Can J Anesth/J Can Anesth (2015) 62:1196–1200
DOI 10.1007/s12630-015-0431-y

REPORTS OF ORIGINAL INVESTIGATIONS

Thoracolumbar interfascial plane (TLIP) block: a pilot study in volunteers

Le bloc du plan interfascial thoraco-lombaire (TLIP): une étude pilote auprès de volontaires

William R. Hand, MD · Jason M. Taylor, MD · Norman R. Harvey, MD · Thomas I. Epperson, MD · Ryan J. Gunselman, MD · Eric D. Bolin, MD · Joseph Whiteley, DO

Received: 6 March 2015 / Revised: 18 March 2015 / Accepted: 29 June 2015 / Published online: 7 July 2015

Abstract

Purpose *Regional anesthesia has been shown to improve outcomes in several recent studies. The transversus abdominis plane (TAP) block provides anesthesia to the abdominal wall by introducing local anesthetic to the ventral rami of the thoracolumbar nerves. This work quantifies the area of anesthesia obtained after performing the novel thoracolumbar interfascial plane block (analogous to the TAP block but intended for the back) which targets the sensory component of the dorsal rami of the thoracolumbar nerves.*

Methods *Ten participants underwent bilateral ultrasound-guided injections of 0.2% ropivacaine 20 mL into the fascial plane between the multifidus and longissimus muscles. After five and 20 min, respectively, the area of anesthesia was plotted on the participant's back. Anesthesia was defined as loss of point discrimination to pinprick.*

Results *Participants reported a mean (SD) area of anesthesia surrounding the needle injection site of 137.4 (71.0) cm^2 and 217.0 (84.7) cm^2 at five and 20 min after injection, respectively. The mean (SD) cephalad and caudal spread of local anesthetic from the site of injection was 6.5 (1.8) cm and 3.9 (1.2) cm, respectively. There were no complications or adverse events reported.*

Conclusion *This report shows that a reproducible area of anesthesia can be obtained by ultrasound-guided injection of local anesthetic in the fascial plane between the multifidus and longissimus muscles of the thoracolumbar spine. The area of anesthesia consistently covered the midline and had a predictable spread. This project was registered with clinicaltrials.gov (NCT02297191).*

Author contributions *William R. Hand*, *Jason M. Taylor*, *Joseph Whiteley*, *Thomas I. Epperson*, and *Ryan J. Gunselman* were involved with the design of the study. *William R. Hand*, *Jason M. Taylor*, Joseph Whiteley, *Norman R. Harvey*, *Eric D. Bolin*, and *Ryan J. Gunselman* were involved with the data collection. *William R. Hand*, *Jason M. Taylor*, Joseph Whiteley, *Norman R. Harvey*, and *Eric D. Bolin* were involved with the data analysis. All authors were involved with manuscript preparation.

This work has been submitted for presentation at the 2015 Annual Meeting for the American Society of Regional Anesthesia and Pain Medicine.

W. R. Hand, MD (✉) · J. M. Taylor, MD ·
N. R. Harvey, MD · T. I. Epperson, MD ·
R. J. Gunselman, MD · E. D. Bolin, MD · J. Whiteley, DO
Department of Anesthesiology and Perioperative Medicine, Medical University of South Carolina, 167 Ashley Ave, SEI 301, Charleston, SC 20425, USA
e-mail: handw@musc.edu

Résumé

Objectif *Plusieurs études récentes ont démontré que l'anesthésie régionale améliorait les résultats postopératoires. Le bloc du plan transverse abdominal (TAP) procure une anesthésie de la paroi abdominale en introduisant un anesthésique local dans les rameaux ventraux des nerfs thoraco-lombaires. Le but de cette étude est de mesurer la surface d'anesthésie obtenue après avoir réalisé un nouveau type de bloc, soit celui du plan interfascial thoraco-lombaire (analogue au bloc TAP mais pratiqué dans le dos) qui cible la composante sensorielle des rameaux dorsaux des nerfs thoraco-lombaires.*

Méthode *Dix participants reçurent des injections bilatérales échoguidées de 20 mL de ropivacaïne 0,2 % dans le plan fascial entre les muscles multifidus et longissimus. Après cinq et 20 minutes, respectivement, la surface d'anesthésie a été tracée sur le dos du participant.*

L'anesthésie était définie comme la perte de discrimination à la piqûre d'épingle.

Résultats *Les participants ont rapporté une surface moyenne (ÉT) d'anesthésie autour du site d'injection de 137,4 (71,0) cm^2 et de 217,0 (84,7) cm^2 à cinq et 20 minutes après l'injection, respectivement. La diffusion moyenne (ÉT) de l'anesthésique local depuis le site d'injection vers la tête et les membres inférieurs était de 6,5 (1,8) cm et 3,9 (1,2) cm, respectivement. Aucune complication n'a été rapportée.*

Conclusion *Ce compte-rendu démontre qu'une zone d'anesthésie reproductible peut être obtenue par injection échoguidée d'anesthésique local dans le plan fascial entre les muscles multifidus et longissimus de la colonne thoraco-lombaire. Dans tous les cas, la surface d'anesthésie recouvrait la ligne médiane et la diffusion de l'anesthésique était prévisible. Ce projet est enregistré au clinicaltrials.gov (NCT02297191).*

Spine surgery in the thoracolumbar region is one of the most common operations performed in the United States to address back and leg pain.[1] Such patients frequently present with chronic preoperative pain, but they also experience surgery-related new onset acute pain in the early postoperative period. A variety of regional anesthesia techniques have been shown to be effective in managing acute and chronic pain during the perioperative period.[2,3] As general anesthesia becomes increasingly safer, our specialty is tasked with making improvements in the other areas of perioperative care that contribute to morbidity and mortality. In addition, expanded use of regional anesthesia techniques is advocated by Enhanced Recovery After Surgery protocols aimed at minimizing opioid analgesics whenever possible.[4-6]

Many patients undergoing lower abdominal surgical procedures now benefit from the transversus abdominis plane (TAP) block, a field block targeting the abdominal intermuscular plane that carries sensory nerves from the ventral ramus of the thoracolumbar nerves.[7,8] Several studies have shown this block to be safe and effective.[9-12] Furthermore, the control of postoperative pain using non-opioid medication has repeatedly been shown to benefit patients in terms of morbidity and mortality.[13] Currently, spine surgeons frequently perform a preoperative field infiltration for lumbar surgery with a total dose of anesthetic similar to that of the TAP block[14]; however, the efficacy of this approach has not been well studied. Nevertheless, the safety of such a procedure with the typically used dose of local anesthetic is supported by the extensive regional anesthesia practice using similar blocks.

In this report, we describe a novel regional anesthesia block that targets the dorsal rami of the thoracolumbar nerves (analogous to the ventral rami for the TAP block) as they pass through the paraspinal musculature (Fig. 1). Accordingly, this newly described block is termed the thoracolumbar interfascial plane (TLIP) block. The purpose of this pilot study is to perform an ultrasound-guided TLIP block showing a reproducible area of sensory blockade in a group of volunteers.

Methods

Institutional Review Board approval was obtained (IRB # Pro00033609, June 2014), and ten healthy volunteers provided written informed consent to participate in this study. After placement of a peripheral intravenous catheter, each participant was placed in the prone position and standard monitors were applied. No sedation was administered. A SonoSite S-Nerve high-frequency linear (HFL) 50X transducer (SonoSite, Bothell, WA, USA) was placed in transverse orientation in a midline position at approximately the level of the third lumbar vertebra (L3). The corresponding spinous process and interspinal muscles were identified, and the probe was then moved laterally to identify the multifidus muscle (MF) and the longissimus muscles (LG). Initial midline placement of the probe with subsequent lateral displacement avoided misinterpretation of the interspinous/MF interface as the MF/LG interface. These landmarks are seen in Fig. 2. The block was performed at the most caudal level that allowed reliable identification of the MF/LG interface. In our pilot study,

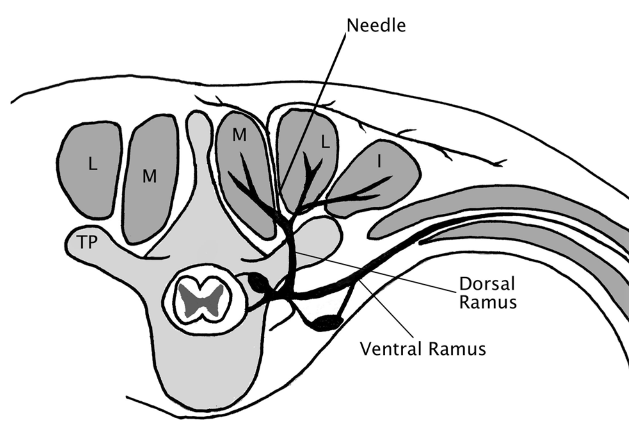


Fig. 1 Illustration shows the dorsal and ventral divisions of each spinal nerve. The paraspinal muscles, including multifidus and longissimus, are displayed along with the approximate needle trajectory that was used. Labelled structures include: I = iliocostalis muscle; L = longissimus muscle; M = multifidus muscle; TP = transverse process

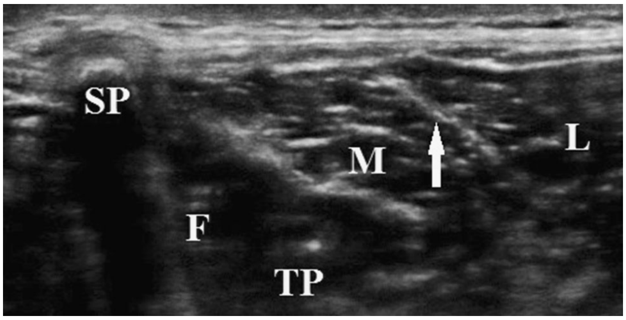


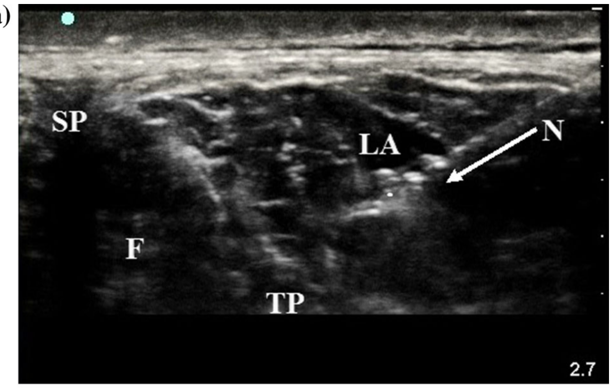
Fig. 2 Ultrasound image of the paraspinal muscles of the thoracolumbar spine. The fascial plane is easily visible between the muscle bellies (arrow). The structures include: SP = spinous process; F = facet joint; TP = transverse process; M = multifidus muscle; L = longissimus muscle

this approach resulted in no more than one variation in vertebral level.

Discrimination of the MF and LG muscles can be difficult as these separate structures can often appear as a single larger muscle. Visualization can be enhanced with lumbar extension and slight rotation of the participant. This maneuver results in "sliding" the LG over the lateral border of the MF better delineating the intended location to inject the local anesthetic. After identifying the muscles, chlorhexidine was applied to the participant's skin in preparation for performing the subsequent block in a sterile manner.

Lidocaine 1% was used to anesthetize the skin and subcutaneous tissues. A 10-cm 21G Stimuplex® needle (Braun Medical Inc, Bethlehem, PA, USA) was inserted bevel up in a lateral-to-medial orientation at an approximate angle of 30° to the skin. The needle was advanced under real-time in-plane ultrasound guidance through the belly of the LG towards the MF. The needle tip was directed towards the LG-MF interface deep to the midpoint (Fig. 3a). After an attempted aspiration with a 3-mL syringe was negative for blood, a 20-mL syringe was used to inject a small volume of local anesthetic to confirm needle tip placement between the MF and LG (i.e., hydrodissection). The location within the desired plane was facilitated by advancing the needle into the MF and subsequently injecting the local anesthetic as the needle was withdrawn. Ropivacaine 0.2% (without epinephrine) was incrementally injected with intermittently repeated negative aspiration. Anterior spread of local anesthetic was viewed as favourable (Fig. 3b). The block was administered bilaterally to each volunteer by injecting ropivacaine 40 mL in total (i.e., 20 mL injected into each side). The site of injection was subsequently marked with a felt-tip pen. The volunteers were monitored for signs or symptoms of local anesthetic systemic toxicity or other complications, with no report of any adverse reactions.

(a)



(b)

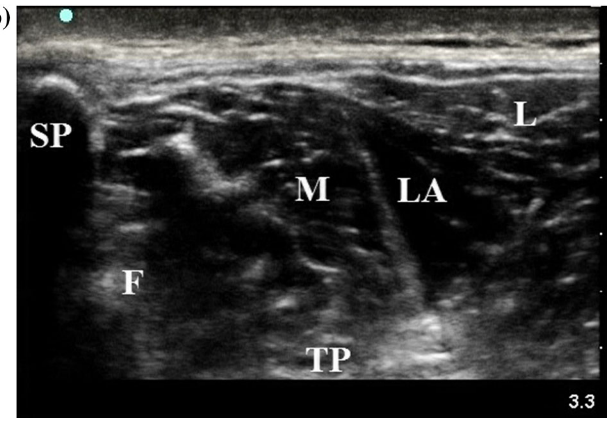


Fig. 3 a Ultrasound image with needle placement. This image was obtained after injection of local anesthetic (approximately 2 mL) to confirm placement. Needle orientation is lateral to medial. SP = spinous process; F = facet joint; LA = local anesthetic; N = needle (arrow immediately below needle showing trajectory); TP = transverse process. b Ultrasound image after injection of local anesthetic (20 mL) and after needle removal. This image is at the level of injection, showing hydrodissection. SP = spinous process; F = facet joint; TP = transverse process; M = multifidus muscle; LA = local anesthetic; L = longissimus muscle

The area of the loss of posterior thoracolumbar sensation to pinprick was assessed at five and 20 min after TLIP administration. The assessment was initiated at the mid-axillary line at the level of injection. Pinprick was assessed in the posteromedial direction until loss of pain was reported, and the assessment continued to the midline to evaluate for non-continuous anesthesia. The inferior and then superior borders (starting from the level of injection) were then assessed, before assessing the contralateral side of the back. Areas with loss of discrimination were designated with a marker and a photograph of each participant was taken with a Canon PowerShot SX400 camera (Canon USA, Melville, NY, USA) after bilateral assessment with centimetre rulers placed perpendicularly (X and Y axes) for subsequent measurement and mapping. The location of the injection was marked to provide reference for the distribution of anesthesia. All injections were performed by two of the authors (E.B. and J.T.).

Statistical analysis

Descriptive statistics of the volunteer population (age, height, body mass index [BMI]) as well as creation of the contour plots were conducted in SAS® v.9.3 (SAS Institute, Cary NC, USA). The colour palette was customized by the authors for visual discrimination.

Results

All ten participants underwent complete injections without complications, adverse events, or perturbations in their vital signs. Nine of the participants were male; the mean (SD) age of the participants was 35.4 (3.3) yr ranging from 27-42 yr, and the mean (SD) height was 178 (9.7) cm ranging from 157-198 cm, which was relevant as the extent of the block was reported in centimetres rather than in dermatomes. The mean (SD) BMI in the volunteers was 25.3 (3.4) $kg \cdot m^{-2}$.

All volunteers described areas of anesthesia demarcated by areas of retained sensation. Figs. 4a and 4b are contour plots showing the number of patients who reported loss of sensation to pinprick at five and 20 min, respectively, at each X-Y coordinate, with a rendering of superimposed vertebrae for visual reference. Five minutes after injection, the participants reported anesthesia to pinprick in a mean (SD) area covering 137.4 (71.0) cm^2 of their lower back. After 20 min, this mean (SD) area increased to 217.0 (84.7) cm^2. The mean (SD) cephalic spread from the injection site was 6.5 (1.8) cm; caudal spread averaged 3.9 (1.2) cm. All volunteers reported anesthesia to pinprick covering the midline at the level of injection.

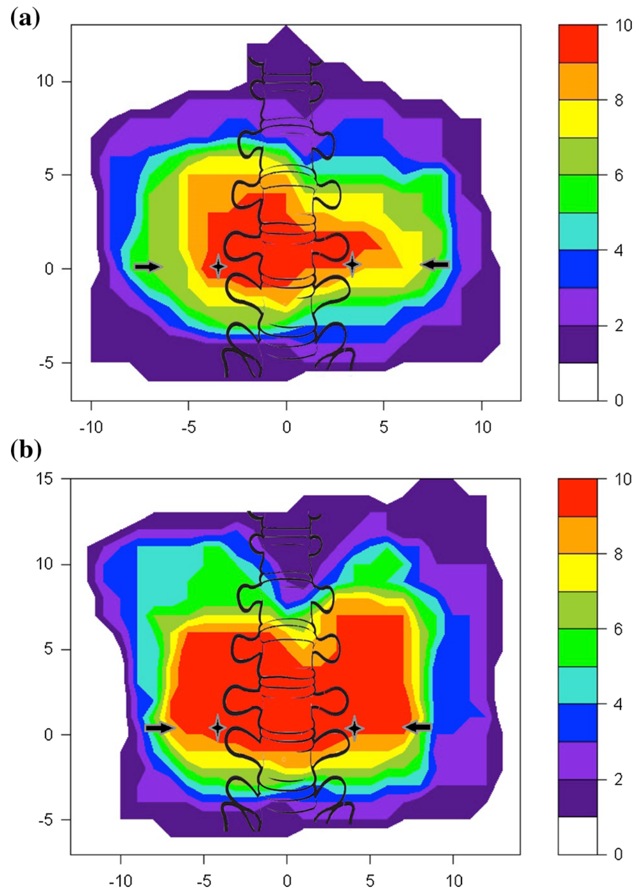


Fig. 4 a Contour plot showing the number of participants endorsing anesthesia after five minutes. The scale (0-10) on the right shows the number of participants who could discriminate to pinprick. The image of the vertebral column is schematic and meant to serve only as visual reference as there may be considerable variance due to participant height. The stars designate the average lateral location of needle insertion; the arrows approximate the orientation of the needle. b A similar contour plot showing the number of participants reporting anesthesia after 20 min

Discussion

This report describes the novel TLIP block that could potentially be an approach for providing anesthesia to the lower back. As seen in Figs. 4a and 4b, the TLIP injection achieved a reproducible area of anesthesia in the volunteer population. While the area anesthetized is not a simple paraspinal rectangle, at both five and 20 min following injection of the local anesthetic, all participants could not discriminate pain and touch at midline at the level of the injection(s). At 20 min, participants reported an average (SD) cephalic spread of anesthesia of 6.5 (1.8) cm, specifically at midline. Midline coverage is emphasized because the impetus for this investigation is a possible clinical application at a single level or minimally invasive lumbar spine surgery. Fig. 2 shows a predictable area of anesthesia following the TLIP injection.

Technical progress continues to be made in minimizing the tissue damage caused during surgery, which allows patients to be candidates for rehabilitation and to be discharged more quickly after surgery.[15,16] Further optimization of care may be possible by using the novel TLIP injection to provide focused regional anesthesia to limit postoperative complications associated with pain and opioid analgesia. In future, the authors expect to study the use of TLIP as the regional anesthesia component of an enhanced surgical recovery protocol for selected patients having single-level lumbar spine surgery.[13,17]

The participants routinely reported cephalolateral spread of anesthesia after 20 min, as seen in Fig. 4b. This pattern may have occurred due to the orientation of the MF/LG groove. In our view, the extension of analgesia outside the level of injection further differentiates this injection from simple field infiltration.

This study was not designed to examine the duration of anesthesia, but it seems reasonable to assume that a shorter or longer duration could be achieved by choice of local anesthetic and the adjuncts injected. Systemic absorption is likely but was not measured in this study. The potential impact of systemic toxicity as well as duration of block will require further study. Furthermore, clinical studies may also be warranted to compare single injection *vs* infusion in terms of duration of perioperative pain control.

This is a pilot study and therefore has considerable limitations before advocating widespread use of this technique. First, all participants who volunteered for this study were younger than 50 yr, whereas back surgery is most common in patients at least 60 yr old.[18] The ability to discriminate between muscle bodies may prove more difficult with aging due to relative atrophy or anatomic changes of the spine itself. Furthermore, no participant had prior surgery in the lumbar spine, so we cannot comment on the efficacy of this technique in patients who have had prior back surgery. Additionally, the ability to discriminate cutaneous pinprick does not necessarily predict loss of sensation to the underlying musculature; therefore, a clinical evaluation with patients undergoing surgery is warranted. Additional validation of this technique with cadaveric injection studies may also be informative.

The thoracolumbar interfascial plane injection consistently provided anesthesia to the midline in all participants in this proof-of-concept pilot study. Further clinical research is needed to optimize volume, concentration, and type of local anesthetic administered. Indeed, we anticipate subsequent prospective research to quantify the effect of TLIP *vs* surgical "field" infiltration for lumbar surgery in terms of duration of analgesia and postoperative opioid consumption. We speculate that the TLIP block may be able to offer reliable pain control for patients having single-level or minimally invasive back surgery and decrease perioperative morbidity.

Funding All funding for this study was provided internally by the Department of Anesthesiology and Perioperative Medicine.

Conflicts of interest None of the authors have any conflicts of interest with the procedure, drugs, or devices utilized during this research.

References

1. *McGirt MJ, Ambrossi GL, Datoo G, et al.* Recurrent disc herniation and long-term back pain after primary lumbar discectomy: review of outcomes reported for limited versus aggressive disc removal. Neurosurgery 2009; 64: 338-44; discussion 344-5.
2. *Humble SR*, *Dalton AJ*, *Li L*. A systematic review of therapeutic interventions to reduce acute and chronic post-surgical pain after amputation, thoracotomy or mastectomy. Eur J Pain 2014; 19: 451-65.
3. *Andreae MH*, *Andreae DA*. Regional anaesthesia to prevent chronic pain after surgery: a Cochrane systematic review and meta-analysis. Br J Anaesth 2013; 111: 711-20.
4. *Tan M*, *Law LS*, *Gan TJ*. Optimizing pain management to facilitate Enhanced Recovery After Surgery pathways. Can J Anesth 2015; 62: 203-18.
5. *Nygren J*, *Thacker J*, *Carli F*, *et al*. Guidelines for perioperative care in elective rectal/pelvic surgery: Enhanced Recovery After Surgery (ERAS((R))) Society recommendations. World J Surg 2013; 37: 285-305.
6. *Bianchini C*, *Pelucchi S*, *Pastore A*, *Feo CV*, *Ciorba A*. Enhanced recovery after surgery (ERAS) strategies: possible advantages also for head and neck surgery patients? Eur Arch Otorhinolaryngol 2014; 271: 439-43.
7. *Elkassabany N*, *Ahmed M*, *Malkowicz SB*, *Heitjan DF*, *Isserman JA*, *Ochroch EA*. Comparison between the analgesic efficacy of transversus abdominis plane (TAP) block and placebo in open retropubic radical prostatectomy: a prospective, randomized, double-blinded study. J Clin Anesth 2013; 25: 459-65.
8. *McDonnell JG*, *O'Donnell BD*, *Farrell T*, *et al*. Transversus abdominis plane block: a cadaveric and radiological evaluation. Reg Anesth Pain Med 2007; 32: 399-404.
9. *Abdallah FW*, *Laffey JG*, *Halpern SH*, *Brull R*. Duration of analgesic effectiveness after the posterior and lateral transversus abdominis plane block techniques for transverse lower abdominal incisions: a meta-analysis. Br J Anaesth 2013; 111: 721-35.
10. *Bhattacharjee S*, *Ray M*, *Ghose T*, *Maitra S*, *Layek A*. Analgesic efficacy of transversus abdominis plane block in providing effective perioperative analgesia in patients undergoing total abdominal hysterectomy: a randomized controlled trial. J Anaesthesiol Clin Pharmacol 2014; 30: 391-6.
11. *De Oliveira GS*, *Jr Fitzgerald PC*, *Marcus RJ*, *Ahmad S*, *McCarthy RJ*. A dose-ranging study of the effect of transversus abdominis block on postoperative quality of recovery and analgesia after outpatient laparoscopy. Anesth Analg 2011; 113: 1218-25.
12. *Zhao X*, *Tong Y*, *Ren H*, *et al*. Transversus abdominis plane block for postoperative analgesia after laparoscopic surgery: a systematic review and meta-analysis. Int J Clin Exp Med 2014; 7: 2966-75.
13. *Kehlet H*, *Holte K*. Effect of postoperative analgesia on surgical outcome. Br J Anaesth 2001; 87: 62-72.
14. *Gurbet A*, *Bekar A*, *Bilgin H*, *Ozdemir N*, *Kuytu T*. Preemptive wound infiltration in lumbar laminectomy for postoperative pain: comparison of bupivacaine and levobupivacaine. Turk Neurosurg 2014; 24: 48-53.
15. *Spetzger U*, *Von Schilling A*, *Winkler G*, *Wahrburg J*, *Konig A*. The past, present and future of minimally invasive spine surgery: a review and speculative outlook. Minim Invasive Ther Allied Technol 2013; 22: 227-41.
16. *Roser F*, *Tatagiba M*, *Maier G*. Spinal robotics: current applications and future perspectives. Neurosurgery 2013; 72(Suppl 1): 12-8.
17. *Fleege C*, *Almajali A*, *Rauschmann M*, *Rickert M*. Improve of surgical outcomes in spinal fusion surgery: evidence based peri- and intra-operative aspects to reduce complications and earlier recovery (German). Der Orthopade 2014; 43: 1070-8.
18. *Kanaan SF*, *Waitman RL*, *Yeh HW*, *Arnold PM*, *Burton DC*, *Sharma NK*. Structural equation model analysis of the length-of-hospital stay following lumbar spine surgery. Spine J 2015; 15: 612-21.