A Doctoral Dissertation

A comparison of methods about pain control after arthroscopic shoulder surgery

Department of Medicine

Graduate School

Jeju National University

Sun Kyung Park

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ABSTRACT

Background: Arthroscopic shoulder procedures are often associated with severe postoperative pain. Nerve blocks have been studied for pain in shoulder surgeries. Interscalene brachial plexus blocks (ISB) and intraarticular injection (IA) were reported in many studies. The aim of this study was to evaluate the effect of ISB, continuous cervical epidural block (CCE) and IA as a means of postoperative pain control and to study the influence of these procedures on postoperative analgesic consumption and intraoperative hemodynamic changes, sevoflurane concentration, and the bispectral index (BIS) during and after arthroscopic shoulder surgery.

Methods: Fifty seven patients who underwent arthroscopic shoulder surgery were randomly assigned to one of three groups; the ISB group (n = 19), the CCE group (n= 19), and the IA group (n = 19). Patients in each group were evaluated on a postoperative numerical rating scale (NRS) pain score, on their rescue opioid dosage (ROD), on intraoperative hemodynamic variables, sevoflurane concentration and BIS and on other side effects.

Results: Postoperative NRS pain scores were reported to be higher in the IA group than in the ISB and CCE groups both at rest and on movement. The ROD was significantly low in the ISB group compared to in the IA group ($p= 0.01$), and significant statistical differences were observed between the CCE and ISB groups ($p = 0.01$). The mean blood pressure (MBP), sevoflurane concentration, and BIS showed significant statistical difference was among the three groups ($p= 0.0019$ for the MBP, $p< 0.001$ for the sevoflurane concentration and BIS). The MBP and sevoflurane concentration were lower in the ISB group than in the CCE and IA groups during the entire study period. The BIS values were higher in the ISB group than in the IA and CCE groups during the entire study period. The patients who used hypotensive

agnets numbered 0 (0 %), 7 (36.8 %), and 14 (73.6 %) in the ISB, CCE, and IA groups, respectively ($p< 0.001$). No patient experienced major complications related to the procedure.

Conclusion: This prospective, randomized study demonstrated that ISB is as effective an analgesic technique as a CCE for postoperative pain control in patients undergoing arthroscopic shoulder surgery. ISB also provides anesthetic-sparing effect and hemodynamic stability during surgery.

Key words: Arthroscopic shoulder operation, Pain control, Interscalene brachial plexus block, Cervical epidural block, Intraarticular injection

I. INTRODUCTION

Although minimally invasive arthroscopic shoulder surgery is widely performed, the procedure is associated with severe postoperative pain [1,2]. Therefore, appropriate pain control in the early postoperative period improves rehabilitation and recovery [2]. The opioid requirements for this pain are known to be similar to those following gastrectomy or thoracotomy [3]. While the administration of parental opioids is considered for severe postoperative pain control, the use of opioids may lead to complications including nausea, vomiting, pruritus, ileus, confusion, urinary retention, hypotension, and respiratory depression [4].

Therefore, nerve block procedures for shoulder surgeries have been studied. The interscalene brachial plexus block (ISB) is regarded as one of effective analgesic methods for arthroscopic shoulder procedures. Previous studies have reported that ISB is excellent due to both its pain control and morphine-sparing effect in the first 24 hours following surgery, compared to either a suprascapular nerve block or a single injection of a local anesthetic especially in shoulder surgeries, and more effective postoperative pain control is achieved through a combination of ISB and local analgesics [2,3,5]. An intraarticular injection (IA) is performed by the surgeon at the end of surgery just before wound closure. With the use of IA, additional procedures for pain control are not needed by patients and the procedure is as effective as an ISB [3]. Also, continuous cervical epidural block (CCE) is known to provide excellent pain relief for patients undergoing upper extremity surgery. Epidural analgesia with a local anesthetic, an opioid or both is regarded as the treatment of choice for postoperative pain control in various surgeries (e.g., total knee arthroplasty, thoracotomy). Epidural analgesia is as effective in pain control as a peripheral nerve block in other surgeries, such as total knee arthroplasty, total hip arthroplasty, arthroscopic anterior cruciate ligament repair and thoracotomy [6]. However, a cervical epidural catheter is uncommonly used and is in

fact rarely utilized in shoulder operations [7]. Despite the severe pain associated with arthroscopic shoulder surgery, comparisons between a neuraxial block such as CCE and other analgesic methods such as ISB and IA are very rare or nonexistent. In addition to pain control, intraoperative hemodynamic instability has also been a troublesome issue for anesthesiologists during arthroscopic shoulder surgery due to disturbance in the operating field for the surgeons and the requirements for additional hypotensive and anesthetic agents.

Therefore, the aim of this study was to compare postoperative pain control, intraoperative hemodynamic changes, sevoflurane concentration and bispectral index (BIS) in the an ISB group compared with CCE and IA groups.

II. MATERIALS AND METHODS

1. Patients

The study protocol was approved by the ethics committee of Jeju National University Hospital and was registered as a clinical trial. The study was carried out according to the principle of the Declaration of Helsinki 2000, and written informed consent was obtained from all participants before inclusion in the trial. Between May 2012 and April 2013, a total of 57 consecutive patients undergoing elective arthroscopic shoulder surgery under general anesthesia at our hospital were recruited for this prospective, randomized study. The exclusion criteria were allergy to any study medication, a history of hypertensive disease, an American Society of Anesthesiologists (ASA) physical status exceeding II, and an inability to understand the instructions concerning the study. All operations were performed by a single surgeon who used an arthroscopic repair technique. The sample size was determined from a previous study in the group ISB and IA. On the basis of previous studies [8,9], we hypothesized that we could observe a 50 % reduction in the NRS pain score immediately after anesthesia between the ISB and IA groups because there have not been reports on comparisons between ISB and CCE. A power analysis estimated that 15 patients would be needed in each group to provide a 90% chance of detecting such a reduction at the 0.01 level of significance. To compensate for possible dropouts, we recruited 19 patients per group. The patients were randomized into three groups of 19 in each group using a simple randomization technique. All patients were randomized into one of three groups : 1) interscalene brachial plexus block group (ISB group ; n = 19) ; 2) continuous cervical epidural block group (CCE group ; n = 19) ; and 3) intraarticular injection group (IA group ; n = 19)

1) Interscalene brachial plexus block group (ISB group)

Patients in the ISB group received the block before the induction of general anesthesia in the operating room. After supine positioning with head rotation to the other side, ISB was performed with ultrasound and nerve stimulation. The brachial plexus was identified using a nerve stimulator (Stimuplex-S, B. Braun Melsungen AG, Melsungen, Germany) connected to the proximal end of the metal inner needle of a plastic cannula (Stimuplex-A, 25 – G, B. Braun Melsungen). The initial current output of the nerve stimulator was 0.7 mA. A linear high frequency 6 - 13 MHz ultrasound probe (Sonosite M-turbo, SonoSite, Inc., Bothell, WA, USA) was used. Upon contraction of the triceps muscle, the C5 - 6 nerve root or superior trunk was found, and 10 ml of 0.25 % ropivacaine with 200 mcg of epinephrine was injected. Twelve hours after the operation, a fentanyl patch (12 mcg/hr) was applied to the patients .

2) Continuous cervical epidural block group (CCE group)

Following the provision of written informed consent, the procedure was performed one day prior to the surgery. After prone positioning of patients and sterile preparation, local anesthetics were injected at the insertion site. A 17 gauge Tuohy needle was inserted under fluoroscopic guidance at the C7 - T1 interspace. After identification of the epidural space using the loss of resistance technique, an epidural catheter (Epidural Catheterization Set, 19 - G, Arrow International, Inc. , Asheboro, NC, USA) was inserted using Tuohy needle. The catheter reached the C4 or C5 epidural space on the ipsilateral side of the affected limb. Following confirmation of the catheter position with contrast medium, the catheter was sutured in place with nylon 3.0.

After patients were transferred to the operating room, and instruments for noninvasive monitoring were applied. A 10 ml bolus of 0.25 % ropivacaine was injected through the epidural catheter, after which an epidural PCA (patient controlled analgesia) infusion pump

(ropivacaine 0.25 %, basal 3 ml, bolus 3 ml, lockout time 30 minutes) was connected to the epidural catheter prior to the induction of general anesthesia. The catheter was removed at 48 hours after the completion of the surgery.

3) Intraarticular injection group (IA group)

After the completion of the arthroscopic procedure, the surgeon inserted a catheter into the joint via an arthroscopy portal. The catheter was attached to a disposable PCA infusion pump (Accufuser®, Wooyoung Medical Co., Ltd., Chungcheongbuk-Do, Korea) containing 100 ml of 0.25 % ropivacaine, with a continuous basal infusion of 2 ml/hour with available patient-controlled boluses available at 4 ml/hour. The catheter was removed at 48 hours after the completion of the surgery.

2. General anesthesia technique

General anesthesia was induced by the IV administration of thiopental (5 mg/kg) after manual ventilation with O_2 given at 6 L/min to all patients. Orotracheal intubation was facilitated with rocuronium (1 mg/kg). Anesthesia was maintained with O_2 and N_2O each at 1 L/min, and the sevoflurane was maintained at a minimum of 1.0 vol%. The non-invasive blood pressure, electrocardiography and pulse oximetry were monitored continuously. No additional intravenous analgesics including opioids were injected. Anesthesia was maintained to keep the BIS values between 40 and 60. After the completion of the surgery, reversal agents (glycopyrolate and neostigmine) were intravenously administered and the patients were extubated. The procedures were performed by one of the two co-authors of the study.

3. The Studied variables

The primary outcome measure was the severity of postoperative pain, assessed by means of the numerical rating scale (NRS) pain score and rescue opioid dosage (ROD) during the first 48 hours postoperative. The secondary outcome measures were the intraoperative hemodynamic variables specifically the heart rate, mean blood pressure and the sevoflurane concentration and the BIS.

The severity of postoperative pain was evaluated by pain at rest and on movement assessed in the PACU (post-anesthesia care unit) at 30 minutes, 4 hours, 24 hours, and 48 hours after the operation with the NRS, with scores ranging from 0 = no pain to 10 = worst pain imaginable. If the NRS pain score was higher than 7, patients were administered with rescue opioids such as fentanyl or pethidine. The ROD was converted to the total morphine equivalent dose with an opioid converter. Rescue opioid analgesia and time of administration were recorded.

We measured the intraoperative heart rate (HR), mean blood pressure (MBP), sevoflurane concentration, BIS at incision and at 5, 10, 15, 20, 25, and 30 minutes. The hypotensive agents such as labetalol or nicardipine were used and it was recorded when they were needed for blood pressure control or were requested by surgeons due to disturbances in the operation field.

Performed procedures included intraarticular and soft tissue procedure, acromioplasty, tendon mobilization and greater tuberosity preparation and tendon repair with a suture bridge. The intraarticular irrigation fluid was provided with a pressure – controlled pump set to 50 mmHg.

4. Statistical analysis

The normally distributed data were presented as the mean ± standard deviation, and the groups were compared using one way analysis of variance (one-way ANOVA) and a post hoc Scheffe test and Dunnett's T3 test for the height, weight, and age of the patients as well as the ROD. Changes in parameters (HR, MBP, sevoflurane concentration, BIS) over time were assessed using a mixed effects linear regression model (linear mixed model) to evaluate within- and between-group differences. The incidence of the use of hypotensive agents, measured by the number of patients requiring these agents, was analyzed using the chi-square test and Fisher's exact test. A p value < 0.05 was considered statistically significant. All statistical analyses were performed using Stata, version 11.0 (StataCorp, College Station, TX, USA).

III. RESULTS

There were no statistical differences in the dermographic data among the three groups (**Table 1**).

Table 1. Dermographic data in the three groups

Variable	Group ISB (n = 19)	Group CCE (n = 19)	Group IA (n = 19)	p-value
Age (yr)	52 (13)	53 (9)	54 (7)	n.s.
Height (cm)	164 (8)	163 (10)	159 (9)	n.s.
Weight (kg)	64 (10)	67 (12)	63 (9)	n.s.
Anesthesia time (min)	113 (21)	117 (31)	113 (26)	n.s.
Op time (min)	59 (22)	68 (27)	61 (20)	n.s.

Result are expressed as mean (SD).

NRS_R= numerical rating scale at rest; NRS_M = numerical rating scale on movement

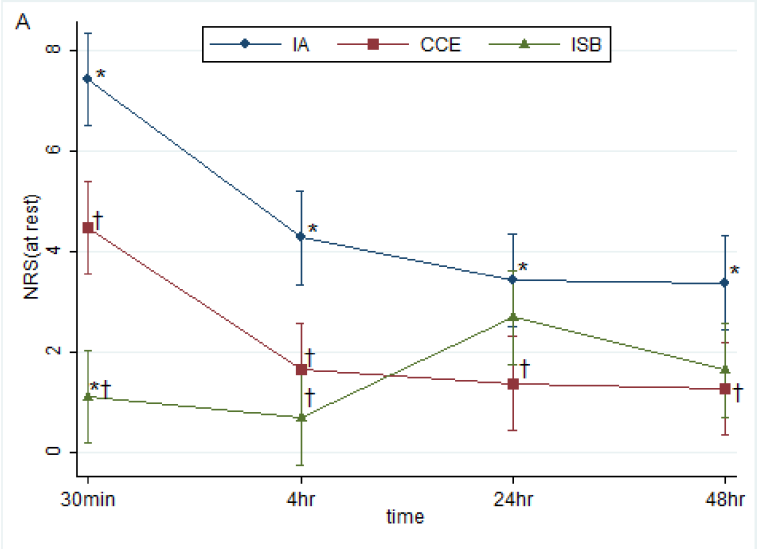
Statistical significance is tested by one way ANOVA among groups.

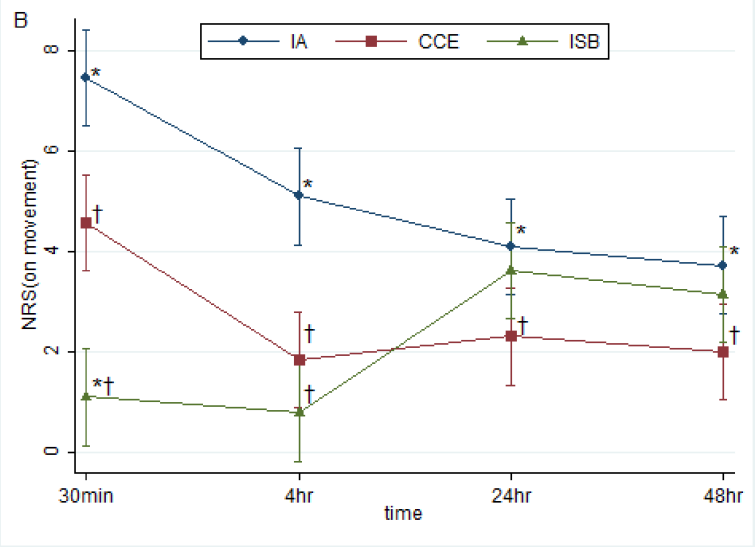
No statistical difference is found among groups.

ISB = interscalene brachial plexus block; CCE = continuous cervical epidural block; IA = intraarticular injection ; n.s. nonsignificant ($p > 0.05$)

The NRS pain scores showed significant statistical differences among all three groups ($p < 0.001$). Postoperative NRS pain scores were higher in the IA group than in the ISB and CCE groups both at rest and on movement during the entire study period. Patients in the ISB group had lower NRS pain scores at rest and on movement than those in CCE and IA groups at 30 minutes postoperative (**Figure 1**) (vs. CCE group, and vs. IA group, $p< 0.001$).

Figure 1. Changes in NRS pain score at rest (A), on movement (B), NRS scores (mean ± SD) were measured at 30 minutes, 4 hours, 24 hours, 48 hours after surgery, ISB = interscalene brachial plexus block; CCE = continuous cervical epidural block; IA = intraarticular injection, *p< 0.05 compared with the CCE group; †p< 0.05 when compared with the IA group





In a comparison of the three groups, ROD was 1.6 ± 2.3 , 3.0 ± 4.9 and 7.1 ± 7.9 mg in groups CCE, ISB, and IA (p= 0.001), respectively, and statistically significant differences were noted between the CCE and IA groups (p= 0.01) but not in between the ISB and CCE groups and the ISB and CCE groups.

Intraoperative HR, MBP are presented in **Figure 2**. In addition, the sevoflurane concentration and BIS are presented in **Figure 3**.

Figure 2. Changes in heart rates (A), mean blood pressure (B) Data expressed as mean ± SD. 0 : immediately after incision, 5 : 5 minutes after incision, 10 : 10 minutes after incision, 15: 15 minutes after incision, 20 : 20 minutes after incision, 25 : 25 minutes after incision, 30: 30 minutes after incision. ISB = interscalene brachial plexus block; CCE = continuous cervical epidural block; IA = intraarticular injection, *p< 0.05 when compared with the CCE group; †p< 0.05 when compared with the IA group; ‡p< 0.05 when compared with baseline (0 minute) within the same group

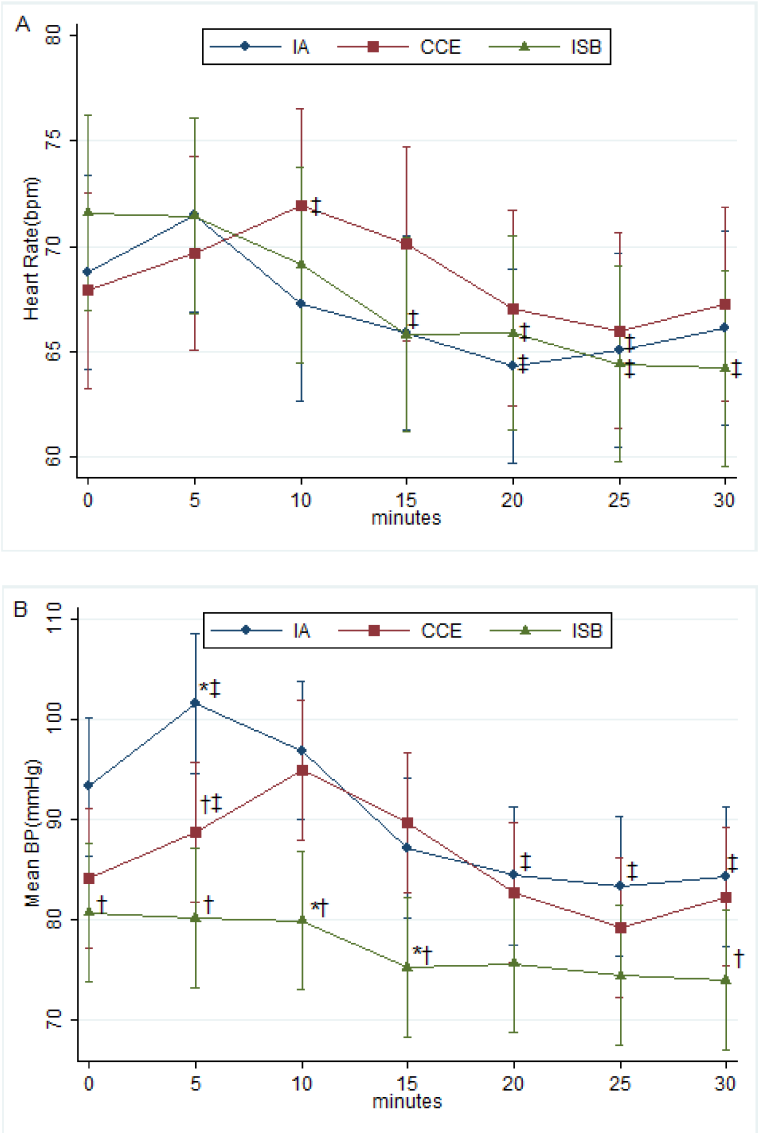
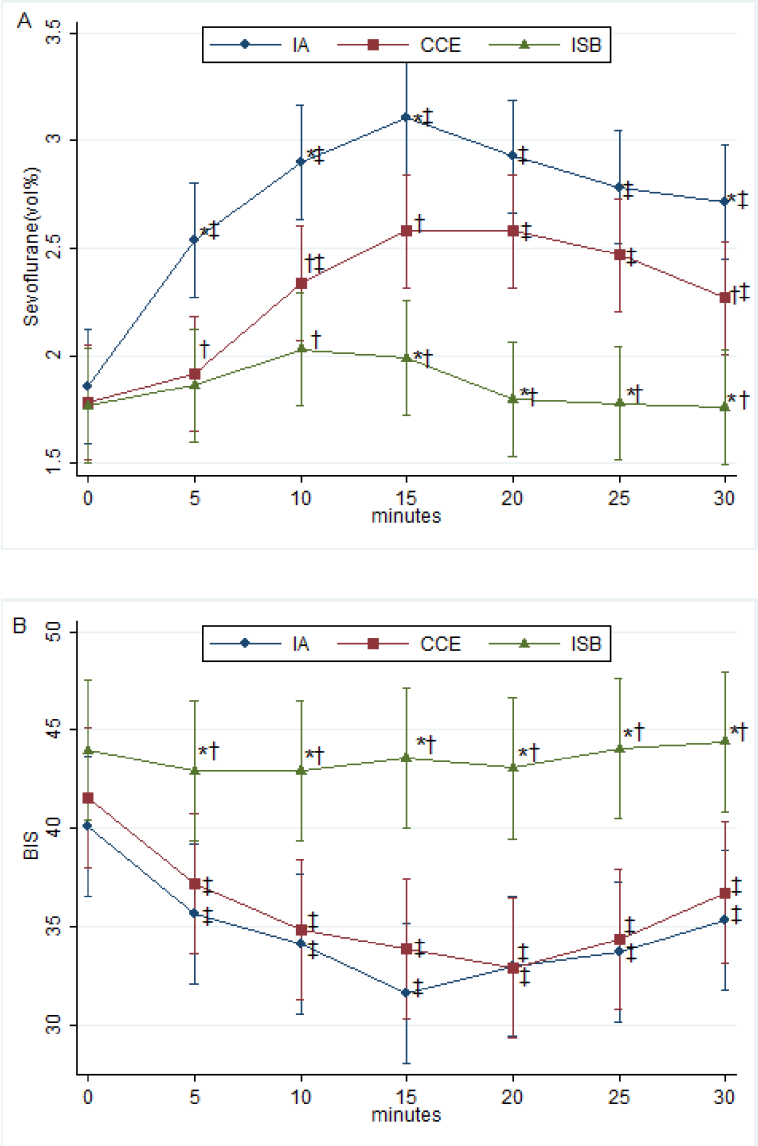


Figure 3. Changes in sevoflurane concentration (A), bispectral index (B) Data expressed as mean ± SD. 0 : immediately after incision, 5 : 5 minutes after incision, 10 : 10 minutes after incision, 15: 15 minutes after incision, 20 : 20 minutes after incision, 25 : 25 minutes after incision, 30: 30 minutes after incision. ISB = interscalene brachial plexus block; CCE = continuous cervical epidural block; IA = intraarticular injection,*p< 0.05 when compared with the CCE group; †p< 0.05 when compared with the IA group; ‡p< 0.05 when compared with baseline (0 minute) within the same group



No significant change in the HR was observed among the three groups (p= 0.8629). The MBP, sevoflurane concentration, BIS showed significant statistical differences among the three groups (p= 0.0019 in MBP, p< 0.001 for the sevoflurane concentration and BIS). The MBP were lower in the ISB group than in the CCE and IA groups during the entire study period. The time periods showing a significant difference in the MBP between the ISB and IA groups were 0, 5, 10, 15, and 30 minutes, and those between the ISB and CCE groups were 10 and 15 minutes. The time periods showing significant differences in the MBP compared to 0 minutes as a baseline were 5, 20, 25, and 30 minutes in the IA group and 5 minutes in the CCE group.

The sevoflurane concentration was also lower in the ISB group than in the CCE and IA groups during the entire study period. The sevoflurane concentration was lower in the ISB group than in the IA group at 5, 10, 15, 20, 25, and 30 minutes and in the CCE group at 15, 20, 25, and 30 minutes. The time periods showing significant differences in thee sevoflurane concentration compared to the baseline indicated from 5 minutes to 30 minutes in the IA group and 10, 20, 25, and 30 minutes in the CCE group. Despite the low concentration of sevoflurane in the ISB group, BIS was maintained below 45, i.e., between 40 and 60 indicating stable degree of sedation during general anesthesia. The BIS values showed no significant differences throughout the entire study period compared to the baseline in the ISB group, but significant differences were shown between 5 minutes and 30 minutes in the CCE and IA groups. The numbers of patients who used hypotensive agnets were 0 (0 %), 7 (36.8 %), and 14 (73.6 %) in the ISB, CCE, and IA groups, respectively (p< 0.001) (**Table 2**). No patients experienced severe major complications such as seizures, pneumothorax, cardiac events or other complications related to the treatment.

Table 2. The patients' number of the additional use of hypotensive agents in three groups.

Variable	Group ISB (n = 19)	Group CCE (n = 19)	Group IA (n = 19)	p-value
The patients' number	0 (0 %)	7 (36.8 %)	14 (73.6 %)	< 0.001

Results are expressed number of patients (percent).

Statistical significance was tested by chi-square and Fisher's exact test among groups.

ISB = interscalene brachial plexus block; CCE = continuous cervical epidural block; IA = intraarticular injection

IV. DISSCUSSION

This prospective, randomized study demonstrated that an ISB is as effective an analgesic technique as CCE for postoperative pain control in patients undergoing arthroscopic shoulder surgery. The ISB group observed a low NRS pain score at 30 minutes postoperative among the three groups. In addition, MBP was well stabilized despite the low sevoflurane concentrations, BIS was maintained below 45, indicating a stable degree of sedation during general anesthesia and the use of hypotensive agents was not required in contrast to other groups.

Arthroscopic shoulder surgery is associated with severe postoperative pain. Severe postoperative pain remains a major morbidity, leading to prolonged hospitalization and delayed rehabilitation programs. Therefore, appropriate pain control for arthroscopic shoulder surgery is recommended [2]. At present, analgesia for shoulder surgery includes subacromial or intraarticular infiltration of local anesthetics, suprascapular with or without an axillary (circumflex) nerve block, a single-injection interscalene nerve block and a continuous interscalene nerve block [3].

ISB is one of the most common regional anesthesia techniques utilized, therefore many reports have described the effectiveness and complications of ISB [2,4,10-18]. The recent use of ultrasound guidance of ISB has been shown to minimize adverse effects by an injection under direct visualization of the target nerve and injection of a lower dose of local anesthetics [18,19]. Improved postoperative pain control using the ISB method leads to earlier initiation of rehabilitation, as evident in other studies [20]. IA injections has been popular among surgeons because they are perceived as a simple and effective technique associated with improved analgesia, the reduced use of analgesics, and improved patients' satisfaction [3,21,22]. CCE was reported to provide excellent postoperative analgesia for patients undergoing upper extremity surgery in a few studies [7,23,24]. Narouze et al.

reported that CCE was effective in the rehabilitation phase after shoulder surgery for adhesive capsulitis [25]. Therefore, we presumed that cervical epidural analgesia may be effective for postoperative pain control and rehabilitation following arthroscopic shoulder surgery. However, placement of a cervical epidural catheter is not a commonly utilized procedure. Rare but severe complications such as an epidural abscess and, permanent spinal cord damage can be devastating, making CCE less attractive for general use [7]. Although lumbar and thoracic epidural analgesia has been studied in various surgical situations as an effective analgesic method in comparison with a peripheral nerve block in a number of reports [26-28], CCE has not been compared with other analgesic methods such as ISB and IA during arthroscopic shoulder surgery, as it is associated with severe postoperative pain as in open shoulder surgery. While there have been studies comparing ISB with IA from the perspectives of pain following arthroscopic shoulder surgery and hemodynamic changes during surgery, there has been no research dealing with comparisons of these procedures with CCE. Therefore, in the current study, the severity of postoperative pain and intraoperative hemodynamic stability were compared among these three groups.

Postoperative NRS pain scores were found to be higher in the IA group than in the ISB and CCE groups in the current study. In contrast, a few studies reported that, IA was an effective alternative to ISB [21,29]. The results of the current study were identical to those of other studies that found that ISB provided better pain control than IA [9,17]. Interestingly in comparison between the CCE and ISB groups, NRS pain scores 30 minutes postoperatively were showed statistically significant lowered in the ISB group. It is well known that cervical epidural analgesia selectively blocks sympathetic fibers, then sensory fibers, and finally motor fibers with an increasing dose of local anesthetics. However, ISB may not achieve effective separation of the motor and sensory block as sensory nerves are in the core bundle, surrounded by motor nerves [7,30]. Therefore, we anticipated that immediate postoperative pain control would be best achieved in the CCE group, but the NRS pain scores of patients in this group were lower than those of the ISB group in the immediate postoperative period. We

presumed that the analgesic effects of CCE were not fully achieved in the lateral decubitus position because the surgical site is located against the direction of gravity and the volume of the local anesthetics was insufficient. This study showed, however, that the ROD was lowest in the CCE group. ISB was shown to be effective for 10 - 12 hours in controlling postoperative pain [13,15]. In order to control postoperative pain after 12 hours in the ISB group, a fentanyl patch was applied to the patients. Although an additional injection of analgesics after the 12 hour window of the ISB effect led to a statistically insignificant state, it appeared that the injected amount of analgesics was smaller in the CCE group.

Contrary to the IA case, CCE and ISB were performed before surgical incision. Preemptive analgesia in procedures such as CCE and ISB could explain their superior analgesic efficiency compared to IA [5]. Consequently, the IA group was considered a control group in a comparison of intraoperative hemodynamics.

The intraoperative HR, MBP, sevoflurane concentration and BIS were evaluated in all three groups. One of the troublesome issues for shoulder arthroscopic procedures is the need for improving the arthroscopic field. Optimal conditions can be achieved by several interventions and manipulations from both surgical and anesthesiologic perspectives. Surgical manipulations to minimize disturbances in the operation field include use of epinephrine irrigation fluid and an increased flow rate of irrigation [31], whereas anesthesiologists focus on hypotensive anesthesia using vasodilators [32], beta blockers [33], and calcium channel blockers [34] as well as increased inhalation agents [35,36]. One study reported that the difference between systolic blood pressure and shoulder joint pressure should be maintained at 49 mmHg or less to secure the surgical field during arthroscopic shoulder surgery. In addition, a reduction of SBP or MBP (20 - 25% of the baseline in a normotensive individual) decreases bleeding from the joints of bones and improves visualization during shoulder arthroscopic surgery [35]. It has been reported that a low blood pressure should be maintained during surgery for lower injection pressure of the irrigation fluid and to minimize the risk of extravasation of the fluid to the subcutaneous tissue [37].

Because unstable hemodynamic changes may be due to manipulation and painful stimuli during surgery, successful blocks blunt sympathetic stimuli and, stabilize hemodynamic changes, as well as providing effective pain control and rehabilitation. Therefore, in arthroscopic shoulder surgery, minimization of hemodynamic changes and reduction of bleeding episodes during the surgery are important. Although CCE was expected to show stable hemodynamic variability during arthroscopic shoulder surgery due to its reported advantages in cardiovascular, respiratory, gastrointestinal, coagulation, metabolic and immune functions as well as a reduction of the intraoperative surgical stress response [26,38], the result of the current study indicated lower dose requirement of inhalation anesthetic agents and better stability in terms of hemodynamic variability in the ISB group. An ISB controls unstable hemodynamic changes during arthroscopic shoulder surgery, and has the advantages of decreased intraoperative bleeding, excellent muscle relaxation, and reduced requirements for additional analgesics following surgery, with the results that the arthroscopic view is improved and fluid extravasation to subcutaneous tissue is also reduced [13].

Several methods have been introduced to measure bleeding in the arthroscopic field, such as evaluations of irrigation fluids and hemoglobin [39]. However, in the current study, because the number of patients who required intraoperative hypotensive agents was confirmed, we used a subjective method to evaluate bleeding. Although hemodynamic changes were not analyzed for each procedure, it is already known that increases in the MBP are commonly evident during acromioplasty and frozen shoulder release [40]. It is believed the research analyzing hemodynamics in accordance with these procedures well be beneficial afterwards. In the current study, hypotensive agents were used in 14 out of 19 patients in the IA group but in none of the patients in the ISB group. Our result showed that the ISB group was characterized by the lowest MBP without the use of hypotensive agents among the three groups. While sevoflurane was used as the inhalation anesthetic agent in all groups, the required concentration of sevoflurane in the ISB group was lower than that of the other

groups. BIS was used to evaluate the depth of anesthesia, it was maintained below 50 in all groups. Despite the fact that the ISB group demonstrated less demand for anesthesia, the surgical field was well secured without the use of hypotensive agents in this group. HR showed no statistical differences among the three groups. Although it is already known that ISB does not increase HR in comparison to a control group, HR was not elevated in the current study in either the IA and the CCE group despite surgical incision because the concentration of sevoflurane was increased prior to the incision. In the current study, side effects were not evident in the ISB and CCE groups using ultrasonography and a C-arm device. Due to their requirement of highly skilled techniques, cervical epidural procedures are not commonly recommended. Cervical epidural block has always been viewed as a relatively safe procedure, with complication rates ranging from 0 - 16.8% [3]. Although the job demands a high degree of skill, CCE should also be considered as an effective method of controlling pain after arthroscopic shoulder surgery due to its comparatively low rates of incidence of complications and its pain relieving effects.

The study has several limitations. The number of participants in each group is relatively small if seeking to claim strong statistical power. Due to difficulties in evaluating actual blood concentration of local anesthetics, it is difficult to conclude that equal anesthetic effects were achieved in the three groups despite the fact that identical anesthetic agents and dosages were administered. Evaluations of experimental factors such as pain scores and hemodynamic stability were not performed blindly after the assignment of patients into the three groups. Because it is known that factors associated with incisions such as fibrosis and joint inflammation influence the operation time and types of anesthetics [35], future research will be required to study those factors.

Further studies are needed to assess the potential advantages of the CCE technique by direct comparisons to a continuous interscalene block. In addition, differences between shoulder joint pressure or arthroscopic pump pressure and the mean arterial pressure should be analyzed. Future studies will need to determine the pump pressure and shoulder joint

pressure in assessments of different anesthetic techniques during arthroscopic shoulder surgery. Our results well have to be confirmed through additional studies and for other arthroscopic procedures as well.

V. CONCLUSION

In conclusion, this prospective, randomized study demonstrated that ISB is as effective an analgesic technique as CCE for postoperative pain control in patients undergoing arthroscopic shoulder surgery. ISB also provides an anesthetic-sparing effect and hemodynamic stability during this type of surgery.

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ABSTRACT IN KOREAN

견관절경 수술 후 통증 관리에 대한 방법들의 비교

박선경

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배경 : 견관절경 수술은 때때로 심한 수술 후 통증이 나타나게 된다. 이러한 통증을 조절하기 위해 어깨 수술에서 시행되는 다양한 신경차단술에 대해 연구되어져 왔다. 목갈비근사이 팔신경얼기 차단술(interscalene brachial plexus block, ISB)과 관절강내 주입술(intraarticular injection, IA)이 여러 연구에서 보고되어져 왔다. 이 연구는 ISB 와 비교하여 지속적 경추 경막외강 차단술(continuous cervical epidural block, CCE)과 IA 를 시행한 환자에서 수술 후 통증 조절 및 수술 중 혈역학적인 변화, sevoflurane 농도와 bispectral index (BIS)에 미치는 영향을 비교하고자 한다.

방법 : 총 57 명의 환자를 대상으로 19 명씩 ISB, CCE, IA 군으로 3 개의 군에 임의로 배정하였다. 각 군간 환자들은 수술 후 숫자통증등급(numerical rating scale, NRS) 점수와 추가로 들어간 마약성 진통제 용량(rescue opioid dosage, ROD), 수술 중 혈역학적인 변수, sevoflurane 농도, BIS 와 다른 부작용에 대해 조사하였다.

결과 : 수술 후 NRS 통증 점수는 휴식과 운동 시 모두에서 IA 군에서 ISB 와

CCE 군에 비해 높게 나타났다. ROD 는 ISB 군에서 IA 군에 비해 유의하게 적게 나타났으며(p= 0.01), ISB 와 CCE 군 간에는 유의한 차이를 보였다(p= 0.01). 평균 혈압(mean blood pressure, MBP)과 sevoflurane 농도는 모든 연구 시점 동안 ISB 군이 CCE 와 IA 군에 비하여 높게 나타났다. 수술 시야를 호전시키기 위하여 혈압강하제를 주입한 환자의 수는 ISB 군은 0 명(0 %), CCE 군은 7 명(36.8 %), IA 군은 14 명(73.6 %)으로 나타났다. 시술과 관련된 합병증은 관찰되지 않았다.

결론 : 이번 전향적, 무작위적인 연구는 견관절경 수술을 시행한 환자에서 수술 후 통증 조절에 있어 ISB 가 CCE 만큼 효과적이라는 것을 확인할 수 있었다. 그리고 ISB 는 견관절경 수술 중 마취제 요구량을 줄일 수 있고, 혈역학적 안정성을 제공할 수 있는 방법이다.