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SCIENTIFIC ARTICLE

Ultrasound-guided versus surgical transversus abdominis plane block in obese patients following cesarean section: a prospective randomised study

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Abstract
Background and objectives: Ultrasound-guided transversus abdominis plane block demonstrated efficacy in providing post-operative analgesia by prolonging the time to first analgesic requirement and reducing the total analgesic consumption. The surgical transversus abdominis plane block, a novel technique, can be performed safely in obese patients in whom muscle layers cannot be sufficiently exposed. Here, we compared applicability, efficacy and complications of surgical transversus abdominis plane and ultrasound-guided transversus abdominis plane blocks in obese pregnant women following cesarean section under general anesthesia.
Methods: Seventy-five pregnant women with pre- and post-pregnancy body mass index > 30 were randomized and allocated into two groups: Ultrasound-guided transversus abdominis plane block (UT group; $n = 38$) and surgical TAP block (ST group; $n = 37$). Visual analogue scale scores at post-operative 0, 2, 6, 12 and 24 hours (h), time to first analgesic requirement, total analgesic consumption amount in 24 h, post-operative side effects, complications and patient satisfaction were recorded.
Results and conclusions: Age, American Society of Anesthesiologist score, operative duration, body mass index, mean time to first analgesic requirement and total analgesic consumption in 24 h were similar between groups, while significant differences in pre- and post-pregnancy body mass index were observed between groups. Block procedure durations were 7 and 10 minutes in ST and UT groups, respectively. No significant differences in visual analogue scale scores

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were observed between the groups at all times; itching and nausea was observed in one (UT group) and four (UT and ST groups) patients, respectively. Surgical transversus abdominis plane block was safe in obese pregnant patients and provided similar post-operative analgesia to ultrasound-guided transversus abdominis plane block.

PALAVRAS-CHAVE
Bloqueio do plano transverso abdominal;
Cesariana;
Grávidas;
Escala visual analógica;
Analgesia

Bloqueio cirúrgico do plano transverso abdominal *versus* guiado por ultrassom em pacientes obesas após cesárea: estudo prospectivo e randomizado

Resumo
Justificativa e objetivos: O bloqueio do plano transverso abdominal (TAP) guiado por ultrassom (US) demonstrou eficácia no fornecimento de analgesia no pós-operatório ao prolongar o tempo até a primeira necessidade de analgésico e reduzir o consumo total de analgésico. O bloqueio TAP cirúrgico (uma nova técnica) pode ser realizado com segurança em pacientes obesas nas quais as camadas musculares não podem ser suficientemente expostas. Comparamos a aplicabilidade, a eficácia e as complicações do bloqueio TAP cirúrgico e do bloqueio TAP-US em gestantes obesas submetidas à cesárea sob anestesia geral.
Método: Setenta e cinco mulheres grávidas com índice de massa corporal (IMC) pré e pós-gravidez > 30 foram randomicamente alocadas em dois grupos: bloqueio TAP-US (Grupo TAP-US, $n = 38$) e bloqueio TAP cirúrgico (Grupo TAP-C, $n = 37$). Os escores da escala visual analógica (VAS) nos tempos 0, 2, 6, 12 e 24 horas de pós-operatório, o tempo até a primeira necessidade de analgésico, o consumo total de analgésico em 24 horas, os efeitos colaterais no pós-operatório, as complicações e a satisfação do paciente foram registrados.
Resultados e conclusões: Idade, estado físico ASA, tempo cirúrgico, IMC, média de tempo até a primeira necessidade de analgésico e consumo total de analgésico em 24 horas foram semelhantes entre os grupos, enquanto diferenças significativas foram observadas entre os grupos em relação ao IMC pré- e pós-gravidez. As durações dos procedimentos de bloqueio foram 7 e 10 minutos nos grupos TAP-US e TAP-C, respectivamente. Não houve diferença significativa nos escores VAS entre os grupos em todos os momentos; prurido e náusea foram observados em um paciente (Grupo TAP-US) e em quatro (Grupo TAP-C), respectivamente. O bloqueio TAP cirúrgico foi seguro nas pacientes grávidas obesas e forneceu analgesia similar à do bloqueio TAP-US no pós-operatório.

Introduction

Adequate pain control following cesarean section provides benefits to mothers and infants and facilitates early rehabilitation and mobilisation of the mother, thereby preventing thromboembolic events and allowing early breastfeeding.[1,2] Although the use of opioids with neuraxial block is preferred because it provides efficient post-operative analgesia following cesarean section, multimodal analgesia protocols including Patient-Controlled Analgesia (PCA) with opioids, paracetamol or Non-Steroidal Inflammatory Drugs (NSAIDs) have also been used with a neuraxial block and, generally, under anesthesia conditions in which the use of a neuraxial block is restricted.[3,4] Despite the substantial efficacy of opioids as analgesic agents, they cause maternal side effects, including nausea, vomiting, sedation, pruritus and respiratory depression. Because neonatal side effects occur via placental transmission, peripheral nerve blocks and infiltration, recently, methods that use lesser amounts of opioids have been developed as a part of multimodal analgesia protocols.[5] The use of the classic Transversus Abdominis Plane block (TAP), a block commonly used for post-operative analgesia following lower abdominal surgery, was first described by Rafi in 2001 and involves blockade of the T7–L1 intercostal, subcostal, ilioinguinal and iliohypogastric nerves that provide sensory innervation to the anterior abdominal wall. The technique involves analgesic agent introduction into the lateral abdominal wall and between the internal oblique and transversus abdominis muscles (termed as TAP).[6] The classic blind method is associated with several complications[7]; therefore, it has largely been replaced by Ultrasound-Guided (USG) TAP, first described by Hebbart et al.,[8] because fewer complications are encountered with USG-TAP.[9,10] USG-TAP blocks performed under general anesthesia or a neuraxial block have efficacy in providing post-operative analgesia by prolonging

time to first analgesic requirement and reducing total analgesic consumption following various surgical procedures.[11,12] However, serious technical difficulties, similar to those reported for classic TAP block, have been reported with the use of USG-TAP, particularly in obese patients who have excess subcutaneous adipose tissue. The use of the TAP block method, described by Owen et al., is currently considered as the most appropriate method for achieving a block in obese patients because complications can be prevented through the use of an intra-abdominal approach.[13] Subsequently, surgical TAP block technique has been used following several laparoscopic surgical procedures.[14–16]

In obese pregnant women, maternal and foetal side effects may contribute to a requirement for high-dose analgesia. Technical challenges have limited the use of USG-TAP block in this group of patients in post-operative analgesia protocols. Therefore, the surgical TAP block has been considered as a more appropriate technique for post-operative analgesia in obese pregnant women following cesarean section under general analgesia compared with USG-TAP block in terms of applicability, efficacy and complications. To our knowledge, in this study, we are the first to compare the utility of USG and surgical TAP block in obese pregnant patients.

Methods

The present study was conducted in Sütcü İmam University, Anesthesiology and Reanimation department, after receiving approval from the Scientific Research Ethics Committee (2014/16 Protocol n° 187) and written consent of all patients. The study was prospectively performed in 75 pregnant women scheduled for elective cesarean section under general analgesia with pre- and post-pregnancy body mass index (BMI) of >30 $kg.m^{-2}$. We included pregnant women who received general analgesia and were at $\geq$37 weeks of gestation, had fasted for 6 h, were aged >18 years and had ASA scores of I–II. Patients with BMI of >30 $kg.m^{-2}$ with known hypertensive diseases (pre-eclampsia, eclampsia and chronic hypertension), placental or foetal abnormalities, abdominal organomegaly or bleeding diathesis were excluded from the study. Seventy-five pregnant women were randomly divided into two groups: UT (USG-TAP block; $n = 38$) and ST groups (Surgical TAP block; $n = 37$) using web-based randomisation software (www.randomizer.org).

After routine monitoring Noninvasive Blood Pressure (NIBP), Heart Rate (HR), pulse oxymetry and three-lead ECG of all patients taken to the operating room, haemodynamic and demographic data (age, weight, height and BMI) of included pregnant women were recorded. General analgesia induction was performed with 2 $mg.kg^{-1}$ IV propofol and 1 $mg.kg^{-1}$ IV succinylcholine. At 30 s after intubation, patients were transferred to the care of surgeons. Sevoflurane (2%) and O_2/air (50%/50%) were used for maintaining anesthesia. TAP block procedure was performed in patients in the UT group following surgery using a MyLabTM five (Esaote, Genoa, Italy) ultrasound device and LA 435 (6–18 MHz) linear probes sterilised with antiseptic solution. The probe was inserted between the costal margin and iliac crest; a 20 gauge 150 mm regional anesthesia needle (Stimuplex, B. Braun Melsungen AG, Germany) was advanced at the same level as the USG probe using an in-plane technique

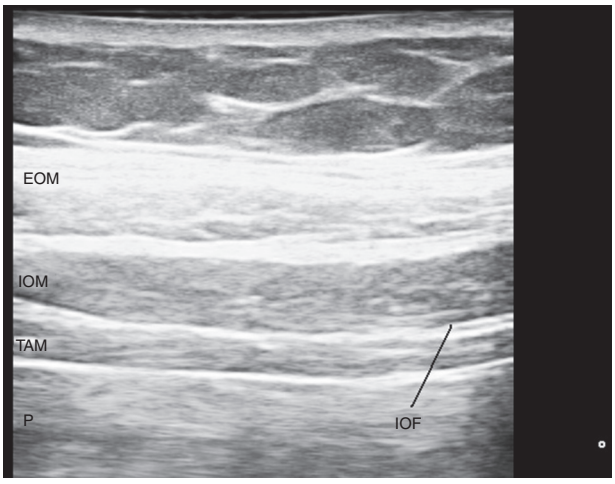

Figure 1 Ultrasound image of the following three abdominal muscle layers: EOM, external oblique muscle; IOM, internal oblique muscle; TAM, transversus abdominis muscle; IOF, internal oblique facia; P, intraperitoneal area.

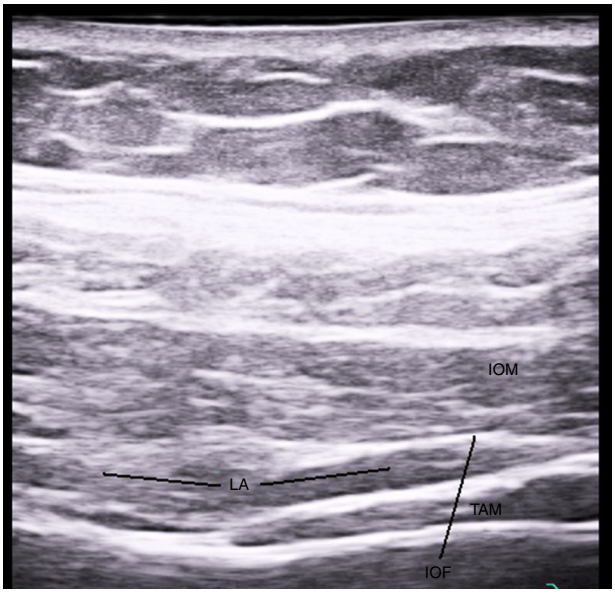

Figure 2 Spread of local anesthetic (LA) within the transversus abdominis plane between the IOM and TAM following injection and downward displacement of the IOF (USG-TAP block).

after visual confirmation of three muscle layers (from external to internal; inward external oblique, internal oblique and transversus abdominis) (Fig. 1). Following transversus abdominis muscle fascia puncture and needle tip visualisation between the internal oblique and transversus abdominis muscles under USG, a pre-prepared dose of 20 mL of 0.25% Bupivacaine (Marcaine 0.5%; AstraZeneca, London, UK) was administered following a 0.5–1 mL test dose. The same procedure was repeated on the opposite side using an identical amount of local anesthetic. Fig. 2 shows TAP spread of local anesthetic.

The ST group ($n = 37$) received the block procedure after uterus closure and haemostasis. Following palpation of the lateral margin of the rectus muscle and inferior epigastric

Figure 3 Intra-abdominal access of a blunt-ended needle into the transversus abdominis plane through the transversus abdominis muscle (surgical TAP block).

vessels by the surgeon using an elevator, a blunt-ended 18 gauge needle was advanced through the parietal peritoneum and transversus abdominis muscle. Following transversus abdominis muscle fascia puncture, 20 mL of 0.25% bupivacaine was intra-abdominally injected into the TAP at the midpoint of the line connecting the crista iliaca and inferior costal margin and at two locations in the lateral abdominal wall at 3–4 cm inferior to the previous midline injection (Fig. 3). The same procedure was repeated on the opposite side using an identical amount of local anesthetic. USG-TAP block and surgical TAP block procedures were performed by the same anesthetic and surgeon. Block procedure duration was defined as the time between probe placement on the skin and local anesthetic injection in the UT group and the time between the start and end of pre-prepared local anesthetic injection into the parietal peritoneum by the surgeon. All patients were administered with 1 g paracetamol IV and 50 mg tramadol IV as standard at 20 min prior to the end of operation. The standard management of post-operative analgesia involved the use of tramadol as a PCA according to patient preference depending on the degree of pain with routine 1 g paracetamol IV (maximal dose, 4 $g.day^{-1}$) administered every 6 h. The PCA protocol was applied without continuous infusion as a 12 mg IV bolus dose of 300 mg (6 mL) tramadol in a 44 mL isotonic solution over 10 min. Post-operative pain was evaluated using Visual Analogue Scale (VAS), with 0 defined as no pain and 10 defined as the worst possible pain and recorded in both groups at 0 (immediately post-operation) and at 2, 6, 12 and 24 h post-operatively. Time to first analgesic requirement (min) and total analgesic consumption (mg) were recorded. Post-operative adverse effects and complications, such as nausea/vomiting, pruritus and respiratory depression, were also recorded. Furthermore, patients were asked to report their satisfaction on a scale between 0 and 10 points, similar to VAS scores, with scores recorded to assess patient satisfaction.

Data were analysed using SPSS 22.0 (IBM Corp., Armonk, NY, USA) and PAST3 (Hammer Ø, Harper DAT, Ryan PD. 2001; Paleontological statistics) software. The conformity of univariate and multivariate data to normal distributions was analysed using the Shapiro–Wilk and Mardia tests, respectively, whereas Levene's test was used to evaluate the homogeneity of variance. The independent *t*-test was used to compare the two independent groups, whereas the Mann–Whitney *U* test was used with the Monte Carlo simulation technique. Wilcoxon signed ranks test was used for two repeat measurements of non-independent variables. General linear model-repeated ANOVA and Friedman's two-way test were used to study the interactions of repeated measurements of variables according to the groups, whereas non-parametric post hoc and LSD tests were used for the post hoc analyses. Fisher's exact test was used to compare categorical data and odds ratios to quantify categorical risk factors. Quantitative data in the tables are expressed as means ± SD (Standard Deviation) and median ± IQR (Interquartile Range) values. Categorical data are given as *n* (number) and percentages (%). Data were examined at a 95% confidence interval. *p*-Values of <0.05 were considered to be statistically significant.

Results

Mean BMI in the ST group were $32.2 \pm 1.56\ kg.m^{-2}$ before pregnancy and $35.5 \pm 1.85\ kg.m^{-2}$ during delivery, with a mean increase of $3.3 \pm 0.77\ kg.m^{-2}$ observed during pregnancy. Mean BMI in the UT group were $32.5 \pm 1.86\ kg.m^{-2}$ before pregnancy and $36.1 \pm 1.97\ kg.m^{-2}$ after pregnancy, with a $3.6 \pm 1.01\ kg.m^{-2}$ change observed during pregnancy. Statistically significant increases in BMI were observed during pregnancy in both groups, with no significant difference observed between groups ($p < 0.01$ and $p = 0.154$, respectively) (Table 1).

The mean age was 30.2 ± 5.17 years in the ST group and 29.4 ± 5.41 years in the UT group. No statistically significant difference was observed between groups ($p = 0.490$). No statistically significant differences in median ASA values or operative duration were observed between groups ($p = 0.628$ and $p = 0.716$, respectively). The median block procedure duration was lower in the UT (mean: 7 min; range: 4–10 min) compared than in the ST group (mean: 10 min; range: 8–12 min; $p < 0.001$). No significant differences in mean time to first analgesic requirement or total analgesic consumption over 24 h were observed between groups ($p = 0.168$ and $p = 0.539$, respectively). A significant difference in median patient satisfaction scores was not observed between groups ($p = 0.962$) (Table 2).

Median VAS scores in both the groups at 0, 2, 6, 12 and 24 h post-operatively, and changes from baseline at each time point are provided in Table 3. Accordingly, no statistical difference in VAS scores was observed between groups at any time point ($p > 0.05$ for all).

Nausea was observed in four patients in each of the UT and ST groups; itching was observed in one patient in the UT group and was attributable to decreased use of opioids following both techniques. *p*-Values could not be calculated because these data were not suitable for statistical analysis.

Discussion

Despite the effective levels of post-operative analgesia achieved with the use of opioids in combination with NSAIDs and paracetamol following general anesthesia, opioids are associated with substantial complications including nausea, vomiting, sedation, pruritus and respiratory depression in

Table 1 BMI of patients before pregnancy and at the time of delivery as well as changes during pregnancy according to study group.

	STB	UTB	*p*-value
BMI			
Pre-pregnancy (1)	32.2 ± 1.56	32.5 ± 1.86	
At the time of delivery (2)	35.5 ± 1.85	36.1 ± 1.97	
Change during pregnancy	3.3 ± 0.77	3.6 ± 1.01	0.154
p-value	<0.001	<0.001	

General linear model repeated ANOVA, Wilks' Lambda; Fisher exact test (Monte Carlo); Post hoc test, Monte Carlo; non-parametric post hoc test.
UTB, USG-guided transversus abdominis plane block; STB, surgical-guided transversus abdominis plane block.

Table 2 Age, ASA, operative duration, block procedure time, time to first analgesic requirement and satisfaction values of patients according to study group.

	STB *n* = 37	UTB *n* = 38	*p*-value
Age[a]	30.2 ± 5.17	29.4 ± 5.41	0.490
ASA[b]	2 (2–1)	2 (2–1)	0.628
Operative duration[a]	40.2 ± 2.66	40.5 ± 2.81	0.716
Block procedure time (min)[b]	7 (10–4)	10 (12–8)	<0.001
Time to first analgesic requirement (min)[a]	513.2 ± 102.78	476.6 ± 125.59	0.168
Total analgesic consumption in 24 h (mg)[a]	91.1 ± 34.00	96.9 ± 46.38	0.539
Patient satisfaction[b]	9 (10–5)	9 (10–4)	0.962

Independent *t*-test (Bootstrap); Mann–Whitney *U* Test (Monte Carlo).
[a] Mean ± SD (standard deviation).
[b] Median range (maximum − minimum).
UTB, USG-guided transversus abdominis plane block; STB, surgical-guided transversus abdominis plane block.

Table 3 Median VAS scores at 0, 2, 6, 12 and 24 h and changes from baseline.

VAS[a]	STB *n* = 37	UTB *n* = 38	*p*-value
Hour 0	1.48 (3–0)	1.67 (3–0)	
Hour 2	2.14 (5–0)	2.23 (7–0)	
Change 2–0	0.66 (2–1)	0.65 (4–1)	0.995
Hour 6	2.13 (5–1)	2.23 (4–1)	
Change 6–0	0.72 (2–1)	0.64 (2–1)	0.633
Hour 12	2.89 (4–1)	2.67 (4–1)	
Change 12–0	1.35 (3–0)	1.06 (2–0)	0.084
Hour 24	1.93 (3–0)	1.87 (3–0)	
Change 24–0	0.47 (2–1)	0.23 (2–1)	0.167

[a] Median, range (maximum − minimum).

addition to neonatal side effects via opioid transmission through breastfeeding during cesarean section.[17,18] Although McKeen et al. reported the contrary, most studies have reported TAP block utility as a component of multimodal analgesia protocols following cesarean sections in reducing the use of opioids and associated opioid-related side effects.[19,20] Besides cesarean section, TAP blockage utility in providing sensorial blockade to the abdominal wall has been demonstrated as a part of post-operative analgesia following many lower abdominal surgical techniques.[21,22] Because the TAP block performed using the classic blind technique is associated with substantial complications, USG, originally used for peripheral nerve blocks, has recently been applied to TAP blocks.[8] The USG-TAP block increased safety; however, because the abdominal muscle layers and needle tip can be visualised, liver damage could be reported. Further, the TAP block technique may remain technically challenging despite the use of USG in obese patients with increased subcutaneous adipose tissue.[9] Thus, the newer technique of surgical TAP block is considered to have reduced morbidity in this group of patients.[13]

Here, we compared the utility of a surgical TAP block, a novel technique, and the USG-TAP block for providing post-operative analgesia in obese patients following cesarean

section under general analgesia in terms of applicability, efficacy and safety. On reviewing the literature, we were unable to find a study directly comparing these two methods in obese women following cesarean section. Although demographic data (age, ASA and operative duration) of the 75 pregnant women who were randomly assigned to the ST and UT groups were found to be similar, here we focused on obese pregnant women with a BMI of >30 $kg.m^{-2}$ because weight gain was an expected pregnancy outcome.

Cesarean section is considered more appropriate in obese women; neuraxial blocks have greater safety during cesarean section than general anesthesia.[23] Therefore, TAP blocks are more often performed with neuraxial blocks in previous studies investigating the post-operative analgesic efficacy of TAP block following cesarean section. Belavy et al. reported that the USG-TAP block provides effective analgesia without the use of opioids following cesarean section performed with spinal anesthesia, thereby decreasing opioid-related adverse effects.[24] TAP block contributes to spinal opioid analgesia by reducing post-operative opioid requirements and VAS scores.[11] Despite the advantages of spinal anesthesia described in this study, general anesthesia may be required in the patients who reject regional anesthesia or have other contraindications. Unlike regional anesthesia, discontinuation of the analgesic effects of neuraxial block in the early post-operative period is a major disadvantage of general anesthesia. Therefore, post-operative analgesia is more important following general anesthesia.

Use of opioids in the first 24 h post-operatively following cesarean section under general analgesia was significantly decreased by the use of a TAP block; however, VAS scores were comparable with the control group.[1] TAP block administered during cesarean section under general analgesia increased time to first opioids requirement, decreased total opioid consumption, and significantly reduced VAS scores up to 12 h post-operatively.[17] Consistent with this result, in our study, time to first analgesic requirement increased in both the ST and UT groups and the total analgesic consumption was low at 24 h post-operatively. Beginning from the early period, post-operative VAS scores were found to be low in both the groups in all times within the 24 h follow-up period. In the study by Tan et al., similarity in VAS scores of the study and control groups may be attributable to the use of other analgesic agents, such as paracetamol, with opioids during the post-operative period, which is similar to our study's results. A TAP block provides somatic sensory blockade only in the abdominal wall, but it does not block visceral pain originating from the uterus.[25] Therefore, visceral pain may not be prevented with the use of additional agents, thereby leading to VAS score misevaluation.

With decreased use of opioids, related adverse effects including nausea, vomiting, pruritus and respiratory depression are expected to be less frequently observed. Here, nausea was seen in four patients in each UT and ST group; itching was observed in one patient in the UT group. This finding was attributable to decreased use of opioids in both groups. Additionally, high patient satisfaction scores in both groups were an expected outcome because of fewer adverse effects and adequate post-operative analgesia. A meta-analysis of multiple TAP block studies found that opioid consumption and related side effects decreased and that patient satisfaction was high when USG-TAP block was performed during lower abdominal surgeries.[20]

Although the use of USG in TAP block was apparently safe, as in the present study, technical difficulties may occasionally be encountered regarding probe insertion and distinction of the abdominal muscle layers because of obesity. Needle-related visceral organ damage can be prevented by the intra-abdominal application of a TAP block by visualising the visceral organs during open surgeries.[13] In our study, no complications were observed following either USG or surgical TAP blocks, whereas surgical block duration was significantly shorter with the surgical TAP block than with the USG block.

There were several limitations of this study. First, the level of sensorial block was not confirmed after blockade, and only post-operative VAS was assessed as a part of blockade success evaluation. However, this evaluation could not be completely performed because patients administered general anesthesia are unlikely to provide reliable responses regarding sensorial block during the early post-operative period and at later times, particularly in T7–L1 dermatome region in which blockade was provided and was enclosed with plaster. Second for comparing TAP block methods, there is a lack of a control group without block in which only PCA is administered. Here, our primary objective was to compare the efficacy and complications between USG and surgical TAP blocks. We did not include a third control group because of a lack of appropriate pregnant women who met the study criteria; the mean time to first post-operative analgesic requirement and total analgesic consumption in this populations has been reported by several previously conducted studies.

Conclusion

USG and surgical TAP blocks were safe and had similar efficacy in providing post-operative analgesia in obese pregnant women following cesarean section under general analgesia. Surgical TAP block is an efficacious, safe and rapid technique, particularly in patients in whom sensory blockade is technically challenging, and does not require additional equipment.

Conflicts of interest

The authors declare no conflicts of interest.

References

1. Tan TT, Teoh WH, Woo DC, et al. A randomised trial of the analgesic efficacy of ultrasound-guided transversus abdominis plane block after caesarean delivery under general anaesthesia. Eur J Anaesthesiol. 2012;29:88–94.
2. Patel SA, Gotkin J, Huang R, et al. Transversus abdominis plane block for postoperative analgesia after cesarean delivery. J Matern Fetal Neonatal Med. 2012;25:2270–3.
3. Kwok S, Wang H, Sng BJ. Post-caesarean analgesia. J Trends Anaesth Crit Care. 2014;4:189–94.
4. Schyns-van den Berg AM, Huisjes A, Stolker RJ. Postcaesarean section analgesia: are opioids still required? Curr Opin Anaesthesiol. 2015;28:267–74.

5. Chandon M, Bonnet A, Burg Y, et al. Ultrasound-guided transversus abdominis plane block versus continuous wound infusion for post-caesarean analgesia: a randomised trial. PLOS ONE. 2014;9:e103971.
6. Rafi AN. Abdominal field block: a new approach via the lumbar triangle. Anaesthesia. 2001;56:1024–6.
7. Farooq M, Carey M. A case of liver trauma with a blunt regional anesthesia needle while performing transversus abdominis plane block. Reg Anesth Pain Med. 2008;33:274–5.
8. Hebbard P, Fujiwara Y, Shibata Y, et al. Ultrasound-guided transversus abdominis plane block. Anaesth Intensive Care. 2007;35:616–7.
9. Lancaster P, Chadwick M. Liver trauma secondary to ultrasound-guided transversus plane block. Br J Anaesth. 2010;104:509–10.
10. Weiss E, Jolly C, Dumoulin JL, et al. Convulsions in 2 patients after bilateral ultrasound-guided transversus abdominis plane blocks for cesarean analgesia. Reg Anesth Pain Med. 2014;39:248–51.
11. Canovas L, Lopez C, Castro M, et al. Contribution to post-caesarean analgesia of ultrasound-guided transversus abdominis plane block. Rev Esp Anestesiol Reanim. 2013;60:124–8.
12. Zhao X, Tong Y, Ren H, et al. Transversus abdominis plane block for postoperative analgesia after laparascopic surgery: a systematic review and meta-analysis. Int J Clin Exp Med. 2014;7:2966–75.
13. Owen DJ, Harrod I, Ford J, et al. The surgical transversus abdominis plane block-a novel approach for performing an established technique. BJOG. 2011;118:24–7.
14. Elamin G, Waters PS, Hamid H, et al. Efficacy of a laparascopically delivered transversus abdominis plane block technique during elective laparascopic cholecystectomy: a prospective double-blind randomised trial. J Am Coll Surg. 2015;221:335–44.
15. El Hachem L, Small E, Chung P, et al. Randomized controlled double-blind trial of transversus abdominis plane block versus trocar site infiltration in gynecologic laparoscopy. Am J Obstet Gynecol. 2015;212, 182.e1-9.
16. El-Dawlatly A, Al-Dohayan A. İnside-out transversus abdominis plane block. Saudi J Anaesth. 2014;8:315–6.
17. Eslamian L, Jalili Z, Jamal A, et al. Transversus abdominis plane block reduces postoperative pain intensity and analgesic consumption in elective cesarean delivery under general anesthesia. J Anesth. 2012;26:334–8.
18. Wittels B, Scott DT, Sinatra RS. Exogenous opioids in human breast milk and acute neonatal neurobehavior: a preliminary study. Anesthesiology. 1990;73:864–9.
19. McKeen DM, George RB, Boyd JC, et al. Transversus abdominis plane block does not improve early or late pain outcomes after cesarean delivery: a randomized controlled trial. Can J Anesth. 2014;61:631–40.
20. Fusco P, Scimia P, Paladini G, et al. Transversus abdominis plane block for analgesia after cesarean delivery. A systematic review. Minerva Anestesiol. 2015;81:195–204.
21. Yu N, Long X, Lujan-Hernandez JR, et al. Transversus abdominis-plane block versus local anesthetic wound infiltration in lower abdominal surgery: a systematic review and meta-analysis of randomized controlled trials. BMC Aneshesiol. 2014;14:121.
22. Walter CJ, Maxwell-Armstrong C, Pinkney TD, et al. A randomised controlled trial of the efficacy of ultrasound-guided transversus abdominis plane (TAP) block in laparoscopic colorectal surgery. Surg Endosc. 2013;27:2366–72.
23. Rao DP, Rao VA. Morbidly obese parturitient challenges for the anaesthesiologist, including managing the diffucult airway in obstetrics. What is new? Indian J Anaesth. 2010;54:508–21.
24. Belavy D, Cowlishaw PJ, Howes M, et al. Ultrasound-guided transversus abdominis plane block for analgesia after caesarean delivery. Br J Anaesth. 2009;103:726–30.
25. Bollag L, Richebe P, Ortner C, et al. Transversus abdominis plane catheters for post-cesarean delivery analgesia: a series of five cases. Int J Obstet Anesth. 2012;21:176–80.