J Anesth (2013) 27:862–867
DOI 10.1007/s00540-013-1647-z

ORIGINAL ARTICLE

Postoperative analgesia after modified radical mastectomy: the efficacy of interscalene brachial plexus block

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Received: 27 September 2012 / Accepted: 17 May 2013 / Published online: 5 June 2013

Abstract
Purpose In the present study, we evaluated the effects of interscalene brachial plexus block on postoperative pain relief and morphine consumption after modified radical mastectomy (MRM).
Methods Sixty ASA I–III patients scheduled for elective unilateral MRM under general anesthesia were included. They were randomly allocated into two groups: group 1 ($n = 30$), single-injection ipsilateral interscalene brachial plexus block; group 2 ($n = 30$), control group. Postoperative analgesia was provided with IV PCA morphine during 24 h postoperatively. Pain intensity was assessed with the visual analogue scale (VAS). Morphine consumption, side effects of opioid, antiemetic requirement, and complications associated with interscalene block were recorded.
Results VAS scores were significantly lower in group 1, except in the first postoperative 24 h ($p < 0.007$). The patients without block consumed more morphine [group 1, 5 (0–40) mg; group 2, 22 (6–48) mg; $p = 0.001$]. Rescue morphine requirements were also higher in the postoperative first hour in group 2 ($p = 0.001$). Nausea and antiemetic requirements were significantly higher in group 2 ($p = 0.03$ and 0.018). Urinary retention was observed in 1 patient in group 2 and signs of Horner's syndrome in 2 patients in group 1.
Conclusions The optimal method has not been defined yet for acute pain palliation after MRM. Our study demonstrated that the use of interscalene block in patients undergoing MRM improved pain scores and reduced morphine consumption during the first 24 h postoperatively. The block can be a good alternative to other invasive regional block techniques used for postoperative pain management after MRM.

Keywords Breast · Carcinoma · Pain · Postoperative · Brachial plexus

Introduction

Modified radical mastectomy (MRM) is the common surgical procedure for breast cancer that removes a generous amount of skin, the entire breast, and the axillary contents [1]. A retrospective cohort study suggests that nearly 60 % of breast surgery patients experience severe acute postoperative pain [2]. Most of the pain originates from the axillary component of the surgery. The management of postoperative pain is important for early mobilization and the well-being of surgical patients. In addition, optimal management of acute postoperative pain may influence the development of chronic pain [3].

Oncological breast surgeries are typically performed under general anesthesia. However, general anesthesia cannot provide adequate postoperative pain control, and routine use of parenteral opioids aggravates postoperative sedation, nausea, emesis, impaired oxygenation, and depressed ventilation [4, 5]. A variety of local and regional techniques have been used to decrease the need for general anesthesia and to reduce postoperative opioid requirements: these have included local anesthetic infiltration, field block, intercostal block, brachial block, thoracal epidural analgesia, and paravertebral block [6–11]. Ipsilateral brachial plexus block with interscalene approach has been combined with thoracic epidural anesthesia for MRM

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surgery [12]. It has not been used solely for postoperative analgesia after MRM.

In the present study we hypothesized that an interscalene brachial plexus block performed at the end of surgery will improve postoperative analgesia and reduce opioid consumption after MRM.

The primary aim of our study was to evaluate the effects of interscalene brachial plexus block on postoperative pain relief and morphine consumption. Secondary outcome variables were postoperative side effects associated with interscalene block and opioid use.

Materials and methods

After obtaining approval from our Institutional Ethics Committee and written informed consent from each patient, 60 ASA physical status I–III female patients scheduled for elective unilateral MRM with axillary dissection under general anesthesia were included in this prospective study. The patients were randomly allocated into one of the two groups: the first group received a single-injection ipsilateral interscalene brachial plexus block (group 1, $n = 30$), and the other was the control group (group 2, $n = 30$). Sealed opaque envelopes were used for the randomization process. Patients with chronic obstructive pulmonary disease, renal or hepatic impairment, mental deterioration, chronic analgesic use, peripheral neuropathy, coagulation abnormalities, allergy to local anesthetics, and having a body mass index (BMI) <20 or >40 were excluded from the study. At a preoperative interview, the patients were instructed in the use of the visual analogue scale (VAS 0, no pain; 100, severe pain) and the patient-controlled analgesia (PCA) device [acute pain manager (APM); Abbott, Abbott Park, IL, USA].

Patients were premedicated with midazolam 0.07 mg/kg intramuscularly 30 min before surgery. In the operation room before performing general anesthesia, all the patients received an infusion of 5 ml/kg NaCl 0.9 %. Routine monitoring included ECG, noninvasive blood pressure, heart rate, and pulse oximeter, and the basal measurements were noted. General anesthesia was induced with 1–2 μg/kg fentanyl and 3–5 mg/kg thiopental. Tracheal intubation was facilitated with rocuronium bromide 0.6 mg/kg. Anesthesia was maintained with 1–2 % end-tidal sevoflurane in 40 % oxygen/N_2O mixture.

At the end of the operation, interscalene brachial plexus block was performed on the operative side in group 1 before extubation. The interscalene groove was identified using the landmarks described by Winnie, and the plexus was located with a 22-gauge, 50-mm short-beveled insulated needle (Stimuplex; Braun, Melsungen, Germany). The initial settings for the nerve-stimulating unit (Stimuplex) were a current of 0.8–1 mA, with pulse duration of 0.1 ms and frequency of 2 Hz. A visible motor response of the deltoid muscle stimulation at a current between 0.2 and 0.5 mA was accepted as correct needle placement. After localization of the brachial plexus and negative aspiration test for blood, 30 ml bupivacaine 0.25 % was injected in increments of 5 ml with aspiration after each incremental injection.

All patients received dexketoprofen trometamol (50 mg) and ondansetron 4 mg IV just before wound closure. Neostigmine 0.05 mg/kg with atropine 0.02 mg/kg were used for neuromuscular blockade reversal. After tracheal extubation, the patients were transferred to the postanesthesia care unit (PACU).

Postoperative analgesia was provided with IV PCA morphine adjusted to deliver PCA boluses of 1 mg with a lockout time of 10 min during the 24 h postoperatively. Pain intensity was assessed with the 100-mm visual analogue scale at 0, 1, 2, 4, 6, 12, and 24 h after the operation. When VAS pain score was ≥40, patients received a morphine 5-mg bolus as a rescue analgesic at 15-min intervals until adequate analgesia was obtained. Morphine consumption, side effects of opioid (nausea, vomiting, pruritus, urinary retention), antiemetic requirement, and complications associated with interscalene block (Horner's syndrome, dyspnea and hoarseness, spinal and epidural anesthesia, pneumothorax, and signs of local anesthetic toxicity) were recorded.

The primary outcome was postoperative morphine consumption in the 24-h period after surgery. A sample size of 22 patients per group was needed to detect at least 20 % decrease in postoperative morphine consumption at a significance level of 5 % and power of 90 %. Thus, 30 patients in each group were recruited to allow for probable dropouts from the study.

The statistical analysis was performed using SPSS 15.0 for Windows. Parametric data with normal distribution were compared by using Student's t test and abnormal distribution with the Mann–Whitney U test. Nonparametric data were compared by using the chi square test and Mann–Whitney U test with a Bonferroni correction for multiple comparisons as appropriate. A p value < 0.05 was considered significant. All data are presented as mean ± SD, median (min–max), and percent.

Results

Sixty patients were included in the present study. Patient demographic data and duration of surgery are presented in Table 1. There were no significant differences between the two groups. No patient was withdrawn from the study.

When compared with group 2, VAS pain scores were lower at all measurement times in group 1, except the postoperative 24 h ($p < 0.007$). Especially, the first two postoperative measurements were more than VAS 4 in group 2 (Fig. 1). Rescue morphine bolus requirements were also significantly

Table 1 Data of patients and duration of surgery in the two groups

	Group 1 ($n = 30$)	Group 2 ($n = 30$)	p	
Age (years)	51 ± 10	48 ± 12	0.263	$t = 1.131$
Weight (kg)	73 ± 11	72 ± 13	0.898	$t = 0.129$
ASA (I/II/III)	10/19/1	13/14/3	0.341	$\chi^2 = 2.149$
Duration of surgery (min)	187 ± 30	181 ± 34	0.482	$t = 0.708$

Values are expressed as mean ± SD; n, number of patients

Group 1, interscalene brachial plexus block group; Group 2, control group

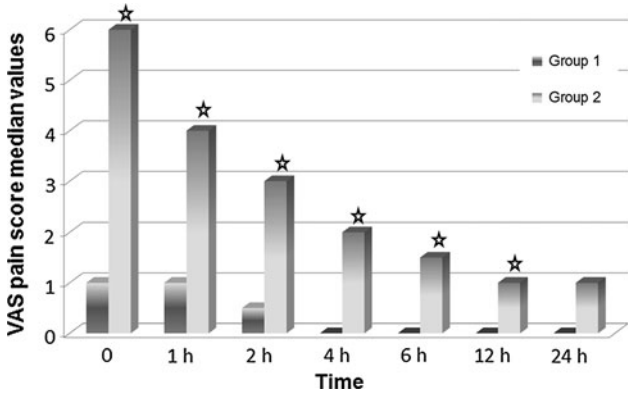

Fig. 1 Visual analogue score (*VAS*) pain scores in two groups: group 1, interscalene brachial plexus block group; group 2, control group. * Values significantly different compared between groups. Bonferroni correction was used; $p < 0.07$ was considered significant

higher in the postoperative first hour in group 2 ($p = 0.001$). The patients without interscalene brachial plexus block consumed more morphine than group 1 patients (Table 2) [group 1, 5(0–40) mg; group 2, 22 (6–48) mg; $p = 0.001$]. Delivery and demand rates of the PCA device were lower in group 1 ($p = 0.01$ and $p = 0.004$, respectively).

Intraoperative hemodynamic data were comparable between the groups. The incidences of side effects are presented in Table 3. Nausea and antiemetic requirements were significantly higher in group 2 ($p = 0.03$ and $p = 0.018$, respectively). Urinary retention was observed in one patient in group 2. None of the patients in either group had pruritus. Signs of Horner's syndrome were observed in two patients in group 1. There was no incidence of postoperative respiratory discomfort and hypoxemia ($SpO_2 <$ 90 %) or hoarseness in any patient. Two patients in this group had a small subcutaneous hematoma at the puncture site. There was no spinal and epidural anesthesia, pneumothorax, and symptoms of local anesthetic intoxication in the interscalene brachial plexus block group.

Discussion

The results of this prospective randomized study demonstrated that the use of interscalene brachial plexus block in patients undergoing MRM improved pain scores and reduced morphine consumption during the first 24 postoperative hours.

Surgery in the form either of lumpectomy, or of MRM with axillary node dissection, in combination with chemotherapy or radiotherapy, remains the treatment of choice for breast cancer. A wide variety of analgesic techniques are employed for managing postsurgical pain, which often proves difficult to treat in the early postoperative period.

The innervation of the breast is supplied mainly by the brachial plexus (C5–T1), branches of intercostal nerves (T3–T6), and the intercostobrachial nerve (T2), which convey sensation to the skin of the breast and sympathetics to the blood vessels and smooth muscle cells in the overlying skin and nipple [13, 14]. The chest wall also receives contributions from intercostobrachial nerve, thoracicus longus nerve, thoracodorsal nerve, lateral pectoral nerve, and medial pectoral nerve. The long thoracic, thoracodorsal, and intercostobrachial nerves are important to visualize as they cross through the anatomic spaces of the breast and axilla and are thus necessary to consider during dissection [13]. The skin of the axilla and upper arm is supplied by the intercostobrachial nerve. This nerve is often sacrificed during axillary node dissection, resulting in numbness of these areas [3, 13, 15]. Therefore, most of the patients experience pain in the axilla and the upper limb after surgery [3, 9]. The interscalene block provides a sensory block in the distribution of the brachial plexus and T1–T2 depending on the volume of local anesthetic. We think that the intercostobrachial nerve was blocked in all the patients because none of the patients in the study group described axillary pain. However, the intercostal nerves, which provide innervation of the skin, cannot be blocked by interscalene blockade. Thus, in our study, patients also required opioid analgesics despite the routine use of nonsteroid antiinflammatory analgesic drugs to supply postoperative analgesia.

For acute pain palliation after MRM, the optimal method has not yet been defined. In the literature, only a few studies have been reported demonstrating the efficacy of brachial plexus analgesia after breast surgery [9, 12]. Fassoulaki [9] has performed brachial plexus block using an infraclavicular approach before closure of the incision,

Table 2 Total morphine consumption, morphine bolus requirement, and delivery and demand rates

	Group 1 ($n = 30$)	Group 2 ($n = 30$)	p	
Total morphine dose (mg)	5 (0–40)	22 (6–48)	0.001*	$Z = -4.685$
Delivery rate	5 (0–40)	13 (1–33)	0.01*	$Z = -2.593$
Demand rate	6 (0–137)	21.5 (0–127)	0.004*	$Z = -2.901$
Morphine rescue bolus dose (mg)	0 (1–10)	10 (5–20)	0.001*	$Z = -6.076$
Number of patients requiring rescue morphine dose [n (%)]	8 (27 %)	30 (100 %)	0.001*	$\chi^2 = 34.737$

Values are expressed as median (minimum–maximum) and n number of patients (percent)

Group 1, interscalene brachial plexus block; Group 2, control group

* Values significantly different compared between groups

Table 3 Opioid side effects and complications caused by interscalene brachial plexus block

	Group 1 ($n = 30$)	Group 2 ($n = 30$)	p	χ^2
Nausea	14 (47 %)	25 (83 %)	0.03*	8.864
Vomiting	13 (43 %)	17 (57 %)	0.302	1.067
Antiemetic requirement	13 (43 %)	22 (73 %)	0.018*	5.554
Urinary retention	–	1 (3 %)	0.313	1.017
Pruritus	–	–		
Horner's syndrome	2 (7 %)	–		
Hoarseness	–	–		

Values are expressed as n (number of patients) (percent)

Group 1, interscalene brachial plexus block; Group 2, control group

* Values significantly different compared between groups

suggesting that this was a safe and effective technique that can be routinely used for the relief of postoperative pain in patients undergoing MRM. In their study, the block was performed by the surgeon at the infraclavicular part of the brachial plexus and also intercostal spaces were infiltrated with local anesthetic. Infraclavicular block does not provide adequate anesthesia in the shoulder, upper limb, and axilla [16]. Therefore, the postoperative analgesia in this study cannot be regarded as a unique result of brachial plexus block. Also, in the brachial plexus block group, 55 % of their patients required additional analgesics in the first 24 postoperative hours compared with 27 % in our study. Sundarathiti et al. [12] compared thoracic epidural analgesia (TEA) in combination with interscalene brachial plexus block with general anesthesia in MRM for adequacy of anesthesia, surgical condition, postoperative analgesia, anesthetic recovery, and patient satisfaction. They concluded that TEA combined with brachial block provides not only effective anesthesia but also better postoperative pain relief, faster recovery, and greater patient satisfaction than general anesthesia.

In our study, postoperative analgesia was more effective and less rescue analgesic treatment was required in the interscalene brachial plexus block group. Another advantage of interscalene block in this study is the reduced incidence of nausea and antiemetic requirement, a result of the reduced need for potent opioid. Total morphine consumption was 8.9 ± 10.9 mg in the interscalene group whereas it was 23.6 ± 10.6 mg in the other group. VAS pain scores were significantly lower in the blocked group at all measurement times except 24 h; this is in accord with the duration of local anesthetic effect. Pain intensity was high in the first postoperative hour in the unblocked group, and frequent use of morphine boluses was needed.

We have used a low concentration of bupivacaine to minimize motor blockade of the brachial plexus block. None of the patients described discomfort as a result of the motor block as their arms on the operated side were partially bandaged and not used.

In the study, we did not observe any serious complication associated with the application of the interscalene brachial plexus block. When using standard local anesthetic volumes with nerve stimulation, interscalene brachial plexus block results in 100 % incidence of phrenic nerve blockade [17]. Ultrasound-guided blocks allow for easy visualization of the nerve, the needle, and the dispersion of the anesthetic. Therefore, the ultrasound technique facilitates adequate injection in the perineural region, resulting in high success rates, reduced latencies, and reduced local anesthetic doses [18, 19]. Nevertheless, in 2010, the American Society of Regional Anesthesia and Pain Medicine has stated that absolute reliance on small-volume or ultrasound-guided blocks was limited as hemidiaphragmatic paresis still occurred unpredictably [20]. Interscalene block should not be attempted, not even with low volumes, in a patient who will not tolerate a hemidiaphragmatic paresis, such as patients with severe pulmonary disease. In our study, we did not obtain chest X-rays to detect hemi-diaphragmatic paresis caused by phrenic nerve block in the patients, but used only clinical signs of respiratory discomfort to evaluate the probable effects of phrenic paralysis. However, this does not mean

that none of the patients had phrenic paralysis. Therefore, patients with chronic obstructive pulmonary disease were excluded from the study. Consequently, we think that performance of the block without using ultrasonography is a limitation of our study.

The other limitation of this study was that the interscalene block was performed under general anesthesia. In adults, regional anesthesia techniques are usually preferred to perform in conscious and cooperated patients, which is believed to reduce complications of the nerve blocks. In our clinic, our practice is also performance of regional blocks in conscious or lightly sedated patients in most cases. In the present study, all the patients were scheduled for MRM and they were to lose their breasts, a very important visual organ of the female. Therefore, most of them were in great anxiety before the surgery, and we thought that performing a block in the neck area before anesthesia would further increase their anxiety as well as their postoperative pain. Also, these patients preferred to undergo those invasive procedures under sedation or general anesthesia.

After breast cancer surgery, incidence of persistent pain as high as 50 % has been reported [21, 22]. Although its mechanisms and the risk factors remain unclear, several reasons including acute postoperative pain have been implicated [2, 23–25]. We think that a good postoperative analgesia and reduced opioid consumption may be helpful in decreasing the incidence of chronic postmastectomy pain. Our study was not designed to evaluate the effects of interscalene analgesia on chronic pain. Further studies can be conducted investigating this issue.

It is now well known that treatment of acute postoperative pain not only improves recovery from surgery but also reduces the risk of persisting chronic pain syndromes and decreases costs to the healthcare system [3, 22, 26]. The routine use of parenteral opioids for postoperative pain management is inadequate and may result in unpleasant side effects [4, 27]. Therefore, in the present study, we have shown that adding interscalene brachial plexus block to the postoperative analgesic regimen after breast surgery improved analgesia as well as reducing opioid requirements and side effects. It can be a good alternative to other invasive regional block techniques used for postoperative pain management after MRM.

Conflict of interest None.

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