Efficacy of laparoscopic transversus abdominis plane block for elective laparoscopic cholecystectomy in elderly patients

Deniz Tihan[1,2*], Tolga Totoz[3], Merve Tokocin[4], Gulcin Ercan[4], Tugba Koc Calikoglu[3], Talar Vartanoglu[4], Fatih Celebi[4], Ozgur Dandin[5], Ilker Mustafa Kafa[2]

[1]Department of General Surgery, Sevket Yilmaz Training and Research Hospital, Bursa, Turkey, [2]Department of Anatomy,Uludag University School of Medicine, Bursa, Turkey, [3]Department of Anesthesiology, Bagcilar Training and Research Hospital, Istanbul, Turkey, [4]Department of General Surgery, Bagcilar Training and Research Hospital, Istanbul, Turkey, [5]Department of General Surgery, Bursa Military Hospital, Bursa, Turkey

ABSTRACT

Transversus abdominis plane (TAP) block technique seems to offer one of the most efficient methods for a local pain control. Our aim is to demonstrate the effectiveness and safety of TAP block for post-operative pain control under laparoscopic vision in elderly patients during laparoscopic cholecystectomy. The patients aged more than 65 years old, who had cholecystectomy due to symptomatic cholelithiasis, were retrospectively evaluated. The patients that were operated under general anesthesia + laparoscopic TAP block and those who were operated only under only general anesthesia were compared according to their' age and gender, comorbidities, American Society of Anesthesiologists scores, visual analog scale (VAS) for pain and length of stay in the hospital. Median (±interquartile range) values of post-operative 24th-hour-VAS for pain was found consecutively 2 (±1-3) in TAP block + group and 3 (±2-5) in TAP block - group. The median post-operative 24th-hour-VAS value in overall patients was three. Patients' VAS values were higher in the TAP block – group with a statistically significant difference (p = 0.001). Furthermore, no statistically significant difference was found for other parameters in two groups. The laparoscopic-guided TAP block can easily be performed and has potential for lower visceral injury risk and shorter operational time. Efficacy, safety and other advantages (analgesic requirements, etc.) make it an ideal abdominal field block in elderly patients.

KEY WORDS: Analgesia; cholecystectomy; laparoscopy; transversus abdominis plane block
DOI: http://dx.doi.org/10.17305/bjbms.2015.841 *Bosn J Basic Med Sci. 2016;16(2):139-144. © 2016 ABMSFBIH*

INTRODUCTION

It is well-known that less post-operative pain and rapid improvement in physical activity are the most important advantages of minimally invasive surgery [1]. Nevertheless, many patients suffer from significant pain after laparoscopic abdominal surgeries [2,3]. For pain control after open or laparoscopic abdominal surgery, different local methods of anesthesia were described. So far, transversus abdominis plane (TAP) block technique which was first reported by Rafi [4], seems to offer an effective local pain control to the patients. Owen et al. [5] first described the open surgical approach for TAP block. A few years later, in 2011, pure laparoscopic TAP block was reported as a new technique [6]. Both techniques allow surgeons to apply TAP block under direct vision prior to the surgery. The anatomical compartment between the transversus abdominis muscle and abdominal oblique internus muscle was described as TAP in clinical practice [3,7]. The bolus anesthetic injection into this neurovascular fascial plane provides the anesthesiologist to block the dermatomal afferents of T7-11 intercostal nerves, T12 subcostal nerve, ilioinguinal and iliohypogastric nerves, and cutaneous branches of L1-3 nerves [8,9]. It is also known that the anatomical variations of the nerve entries and exits of the TAP are common. The inferior lumbar triangle (triangle of Petit) which is an upright triangle and contains three major layers from superficial to deep: Subcutaneous fatty tissue, the abdominis obliquus internus muscle and transversus abdominis muscle and their fascias, is located among the anterior margin of the latissimus dorsi muscle, posterior margin of the abdominis obliquus externus muscle and inferiorly the crista iliaca. Its apex is the

*Corresponding author: Deniz Tihan,
Department of General Surgery, Sevket Yilmaz Training and Research Hospital, Bursa, Turkey. Tel.: +90 536 222 44 17. Fax: +90 224 295 52 82.
E-mail: dtihan@yahoo.com

Submitted: 01 November 2015 / Accepted: 07 December 2015

major anatomic landmark of the insertion [8]. This triangular region is also known as a weak area in the posterior abdominal wall (Figure 1).

At the initial reports, the apex of the triangle of Petit was described as the "blind" insertion point of the needle [10,11]. On the other hand, recent studies propose to use an ultrasound probe for needle placement because of the potential risk for damage to adjacent structures [12-14]. Magee et al. [6] performed TAP block under direct laparoscopic vision prior to laparoscopic surgical intervention and suggested the approach as an alternative method to avoid iatrogenic injuries.

Some studies support that the pain threshold does not change with the age; however some researches are climbing the opposite and report that pain threshold increases in the elderly population [15-17]. Still, pain control in the geriatric population is much more difficult due to the comorbidities which may be influenced easily from the pain-induced metabolic and hormonal responses and pharmaceuticals.

In the study, we aimed to demonstrate the effectiveness of pain control in elderly patients after laparoscopic cholecystectomy using TAP block under direct laparoscopic vision.

MATERIALS AND METHODS

This retrospective comparative study was conducted in the Department of General Surgery and Department of Anesthesiology. Between 2007 and 2014; we retrospectively evaluated data files of patients aged more than 65 years old who had laparoscopic cholecystectomy due to symptomatic cholelithiasis in our general surgery department. Standardized four-port laparoscopic cholecystectomy was performed in all patients by experienced surgeons. The patients who had a history of acute or chronic cholecystitis, gallbladder empyema, porcelain gallbladder, intra-abdominal adhesions due to previous upper abdominal surgery, an additional disease that may affect the biliary tract surgery and bleeding disorders were excluded from the study to ensure the homogeneity. Patients with a provisional diagnosis of gallbladder cancer were also excluded. A comparison was performed between the patients who were operated under general anesthesia + laparoscopic TAP block and those who received only general anesthesia. TAP block preference was made by anesthesiologists depending on the patient's clinical condition after obtaining written informed consent from all participants. Bupivacaine was chosen as a local anesthetic agent. All patients in both groups were received additional intravenous paracetamol treatment at the 1st, 6th, 12th, and 18th hour after surgery in accordance with our clinical practice. Groups were evaluated according to the patients' age and gender, comorbidities, American Society of Anesthesiologists (ASA) scores, visual analog scale (VAS) (Figure 2) for pain and length of stay in hospital (Figure 3).

A standardized general anesthesia was applied to all participants. Rocuronium (0.8 mg/kg), remifentanil (0.2-0.5 μg/kg/minute) and propofol (1-2 mg/kg) were utilized for induction. Fentanyl, sevoflurane and remifentanil combination utilized for maintenance.

After induction of general anesthesia before surgery began TAP block was applied. The first 10-mm-trocar inserted and a general abdominal exploration with a laparoscope, puncture with an 18-gauge-needle was performed at the both side of the abdominal wall using the classical anatomical landmarks. Subsequent to the perpendicular insertion, localization of

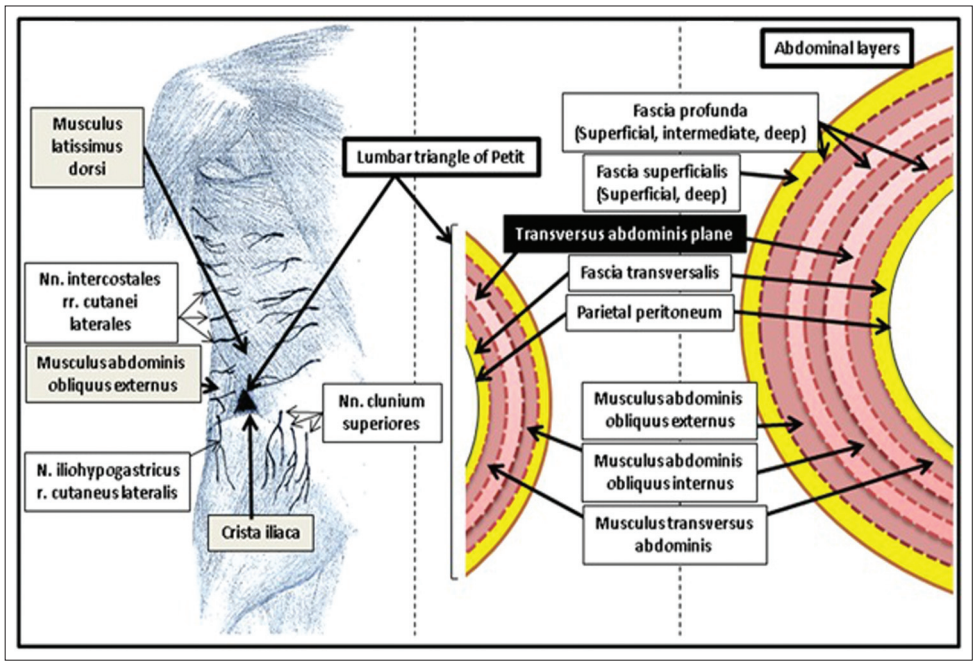

FIGURE 1. Panel A: Localizations of the triangle of Petit and neighboring superficial nerves. Panels B and C: Layers of the triangle of Petit and the anterior abdominal wall.

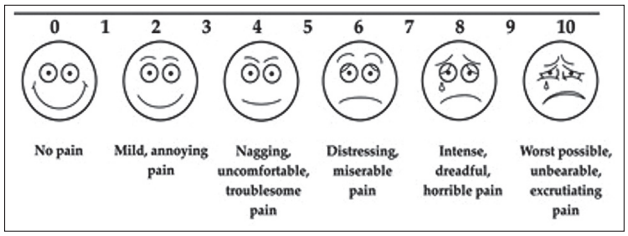

FIGURE 2. Visual analog scale for pain.

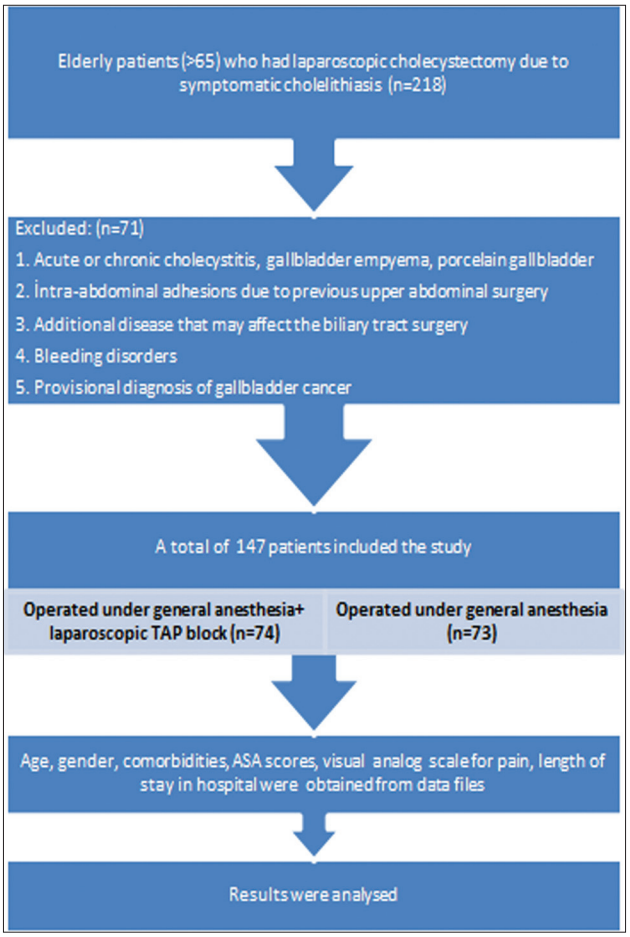

FIGURE 3. Study flow diagram. TAP: Transversus abdominis plane.

the needle was detected under direct laparoscopic vision with the help of its trace, and when the needle's tip was positioned at the fascial space between the internal oblique and the transversus abdominis muscle, 15 cc of 0.25% bupivacaine was injected bilaterally. Bulging inferiorly of the transversus abdominis muscle away from the internal oblique was observed with the injection (Figures 4 and 5). Furthermore, ultrasound examination demonstrated that exact placement of the local anesthetics of TAP block with laparoscopy-guided insertion was provided in all patients.

Statistical analysis

The statistical analyses were performed using SPSS (Statistical Package for the Social Sciences ver. 21.0, SPSS Inc, Chicago, Illinois, USA) computer program. For analysis of data

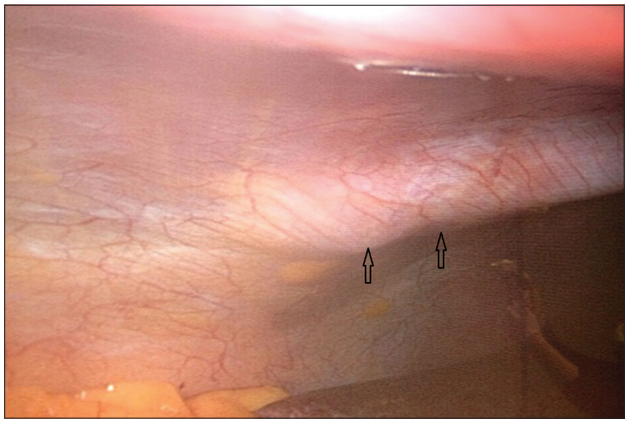

FIGURE 4. View of transversus abdominis plane block under direct laparoscopic vision.

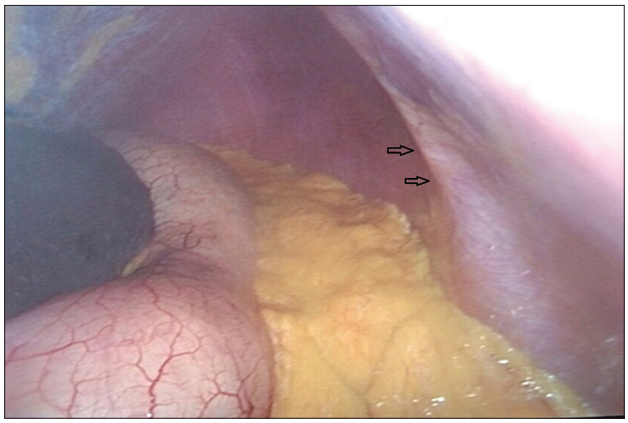

FIGURE 5. Another laparoscopic view demonstrating peritoneal bulging during transversus abdominis plane block.

from all subjects, normality was assessed using Kolmogorov–Smirnov test because the number of sample is >50. In descriptive analyses, median ± standard deviation was used for the data following the normal distribution and median and interquartile range (IQR) values for the data following an abnormal distribution. For comparisons between groups, variables not following the normal distribution were compared using Student's t-test and variables following the normal distribution using Mann–Whitney U-test. Between-group comparison of categorical variables was conducted using Yates-corrected Chi-square test. In all statistical tests conducted as part of the study, α value was taken as 0.05 and $p < 0.05$ was considered statistically significant.

RESULTS

A total of 147 patients were enrolled in this study. Demographic and other characteristics including VAS value, ASA score, comorbidities, the length of hospital stay; of the patients in two groups are presented in Table 1. The median (±IQR) age of the patients was 69 (±65-86). Out of a total of 147 patients, 37 were male (25.2%) and 110 were female (74.8%). Laparoscopic TAP block was carried out in 74 (50.3%) patients during the cholecystectomy.

TABLE 1. Result of descriptive and comparative statistics

Characteristics	TAP block+group	TAP block - group	Overall patients	*p* value
Age	69 (±68-83)	69 (±65-86)	69 (±65-86)	0.410
Gender (%)				
Male	17 (11.6)	20 (13.6)	37 (25.2)	0.704
Female	56 (38.1)	54 (36.7)	110 (74.8)	
Comorbidity (%)				
+	64 (43.5)	64 (43.5)	128 (87)	0.999
–	9 (6.2)	10 (6.8)	19 (13)	
ASA	2 (±1-3)	2 (±1-3)	2 (±1-3)	0.865
VAS	2 (±1-3)	3 (±2-5)	3 (±1-5)	0.001
Length of stay (days)	2 (±1-6)	2 (±1-6)	2 (±1-6)	0.718

TAP: Transversus abdominis plane; VAS: Visual analog scale; ASA: American Society of Anesthesiologists

Median score of patients' physical status according to ASA classification system was found 2 (discrete systemic disease). ASA score of 19 (12.9%) patients were 1 (normally healthy) and 14 (9.5%) patients were 3 (serious, non-incapacitating, systemic disease). Median (±IQR) values of patients' post-operative 24th-hour-VAS for pain were found consecutively 2 (±1-3) in Group 1 and 3 (±2-5) in Group 2. The median post-operative 24th-hour-VAS value in overall patients was three.

Patients' VAS values were higher in the TAP block – group with a statistically significant difference (p = 0.001). However, no statistically significant difference was found between two groups in terms of age, ASA scores and length of stay in hospital (p = 0.410; p = 0.865; p = 0.718). Furthermore, no statistically significant was found between two groups in terms of gender and comorbidities (p = 0.704; p = 0.999).

In addition, no complications such as massive bleeding requiring re-laparotomy, biliary leakage, surgical site infections, and visceral injury were observed due to laparoscopic cholecystectomy and TAP block in all participants.

DISCUSSION

An adequate post-operative pain control provides low morbidity rates, reduces the severity of endocrine and metabolic response due to the surgery and shortens the recovery period [18]. Over the last decade, the effectiveness of TAP block for post-operative pain control complementary to the general anesthesia has been demonstrated in many studies [3,9,19-24].

One of the earliest prospective randomized controlled trials about the efficacy of TAP block published in late 2000's. McDonnell et al. [18] declared that TAP block was found "highly" effective in post-operative wound pain relief. According to the study results, in TAP block group VAS scores has been reduced at all post-operative time points and at the 24th hour after surgery mean VAS scores were lower. As different from our study, the authors also evaluated the patients' post-operative sedation scores which were reduced at 4th and 6th hour after surgery. However, our results confirm the effectiveness of TAP block especially at the 24th-post-operative-hour regarding the VAS scores.

In a similar study, Niraj et al. [25] reported that TAP block has reduced morphine consumption at the 24th post-operative hour and found significantly a lower pain scores at rest and on coughing in the TAP block group comparing with standard pain care group.

Furthermore, the most studies have demonstrated that reducing post-operative opioid requirements diminish opioid-induced side effects such as sedation and nausea [21].

Nevertheless, some authors claimed that TAP block could not provide such an effective analgesia as presented. Ortiz et al. [26] found no statistically difference between the analgesic efficiency of TAP block and local anesthetic infiltration of trocar insertion sites for overall post-operative pain in patients who underwent laparoscopic cholecystectomy. In the study of McMorrow et al. [27] concluded that TAP block does not provide comparable pain relief and additional benefit to spinal morphine in post cesarean section patients.

Rafi [4] described some "trick" points to minimize the possibility of visceral damage such as "double-pop" technique [4]. Regarding the literature, Hebbard et al. [28] were the first mentioned the ultrasound-guided TAP block in 2007. During next 2 years, several studies were published about the usage of ultrasound to perform TAP block [29-31]. The common conclusion of all these studies was the ultrasonographic guidance could permit a precise and safe placement of the anesthetic agent for TAP block.

Despite ultrasound guidance, the identification of muscle planes can be challenging in some cases. In year 2011, Owen et al. [5] described a new approach: TAP block under direct vision in open surgery they concluded that the risks associated with the conventional approach could be prevented with this easy technique. In the same year, Magee et al. [6], reported a single case based on the same idea. They performed TAP block under direct vision but on laparoscopic procedures. Following this report, Chetwood et al. [32] described a similar laparoscopic-guided TAP block technique during laparoscopic nephrectomy and they suggested that safety and time profit were the main advantages of this approach. Favuzza and Delaney [33] declared the use of laparoscopic-guided TAP block in more than 100 patients who had laparoscopic colorectal surgery. Their preliminary results without statistical comparisons demonstrated that efficient pain relief for abdominal incisions; reduced narcotic use and short hospital stay were provided with the help of this method even in obese patients. According to our knowledge in English literature, limited studies were published about TAP block under direct laparoscopic vision during laparoscopic abdominal operations [34-37]. In another retrospective study of Favuzza

and Delaney [34], the authors demonstrated that laparoscopic-guided TAP block with a well-established enhanced recovery pathway (ERP) provided shorter hospital stay with safe and cost-effective laparoscopic colorectal surgery. In addition, Alvarez et al. [35] presented a new the concept of "comprehensive enhanced recovery pathway" which includes laparoscopic-guided TAP block in patients who underwent laparoscopic colectomy after another retrospective analysis. They found reduced opioid consumption in ERP group which allowed the surgeon to discharge patient earlier and TAP block as part of this protocol was shown an effective method for providing pain relief. However in our study, we could not found any benefit of TAP block in term of post-operative length of stay. The benefit of the TAP block was tested in a trial of Keller et al. [36] including 200 patients who underwent colorectal surgery and compared with previous similar studies. They demonstrated that to add TAP block to ERP provided shorter hospital stay with low complication, readmission and reoperation rates. Among these four trials, only one [37] reported the role of laparoscopic-guided TAP blocks for perioperative pain relief in laparoscopic cholecystectomy similar to our study. In this prospective, randomized, double-blinded trial the participants who were applied laparoscopic-assisted TAP block with bupivacaine + periportal saline injection were compared with those who were applied a laparoscopic assisted TAP block with saline + periportal bupivacaine. They found significantly reduced post-operative pain scores during coughing and at rest in TAP block with bupivacaine group. In addition, post-operative nausea was found significantly lower in this group. The other difference from our study was involving the patients aged <65 years old in both study groups.

The most important limitation of our research is the lack of a prospective, controlled, blind study. Moreover, we only evaluated the efficacy of TAP block in term of the 24th hour pain scores. Focusing more various data of patients, such as sedation scores, nausea, vomiting, return of intestinal function, opioid or NSAIDs consumption after the operation and general anesthesia requirements, will help us to demonstrate significant results in further studies.

CONCLUSION

As a promising novel post-operative pain treatment procedure, TAP block is cost effective and one of the safest, easiest and the most effective supplemental techniques as part of the multimodal post-operative analgesic regimen. It improves pain scores in open or minimally invasive surgery involving the anterior abdominal wall. Laparoscopic-guided TAP block may probably has lower the visceral injury risk and shortens the operational time. Furthermore, this approach can be easily performed during any laparoscopic procedure. Efficacy, safety and other advantages of this procedure such as reducing opioid and non-steroid anti-inflammatory drugs requirement, make this technique an ideal abdominal field block in elderly patients. Prospective studies with a large volume of case series supported by subgroup analysis will help us to obtain more concrete and reliable reports.

DECLARATION OF INTERESTS

The authors declare no conflict of interest.

REFERENCES

[1] Kulen FT, Tihan D, Duman U, Bayam E, Zaim G. Laparoscopic partial cholecystectomy: A safe and effective alternative surgical technique in difficult cholecystectomies. Turkish Journal of Surgery. DOI: 10.5152/UCD.2015.3086.

[2] Mitra S, Khandelwal P, Roberts K, Kumar S, Vadivelu N. Pain relief in laparoscopic cholecystectomy – A review of the current options. Pain Pract 2012;12(6):485-96. http://dx.doi.org/10.1111/j.1533-2500.2011.00513.x.

[3] Ra YS, Kim CH, Lee GY, Han JI. The analgesic effect of the ultrasound-guided transverse abdominis plane block after laparoscopic cholecystectomy. Korean J Anesthesiol 2010;58(4):362-8. http://dx.doi.org/10.4097/kjae.2010.58.4.362.

[4] Rafi AN. Abdominal field block: A new approach via the lumbar triangle. Anaesthesia 2001;56(10):1024-6. http://dx.doi.org/10.1046/j.1365-2044.2001.02279-40.x.

[5] Owen DJ, Harrod I, Ford J, Luckas M, Gudimetla V. The surgical transversus abdominis plane block – a novel approach for performing an established technique. BJOG 2011;118(1):24-7. http://dx.doi.org/10.1111/j.1471-0528.2010.02779.x.

[6] Magee C, Clarke C, Lewis A. Laparoscopic TAP block for laparoscopic cholecystectomy: Description of a novel technique. Surgeon 2011;9(6):352-3. http://dx.doi.org/10.1016/j.surge.2010.11.027.

[7] Finnerty O, McDonnell JG. Transversus abdominis plane block. Curr Opin Anaesthesiol 2012;25(5):610-4. http://dx.doi.org/10.1097/ACO.0b013e328357b165.

[8] Jankovic ZB, du Feu FM, McConnell P. An anatomical study of the transversus abdominis plane block: location of the lumbar triangle of Petit and adjacent nerves. Anesth Analg 2009;109(3):981-5. http://dx.doi.org/10.1213/ane.0b013e3181ae0989.

[9] Ekmekçi P, Kazak Bengisun Z, Kazbek BK, Han S, Tüzüner F. Ultrasound guided TAP block for the treatment of postoperative prolonged pain - An alternative approach. Agri 2012;24(4):191-3. http://dx.doi.org/10.5505/agri.2012.82905.

[10] Abdallah FW, Chan VW, Brull R. Transversus abdominis plane block: A systematic review. Reg Anesth Pain Med 2012;37:193-209. http://dx.doi.org/10.1097/AAP.0b013e3182429531.

[11] Milan Z, Tabor D, McConnell P, Pickering J, Kocarev M, du Feu F, et al. Three different approaches to transversus abdominis plane block: A cadaveric study. Med Glas (Zenica) 2011;8(2):181-4.

[12] Aissou M, Ghalayini M, Yazid L, Abdelhalim Z, Dufeu N, Beaussier M. Ultrasound control of local anaesthetic location after TAP block performed using landmark-based technique: A cohort study. Ann Fr Anesth Reanim 2011;30(9):641-4. http://dx.doi.org/10.1016/j.annfar.2011.03.020.

[13] Kadam RV, Field J. Ultrasound-guided continuous transverse abdominis plane block for abdominal surgery. J Anaesthesiol Clin Pharmacol 2011;27(3):333-6. http://dx.doi.org/10.4103/0970-9185.83676.

[14] McDermott G, Korba E, Mata U, Jaigirdar M, Narayanan N, Boylan J, et al. Should we stop doing blind transversus abdominis plane blocks? Br J Anaesth 2012;108(3):499-502. http://dx.doi.org/10.1093/bja/aer422.

[15] Albrecht M, Hohner E, van Ackern K. The rationale of pain therapy

in the aged. Z Gerontol 1987;20(1):23-30.
[16] Donat H, Ozcan A, Ozdirenç M, Aksakoglu G, Aydinoglu S. Age-related changes in pressure pain threshold, grip strength and touch pressure threshold in upper extremities of older adults. Aging Clin Exp Res 2005;17(5):380-4. http://dx.doi.org/10.1007/BF03324626.
[17] Huang HW, Wang WC, Lin CC. Influence of age on thermal thresholds, thermal pain thresholds, and reaction time. J Clin Neurosci 2010;17(6):722-6. http://dx.doi.org/10.1016/j.jocn.2009.10.003.
[18] McDonnell JG, O'Donnell B, Curley G, Heffernan A, Power C, Laffey JG. The analgesic efficacy of transversus abdominis plane block after abdominal surgery: A prospective randomized controlled trial. Anesth Analg 2007;104(1):193-7. http://dx.doi.org/10.1213/01.ane.0000250223.49963.of.
[19] De Oliveira GS Jr, Castro-Alves LJ, Nader A, Kendall MC, McCarthy RJ. Transversus abdominis plane block to ameliorate postoperative pain outcomes after laparoscopic surgery: A meta-analysis of randomized controlled trials. Anesth Analg 2014;118(2):454-63. http://dx.doi.org/10.1213/ANE.0000000000000066.
[20] Abdallah F, 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(5):721-35. http://dx.doi.org/10.1093/bja/aet214.
[21] Petersen PL, Mathiesen O, Torup H, Dahl JB. The transversus abdominis plane block: A valuable option for postoperative analgesia? A topical review. Acta Anaesthesiol Scand 2010;54(5):529-35. http://dx.doi.org/10.1111/j.1399-6576.2010.02215.x.
[22] Johns N, O'Neill S, Ventham NT, Barron F, Brady RR, Daniel T, et al. Clinical effectiveness of transversus abdominis plane (TAP) block in abdominal surgery: A systematic review and meta-analysis. Colorectal Dis 2012;14(10):e635-42. http://dx.doi.org/10.1111/j.1463-1318.2012.03104.x.
[23] Ishida T, Sakamoto A, Tanaka H, Ide S, Ishida K, Tanaka S, et al. Transversus abdominis plane block with 0.25% levobupivacaine: A prospective, randomized, double-blinded clinical study. J Anesth 2015;29(4):557-61. http://dx.doi.org/10.1007/s00540-015-1993-0.
[24] Fiala T. Tranversus abdominis plane block during abdominoplasty to ımprove postoperative patient comfort. Aesthet Surg J 2015;35(1):72-80. http://dx.doi.org/10.1093/asj/sju019.
[25] Niraj G, Searle A, Mathews M, Misra V, Baban M, Kiani S, et al. Analgesic efficacy of ultrasound-guided transversus abdominis plane block in patients undergoing open appendicectomy. Br J Anaesth 2009;103(4):601-5. http://dx.doi.org/10.1093/bja/aep175.
[26] Ortiz J, Suliburk JW, Wu K, Bailard NS, Mason C, Minard CG, et al. Bilateral transversus abdominis plane block does not decrease postoperative pain after laparoscopic cholecystectomy when compared with local anesthetic infiltration of trocar insertion sites. Reg Anesth Pain Med 2012;37(2):188-92. http://dx.doi.org/10.1097/AAP.0b013e318244851b.
[27] McMorrow RC, Ni Mhuircheartaigh RJ, Ahmed KA, Aslani A, Ng SC, Conrick-Martin I, et al. Comparison of transversus abdominis plane block vs spinal morphine for pain relief after Caesarean section. Br J Anaesth 2011;106(5):706-12. http://dx.doi.org/10.1093/bja/aer061.
[28] Hebbard P, Fujiwara Y, Shibata Y, Royse C. Ultrasound-guided transversus abdominis plane (TAP) block. Anaesth Intensive Care 2007;35:616-7.
[29] El-Dawlatly AA, Turkistani A, Kettner SC, Machata AM, Delvi MB, Thallaj A, et al. Ultrasound-guided transversus abdominis plane block: Description of a new technique and comparison with conventional systemic analgesia during laparoscopic cholecystectomy. Br J Anaesth 2009;102(6):763-7. http://dx.doi.org/10.1093/bja/aep067.
[30] Suresh S, Chan VW. Ultrasound guided transversus abdominis plane block in infants, children and adolescents: A simple procedural guidance for their performance. Paediatr Anaesth 2009;19(4):296-9. http://dx.doi.org/10.1111/j.1460-9592.2009.02958.x.
[31] Tran TM, Ivanusic JJ, Hebbard P, Barrington MJ. Determination of spread of injectate after ultrasound-guided transversus abdominis plane block: a cadaveric study. Br J Anaesth 2009;102(1):123-7. http://dx.doi.org/10.1093/bja/aen344.
[32] Chetwood A, Agrawal S, Hrouda D, Doyle P. Laparoscopic assisted transversus abdominis plane block: A novel insertion technique during laparoscopic nephrectomy. Anaesthesia 2011;66(4):317-8. http://dx.doi.org/10.1111/j.1365-2044.2011.06664.x.
[33] Favuzza J, Delaney CP. Laparoscopic-guided transversus abdominis plane block for colorectal surgery. Dis Colon Rectum 2013;56(3):389-91. http://dx.doi.org/10.1097/DCR.0b013e318280549b.
[34] Favuzza J, Delaney CP. Outcomes of discharge after elective laparoscopic colorectal surgery with transversus abdominis plane blocks and enhanced recovery pathway. J Am Coll Surg 2013;217(3):503-6. http://dx.doi.org/10.1016/j.jamcollsurg.2013.03.030.
[35] Alvarez MP, Foley KE, Zebley DM, Fassler SA. Comprehensive enhanced recovery pathway significantly reduces postoperative length of stay and opioid usage in elective laparoscopic colectomy. Surg Endosc 2014;29(6):1-6.
[36] Keller DS, Ermlich BO, Delaney CP. Demonstrating the benefits of transversus abdominis plane blocks on patient outcomes in laparoscopic colorectal surgery: Review of 200 consecutive cases. J Am Coll Surg 2014;219(6):1143-8. http://dx.doi.org/10.1016/j.jamcollsurg.2014.08.011.
[37] Elamin G, Waters PS, Hamid H, O'Keeffe HM, Waldron RM, Duggan MS. Efficacy of a laparoscopically delivered transversus abdominis plane block technique during elective laparoscopic cholecystectomy: A prospective, double-blind randomized trial. J Am Coll Surg 2015;221(2):335-44. http://dx.doi.org/10.1016/j.jamcollsurg.2015.03.030.