



REVISTA BRASILEIRA DE ANESTESIOLOGIA

Publicação Oficial da Sociedade Brasileira de Anestesiologia
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SCIENTIFIC ARTICLE

Post-operative pain after ultrasound transversus abdominis plane block versus trocar site infiltration in laparoscopic nephrectomy: a prospective study[☆]

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Received 16 March 2016; accepted 10 August 2016

KEYWORDS

Multimodal analgesia;
Laparoscopic
nephrectomy;
Ultrasound
Transversus
abdominis plane
block

Abstract

Background: Transversus abdominis plane (TAP) block is useful in reducing post-operative pain in laparoscopic nephrectomy compared to placebo. The purpose of this work is to compare post-operative pain and recovery after TAP block or trocar site infiltration (TSI) in this surgery. **Methods:** A prospective, single blinded study on patients scheduled for laparoscopic nephrectomy. Patients were assigned to two groups: TSI Group: trocar site infiltration at the end of surgery; TAP Group: unilateral ultrasound-guided TAP block after induction. Sevoflurane and remifentanyl, in a target controlled infusion mode, were used for maintenance of general anaesthesia. Before the end of surgery paracetamol, tramadol and morphine were administered. Visual analogue scale (VAS 0–100 mm) at rest and with cough was applied in three moments: in recovery room (T1 at admission and T2 before discharge) and 24 h after surgery (T3). Pain scores with incentive spirometer were also evaluated at T3. In recovery, morphine was administered as a rescue drug whenever VAS > 30 mm. Time to oral intake, chair sitting, ambulation and length of hospital stay were evaluated 24 h after surgery. Statistical analysis: Student's *t*-test and Chi-squared test, and linear regression models. A *p*-value < 0.05 was considered significant. Data are presented as mean (SD).

Results: Forty patients were enrolled in the study. The primary outcome variable, VAS pain scores did not show a statistical significant difference between groups (*p* > 0.05). VAS at rest (TAP vs. TSI groups) was: T1 = 33 ± 29 vs. 39 ± 32, T2 = 10 ± 9 vs. 17 ± 18 and T3 = 7 ± 12 vs. 10 ± 18. VAS with cough (TAP vs. TSI groups) was: T1 = 51 ± 34 vs. 45 ± 32, T2 = 24 ± 24 vs. 33 ± 23 and T3 = 20 ± 23 vs. 23 ± 23. VAS with incentive spirometer (TAP vs. TSI groups) was: T3 = 21 ± 27 vs. 21 ± 25. Intraoperative

[☆] This study was conducted at Centro Hospitalar do Porto (CHP), Porto, Portugal.

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<http://dx.doi.org/10.1016/j.bjane.2016.08.004>

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Please cite this article in press as: Araújo AM, et al. Post-operative pain after ultrasound transversus abdominis plane block versus trocar site infiltration in laparoscopic nephrectomy: a prospective study. Rev Bras Anesthesiol. 2016. <http://dx.doi.org/10.1016/j.bjane.2016.08.004>

PALAVRAS-CHAVE

Analgesia multimodal;
Nefrectomia laparoscópica;
Bloqueio TAP guiado por ultrassom

remifentanil consumption was similar between TAP (0.16 ± 0.07 mcg/kg/min) and TSI (0.18 ± 0.9 mcg/kg/min) groups. There were no differences in opioid consumption between TAP (4.4 ± 3.49 mg) and TSI (6.87 ± 4.83 mg) groups during recovery. Functional recovery parameters were not statistically different between groups.

Conclusions: Multimodal analgesia with TAP block did not show a significant clinical benefit compared with trocar site infiltration in laparoscopic nephrectomies.

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Dor no período pós-operatório de nefrectomia laparoscópica com bloqueio do plano transversal abdominal guiado por ultrassom versus infiltração do sítio do trocarte: um estudo prospectivo

Resumo

Justificativa: O bloqueio do plano transversal abdominal (TAP) é útil para reduzir a dor no pós-operatório de nefrectomia laparoscópica comparado ao placebo. O objetivo deste estudo foi comparar a dor no pós-operatório e a recuperação após bloqueio TAP ou infiltração do sítio do trocarte (TSI) nesse tipo de cirurgia.

Métodos: Estudo prospectivo e cego com pacientes agendados para nefrectomia laparoscópica. Os pacientes foram divididos em dois grupos: Grupo TSI: infiltração do sítio do trocarte ao final da cirurgia; Grupo TAP: bloqueio TAP unilateral guiado por ultrassom após a indução. Sevoflurano e remifentanil, administrados em perfusão alvo-controlada, foram usados para a manutenção da anestesia geral. Antes do final da cirurgia, paracetamol, tramadol e morfina foram administrados. Escala analógica visual (VAS 0–100 mm), para avaliar a dor em repouso e durante a tosse, foi aplicada em três momentos: na sala de recuperação [na admissão (T1) e antes da alta (T2)] e 24 horas após a cirurgia (T3). Os escores de dor com espirômetro de incentivo também foram avaliados em T3. Durante a recuperação, morfina foi administrada como medicamento de resgate, sempre que VAS >30 mm. Os tempos até a ingestão oral, sentar em cadeira, deambulação e de permanência hospitalar foram avaliados 24 horas após a cirurgia. Análise estatística: teste-t de Student, teste do qui-quadrado e modelos de regressão linear. Um valor de $p < 0,05$ foi considerado significativo. Os dados foram expressos em média (DP).

Resultados: Quarenta pacientes foram incluídos no estudo. Os escores do desfecho primário e da VAS não apresentaram diferença estatística significativa entre os grupos ($p > 0,05$). Os escores VAS em repouso (TAP vs. TSI) foram: T1 = 33 ± 29 vs. 39 ± 32 ; T2 = 10 ± 9 vs. 17 ± 18 e T3 = 7 ± 12 vs. 10 ± 18 . Os escores VAS durante a tosse (TAP vs. TSI) foram: T1 = 51 ± 34 vs. 45 ± 32 ; T2 = 24 ± 24 vs. 33 ± 23 e T3 = 20 ± 23 vs. 23 ± 23 . Os escores VAS com espirômetro de incentivo (TAP vs. TSI) foram: T3 = 21 ± 27 vs. 21 ± 25 . O consumo de remifentanil no intra-operatório foi semelhante entre os grupos TAP ($0,16 \pm 0,07$ mcg/kg/min) e TSI ($0,18 \pm 0,9$ mcg/kg/min). Não houve diferença no consumo de opiáceos entre os grupos TAP ($4,4 \pm 3,49$ mg) e TSI ($6,87 \pm 4,83$ mg) durante a recuperação. Os parâmetros funcionais de recuperação não foram estatisticamente diferentes entre os grupos.

Conclusões: A analgesia multimodal com bloqueio TAP não mostrou benefício clínico significativo comparado à infiltração do sítio do trocarte em nefrectomia laparoscópica.

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Introduction

Laparoscopic techniques are widely used in different urologic procedures since 1990s¹ with proved patients benefits including less post-operative pain. A multimodal pain management approach with non-steroidal anti-inflammatory drugs, opioids and loco-regional techniques have been recommended for laparoscopic surgery.²

The transversus abdominis plane (TAP) block is a loco-regional anaesthetic technique that blocks neural afferents of the anterolateral abdominal wall (from T6 to L1). Local anaesthetics are injected into the transversus abdominis fascia plane guided by ultrasound or anatomical landmark guidance. This technique has been used for post-operative pain control after gynaecologic and abdominal surgery.³ The ultrasound-guided TAP has been assessed in randomized

controlled trials for colorectal, caesarean, cholecystectomy, hysterectomy, inguinal hernia surgery, appendectomy, nephrectomy, gastrectomy and bariatric surgery.⁴

Concerning urologic procedures, two randomized controlled trials in living-donor nephrectomy compared TAP with placebo. In both studies, lower mean opioid consumption in the first 24 h and lower postoperative visual analogue scale (VAS) scores were demonstrated.^{5,6} However, these studies did not compare TAP block with other loco-regional technique, they did not measure intraoperative opioid consumption and they did not evaluate the quality of recovery.

The aim of this study was to compare post-operative pain scores in laparoscopic nephrectomies using TAP block or trocar site infiltration. Additionally, this study intended to evaluate perioperative opioid consumption and quality of functional recovery with both loco-regional techniques.

Methods

Ethical issues

The study was performed after Hospital Review Board and Ethical Committee approvals IRB: N/REF. 2014.013(011-DEFI/013-CES). Either TAP block or trocar site infiltration is standard practice in the hospital.

Ropivacaine was the local anaesthetic of choice; it is approved for perineural administration by United States Food and Drug Administration (FDA) and National Authority of Medicines and Health Products (INFARMED).

On the day before surgery all patients received both written and oral information regarding the trial and signed informed consent. Patients were also instructed in the use of an ungraded 100 mm VAS and trained in the use of an incentive spirometer.

Anaesthetic protocol and surgical technique

Patients were assigned to receive a TAP block (TAP group) or trocar site infiltration (TSI group) by the principal investigator, according to the expertise of allocated anaesthetist in TAP blocks performance. The patients and the investigator providing postoperative evaluation were blinded to group assignments.

Adult patients, ASA physical status I to III, 18 years of age or older, scheduled for elective laparoscopic nephrectomy were included. Exclusion criteria were as follows: inability to understand Portuguese, relevant drug allergy, alcohol or drug abuse, daily opioids intake, consumption of pain medication within 24 h before surgery and infection at the injection site.

All patients received a standardized anaesthetic protocol: induction of general anaesthesia with propofol 1–2 mg/kg, rocuronium 0.6 mg/kg and remifentanyl using a target controlled infusion device (Orchestra® Base Primea – Fresenius Kabi), with Minto's model considering an effect-site concentration of 2.5 ng/mL. After orotracheal intubation, remifentanyl effect-site target decreased to 1.5 ng/mL and, prior to incision, remifentanyl effect-site concentration was increased to 3.5 ng/mL. Anaesthesia was maintained with sevoflurane and remifentanyl in order to keep bispectral index values between 40 and 60, mean

arterial pressure and heart rate in a 10–20% interval in relation to pre-operative values. During surgery, remifentanyl effect-site target was adjusted by 0.5 ng/mL changes according to physiologic parameters. Remifentanyl infusion was stopped immediately after the end of surgery and neuromuscular blockade was reversed according to train-of-four monitoring.

Thirty minutes before the end of surgery intravenous paracetamol 1000 mg, tramadol 100 mg and morphine 0.05 mg/kg were administered to all patients.

The laparoscopic procedure was performed with 4 ports for left nephrectomy (three 5 mm ports and one 10 mm port) and 5 ports for right nephrectomy (three 5 mm ports and two 10 mm ports). In both situations, a 10 mm port was extended to 60–70 mm for kidney removal. Pneumoperitoneum was maintained around 12 mmHg for all procedure.

In the post-anaesthesia care unit, intravenous bolus dose of 2 mg morphine was administered every 10 min if VAS scores were higher than 30 mm.

In the ward, postoperative analgesic regimen included intravenous paracetamol 1000 mg every 8 h and intravenous tramadol 100 mg every 6 h. For nausea and vomiting prophylaxis, intravenous ondansetron (4 mg) was given every 8 h.

Interventions

In the TAP group, a unilateral TAP block was performed by an anaesthesiologist after anaesthesia induction. The ultrasound probe was placed in the midaxillary line between the iliac crest and costal margin. The external oblique, internal oblique and transversus abdominis muscles and their fascia were identified. A 21 gauge, 50 mm needle (Echoplex®, Vygon, United Kingdom) was introduced anteriorly *in plane* with the ultrasound probe and ropivacaine 0.375% in a total volume of 30 mL was injected after confirming the correct needle positioning.

In the TSI group, the port site infiltration was performed by the surgeon immediately before port site suture. The skin, subcutaneous tissue and deep abdominal fascia of each port site edge were infiltrated with 30 mL of ropivacaine 0.375%, according to port site size.

Outcomes

Primary outcomes were VAS pain scores at rest and while coughing at admission in post-anaesthesia care unit (T1), immediately before post-anaesthesia care unit discharge (T2) and 24 h after the surgery (T3) and VAS pain scores with incentive spirometer efforts 24 h after the surgery (T3).

Secondary outcomes were remifentanyl consumption in the intraoperative period, morphine administration in the post-anaesthesia care unit and quality of functional recovery 24 h after the surgery considering time to oral intake, chair sitting, ambulation and length of hospital stay.

Sample size

We based our sample size calculation in a previous randomized controlled trial in living-donor nephrectomy comparing

Table 1 Patient demographic characteristics and perioperative data.

Variables	TAP group	TSI group
<i>Local anaesthetic technique^a</i>	TAP block	TSI
<i>Age (years)^a</i>	53.21 (16.32)	53.10 (13.72)
<i>Gender^a</i>		
Female	11	16
Male	8	4
<i>Weight (kg)^a</i>	69.47 (12.10)	71.15 (15.92)
<i>Height (cm)</i>	164.63 (9.27)	162.80 (6.48)
<i>LBM (kg)</i>	49.86 (7.97)	48.26 (7.37)
<i>ASA classification^a</i>		
ASA I	7	6
ASA II	11	12
ASA III	1	2
<i>Duration of surgery (min)^a</i>	156.05 (47.84)	154.30 (35.47)

Data are presented as frequency or mean (SD).

^a Input variables for multivariate linear model.

ASA, American Society of Anaesthesiology; LBM, lean body mass; TAP, transverse abdominal plane; TSI, trocar site infiltration.

TAP versus placebo.⁵ In this study, the anticipated VAS score at 24 h was 19 mm (SD 15 mm). We considered a 20% reduction in VAS pain scores to be of clinical relevance. Considering an α error of 0.05 and a $1 - \beta$ error of 0.8, a sample size calculation has determined 20 patients in each group.

Statistical methodology

Statistical analysis was performed using IBM SPSS statistics version 21. Categorical variables are presented as frequency and percentage and continuous variables are presented as mean \pm standard deviation (SD). For comparison between groups, the Student's *t*-test and Chi-squared test were used for continuous variables and categorical variables, respec-

tively. Multivariate linear modelling was used to identify independent risk factors for VAS scores (at rest, with cough and with incentive spirometer), including patient baseline characteristics (age, gender, weight, ASA classification), morphine consumption and time of surgery. The Pearson correlation coefficient (*r*) was used to analyze the correlations between remifentanyl consumption and time of surgery and VAS score at recovery room admission. A *p*-value < 0.05 was considered to be statistically significant.

Results

Forty-two patients were eligible for participation in the study from February 2014 to November 2014. Two patients were excluded because of pain medication consumption within 24 h before surgery and 40 patients were recruited and assigned to their treatment group. One patient with a surgical complication initiated patient controlled analgesia with morphine in the recovery room and was later excluded from final analysis, resulting in 39 patients in the final analyses. All ultrasound guided TAP blocks were performed without complications. Patient's demographics and perioperative data are presented in Table 1; there were no differences between groups. The primary outcome variables, VAS pain scores at rest and while coughing in the recovery room at admission (T1) and before discharge (T2) and 24 h after surgery (T3) show no statistically significant difference between TAP and TSI groups. VAS pain scores with incentive spirometer 24 h after surgery (T3) also showed no statistically significant difference between TAP and TSI groups. VAS pain scores at each time point (T1, T2 and T3) are depicted in Table 2.

Additionally, remifentanyl consumption intraoperatively, morphine administration in the recovery room and functional recovery variables did not demonstrate any statistically significant difference between groups (Tables 2 and 3). Time to oral intake was <6 h in the majority of patients in both groups (TAP 89%; TSI 65%); time to chair sitting occurred mostly between 12 h and 18 h (TAP 74%; TSI 65%) and time to ambulation was initiated more frequently

Table 2 Primary and secondary outcomes.

Variables	TAP group	TSI group	<i>p</i> -Value
VAS-R T1 (mm) ^a	32.79 (29.45)	39.40 (32.23)	0.509
VAS-R T2 (mm) ^a	10.11 (9.57)	16.75 (18.08)	0.159
VAS-R T3 (mm) ^a	7.21 (12.35)	10.45 (18.05)	0.519
VAS-C T1 (mm) ^a	44.63 (31.89)	50.95 (33.60)	0.551
VAS-C T2 (mm) ^a	23.74 (23.81)	32.90 (22.78)	0.227
VAS-C T3 (mm) ^a	20.16 (23.23)	22.75 (23.24)	0.730
VAS-S T3 (mm) ^a	21.06 (26.67)	20.63 (25.23)	0.962
Remifentanyl consumption (mcg)	1247.11 (630.27)	1284.05 (583.91)	0.854
Remifentanyl consumption (mcg/LBM/min)	0.16 (0.07)	0.18 (0.09)	0.541
Morphine consumption at recovery room (mg) ^b	4.40 (3.49)	6.87 (4.83)	0.077

Data are presented as mean (SD).

^a Output variables for multivariate linear model.

^b Input variables for multivariate linear model.

T1, recovery room admission; T2, recovery room discharge; T3, 24 h postoperative; TAP, transverse abdominal plane; TSI, trocar site infiltration; VAS-R, visual analogue scale score at rest; VAS-C, visual analogue scale score while coughing; VAS-S, visual analogue scale with incentive spirometer.

Table 3 Functional recovery variables.

Variables	TAP group	TSI group	p-Value
<i>Time to oral intake</i>			0.303
<6 h	17	13	
≥6–12 h	1	2	
>12–18 h	1	4	
>18–24 h	0	0	
>24 h	0	1	
<i>Chair sitting</i>			0.323
<6 h	0	0	
≥6–12 h	0	1	
>12–18 h	14	13	
>18–24 h	4	2	
>24 h	1	4	
<i>Ambulation</i>			0.229
<6 h	0	0	
≥6–12 h	0	1	
12–18 h	7	9	
>18–24 h	8	3	
>24 h	4	7	
Length of hospital stay (days)	3.84 (0.96)	4.20 (1.70)	0.422

Data are presented as nominal values or mean (SD).
TAP, transverse abdominal plane; TSI, trocar site infiltration.

between 12 h and 24 h (TAP 79%; TSI 60%). There were also no significant differences in length of hospital stay between groups (TAP \approx TSI \approx 4 days).

The multivariate linear regression did not identify any significant independent factor among patient demographic characteristics and VAS score at rest in the recovery room admission. However, the multivariate linear regression for VAS scores revealed that morphine consumption was an independent predictor of incentive spirometer VAS score.

With respect to the correlation analysis, it has been observed that remifentanyl consumption and VAS score at rest in recovery room admission was correlated at a significant level ($r=0.472$; $p=0.003$). Additionally, the correlation analysis identified that morphine consumption in the recovery room and incentive spirometer VAS scores were correlated at a significant level ($r=0.373$, $p=0.035$).

No adverse effects or complications related to TAP block or trocar site infiltration were reported.

Discussion

Laparoscopic surgery may be associated with reduced surgical trauma response and shortened convalescence when compared with open procedures. However, early post-operative pain is a frequent complaint among patients. Accordingly, peripheral loco-regional techniques for post-operative pain relief are an attractive approach which may improve early pain control and minimize the need for opioids.⁷ Although the use of incisional and intraperitoneal local anaesthetics is a common practice, TAP block has recently become more popular owing to the ultrasound guidance practice. Actually, the ultrasound-guided TAP block has been used and evaluated in randomized controlled trials for

various types of surgery.⁴ Nonetheless, these results highlight the substantial heterogeneity from available trials.⁸

Our study shows that VAS scores had no statistically significant difference between TAP and trocar site infiltration groups. Additionally, our results show that intraoperative remifentanyl consumption and morphine administration in the recovery room did not demonstrate any statistically significant difference between groups. These results do not disagree with the previous published trials in donor laparoscopic nephrectomies, which stated that TAP block was associated with a lower postoperative VAS score and a lower mean opioid consumption in the first 24 h since the mentioned trials were placebo-controlled and port infiltration with local anaesthetic was not accomplished.

Our results can be explained considering that TAP block provides analgesia to the skin, to subcutaneous tissue and to parietal peritoneum. As a result, TAP block is not effective in the control of visceral pain and it should be always executed as an additional component within multimodal analgesia. When trocar site infiltration is correctly performed, the same anatomic planes will be covered by local anaesthetic. In fact, it has already been discussed in a previous trial³ evaluating TAP block in cholecystectomy surgeries that TAP block may be unnecessary considering pain levels and port infiltration with local anaesthetic may be a better option. Furthermore, there is no agreement about the local anaesthetic distribution after a single-injection TAP block, since some studies establish an extension from T7 to L1 and others, an extension from T10 to L1. The highest spreading observed with the ultrasound-guided technique was T7 by oblique subcostal TAP block, T9 by the mid-axillary approach and T4 to L1 by the posterior approach. Actually, the randomized clinical trials are poorly correlated to the anticipated extension and consequently the TAP blocks are not all equivalent. The technical approach significantly modifies the pharmacodynamics and the subsequent analgesic characteristics.⁴ In addition, despite local anaesthetic has been used to prevent sensitization of nociceptors before surgical incision,² our results did not show a significant difference in opioid consumption between TAP block performed before surgical incision and port site infiltration performed at the end of surgery.

In this study morphine consumption was an independent predictor of incentive spirometer VAS scores. Although the regression only had accuracy close to 30%, it identified an important correlation between VAS and the morphine consumption, suggesting that some patients with superior opioid requirements in the recovery room may benefit from other analgesic strategies in order to reduce pain with respiratory efforts in the day after surgery.

Our results also show no differences in time to oral intake, chair sitting and ambulation between groups. According to the literature, functional recovery after laparoscopic nephrectomies has been evaluated in comparison to open procedures. Acar et al.⁹ evaluated functional recovery using pethidine patient-controlled analgesia. They showed that mean time to oral intake in the laparoscopic group was 19 h and ambulation started 14 h after surgery. In our study the majority of patients started oral intake in less than 6 h which may be associated with an overall reduction in opioid consumption and its side effects. Our results related to ambulation time were not superior. The

effectiveness of TAP block has already been evaluated only after gynaecologic laparoscopic surgery. De Oliveira et al.¹⁰ concluded TAP block provided earlier discharge readiness that was associated with better quality of recovery. However, this study was placebo-controlled.

There are potential limitations associated to our study. Firstly, although the TAP blocks were performed under ultrasound guidance by an experience anaesthetist, pinprick sensation was not used to assess sensory blockage and the effectiveness of TAP block. However, this was circumvented in the present trial to attain patient blinding. Additionally, the anaesthetist allocated to the urologic surgery operative room was not blind to the studied group. Simultaneously, the TAP blocks were performed by different operators which also introduce variability to the effectiveness of the technique.

In this study, multimodal analgesia with TAP block or with trocar site infiltration was an effective technique for post-operative analgesia in laparoscopic nephrectomies.

Conflicts of interest

The authors declare no conflicts of interest.

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