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Original Article

Prospective study of ultrasound-guided peri-plexus interscalene block with continuous infusion catheter for arthroscopic rotator cuff repair and postoperative pain control☆

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ABSTRACT

Objective: This trial investigated postoperative analgesia in arthroscopic rotator cuff repair surgery patients under general anesthesia, associated with ultrasound-guided peri-plexus interscalene brachial plexus block (US-IBPB), and compared single injection to elastomeric pump continuous infusion of local anesthetics. Complications associated to both techniques are described.

Methods: In this prospective, quasi-randomized controlled clinical trial, 68 adults scheduled for elective arthroscopic rotator cuff repair were assigned to receive Group 1 (G1 = 41) US-IBPB with a 20 mL injection of 0.5% peri-plexus ropivacaine, introduction of catheter, injection of 20 mL of 0.5% ropivacaine through continuous catheter infusion of local anesthetic by elastomeric pump (ropivacaine 0.2%, infusion of 5 mL/h). In Group 2 (G2 = 27), US-IBPB, with a single peri-plexus injection of 40 mL ropivacaine 0.5%. In both groups oral analgesics were prescribed, paracetamol 500 mg associated to codeine 30 mg for patients with VAS between 3 and 5, and also oxycodone 20 mg for VAS ≥ 6. The anesthesiology team was available through contact telephones and the patients received a table to complete in order to report pain intensity according to VAS, use of oral medication, and complications related to the catheter and pump, until the third postoperative day.

Results: The intensity of pain was higher on second day after surgery than on days 1 and 3, in both groups confirmed by the ANOVA test ($p = 0.00006$) Among the groups, G1 patients had lower pain intensity than G2, ($p = 0.000197$). G2 patients presented greater pain intensity during all periods studied (days 1, 2, and 3) than G1 patients. Postoperatively, G2 patients had higher consumption of rescue analgesics, nausea, and vomiting (40.74%) *vs.* G1 (5%) and

☆ Study conducted at the Hospital Orthomed Center, Uberlândia, MG, Brazil.

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dizziness (25.92%). No patient with catheter and elastomeric pump (G1) had complications regarding its insertion and maintenance during postoperative period.
Conclusion: The quality of analgesia for arthroscopic rotator cuff repair with peri-plexus US-IBPB and continuous infusion with elastomeric pump presented superior postoperative analgesia quality to single puncture IBPB on postoperative days 2 and 3, with lower consumption of rescue opioids in this period.

Estudo prospectivo do bloqueio interscalênico periplexo guiado por ultrassom com cateter de infusão contínua para reparo artroscópico do manguito rotador e controle pós-operatório da dor

Palavras-chave:
Manguito rotador
Artroscópico
Ombro
Dor pós-operatória
Plexo braquial

RESUMO

Objetivo: Esse estudo investigou a analgesia pós-operatória em pacientes submetidos a cirurgia de reparo artroscópico do manguito rotador sob anestesia geral, associada ao bloqueio interescalênico periplexo guiado por ultrassom (BIPB-US), comparando injeção única com a infusão contínua de anestésicos locais com bomba contínua de elastômero. As complicações associadas a ambas as técnicas são descritas.
Métodos: Neste estudo clínico prospectivo, controlado e quase randomizado, 68 adultos programados para reparo artroscópico eletivo do manguito rotador foram designados para o Grupo 1 (G1 = 41) sumetidos à US-IBPB com uma injeção de 20 mL de ropivacaína periplexo a 0,5%, introdução de cateter e 20 mL de ropivacaína a 0,5% por meio de infusão contínua de anestesia local por bomba elastomérica (ropivacaína 0,2%, infusão de 5 mL/h). No Grupo 2 (G2 = 27), os pacientes foram submetidos à BIPB-US com uma única injeção periplexo de 40 mL de ropivacaína 0,5%. Em ambos os grupos, foram prescritos analgésicos orais: paracetamol 500 mg associado a codeína 30 mg para pacientes com VAS entre 3 e 5, e a mesma combinação associada a oxicodona 20 mg para aqueles com VAS $\geq$ 6. A equipe de anestesiologia estava disponível através de telefones de contato e os pacientes receberam uma tabela para relatar a intensidade da dor de acordo com aVAS, uso de medicação oral e complicações relacionadas ao cateter e à bomba, até o terceiro dia pós-operatório.
Resultados: A intensidade da dor foi maior no segundo dia após a cirurgia do que nos dias 1 e 3, em ambos os grupos, confirmado pelo teste ANOVA (p = 0,00006). Entre os grupos, os pacientes do G1 apresentaram menor intensidade de dor do que os do G2, (p = 0.000197). Os pacientes do G2 apresentaram maior intensidade de dor durante todos os períodos estudados (dias 1, 2 e 3) do que pacientes com G1. No pós-operatório, os pacientes com G2 apresentaram maior consumo de analgésicos de resgate, náuseas e vômitos (40,74%) *vs*. G1 (5%) e tonturas (25,92%). Nenhum paciente com cateter e bomba elastomérica (G1) apresentou complicações quanto à inserção e manutenção durante o pós-operatório.
Conclusão: A qualidade da analgesia para reparo artroscópico do manguito rotador com BIPB-US periplexo e infusão contínua com bomba elastomérica apresentou qualidade de analgesia pós-operatória superior à da IBPB de punção única no segundo e terceiro dias pós-operatórios, com menor consumo de opioides de resgate neste período.

Introduction

Surgical treatment of arthroscopic rotator cuff repair (ARCR), of total thickness rupture, is associated with a significant postoperative pain in the first 72 hours, which can be exacerbated by movements and rehabilitation therapy.[1] Peripheral nerve blocks such as interscalene brachial plexus block, paravertebral cervical block, suprascapular block associated to axilar nerve block, subacromial block or intra articular injection of analgesics can be associated to general anesthesia, to improve pain control in patients submitted to shoulder arthroscopy.[1]

The ultrasound-guided interscalene brachial plexus block (US-IBPB) technique allows precise visualization of adjacent nerves and structures, making the procedure safer, since paresthesia techniques, as well as those associated with a peripheral nerve stimulator, require extreme proximity or direct contact between the needle and the nerve.[2]

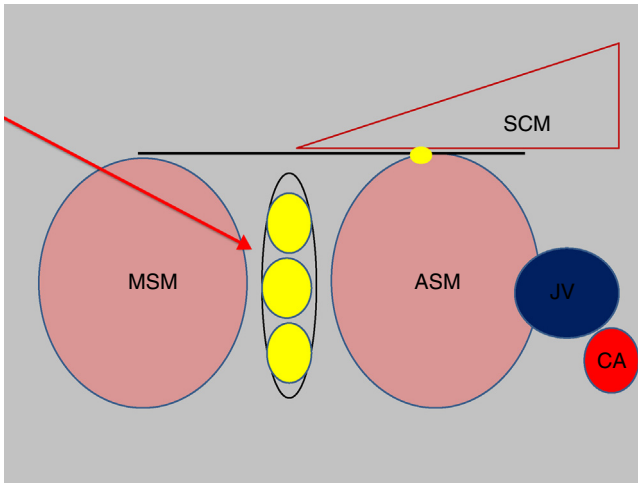

Fig. 1 – Peri-plexus technique (between fascial layer of the plexus and fascial layer of middle scalene muscle), less invasive.

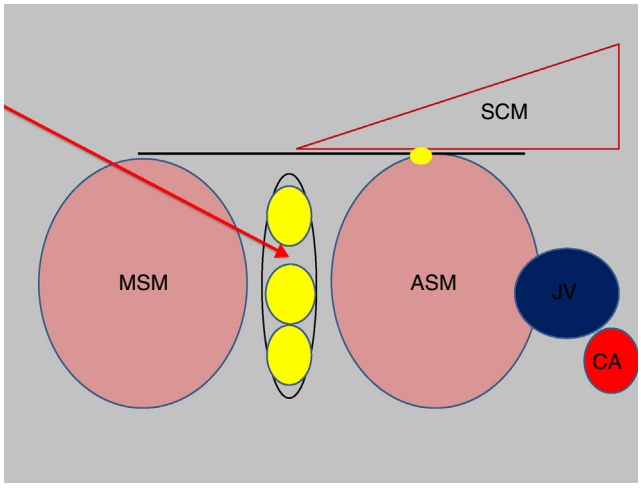

Fig. 2 – Intra-plexus technique (inside fascial layer of middle scalene muscle), more invasive.

Interscalene brachial plexus block anesthesia for ARCRs patients, using single injection or continuous infusion of local anesthetics, associated to general anesthesia,[3] may be performed in a less invasive manner with peri-plexus injection (Fig. 1), in which the anesthetic is injected out of the sheath, between it and the fascia of median scalene muscle, which was proven to be as effective as intra-plexus, but safer.[4] The more invasive intra-plexus technique (Fig. 2), where anesthetic is injected into the sheath of connective tissue that surrounds the plexus, is generally associated to a greater number of complications.[4]

Disposable elastomeric pumps can also provide safe pain control due to a non-electronic device, for outpatient use, that allows continuous infusion of 12 hours to seven days, depending on their configuration. They are designed for outpatient drug therapies that require slow and continuous infusion.[5]

This study aimed to evaluate postoperative analgesia in ARCR surgery patients under general anesthesia, associated with ultrasound-guided peri-plexus ISBPB, comparing single injection to elastomeric pump continuous infusion of local anesthetics. We also described complications associated to both techniques.

Patients and methods

After obtaining informed consent and approved by our institution's ethics committee, 68 adults scheduled for elective ARCR were included in a prospective, quasi-randomized controlled clinical trial performed, from March 2013 to March 2014. Patients over 18 years of age, ASA 1 or ASA 2; who would undergo arthroscopy of shoulder and evaluated at preanesthetic consultation were included. After good explanation of the two methods, they were inquired to choose, preoperatively between one of each, single puncture or continuous block ISBPB. According by the choose, they were divided in Group 1 (interescalene block + catheter + elastomeric pump) and Group 2 (single interescalene block). Patients with neurological lesions or deficits prior to blockade and those with coagulopathy were excluded (Fig. 3).

Patients were monitored with electrocardiogram, non-invasive blood pressure, pulse oximeter and were sedated with midazolam 2 mg (IV), then submitted to rigorous technique of asepsis with alcoholic chlorhexidine, and positioned in lateral decubitus, with the limb to be anesthetized upward. After an inventory of the brachial plexus, high-frequency ultrasound with a linear transducer (MyLabTM 25 Esaote, Genoa, Italy) was used to find supraclavicular approach and the ultrasound probe was cephalad positioned to the interscalene sheath. For the blockade, Tuohy 18 needle was introduced 3 cm posterior to the probe, to in-plane approach and a 20 G catheter placed.

Patients were divided into two groups: Group 1 (G1) patients who underwent ultrasound guided IBPB with a 20 mL injection of 0.5% peri-plexus ropivacaine, with interscalene space dilatation (between the median scalene muscle fascia and brachial plexus sheath), introduction of the catheter 10 to 15 centimeters and then injection of 20 mL of 0.5% ropivacaine through catheter and analgesia with continuous infusion of local anesthetic by elastomeric pump with ropivacaine 0.2% In infusion of 5 ml/h (Fig. 4). In Group 2 (G2) the patients received ultrasound-guided ISBPB, with a single peri-plexus injection of 40 mL ropivacaine 0.5%. In both groups, oral analgesics were prescribed in the postoperative period, as codeine 30 mg with 500 mg of paracetamol and oxycodone 20 mg.

Group 1 patients were discharged 12–16 hours after the end of surgery, with catheter and continuous infusion of 0.2% ropivacaine 5 mL/h in a fixed-flow elastomeric pump of 5 ml/h (Easy Pump TM C-block RA – BBraum Germany®). On both groups oral analgesics were prescribed, paracetamol 500 mg associated to codeine 30 mg for patients with VAS between 3 and 5, and also oxycodone 20 mg for VAS $\geq$ 6. The anesthesiology team was available through contact telephones and the patients received a table to fill the pain intensity according to visual analog scale (VAS), use of oral medication and complications related to the catheter and pump, until the third postoperative day.

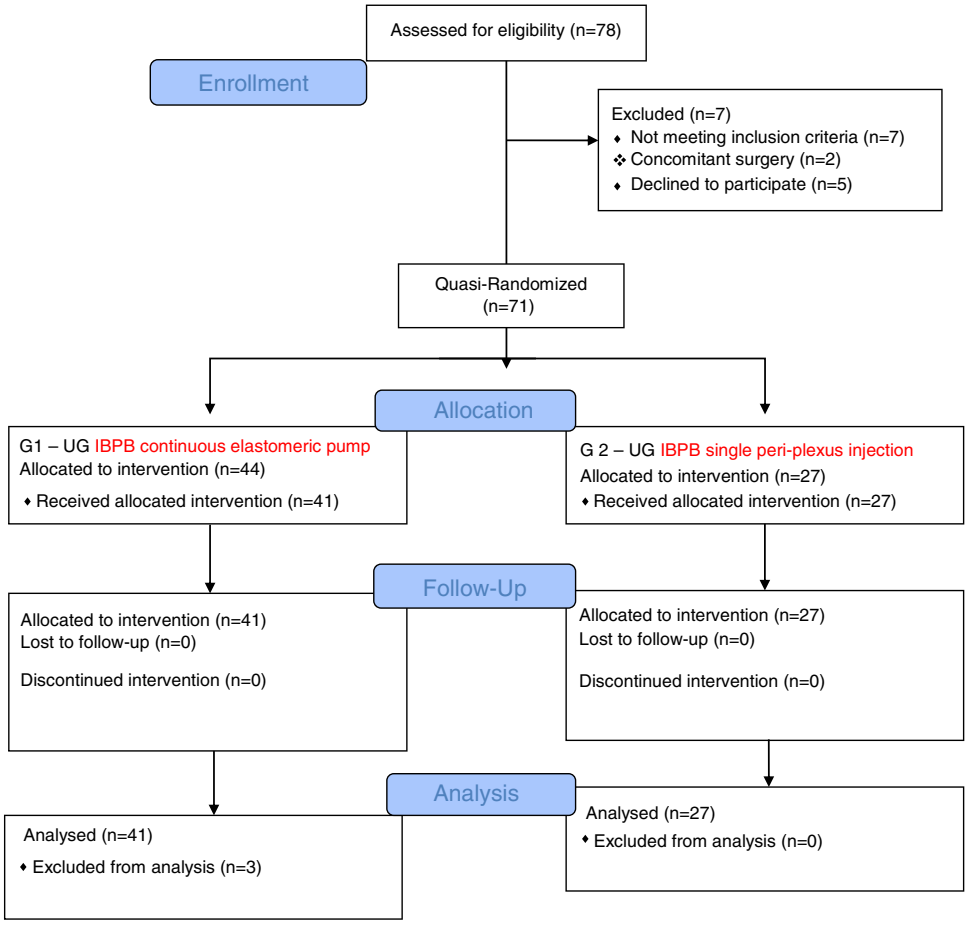

Fig. 3 – CONSORT ultrasound-guided interscalene block (UG IBPB) continuous infusion catheter for arthroscopic rotator cuff repair and postoperative pain control.

Statistical analysis

The sample size calculation took into consideration previous studies witch found that the incidence of postoperative pain was 30% after shoulder arthroscopy[6] and that association of US-IBPB decreased the frequency of postoperative pain in patients who received US-IBPB anesthesia to 7.5%[7] being the risk difference, therefore, −0.22 with the 95% confidence interval from −0.30 to −0.075. Based on such evidences, the following parameters were used to consider the sample size calculation via G*power program[8] under a z-test family (two-tailed): Alpha error probability = 0.05, Power (1−beta error probability) = 0.80, Allocation ratio = 1. It was expected large proportion differences between the two evaluated groups of US-IBPB with and without continuous infusion in order to provide evidences regarding 48hs postoperative analgesia. It was considered the proportion of analgesia Group 1 = 0.075 and Group 2 = 0.30, post-intervention. Hence, a risk difference of 0.225 was expected. Such parameters returned a sample size of maximum of 80.64 patients to Group 1 and minimum of 26.64 to Group 2 to identify 0.20 in risk difference.

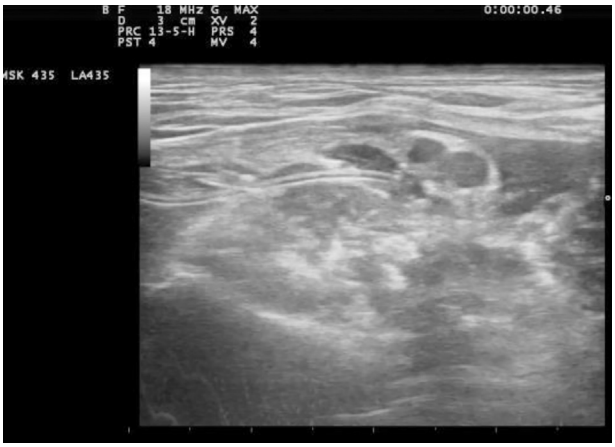

Fig. 4 – Peri-plexus catheter placement, located between fascial layer of the plexus and fascial layer of middle scalene muscle.

The SPSS software, provided by International Business Machines (IBM), was used to perform analyzes. Statistical study of anthropometric data was performed using Student's *t*-test. Analysis of variance ANOVA was used to evaluate postoperative pain scores in the periods studied (ANOVA single factor) and to evaluate the variation of scores between groups and within groups. The *F* test was used to evaluate pain intensity variances between days 1, 2 and 3, in addition to a *t*-test for two means, uni- and two-tailed, assuming that the variances between days were different.

Table 1 – Characteristics of patients in each group, Group 1 (continuous infusion) and Group 2 (single puncture).

	G1 ($n=41$)	G2 ($n=27$)	p-value
Categorical measurements: absolute values			
Masculine	$n=18$ (43.90)	$n=12$ (44.44)	Total: 30
Feminine	$n=23$ (56.09)	$n=15$ (55.55)	Total: 38
Continuous measurements: mean (SD)			
Age (years)	58.32 (13.41)	46.48 (14.76)	0.0011
Weight (kg)	81.56 (15.90)	77.52 (14.39)	0.2909
Height (m)	1.66 (0.10)	1.68 (0.09)	0.3735
Surgery duration (min)	139.86 (34.83)	133.52 (26.56)	0.4309

Data shown as mean and standard deviation.

Table 2 – Need for systemic analgesia with codeine/paracetamol and oxycodone on days 1, 2 and 3.

Day after surgery	Group	Codeine/ paracetamol	Oxycodone
Day 1	G1 ($n=41$)	11 (26.82%)	2 (4.87%)
	G2 ($n=27$)	20 (74.07%)	15 (55.55%)
Day 2	G1 ($n=41$)	8 (19.51%)	1 (2.43%)
	G2 ($n=27$)	23 (85.18%)	17 (62.96%)
Day 3	G1 ($n=41$)	6 (14.63%)	1 (2.43%)
	G2 ($n=27$)	21 (77.77%)	13 (48.14%)

Data presented in total of patients who took the medication in the postoperative period.

Statistical study of anthropometric data was performed using Student's *t*-test. Analysis of variance ANOVA was used to evaluate postoperative pain scores in the periods studied (ANOVA single factor) and to evaluate the variation of scores between groups and within groups. The *F* test was used to evaluate pain intensity variances between days 1, 2 and 3, in addition to a *t*-test for two means, uni and two-tailed, assuming that the variances between days were different. In order to know if the patients in the study (G1) presented greater or less pain intensity than those of the control (G2), the ANOVA, *F* test and *t* test were also used. In all tests, the rejection level of the null hypothesis was set at 5%, with significant values being marked with an asterisk.

In order to know if the patients in the study (G1) presented greater or less pain intensity than those of the control (G2), the ANOVA, *F* test and *t* test were also used. In all tests, the rejection level of the null hypothesis was set at 5%, with significant values being marked with an asterisk.

Results

We studied 68 patients who were divided as follows: G1 with 41 patients who preferred US-IBPB under analgesia with continuous infusion and elastomeric pump and G2 with 27 patients who received US-IBPB single puncture and postoperative oral analgesia. The groups were similar for anthropometric data regarding weight, height and duration of surgery (Table 1). However, G1 patients had a mean age higher than G2, which was statistically significant. In all patients it was possible to perform US-IBPB with no complications during procedure, mainly in catheter location and infusion, as well as no failure of the block performed.

The intensity of pain was higher on 2nd day after surgery than on days 1 and 3, in both groups, confirmed by the ANOVA test ($p=0.00006$) and *F* tests ($p=0.00081$). The *t* test confirmed the highest intensity of pain on day 2 ($p=0.00125$). Among the groups, G1 patients had lower pain intensity than G2, ($p=0.000197$) after ANOVA test, with statistical significance. Variations in pain intensity measured by VAS, distributed along days 1 to 3, are shown in Fig. 5. Group 2 patients presented greater pain intensity during all periods studied (days 1, 2 and 3) than patients of G1.

In the postoperative period, patients of G2 had higher consumption of rescue analgesics than G1 (Table 2). Nausea and vomiting was more prevalent in G2 patients (40.74%) compared to G1 (5%). Dizziness was reported in 2.5% of G1 patients and 25.92% of G2. It is worth noting that no patient with catheter and elastomeric pump (G1) had complications in its insertion and maintenance during postoperative period.

Discussion

The quality of analgesia in patients submitted to ultrasound guided US-IBPB and continuous infusion using elastomeric

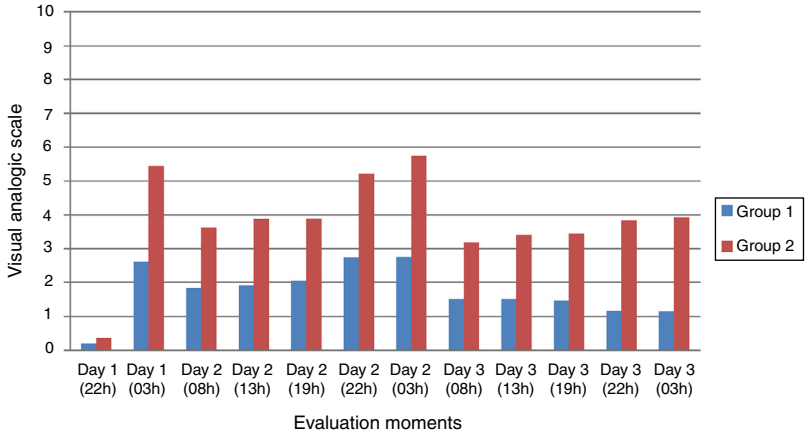

Fig. 5 – Variations of pain intensity assessed by visual analog scale in different evaluation moments during postoperative period.

pump for ARCR surgery was superior to the single puncture US-IBPB, in our study. The overall quality of analgesia was lower on the second postoperative day, mainly in patients who had single-puncture US-IBPB in contrast to better results in the group that had continuous analgesia. Interscalene blocks are gold standard for analgesia in shoulder surgeries. However, the duration of analgesia is directly related to local anesthetic duration time[9] and rescue analgesic medication is often necessary for postoperative analgesia, coincidently on second postoperative day.[10] The regional block technique was probably superior to systemic analgesia in this type of surgery, mostly on early postoperative period and patients who received no continuous analgesia had higher pain scores on the second and third postoperative day.

Bjornholdt et al.[10] evaluated postoperative analgesia for shoulder arthroplasty comparing US-IBPB catheter patient-controlled analgesia (PCA) and local infiltration analgesia (LIA), and found that despite perioperative opioid consumption being similar in both groups, postoperative analgesia in LIA group was worse when compared to continuous US-IBPB. However, in this study there were also unsatisfactory results in US-IBPB group due to the high failure rate of infusion by catheter displacement. Fredrickson et al.[9] reviewed the techniques used in postoperative analgesia for shoulder surgeries and concluded that IBPB continuous analgesia was superior to supraclavicular block analgesia and that LIA was ineffective and could cause serious damage, since it had been associated with postoperative severe chondrolysis in some patients. However, these authors emphasized that regional blocking techniques such as US-IBPB only should be performed by trained professionals.

In our study, no patient presented complications due to catheter insertion and continuous analgesia. The high success rate should probably be related to massive training, with positive results, since all US-IBPB were performed by the same anesthesiologist with experience in ultrasound-guided regional analgesia and also to the peri-plexus technique used to perform the blocks. Intra-plexus blocks were initially considered the best technique to perform IBPB, with injection of local anesthetic around the neural structure that formed a black halo, called "donut sign". According to Spence et al.,[4] this signal is not sufficient enough for the correct performance of US-IBPB, otherwise, injection into the potential space between the median scalene muscle and the peri-plexus brachial sheath is equally effective and can avoid neural traumas of needle replacement during the blockade and postoperative dysesthesias.[11]

Continuous analgesia with elastomeric pump provides pain relief and early hospital discharge maintaining infusion during three days in home use, that provides association between comfort and effectiveness of pain relief and less use of opioids.[12,13] In orthopedic procedures, more than 40% of patients experience moderate to severe postoperative pain at home.[3] Generally, upon completion of the analgesic effect provided by the local anesthetic present in the peripheral nerve block, the patients follow a prescription with oral opioids to control postoperative pain. Unfortunately, opioids are associated with undesirable side effects, such as pruritus, nausea and vomiting, sedation and constipation.[14–16] Our results are in line with these advantages since patients who had used elastomeric pump had no complications, low intensity of pain, used less analgesic rescue medications, with less nausea and vomiting and dizziness, as well as good comfort at home.

Some limitations of the present study were that it was not possible to blind to the doctor who performed the blockade and it is possible that due to the experience of the performer, we have obtained a high success rate in the blockade and insertion of the catheters. In addition, patient randomization was not entirely random as there were financial difficulties for some patients to acquire elastomeric pump and this resulted in non-homogeneous groups in relation to age and size of each group. According to the study by Schwenk et al.,[7] with the insertion of the needle into the plane it is possible to observe the dispersion of the anesthetic injected during the execution of the blockade and the insertion of the catheter at the desired site during US-IBPB, however the final position of the catheter might not be in the ideal location since the three-dimensional view of the catheters is unreliable. Finally, our sample did not detected rare complications of catheter insertion, like entrapment in the brachial plexus, insertion into the vertebral artery or epidural space with permanent loss of cervical spinal function and subarachnoid anesthesia.[7,17–19]

Conclusion

The quality of analgesia for ARCR with ultrasound-guided peri-plexus IBPB and continuous infusion with elastomeric pump presented superior postoperative analgesia quality to the single puncture IBPB on postoperative days 2 and 3, with lower consumption of rescue opioids in this period.

Conflict of interest

The authors declare no conflicts of interest.

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