Analgesia for Arthroscopic Shoulder Surgery: A Comparison of Interscalene and Subacromial Levobupivacaine with IV Morphine Patient Controlled Analgesia

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Abstract: *Backgorund and Aim*: Arthroscopic shoulder surgery (ASS) may result in severe postoperative pain. We compared a continuous subacromial infusion of levobupivacaine after single shot interscalene block (ISB), a continuous ISB with levobupivacaine and intravenous morphine PCA with preoperative ISB for patients undergoing arthroscopic shoulder surgery.

Methods: After obtaining ethics committee approval and informed consent 120 patients were randomized to three groups, Group 1 (G1) ISB with 0.5% levobupivacaine (l-bupi) (30 mL) followed by a postoperative subacromial infusion: 0.125% l-bupi 5 mL/h basal infusion, 5mL bolus dose and a 20 min lockout time or; Group 2 (G2) ISB with 0.5% l-bupi (30 mL) followed by a postoperative interscalene infusion: 0.125% l-bupi 5 mL/h basal infusion, 5mL bolus dose and a 20 min lockout time; or Group 3 (G3) ISB with 0.5% l-bupi (30 mL) followed by a postoperative morphine PCA 0.3 mg/h basal infusion, 1mg bolus dose and a 20 min lockout time. Infusions were maintained for 24 hours.

Results: The median VAS scores in the postanesthesia care unit and at 4 h were not different. The median VAS scores at 8, 12, and 24 hours were ≤ 4 in all groups; but they were significantly lower in G2. There were no differences in VAS values of G1 and G3 patients. Additional analgesic requirements were lower in G2 (60% vs 7.5% vs 50% respectively for G1, G2 and G3). Nausea and vomiting were more common in G3. Patients' satisfaction scores of groups were 8 ± 0.7 in G1, 9 ± 0.8 in G2 and 7.1 ± 0.9 in G3 (G1 vs G3, p< 0,001).

Conclusions: Subacromial infusion provided good postoperative analgesia for ASS, but it's less effective than ISB, but is superior to intravenous PCA because it causes less nausea and vomiting with higher patient satisfactions. Subacromial infusions can be considered as an alternative for postoperative pain treatment after ASS when ISB is contrainticated.

Keywords: Interscalene, subacromial, levobupivacaine, intravenous morphine, shoulder surgery.

1. INTRODUCTION

Postoperative analgesic modalities that can be used after orthopedic operations include intramuscular injection of analgesics, intraarticular injection of morphine and bupivacaine [1, 2], peripheral nerve blocks [3], patient-controlled analgesia (PCA) using intravenous injections [4], and continuous-flow cold therapy [5]. Patient-controlled intravenous injections [6] and patient-controlled subacromial infusions [7, 8] have been used for postoperative analgesia after arthroscopic surgery. The analgesic efficacy of subacromial infusions after arthroscopic shoulder surgery has been confirmed in several studies [7-9], but no study to present date has compared pain control results between subacromial infusion and interscalene infusion of levobupivacaine with morphine PCA.

The aim of this prospective, randomized study was to compare the effectiveness, patients' satisfaction, and complications of subacromial infusion and interscalene infusion of levobupivacaine with PCA morphine after arthroscopic shoulder surgery.

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2. METHODS

The study protocol was approved by the Ethical Committee of our hospital and informed patient consent was obtained. Patients scheduled for arthroscopic rotator cuff surgery classified as ASA physical status I–II, aged 18 yr or older, participated in this study. Patient exclusion criteria included chronic opioid use, morbid obesity or contraindications to regional anesthesia.

After an 18-gauge IV cannula was inserted in the forearm, midazolam 0.05 mg/kg IV was given as premedication, and standard monitors were placed, including noninvasive arterial blood pressure, heart rate, and pulse oximetry. After local skin infiltration with 20 mg of 2% lidocaine all patients received an interscalene brachial plexus block with 30 mL levobupivacaine 0.5% preoperatively. Patients were randomized to one of three groups: 1) subacromial catheter group (SAC; n = 40): postoperative continuous subacromial infusion; 2) interscalene group (ISC; n = 40): postoperative continuous interscalene infusion; 3) Group (IVMPCA; n=40) postoperative morphine.

Using the approach previously described by Meier (10) single injection blocks were placed using a 50-mm

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insulated, blunt needle and a nerve stimulator. After finding a distal motor response at < 0.5 mA, 30 mL of 0.5% levobupivacaine was injected to all patients. The SAC group had the epidural catheters inserted through the anterior portal and located in the subacromial space at the end of the operation by the surgeon. The ISC group had their blocks placed using the same technique but with the Contiplex D System® (B. Braun Medical, Melsungen AG, Melsungen, Germany). The ISC group also had a catheter was inserted through the introducer needle for 4–5 cm into the plexus sheath and secured to the skin. After negative aspiration of the catheter, a 3 mL test dose was given. The IVMPCA group had their blocks done with the same technique and after the operation a postoperative morphine PCA was started. Infusions were maintained for 24 hours.

General anesthesia was induced in all patients with 1-2 µg/kg fentanil, 2–2.5 mg/kg propofol, and 0.5 mg/kg atracurium. The trachea was intubated, and controlled ventilation was started. Anesthesia was maintained with a mixture of nitrous oxide (60%) and sevoflurane in oxygen.

In the recovery room, the correct position of the interscalene catheter was confirmed by a sensory block (reduced or loss of temperature sense assessed by using an ether-soaked swab) involving at least one major nerve distribution (axillary, musculocutaneous, median, or radial) of the arm. Patient controlled analgesia was started 4 h after the initial interscalene block and continued during the first 24 h postoperatively, Group 1 received, through the subacromial catheter, a continuous infusion of 0.125% levobupivacaine 5 mL/h, a bolus of levobupivacaine 0.125% 5 mL with a 20 minutes lockout time. Group 2 received, through the interscalene catheter, a continuous infusion of 0.125% levobupivacaine 5 mL/h, a bolus of levobupivacaine 0.125% 5 mL with a 20 minutes lockout time. Group 3 received a postoperative morphine PCA with a 0.3 mg/h basal infusion, 1mg bolus dose and a 20 min lockout time.

If pain was not adequately controlled (pain score >3 on the visual analog scale [VAS; ranging from 0= no pain to 10= worst pain imaginable]), patients received 20 mg of intravenous tenoxicam followed by 2 mg of intravenous morphine, if pain remained unchanged after 30 minutes.

Pain intensity was assessed with a 10-cm visual analog scale (0 cm= no pain; 10 cm = worst possible pain) while asking the patients to move the hand and flex the elbow joint. The degree of pain was recorded at the immediate postoperative period and then at 4, 8, 12, and 24 h after surgery. Total consumption of local anesthetic solutions and the number of rescue tenoxicam and morphine given during the first 24 h were recorded. At the end of the 24 h study period, the catheters were removed and patients were given oral analgesics, as routine in our institutions. Patient's satisfaction was evaluated 24 h after surgery with a 10-cm scale (0 cm= completely dissatisfied; 10-cm= completely satisfied).

Statistical analyses used an ordinary ANOVA test for intragroup differences with Dunn's post-hoch test when P<0.05 and Mann-Whitney U test for intergroup differences. Differences in group demographic characteristics were tested by Student's t-test or contingency-table chi-square test for categorical measures. A P value < 0.05 was considered significant.

3. RESULTS

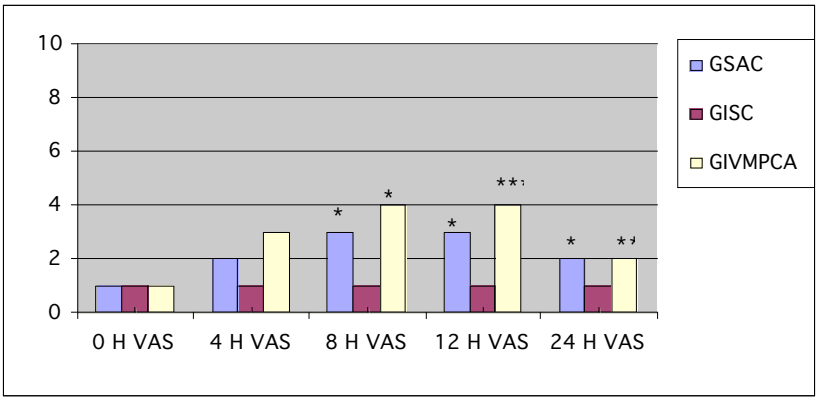
No differences in demographic variables as well as duration of surgical procedure were reported between the three groups (Table **1**).

On arrival to the PACU, median VAS scores were 1 (range: 0-4) in group SAC, 1 (range: 0- 3) in group ISC and, 1 (range: 1-3) in group IVMPCA indicating the effectiveness of the initial interscalene block in all of the three groups. In the early postoperative period (4 h), median VAS scores were comparable in all of the groups: median VAS scores were 2 (range: 1-5) in

Table 1: Age, Sex, ASA Status and Operation Durations of Groups (Mean ± SD)

	GSAC (G1)	GISC (G2)	GIVMPCA (G3)	p
Age (years)	48.6 ± 11.2	44.2 ± 11.6	44.6 ± 12.1	ns
Sex (F/M)	29/11	28/12	30/10	ns
ASA status (I/II/)	27/13	28/12	29/11	ns
Operation duration (min)	142. 8 ± 31.4	138.4 ± 26.7	140.2 ± 29.2	ns

GSAC: Group subacromial catheter GISC: Group interscalene catheter GIVMPCA: Group intravenous morphine patient controlled analgesia.



Graphic 1: VAS Scores of Groups (Median values).

*: p <0,05 **: p<0,01 ***: p < 0,001 (G1 and G3 vs G2).

GSAC: Group subacromial catheter GISC: Group interscalene catheter GIVMPCA: Group intravenous morphine patient controlled analgesia.

group SAC, 1 (range: 0-3) in group ISC and 3 (range: 0-6) in group IVMPCA. At 8, 12, and 24 h postoperatively the median VAS values in all of the groups were ≤ 4, although they were significantly lower in Group 2 (ISC) when compared with Group 1(SAC) and 3 (IVMPCA) (P< 0.001, P<0.001 and P<0.001 for G1 vs G2 and P< 0.05, P<0.001 and P< 0.05 for G3 vs G2 respectively) (Graphic **1**).

The volume of local anesthetic solution administered to the patients at the end of 24 h PCA infusion were 225 ± 51ml in group SAC and 145 ± 43 ml in group ISC (p<0.0001, Table **2**).

Rescue analgesics were given in 24 patients of the subacromial group (60%), 3 patients of the interscalene group (7.5%) and 20 patients (50%) in IVMPCA (p< 0.001, Table **2**). In 20 of the 24 patients of the subacromial group tenoxicam were adequate and only 4 of the patients' required intravenous morphine while 3 patients of the interscalene group and 20 patients of the IVMPCA group required only intravenous tenoxicam.

Except one light local anesthetic toxicity, no severe complications were reported in all of the groups. Horner's syndrome (20/120, 16.6%), hoarseness (6/120, 5%) and respiratory distress (9/120, 7.5%) were reported after interscalene block and were evenly distributed between the three groups. No complications were reported after subacromial catheterization.

Patients' satisfaction scores of groups were 8 ± 0.7 in G2 (SAC), 9 ± 0.8 in G1 (ISC) and 7.1 ± 0.9 in G3 (IVMPCA) (G1 vs G3, p< 0,001, Table **2**).

The number of patients with nausea and vomiting is significantly higher in patients in group IVMPCA than the other two groups (32.5% vs 10% for GSAC (G1) and 12.5% for GISC (G2) and p< 0.05and p< 0.05 for G3 vs G1 and G3 vs G2 respectively).

4. DISCUSSION

The main finding of the present study is that the interscalene infusion of levobupivacaine *via* a catheter provided superior postoperative analgesia compared to

Table 2: The Total Volume of Local Anesthetic Consumption, the Number and Percentage of Patients Given Rescue Analgesic, Patients' Satisfaction Scores and the Number and Percentage of Patients who had Nausea and Vomitting (Mean ± SD or no and %)

	GSAC (G1)	GISC (G2)	GIVMPCA (G3)
LA Used (ml)	225 ± 51	145 ± 43	0
Patients Given Rescue Analgesic	24 (60%)	3 (7.5%)	20 (50%)
Patients' Satisfaction	8 ± 1.2	9.4 ± 0.8	7.1± 0.9 ***
Patients with Nausea and Vomiting	4 (10%)	5 (12.5%)	13 (32.5%)*

*p< 0.05 (G1 vs G2 and G3) and *** p< 0.001 (G2 vs G3).
GSAC: Group subacromial catheter GISC: Group interscalene catheter GIVMPCA: Group intravenous morphine patient controlled analgesia LA: local anesthetic.

subacromial infusion of levobupivacaine and intravenous morphine PCA.

When the literature is investigated there are several studies comparing intravenous patient controlled opioids with interscalene catheters: Borgeat *et al.* compared [11-13] 0.15% bupivacaine and 0.2% ropivacaine with nicomorphine and found better postoperative pain control with the patient controlled interscalene analgesia groups. The results of these studies are similar to the present one: after the initial effect of the single shot interscalene block vanished (12 hours in all 3 studies of Borgeat *et al*. and 8 hours in the present one) the interscalene groups provided better pain control than intravenous opioid analgesics.

In the literature there is a great controversy about the effectiveness of subacromial catheters after shoulder surgery [9, 14, and 15] and different protocols and doses were used for pain control after shoulder surgery. For example Savoie *et al*. [9] divided 62 patients who received subacromial decompression into 2 groups and infused 0.25% bupivacaine into the subacromial space in one group and normal saline in the other. They reported that the group with continuous infusion of bupivacaine showed better pain control. Barber and Herbert [5] found that subacromial or intraarticular injection of 0.5% bupivacaine was effective in various types of arthroscopic shoulder surgeries. Quick *et al*. [14] found no benefit over placebo with regard to pain, demand for rescue narcotic, or recovery of motion with subacromial bupivacaine infusion. In the present study subacromial infusion of levobupivacaine provided effective analgesia although inferior to interscalene group; but equivalent to intravenous morphine group. The reason of this controversy may be the use of different protocols and the use of subacromial catheters in different types of surgeries. The presence of an interscalene block done with a long acting local anesthetic might also have a residual effect on postoperative analgesia.

In our series the volume of local anesthetic solution administered after 24 h PCA infusion was 145 ± 43 mL for 24 h in group ISC. Casati *et al*. [15] found the total consumption of local anesthetic infused during the first 24 h 147 mL (144-196 mL) with levobupivacaine. When we reviewed our data for median value for group ISC we found that it was 142.5 mL (range: 85-225 mL) which is similar to Casati's results. In a previous study [16] Koltka *et al.* found the total consumption of bupivacaine 0.125% infused during the first 24 h in group ISC 150 ± 36 mL and this is also similar to our findings with levobupivacaine.

There are limited data about the total volume of local anesthetic infused *via* the subacromial catheter: the number is given two studies as mL for 24 h and for 48 h [16, 17] and in one study it is given as mg [18]. In our series the volume of local anesthetic solution administered to the patients at the end of 24 h PCA infusion were 225 ± 51 mL in group SAC and this value is higher than the values in the literature [16-18]. The reason of this situation is probably the differences in PCA protocols.

In the present study rescue analgesic medication requirement was significantly lower in the ISC group. Similar lower results have been given by Borgeat *et al*. in studies comparing patient controlled interscalene analgesia (PCIA) with intravenous PCA [11-13]. For SAC, in studies comparing local anesthetic infusions with placebo lower additional analgesic requirements were found with local anesthetic infusions [5, 9, 18, 19].

In the present study patient satisfaction was higher in the ISC group like in several studies comparing PCIA with other PCA modalities [11, 12, 16].

When the number of patients with nausea and vomiting were evaluated it was found out that patients in group IVMPCA had significantly more nausea and vomiting which is not surprising. In several studies comparing interscalene local anesthetic infusion with intravenous opioids similar results were found [11-13]. In a study comparing fentanyl, morphine and hydromorphone the incidence of nausea and vomiting of intravenous morphine PCA was found as 31% and this is higher than fentanyl and similar to hydromorphone [20]. This result is also similar to the result found in the present study.

Although interscalene block provided better postoperative analgesia, it is not devoid of side effects, in a study there was a 0.35% major complication rate and an 11.32% minor complication rate in 6243 patients [21]. Ipsilateral phrenic paralysis can lead to acute respiratory failure in patients with chronic respiratory disease or with contralateral phrenic nerve paralysis and is, therefore, contraindicated in these patients [22-24]. In these cases, subacromial infusion could be an alternative and in the present study there were some complications after interscalene block; but no complications were reported after subacromial catheterization.

Intraarticular injection of local anesthetics especially bupivacaine 0.25-0.5% can be chondrotoxic and also ropivacaine and mepivacaine are chondrotoxic but there are no data about levobupivacaine [25]. In a study Busfield *et al.* used subacromial bupivacaine and found no evidence of chondrotoxicity in the early period (1 month); although postarthroscopic glenohumeral chondrolysis can take longer times to develop [26]. Although there is no evidence supporting the risk of chondrotoxicity after subacromial infusions it seems wise to limit the duration of subacromial infusion up to 24-48 hours and use dilute local anesthetics without epinephrine.

The present study has several limitations: the patients were evaluated for only 24 hours which is quite short and also we did not evaluate the physiotherapy performances of the patients and we did not evaluate the patients for chondrotoxicity.

In conclusion, after arthroscopic shoulder surgery, continuous interscalene infusion of levobupivacaine is more efficient than continuous subacromial infusion of levobupivacaine and intravenous morphine for pain control. Nevertheless, continuous subacromial infusion could be considered as an alternative in case of contraindication of interscalene block.

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