Ultrasound-guided thoracic paravertebral block for percutaneous kyphoplasty: A prospective non-randomized comparative study

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Research article

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Abstract

Introduction Kyphoplasty for osteoporotic vertebral compression fractures was short but painful. The purpose of the current study was to investigate the effects and safety of ultrasound-guided thoracic paravertebral block in patients undergoing percutaneous kyphoplasty (PKP).

Methods A prospective study of 195 patients with thoracic compression fracture undergoing PKP was conducted. The patients were non-randomly assigned to receive an ultrasound-guided thoracic paravertebral block (Group P, n=96) and local infiltration anesthesia (Group L, n=99), and were compared along with intraoperative parameters and anesthetic effects. Visual analog scale (VAS) of pain, systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) were measured at pre-anesthesia (T0), post-anesthesia (T1), trocar insertion (T2), balloon dilatation (T3), cement injection (T4) and post-operation (T5).

Results The anesthesia time was significantly longer in group P than in group L. There were no significant differences in the epidemiological data, operation time, blood loss, hospitalization time complications and costs between the two groups. The additional analgesics rate was significantly lower in group P than in group L. The investigators' satisfaction scores, patients' anesthesia satisfaction scores and intention rate of re-administration anesthesia were significantly higher in group P than in group L. Intraoperative VAS score (T1-T4) was significantly lower in group P than in group L. There was no significant difference in VAS scores (T0 and T5), SBP, DBP and HR between these two groups.

Conclusion Ultrasound - guided thoracic paravertebral block achieved more effective analgesia in comparison to local infiltration groups in patients undergoing percutaneous kyphoplasty.

Introduction

With the aging of the population, annual incidence of osteoporosis and its associated fractures is prevalent. Osteoporotic vertebral compression fracture (OVCF) can affect a patient's quality of life, which have become an important health issue[1]. Many patients with OVCF have recently undergone percutaneous kyphoplasty (PKP) with good clinical and radiological results[2].

The procedure of PKP is short but painful especially during trocar insertion, balloon dilatation and cement injection. Different anesthetic techniques have been proposed to control pain during kyphoplasty, but all have limitations. General anesthesia adds its own risks for elderly patients and prevents clinical assessment of bone cement leakage during the procedure[3]. Although monitored sedative analgesia is a safe and feasible method for PKP, which can be hazardous, especially with the patient in the prone position, as conventional systemic opioid administration entails the potential risk of respiratory depression[4]. Local anaesthesia for PKP is effective, well tolerated and easy to use. However, some patients with local anesthesia have severe pain and restlessness during surgery and cannot cooperate with the doctor to complete the operation[5]. Thoracic epidural block has a high failure rate and the risk of severe complications such as epidural abscess and spinal hematoma[6].

Thoracic paravertebral block (TPVB) has been studied as a possible alternative to provide high quality analgesia and great advantages for many types of surgery[7-10]. Meanwhile, perioperative pain of PKP is also dominated by these nerves passing through the thoracic paravertebral space. Thus, TPVB may be effective for PKP. However, no study has evaluated the TPVB for PKP in patients with OVCF. Therefore, the aim of our present study was to investigate the clinical effect and safety of the ultrasound-guided thoracic paravertebral block (USG-TPVB) for PKP in patients undergoing OVCF.

Materials And Methods

Study design

Ethical approval for this prospective, non-randomized study was provided by the Ethics Committee of the authors' institute. Patients were given sufficient explanation of the study goals and signed a consent form. Inclusion criteria were as follows: 1) elderly (>60 years), 2) MR confirmed fresh single-segment compression fracture between T8 to T12, 3) minor injury or no history of trauma without neurological deficit, 4) the constant ache and fatigue in thoracic vertebrae that can significantly affect daily life, 5) being diagnosed with osteoporosis according to T value of bone density test less than -2.5 using dual-energy x-ray absorptiometry(DXA). The excluding criteria were as follows: 1) symptoms of neurological deficits, 2) clinical or imaging evidence of metastatic bone tumor or multiple myeloma, 3) asymptomatic fractures, 4) systemic or local infections and severe bleeding disorders.

From January 2015 to August 2017, 290 consecutive patients received PKP for thoracic OVCF. Following a comprehensive explanation of this study and expected benefits and risks, fifty four patients refused to consent to the study. After applying exclusion criteria, we analyzed 195 patients received USG-TPVB (group P, n = 96) and local infiltration anesthesia (group L, n = 99). The differences between local infiltration anesthesia and USG-TPVB were explained to all patients before surgery, and the anesthetic methods were selected according to patient preference. The clinical characteristics of the 195 patients were summarized in Table 1.

Preoperatively, standard clinical examination and evaluation including the medical history, physical examination of percussion pain, and assessment of pain intensity [visual pain analogue scale (VAS)] were performed. Additionally, X-rays of the relevant spinal region in two planes, computed tomography (CT) scan and magnetic resonance imaging (MRI) (T1w and T2w sequences including fat suppression sequences) and bone density measurement (DXA) were carried out.

Anesthesia procedures

Standard electrocardiogram, non-invasive blood pressure and pulse oximetric oxygen saturation (SpO_2) monitorization processes were performed for all patients. Each patient had brief preoperative teaching to rate their pain on the VAS scale (VAS of 0 as no pain and 10 as maximal pain). Furthermore the patients were also notified that they could receive additional analgesia in a severe pain event. TPVB and local anesthesia were performed by two experienced attending anesthesiologists.

In group P, after placing the patient in the prone position, the attending anesthesiologist discerned the puncture site using a linear 2- to 5-MHz ultrasound scanning probe (SonoSite S-Nerve, Bothell, Wash), which were placed parallel to the rib. The transverse process, transverse ligament of rib and pleura was carefully distinguished on the ultrasound image (Fig. 1). Needle insertion point was confirmed at approximately 40 mm from the midline by ultrasound. After local anesthesia with 1% lidocaine 5 ml, an 8-cm, 18-gauge needle (Peridural Catheter set; B. Braun, Melsungen, Germany) was inserted from lateral to medial under real-time ultrasound monitoring using an in-plane technique. Keep the needle body in the ultrasonic field of view and guide the needle tip along the intercostal approach into the thoracic paravertebral space. After a negative aspiration test for blood, cerebrospinal fluid, or air, 10 ml of 0.5% ropivacaine was injected into the thoracic paravertebral space slowly. The pleura was seen being pressed ventrally during local anesthetic injection. We performed single blocks with 10 ml of 0.5% ropivacaine at the fracture vertebra. An independent observer tested the block by loss of pain sensation in the sensory distribution of the ipsilateral and contralateral vertebral dermatomes 10 mins after block performance. An additional local infiltration anesthesia in the form of 10 mL of 0.5% ropivacaine hydrochloride was required preoperatively when failed USG-TPVB.

Group L was treated with local infiltration anesthesia. The patient was in a prone position. The puncture target point was located by the C-arm X-ray. 5 mL of 1% lidocaine hydrochloride was used to infiltrate the skin, subcutaneous tissue, and part of the thoracic muscles. 10 mL of 0.5% ropivacaine hydrochloride was injected around the pedicular insertion point.

VAS score more than four indicated an inadequate block. An additional analgesia in the form of dexmedetomidine intravenous injection 0.05mg was required until the VAS for pain score was four or less.

Surgical procedures

All operations were carried out by the same surgical team using the same technique. The manual lordotic manoeuvre was first performed to correct kyphosis. A 1cm skin incision was made laterally to the desired entry point of the pedicle percutaneously. A trocar (Shandong Guanlong Medicial utensils Co., Ltd., Jinan City, Shandong Province, China) in a cannula was inserted into pedicle at the fractured vertebra through a unipedicular approach as a working channel. After removing the trocar, a balloon was placed into the working channel and slowly inflated to create a low-pressure cavity for cement injection. Inflation continued until the balloon pressure up to 300 psi. Then the balloon was deflated and removed, and polymethyl methacrylate (PMMA) cement was injected into the fractured body through the cannula under continuous fluoroscopic monitoring (Fig. 2). The cement insertion was considered complete when it reached the posterior third of the vertebral body or had a potential tendency of cortical, epidural, and anterior venous cement leakage.

Outcome assessment

Operation time, anesthesia time (the beginning of anesthesia to the start of surgery), blood loss, hospitalization time, and cost were calculated. VAS, systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) were recorded by independent assessors at every step during the procedure(i.e., T0, preanesthesia, T1, postanesthesia, T2, trocar insertion, T3, balloon dilatation, T4, cement injection and T5, postoperation). Complications, such as hemothorax, atelectasis, pneumonia, pneumothorax, epidural injection, spinal anesthesia, Horner syndrome, urinary retention, nausea/vomiting were recorded by independent assessors. Investigators' satisfaction scores (0;extensive movement and complaints, several interruptions; 1, movements, two interruptions; 2, small movements, no interruptions; 3, no movements, no interruptions) , patients' anesthesia satisfaction scores (1, very dissatisfied; 2, not satisfied; 3, general; 4, satisfied; 5, very satisfied), additional analgesia rate, and intention rate of re-administration anesthesia(whether patients willing undergo the analgesia procedure again) were also collected after the procedures by two independent blinded anesthesiologists and one independent blinded orthopedist.

Statistical analysis

Statistical analysis was performed using the SPSS18.0 software(SPSS Inc., Chicago, Illinois, USA). Numeric variables were presented as means ± standard deviation (SD) or median (25th–75th percentile). Student *t* or Wilcoxon signed rank tests were used to compare measurements between the two groups. Repeated measures variance analysis was used to compare measurements of HR, DP and SBP from T0 to T5. Nominal variables (sex, fracture distribution, additional analgesia rate, and intention rate of re-administration anesthesia) were presented as number (percent) and compared by means of the Chi-square test. A two-sided p value of <0.05 was considered to show a statistically significant difference.

Results

No significant between-group differences were detected in the patients' sex, age, the distribution of fracture, T-score, height, weight, injury time operation time, blood loss, hospitalization time and cost (Table 1). The anesthesia time was significantly longer in group P than in group L (23.73±4.20 min vs. 6.31±2.14 min, $P<0.05$) (Table 1). There was no failed block or need for additional local infiltration anesthesia in this study.

There was no significant difference in pain VAS scores (T0 and T5) between two groups (Tables 2). Intraoperation pain VAS score (T1-T4) was significantly lower in group P than in group L [2 (1-3) vs. 3 (2-4), 2 (2-3) vs. 4 (2-4), 2 (2-3) vs. 5 (3-5), 3 (2-3) vs. 5 (3-5), $P<0.05$] (Tables 2). Six patients in group P, and 23 patients in group L required additional analgesics in the form of dexmedetomidine intravenous injection 0.05mg. The additional analgesics rate was significantly lower in group P than in group L (6.25% vs. 23.23%, $P<0.05$) (Tables 2). The investigators' satisfaction scores and patients' anesthesia satisfaction scores were significantly higher in group P than in group L [4 (3-5) vs. 3(2-4), $P<0.05$; 2 (2-3) vs. 2 (1-3), $P<0.05$]. Eighty-seven patients in group P, and 69 patients in group L were willing to choose

their anesthesia method again. The intention rate of re-administration anesthesia was significantly higher in group P than in group L (90.63% vs. 69.70%, $P<0.05$) (Tables 2). There was no significant difference in average SBP, DBP and HR between two groups (Fig. 3a, b, c; Table 3). Urinary retention was observed in 2.08%(2/96) cases of group P and 1.01% (1/99) of group L, respectively. Nausea/vomiting was observed in 3.13%(3/96) cases of group P and 4.04% (4/99) of group L, respectively. There was no significant difference in urinary retention and nausea/vomiting between two groups. In both groups, patients with urinary retention were treated with catheterization for less than one week. Complications, such as atelectasis, pneumonia, pneumothorax, hemothorax, epidural injection, spinal anesthesia, Horner syndrome were not observed in both groups.

Discussion

This study showed that ultrasound-guided thoracic paravertebral block provided more effective analgesia in comparison to the local infiltration anesthesia in patients underwent PKP.

Osteoporosis is a progressive, systemic disease and the most common cause of vertebral fractures. OVCF can cause debilitating back pain, functional decline, depression, disability in elderly populations[1]. Minimally invasive augmentation techniques such as PKP have become prominent in OVCF treatments[2, 11, 12]. However, the issue of pain during this period has not yet been completely solved.

The anesthetic method for PKP usually includes local anesthesia, sedative analgesia, and general anesthesia. Although general anaesthesia for PKP provides has been proven to be effective, elderly patients may increase the risk of anaesthesia-related cardiopulmonary complications. In addition, intraoperative neurological symptoms may not be discovered in a timely manner[3, 13]. Sedative analgesia with opioids and benzodiazepines, which controls the patient’s anxiety and pain without the need for an intervention to maintain respiratory and cardiac function, may be appropriate for elderly patients with increased general anaesthesia risk. However, the use of sedatives in elderly patients in the prone position may carry the potential for opioid-induced respiratory depression[4, 14]. Although subarachnoid and thoracic epidural anesthesia may be effective for PKP, these anesthesia methods are often associated with a high failure rate and complications such as epidural hematoma, infection, hypotension and urinary retention[3, 15]. Local anesthesia can keep patients awake during operation. Surgeons discover neurological symptoms in time to avoid nerve damage. Furthermore, the use of local anesthesia avoids the potential complications of sedative and general anesthesia. However, the local anesthetic often results in a painful response, discomfort, anxiety and agitation, and not be well coordinated with the doctor to complete the operation[5, 16, 17]. Therefore, it’s necessary to find an alternative anesthesia method for these patients undergoing PKP. However, the method for determining if the patient would receive paravertebral blocks or local anesthesia infiltration preoperative is still controversial. Several studies proposed to predict the amount of postoperative analgesics in patients by measuring the sensitivity of preoperative patients to pain, anxiety, pain threshold, pain tolanrance threshold[18-21]. Thus, studies on the indication of paravertebral blocks and local infiltration anesthesia for PKP will be included in our future work.

Thoracic paravertebral space is a wedge-shaped region on both sides of the vertebrae. Each thoracic paravertebral space contains adipose tissue, spinal nerves (intercostal nerves), dorsal branches of the spinal nerves, abdominal branches of the spinal nerves, traffic branches, sympathetic trunks, and intercostal vessels[22]. Therefore, injection of a local anesthetic into the gap can block the sensory nerve, motor nerve, and sympathetic nerves passing through the gap, thereby achieving anesthesia effect[23]. The wedge-shaped bottom of the thoracic paravertebral space is filled with loose connective tissue. Local anesthetics can spread superior and inferior along this gap (Fig. 4). So, a single dose of local anesthetic can receive multiple segments of anesthesia[24] [25]. TPVB has been studied as a possible alternative to provide high quality analgesia and great advantages in breast surgery, thoracic and upper abdominal surgery, thoracic myofascial pain syndrome, pain caused by cervical spondylosis, zoster-associated pain, etc[7-10]. Meanwhile, perioperative pain of PKP is also dominated by these nerves passing through the thoracic paravertebral space. Therefore, we applied thoracic paravertebral nerve block for PKP.

According to the results of this study, intraoperative pain tolerance and satisfaction of patients with thoracic paravertebral nerve block were significantly better than the local anesthesia group.

Although there are no studies in the literature which compared paravertebral block and local infiltration in PKP, there are studies which compared paravertebral block and local infiltration in breast surgery, thorax surgery, mastectomy, percutaneous nephrolithotomy and laparoscopic cholecystectomy[26-31]. A study reported the effectiveness of TPVB in reducing postoperative opioid consumption, pain score, and opioid-related side effects[26, 29, 31]. However, some studies showed that TPVB did not have any advantages over wound side infiltration[27, 28, 30]. In our study, dynamic VAS scores and additional analgesia rate in group P were lower than those in group L.

Numerous techniques were applied for TPVB in the literature. Landmark technique (loss of resistance technique) has a high failure rate and complications[32]. Although Nerve stimulator-guided technique can improve the failure rate, the incidence of nerve injury was high when the effectiveness of neurostimulation is affected[33, 34]. Several authors also recommend implementations accompanied by ultrasound to reduce the risk of complications[7, 8, 35, 36]. Compared with the X-ray, ultrasound can reduce the radiation damage of both doctors and patients. At the same time, ultrasound can be dynamically multi-planar and multi-angle observation, and the doctor can be instructed to adjust the puncture path in time during the puncture process to reach a satisfactory puncture point. The pleura, lungs, blood vessels and other tissues can be clearly distinguished by ultrasound to choose the appropriate puncture path and avoid the iatrogenic injury during the puncture.

Of course, ultrasound-guided thoracic paravertebral nerve block has puncture failure, pleural, pulmonary, vascular and nerve injury complications[37-40]. The most important way to improve the safety of the puncture is to use "in-plane technology" to see the entire needle and the needle tip to prevent iatrogenic injury[41]. It is also possible to gently twitch the needle under ultrasound monitoring and observe the movement of the needle to confirm the position of the needle. When the needle reaches the target point, a

small amount of local anesthetic can be injected to observe the diffusion of the liquid to confirm the position of the needle tip. When the local anesthetic was injected, the weak echo group can be formed on the outside of the pleura under ultrasound to push down the pleura[41]. Due to limited range of thoracic paraspinal nerve block, sympathetic nerve suppression is mild. Furthermore, the incidence of complications such as oxygen desaturation, respiratory depression, hypotension, hypertension, bradycardia, tachycardia were low. In this study, we applied TPVB with USG by achieving real-time imaging, and we did not encounter any complications such as atelectasis, pneumonia, pneumothorax, hemothorax, epidural injection, spinal anesthesia, Horner syndrome.

In conclusion, ultrasound guided thoracic paravertebral nerve block achieved more effective analgesia by reducing intraoperative pain VAS scores and opioid consumption in comparison to local infiltration analgesia for patients undergoing percutaneous kyphoplasty.

Abbreviations

PKP: Percutaneous kyphoplasty; VAS: Visual pain analogue scale; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; HR: Heart rate; OVCF: Osteoporotic vertebral compression fractures; DXA: Dual-energy x-ray absorptiometry; CT: Computed Tomography; MRI: Magnetic resonance imaging; TPVB: Thoracic paravertebral block; USG-TPVB: Ultrasound-guided thoracic paravertebral block; SpO_2: pulse oximetric oxygen saturation; PMMA: Polymethylmethacrylate.

Declarations

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Availability of data and materials

The patients’ data were collected in the Third affiliated Hospital of Wenzhou Medical University.

Authors’ contributions

CXT, MXP, and SQH designed the study. SQH, XJT, and WHZ collected the data. SQH, MHD, and XJT were involved in the manuscript writing, literature search, data interpretation, and data monitoring. CXT was responsible for the data collection and analysis. All authors read and approved the final manuscript.

Ethics approval and consent to participate

This study was conducted with approval from the Ethics Committee of the Third affiliated Hospital of Wenzhou Medical University. Written informed consent to participate was obtained from all participants.

Consent for publication

We have obtained consent to publish from the participants.

Competing interests

We confirm that we have read BioMed Central's guidance on competing interests. The authors declare that they have no competing interests.

References

[1] Fehlings MG, Tetreault L, Nater A, et al. The Aging of the Global Population: The Changing Epidemiology of Disease and Spinal Disorders. Neurosurgery. 2015. 77 Suppl 4: S1-5.

[2] Comstock BA, Sitlani CM, Jarvik JG, Heagerty PJ, Turner JA, Kallmes DF. Investigational vertebroplasty safety and efficacy trial (INVEST): patient-reported outcomes through 1 year. Radiology. 2013. 269(1): 224-31.

[3] Apan A, Cuvaş AÖ, Köse EA. Segmental epidural anesthesia for percutaneous kyphoplasty:comparison with general anesthesia. Turk J Med Sci. 2016. 46(6): 1801-1807.

[4] Mohr M, Pillich D, Kirsch M, et al. Percutaneous balloon kyphoplasty with the patient under intravenous analgesia and sedation: a feasibility study. AJNR Am J Neuroradiol. 2011. 32(4): 649-53.

[5] Bonnard E, Foti P, Kastler A, Amoretti N. Percutaneous vertebroplasty under local anaesthesia: feasibility regarding patients' experience. Eur Radiol. 2017. 27(4): 1512-1516.

[6] Dango S, Harris S, Offner K, et al. Combined paravertebral and intrathecal vs thoracic epidural analgesia for post-thoracotomy pain relief. Br J Anaesth. 2013. 110(3): 443-9.

[7] Agnoletti V, Gurioli C, Piraccini E, et al. Efficacy and safety of thoracic paravertebral block for medical thoracoscopy. Br J Anaesth. 2011. 106(6): 916-7.

[8] Hara K, Sakura S, Nomura T, Saito Y. Ultrasound guided thoracic paravertebral block in breast surgery. Anaesthesia. 2009. 64(2): 223-5.

[9] Santonastaso DP, de Chiara A, Piccioni F, Tognù A, Agnoletti V. Awake mastectomy under ultrasound guided thoracic paravertebral block in elderly patients. J Clin Anesth. 2018. 47: 50-51.

[10] Yenidünya O, Bircan HY, Altun D, Caymaz I, Demirag A, Turkoz A. Anesthesia management with ultrasound-guided thoracic paravertebral block for donor nephrectomy: A prospective randomized study. J Clin Anesth. 2017. 37: 1-6.

[11] Masala S, Magrini A, Taglieri A, et al. Chronic obstructive pulmonary disease (COPD) patients with osteoporotic vertebral compression fractures (OVCFs): improvement of pulmonary function after percutaneous vertebroplasty (VTP). Eur Radiol. 2014. 24(7): 1577-85.

[12] Burton AW, Mendoza T, Gebhardt R, et al. Vertebral compression fracture treatment with vertebroplasty and kyphoplasty: experience in 407 patients with 1,156 fractures in a tertiary cancer center. Pain Med. 2011. 12(12): 1750-7.

[13] Fortier S, Hanna HA, Bernard A, Girard C. Comparison between systemic analgesia, continuous wound catheter analgesia and continuous thoracic paravertebral block: a randomised, controlled trial of postthoracotomy pain management. Eur J Anaesthesiol. 2012. 29(11): 524-30.

[14] Lee JM, Lee SK, Lee SJ, Hwang WS, Jang SW, Park EY. Comparison of remifentanil with dexmedetomidine for monitored anaesthesia care in elderly patients during vertebroplasty and kyphoplasty. J Int Med Res. 2016. 44(2): 307-16.

[15] Souvatzis X, Katonis PG, Licoudis SA, Marouli DG, Askitopoulou H. Case report: subarachnoid anesthesia for kyphoplasty: is anesthesia adequate. Anesth Analg. 2010. 111(1): 238-40.

[16] Sesay M, Dousset V, Liguoro D, Péhourcq F, Caillé JM, Maurette P. Intraosseous lidocaine provides effective analgesia for percutaneous vertebroplasty of osteoporotic fractures. Can J Anaesth. 2002. 49(2): 137-43.

[17] Liu L, Cheng S, Lu R, Zhou Q. Extrapedicular Infiltration Anesthesia as an Improved Method of Local Anesthesia for Unipedicular Percutaneous Vertebroplasty or Percutaneous Kyphoplasty. Biomed Res Int. 2016. 2016: 5086414.

[18] Hofmann UK, Dobler C, Gesicki M, Kluba T, Scheidt S. [Predictability of Postoperative Pain and Satisfaction. How Precise Are We and What Is the Role of Professional Experience?]. Z Orthop Unfall. 2017. 155(5): 592-601.

[19] Laufenberg-Feldmann R, Kappis B, Cámara R, Ferner M. Anxiety and its predictive value for pain and regular analgesic intake after lumbar disc surgery - a prospective observational longitudinal study. BMC Psychiatry. 2018. 18(1): 82.

[20] Seringec Akkececi N, Oksuz G, Urfalioğlu A, et al. Preoperative Serum Leptin Level Is Associated with Preoperative Pain Threshold and Postoperative Analgesic Consumption in Patients Undergoing Cesarean Section. Med Princ Pract. 2019. 28(4): 333-340.

[21] Orbach-Zinger S, Fireman S, Ben-Haroush A, et al. Preoperative sleep quality predicts postoperative pain after planned caesarean delivery. Eur J Pain. 2017. 21(5): 787-794.

[22] Bouman E, Sieben JM, Balthasar A, et al. Boundaries of the thoracic paravertebral space: potential risks and benefits of the thoracic paravertebral block from an anatomical perspective. Surg Radiol Anat. 2017. 39(10): 1117-1125.

[23] Taketa Y, Fujitani T. Approach affects injectate spread in ultrasound-guided thoracic paravertebral block: a cadaveric trial. Br J Anaesth. 2017. 119(2): 339-340.

[24] Uppal V, Sondekoppam RV, Sodhi P, Johnston D, Ganapathy S. Single-Injection Versus Multiple-Injection Technique of Ultrasound-Guided Paravertebral Blocks: A Randomized Controlled Study Comparing Dermatomal Spread. Reg Anesth Pain Med. 2017. 42(5): 575-581.

[25] Saran JS, Hoefnagel AL, Skinner KA, Feng C, Smith DI. Comparison of single-injection ultrasound-guided approach versus multilevel landmark-based approach for thoracic paravertebral blockade for breast tumor resection: a retrospective analysis at a tertiary care teaching institution. J Pain Res. 2017. 10: 1487-1492.

[26] Sidiropoulou T, Buonomo O, Fabbi E, et al. A prospective comparison of continuous wound infiltration with ropivacaine versus single-injection paravertebral block after modified radical mastectomy. Anesth Analg. 2008. 106(3): 997-1001, table of contents.

[27] Visoiu M, Cassara A, Yang CI. Bilateral Paravertebral Blockade (T7-10) Versus Incisional Local Anesthetic Administration for Pediatric Laparoscopic Cholecystectomy: A Prospective, Randomized Clinical Study. Anesth Analg. 2015. 120(5): 1106-13.

[28] Abdelsattar JM, Boughey JC, Fahy AS, et al. Comparative Study of Liposomal Bupivacaine Versus Paravertebral Block for Pain Control Following Mastectomy with Immediate Tissue Expander Reconstruction. Ann Surg Oncol. 2016. 23(2): 465-70.

[29] Zhang X, Shu L, Lin C, et al. Comparison Between Intraoperative Two-Space Injection Thoracic Paravertebral Block and Wound Infiltration as a Component of Multimodal Analgesia for Postoperative Pain Management After Video-Assisted Thoracoscopic Lobectomy: A Randomized Controlled Trial. J Cardiothorac Vasc Anesth. 2015. 29(6): 1550-6.

[30] Bouman EA, Theunissen M, Kessels AG, et al. Continuous paravertebral block for postoperative pain compared to general anaesthesia and wound infiltration for major oncological breast surgery. Springerplus. 2014. 3: 517.

[31] Yayik AM, Ahiskalioglu A, Demirdogen SO, Ahiskalioglu EO, Alici HA, Kursad H. Ultrasound-guided low thoracic paravertebral block versus peritubal infiltration for percutaneous nephrolithotomy: a prospective randomized study. Urolithiasis. 2018 .

[32] Ruscio L, Renard R, Lebacle C, Zetlaoui P, Benhamou D, Bessede T. Thoracic paravertebral block: comparison of different approaches and techniques. A study on 27 human cadavers. Anaesth Crit Care Pain Med. 2019 .

[33] Kaya FN, Turker G, Mogol EB, Bayraktar S. Thoracic paravertebral block for video-assisted thoracoscopic surgery: single injection versus multiple injections. J Cardiothorac Vasc Anesth. 2012. 26(1): 90-4.

[34] Lang SA. The use of a nerve stimulator for thoracic paravertebral block. Anesthesiology. 2002. 97(2): 521; author reply 521-2.

[35] Abdallah FW, Morgan PJ, Cil T, et al. Ultrasound-guided multilevel paravertebral blocks and total intravenous anesthesia improve the quality of recovery after ambulatory breast tumor resection. Anesthesiology. 2014. 120(3): 703-13.

[36] Piccioni F, Langer M, Fumagalli L, Haeusler E, Conti B, Previtali P. Thoracic paravertebral anaesthesia for awake video-assisted thoracoscopic surgery daily. Anaesthesia. 2010. 65(12): 1221-4.

[37] Pace MM, Sharma B, Anderson-Dam J, Fleischmann K, Warren L, Stefanovich P. Ultrasound-Guided Thoracic Paravertebral Blockade: A Retrospective Study of the Incidence of Complications. Anesth Analg. 2016. 122(4): 1186-91.

[38] Fagenholz PJ, Bowler GM, Carnochan FM, Walker WS. Systemic local anaesthetic toxicity from continuous thoracic paravertebral block. Br J Anaesth. 2012. 109(2): 260-2.

[39] Song L, Zhou Y, Huang D. Inadvertent posterior intercostal artery puncture and haemorrhage after ultrasound-guided thoracic paravertebral block: a case report. BMC Anesthesiol. 2018. 18(1): 196.

[40] Albi-Feldzer A, Duceau B, Nguessom W, Jayr C. A severe complication after ultrasound-guided thoracic paravertebral block for breast cancer surgery: total spinal anaesthesia: A case report. Eur J Anaesthesiol. 2016. 33(12): 949-951.

[41] Taketa Y, Fujitani T. A Novel Paralaminar In-Plane Approach for Ultrasound-Guided Continuous Thoracic Paravertebral Block Using Microconvex Array Transducer. Reg Anesth Pain Med. 2015. 40(4): 390.

Tables

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Figures

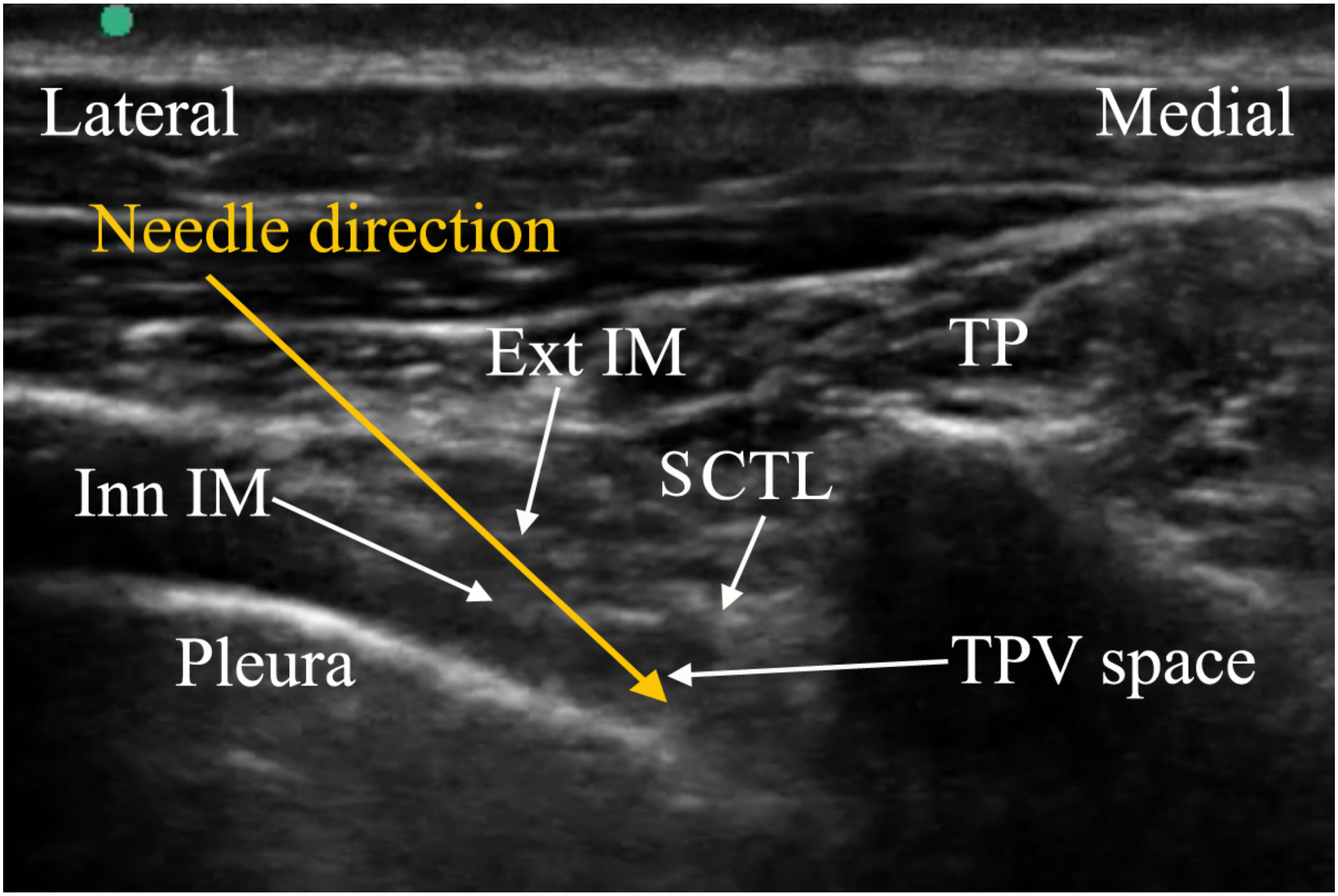

Figure 1

Ultrasound-guided injection image (paramedian view). TP transverse process, SCTL superior costotransverse ligament, TPV thoracic paravertebral, Int IM internal intercostal muscles, and Ext IM external intercostal muscles.

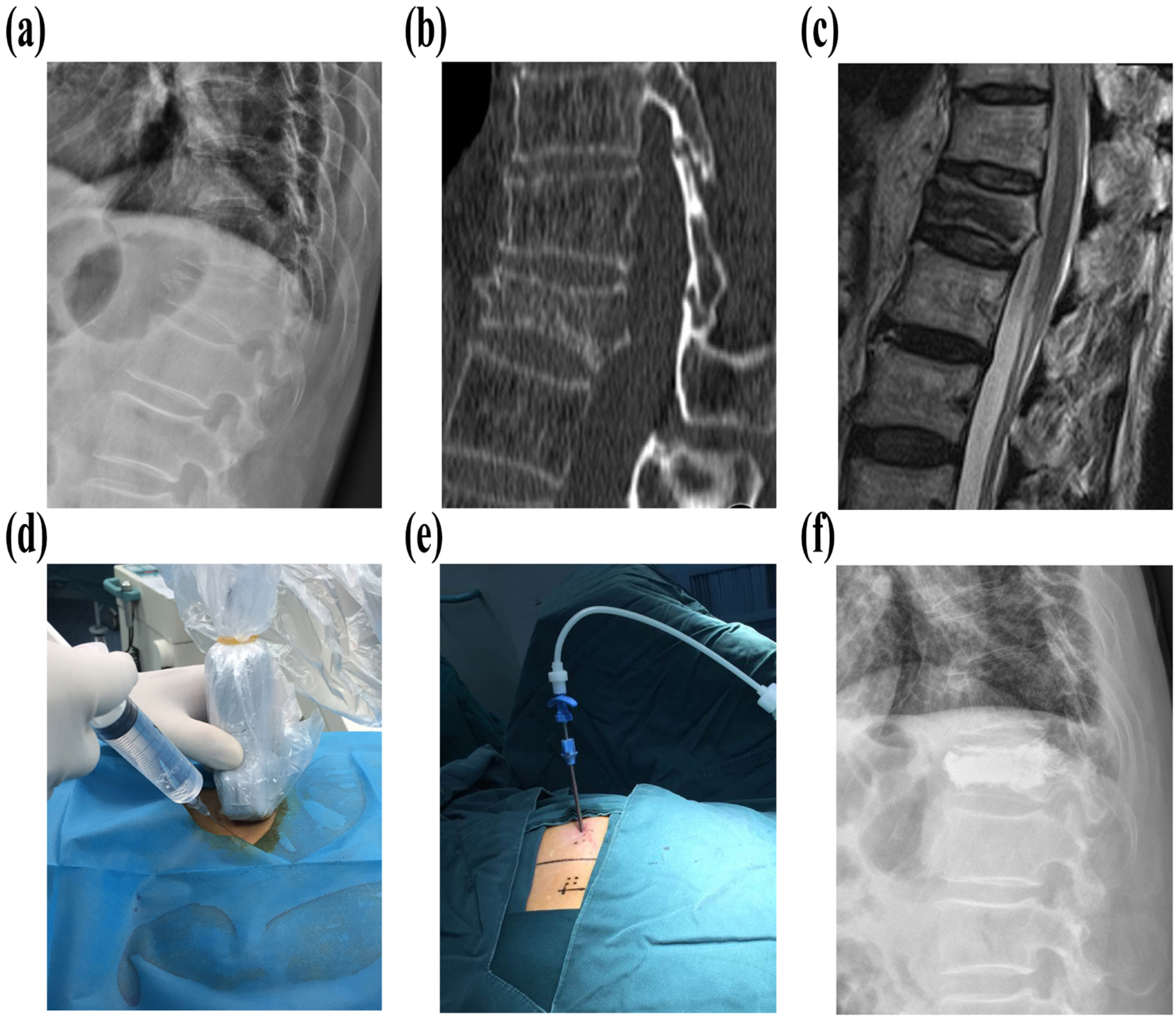

Figure 2

PKP surgical procedure for the treatment of a 70-year-old female patient with osteoporotic vertebral compression fracture at thoracic(T) 12 vertebra. (a): Lateral roentgenogram showing a osteoporotic vertebral compression fracture at T12. (b): Preoperative CT-scan (sagittal reconstruction image) of the patient showing a osteoporotic vertebral compression fracture with spinal canal encroachment. (c): MRI (T2-weighted) of the patient showing a osteoporotic vertebral compression fracture at T12 with spinal canal encroachment. (d): External (posterior) view of the patient showing ultrasound-guided thoracic paravertebral block. (e): Intraoperative view of the patient showing the PKP procedure. (f):Lateral roentgenogram two days after surgery of the patient showing better alignment following cement injection and adequate vertebral body reduction.

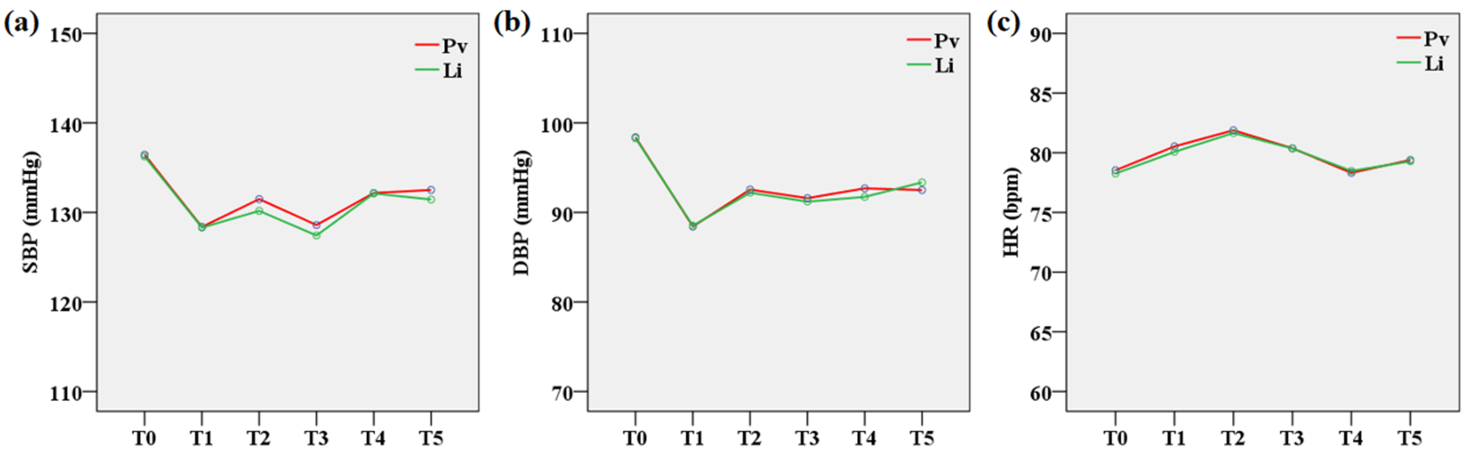

Figure 3

Time course of (a) systolic blood pressure (SBP), (b) diastolic blood pressure (DBP) and (c) heart rate (HR).

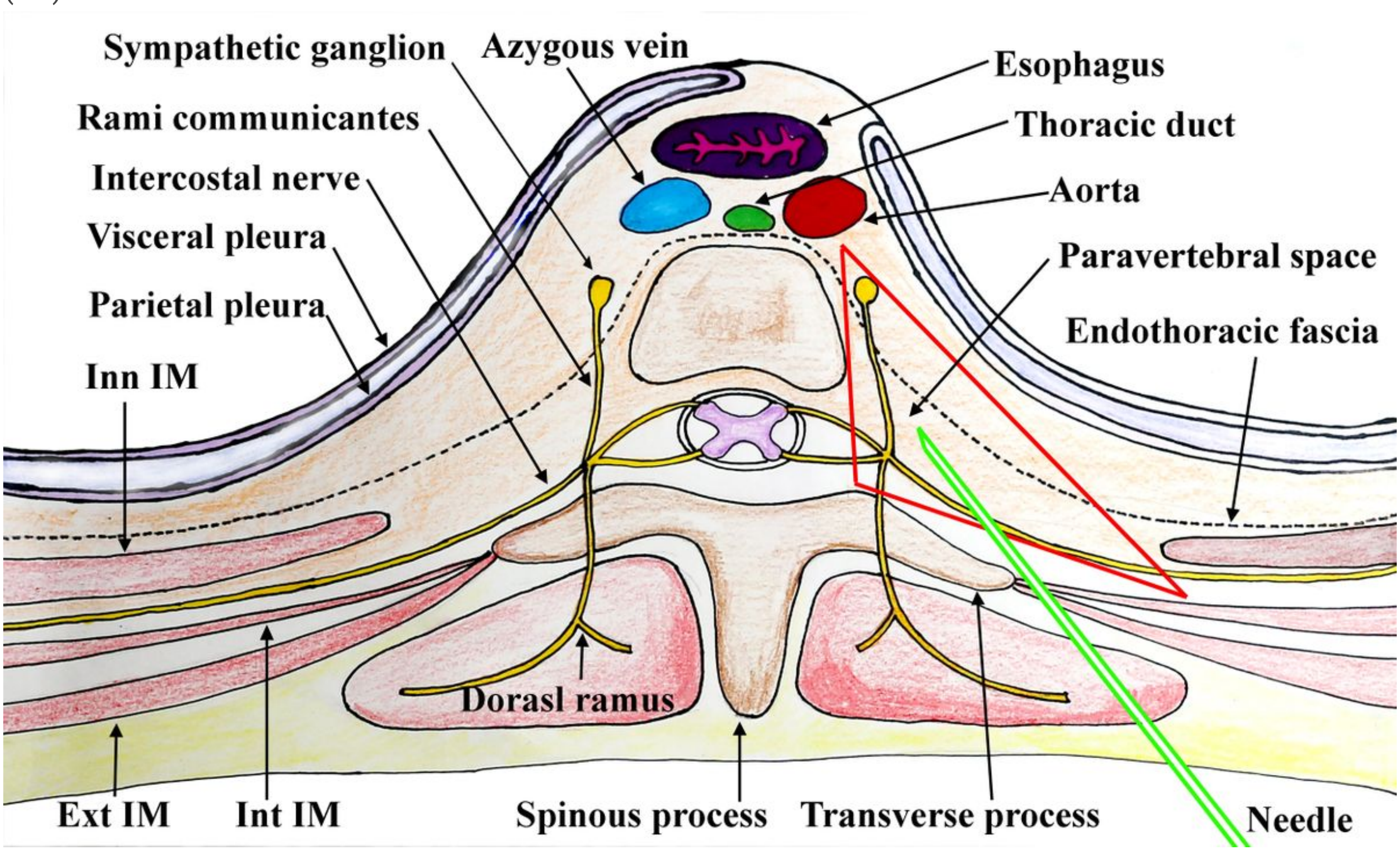

Figure 4

Schematic drawings of thoracic paravertebral space. The paravertebral space with approaching needle and surrounding vertebral body, transverse process, and spinous process. The aorta, thoracic duct,

azygous vein, and esophagus sit anteriorly and innermost (Inn IM), internal (Int IM), and external (Ext IM) intercostal muscles laterally. The red triangle area represents the paravertebral space.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- table2.doc
- TemplateESJslides2.pptx
- Table1.doc
- Table3.docx