C, Schmidt GP et al (2011) Correlation between vacuum phenomenon on CT and fluid on MRI in degenerative disks. Am J Roentgenol 197:1182–1189. https://doi.org/10.2214/AJR.10.6359
14. Gohil I, Vilensky JA, Weber EC (2014) Vacuum phenomenon: clinical relevance. Clin Anat 27:455–462. https://doi.org/10.1002/ca.22334

15. Sachs BL, Spivey MA, Vanharanta H et al (1990) Techniques for lumbar discography and computed tomography/discography in clinical practice. Orthop Rev 19:775–778
16. Daubs MD, Lenke LG, Cheh G et al (2007) Adult spinal deformity surgery. Spine (Phila Pa 1976) 32:2238–2244. https://doi.org/10.1097/brs.0b013e31814cf24a
17. Pateder DB, Gonzales RA, Kebaish KM et al (2008) Pulmonary embolism after adult spinal deformity surgery. Spine (Phila Pa 1976) 33:301–305. https://doi.org/10.1097/brs.0b013e31816245e1
18. Carreon LY, Puno RM, Dimar JR et al (2003) Perioperative complications of posterior lumbar decompression and arthrodesis in older adults. J Bone Jt Surg Am 85-A:2089–2092
19. Rosen DS, O'Toole JE, Eichholz KM et al (2007) Minimally invasive lumbar spinal decompression in the elderly: outcomes of 50 patients aged 75 years and older. Neurosurgery 60:503-9–503-10. https://doi.org/10.1227/01.neu.0000255332.87909.58