Clinical Trial

Effects of Ultrasound-Guided Stellate Ganglion Block on Acute Pain after Arthroscopic Shoulder Surgery

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Background and Objectives: Apart from a few case reports, the effectiveness of stellate ganglion block (SGB) as a monotherapy in acute nociceptive pain has not been determined. We aimed to assess the effects of SGB on postoperative pain after arthroscopic shoulder surgery.

Study Design: Randomized, blind, controlled, clinical trial.

Setting: University Hospital outpatient.

Methods: Forty-six patients undergoing arthroscopic shoulder surgery were assigned randomly to 2 groups: group S included patients who underwent SGB prior to surgery and group C did not. In group S, subfascial ultrasound-guided SGB was conducted with 4 mL of 0.375% levobupivacaine. For the first postoperative 48 hours, postoperative visual analog scale (VAS) and analgesic requirements were compared.

Results: The results of 40 patients were included in the study. There was no difference between groups with regards to analgesics requirement for the first postoperative 48 hours and no difference in VAS score ($P > 0.05$).

Limitations: Small number of patients in study.

Conclusion: Preoperative ultrasound-guided SGB did not reduce postoperative acute pain in arthroscopic shoulder surgery.

Key words: Acute pain, sympathetic nerve block, stellate ganglia

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Although arthroscopic shoulder surgery is less invasive and less painful than open shoulder surgery, it may lead to intraoperative hemodynamic instability as well as severe postoperative pain (1). Patients require substantial amounts of opioid analgesics postoperatively, which can lead to adverse events, such as nausea, vomiting, and over-sedation (2-5). Thus, it is important to appropriately manage postoperative pain with procedures such as regional nerve blocks and intravenous patient-controlled analgesia (PCA). Interscalene brachial plexus block, which is a commonly used regional nerve block, can effectively manage pain for up to 10 hours postoperatively (1,6). However, relatively large amounts of local anesthetic are used, and this method can result in serious complications, such as peripheral neurologic injury, central nervous system (CNS) injury, pneumothorax, and phrenic nerve palsy (7,8).

Recently, it was reported that when stellate ganglion block (SGB), a type of sympathetic nerve block-

ade, rather than a somatic nerve block, is conducted in upper limb surgery, pain was managed appropriately for 48 hours postoperatively (9). The stellate ganglion is the tissue that provides sympathetic nervous system connectivity to the head and neck, and the SGB is involved in a widely used treatment method for a chronic pain in the head and neck region (10).

However, apart from a few case reports (9,11), the effectiveness of SGB as a monotherapy has not been yet studied. Thus, we aimed to assess the effects of ultrasound-guided SGB prior to arthroscopic shoulder surgery on postoperative acute pain.

Methods

This prospective study was conducted as a randomized, blinded, and controlled clinical trial. This study protocol was approved by our Institutional Review Board and registered at the Clinical Research Information Service (registration no. KCT0001014). Written informed consent was obtained from all study patients. Data were collected from October 2012 to March 2013.

The study patients consisted of patients who planned to undergo arthroscopic rotator cuff repair under general anesthesia, due to rotator cuff muscle disruption. Exclusion criteria were hemostatic disorders, cardiovascular disorders, disorders of the bronchus or lung, chronic administration of opioid analgesics, sedative or anti-epileptic use, and known hypersensitivity to medications.

Preparation

Patients were assigned randomly to 2 groups. Group S consisted of patients who underwent preoperative SGB and postoperative intravenous PCA. Group C consisted of patients who received only postoperative intravenous PCA. In total, 3 medical staff performed the SGBs, induction and maintenance of anesthesia, and postoperative evaluations. SGB and pre-anesthetic management were conducted by one anesthesiologist who was involved in the study, but not in the postoperative assessments. Anesthesia was induced and maintained by another anesthesiologist who was blinded to the patient groups. Postoperative assessments were conducted by a nurse who was also blinded to the patient groups.

Stellate Ganglion Block and Anesthesia

A standardized monitoring device was attached to the study patient in the operating room to measure ECG, blood pressure, pulse, and oxygen saturation. Vital signs and a visual analog scale (VAS, 0 = no pain, 10 = the most severe pain imaginable) were recorded in all patients. In group S, thermometers were attached to the thumbs of both hands of the patients. The SGB was conducted under ultrasound guidance (Sonosite, Korea). At the C6 level, a 7 – 14 MHz linear probe was placed at the anterior scalene muscle, located between the carotid sheath and the brachial plexus. A 25-gauge, 6 cm needle (Kovax) was inserted laterally, 2 mm from the probe. The needle tip was placed posterior to the carotid artery, anterior to the longus colli muscle under the transverse short axis for the in-plane approach (subfascial injection; Fig. 1). Then, 4 mL of 0.375% levobupivacaine (Chirocaine, Abbott, Norway) was administered and a bandage was applied after removal of the needle. The patient's vital signs were recorded every 5 minutes for 20 minutes after the block procedure; the presence of Horner's syndrome and temperature change in the patient were recorded to assess whether the sympathetic block was appropriately achieved. Motor function in both limbs and the presence of sensory extinction were recorded to confirm the induction of interscalene nerve block, and hoarseness, VAS, and complications such as dyspnea were recorded. In group C, after the monitoring device was attached, a bandage was attached at the same position as the one in the SGB group, and changes in vital signs and VAS were observed for 20 minutes, followed by recording.

Equipment to measure BIS (a bispectral index monitor, Aspect Medical Systems, Inc., USA) was attached, followed by intravenous administration of propofol (2 – 2.5 mg/kg) and fentanyl (1 – 1.2 μg/kg) for induction, then intravenous rocuronium (0.6 mg/kg) was administered after confirmation of anesthesia. Endotracheal intubation was performed after the confirmation of muscle relaxation. At this point, the anesthesiologist was changed to the one who was blinded to the patient groups. After completion of the induction phase, the maintenance phase was conducted per protocol. Maintenance was achieved with 1.5% – 3.5% sevoflurane and 50% N2O and BIS was controlled at 40 – 60. During the operation, if the patient's blood pressure decreased by 20% of the patient's baseline, ephedrine was administered up to 4 mg, and glycopyrrolate (0.2 mg) or esmolol (10 mg) was administered intravenously if the heart rate was 50 beats/min or less, or 110 beats/min or more. Fentanyl (50 μg) was administered intravenously if the heart rate continued above 110 beats/min or more after administration. Nicardipine (0.6 μg/

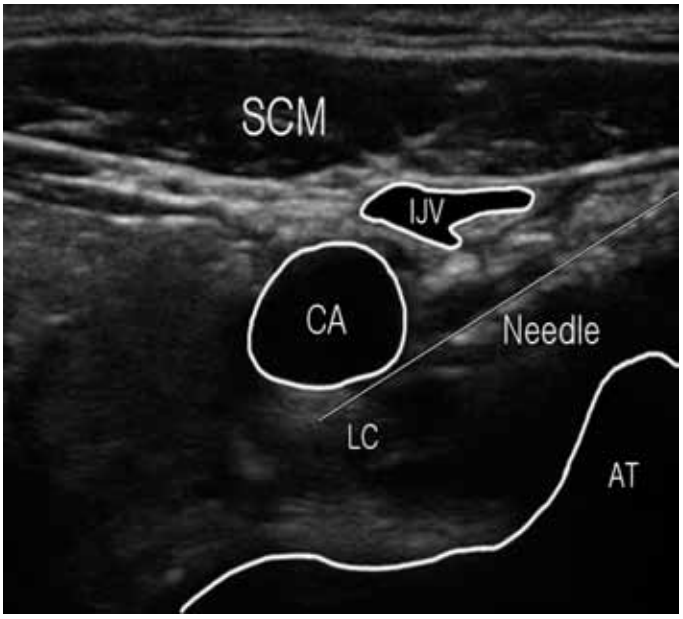

Fig. 1. *The target point was the prevertebral fascia under the carotid artery. The C6 anterior tubercle, IVC, and carotid artery were revealed by the transverse short axis. By an in-plane approach, the needle tip was checked and pushed. When the tip approached the prevertebral fascia, the drugs were injected (subfascial injection). CA, carotid artery, IJV, internal jugular vein, LC, longus colli muscle, AT, anterior tubercle of C6.*

kg) was administered intravenously if there was an increase in blood pressure of 20% from baseline. If any change in patient status occurred during surgery, immediate action was taken, observed, and recorded. When the operation was completed, fentanyl (1.5 μg/kg, maximum 100 μg), ketorolac tromethamine (30 mg), and ramosetron (0.3 mg/2 mL/ampule) were administered intravenously before closure. Glycopyrrolate (0.4 mg) and pyridostigmine (20 mg) were administered intravenously to reverse muscle relaxation and end tidal carbon dioxide concentration was maintained between 35 and 45 mm Hg by manual ventilation with 100% oxygen. The patient was extubated and transferred to the post-anesthesia care unit (PACU) when the patient responded (with open eyes to a verbal order) and had an appropriate tidal volume (or sufficient antagonism). Postoperatively, intravenous PCA was given to all patients in both groups. The PCA consisted of fentanyl (20 μg/kg), ketorolac tromethamine (90 mg), and ramosetron (0.3 mg) for 48 hours. The bolus button was removed.

Assessment

The patient was transferred to the post-anesthesia care unit (PACU) and hemodynamic baseline, VAS, ptosis, conjunctival flushing, hoarseness, and sensation and motor function in both arms were recorded for one hour. Nausea and vomiting, sedation status, pain in the surgical wound, other complications, and doses of analgesics administered were also recorded. When the patient's VAS was > 4, fentanyl 50 μg was administered intravenously and pain was reassessed after 15 minutes; an additional dose of fentanyl 25 μg was administered if the VAS was still > 4. Pain was reassessed after 15 minutes and an additional fentanyl dose (25 μg) was administered, and other analgesics as necessary, when the VAS was still > 4. Glycopyrrolate (0.2 mg) was administered intravenously when the patient's heart rate was 50 beats/min or less, and nicardipine (6 μg/kg) was administered intravenously when the systolic blood pressure was 180 mm Hg or higher or the diastolic blood pressure was 120 mm Hg or higher. Ephedrine was administered intravenously up to 4 mg if the patient's blood pressure decreased by 20% from baseline. An antiemetic was administered for nausea and vomiting postoperatively and the patient was transferred to the ward when stabilized.

Once the patient was transferred from the recovery room to the ward, a nurse who was blinded to the patient groups observed and recorded the following

Table 1. *Characteristics of patients and anesthesia.*

	Group S (n = 20)	Group C (n = 20)	*P*-value
Age (yr)	47.3 ± 13.3	49.1 ± 11.1	0.77
Sex (M/F)	11/9	10/10	0.77
BMI (kg/m2)	23.9 ± 2.0	23.9 ± 3.4	0.90
Operation time (min)	86.8 ± 28.8	100.3 ± 30.7	0.09
Anesthesia time (min)	153.3 ± 33.2	160.3 ± 31.8	0.47
Patients who received ephedrine (n)	3	2	
Patients who received nicardipine (n)	1	3	
Patients who received atropine (n)	3	0	

Values are presented as the mean ± SD. The dosing frequency was indicated as number of patients. No statistical difference was found between groups. BMI: body mass index

for 48 hours: vital signs, VAS, nausea and vomiting, sedation, complications, and doses and types of analgesics administered. Tramadol (50 mg/1 mL/ampule) was administered intravenously when the patient's VAS was > 4, and pain was reassessed after 30 minutes; additional analgesic was administered if the VAS was still > 4. Pain was then reassessed after one hour and additional analgesic was administered if the VAS was > 4; when the patient complained about pain again, the process was repeated. The administration of additional analgesic was decided by the orthopedic department; the dose administered and type of analgesic were recorded.

Statistical Analysis

Statistical analysis was performed using SAS statistical software (version 9.2; SAS Institute Inc., Cary, NC, USA). The $\chi 2$ test or Fisher's exact test were conducted for categorical variables and the unpaired t-test was used for continuous variables. A linear mixed model was applied to the repeated measurement data to test the pattern with time flow, and a post hoc test was conducted when the result was statistically significant. Results are presented as the mean ± SD. A *P*-value of less than 0.05 was considered to be statistically significant. The primary outcome was VAS in the recovery room and secondary outcomes were postoperative fentanyl requirement, nausea and vomiting, and sedation.

We considered a 30% reduction in pain in group S (SGB group) versus group C (control group) to be significant, based on published reports of a 50% reduction in pain with interscalene block, a somatic nerve block procedure. To identify this 30% reduction with an alpha error of 0.05 and a power of 80%, the required sample size was calculated to be 20 per group. To account for drop-out, we planned to include 23 patients in each group.

Results

Six patients were excluded from the analysis due to incomplete data. Thus, the data of 40 patients were included in the analysis. There was no difference between groups with regards to demographics, operative characteristics, or anesthesia. There was also no difference between groups regarding additionally administered medications during the operation (Table 1).

There was no significant difference between groups in vital signs 20 minutes prior to surgery. In group S, temperature, conjunctival flushing, ptosis, and change in VAS to establish outcome of the SGB are presented in Table 2. The mean ± SD of the change in temperature (before and after the procedure) on the ipsilateral side was 1.56 ± 1.25°C; the contralateral side had a mean ± SD change in temperature of 0.3 ± 0.84°C; the ipsilateral side showed a significant increase (P = 0.001). After the procedure, conjunctival flushing and ptosis occurred in all 20 patients in group S (100%). The VAS (mean ± SD) was reduced from 2.70 ± 2.49 to 1.10 ± 1.83 (P = 0.04). No reduction in motor function, loss of sensation, hoarseness, or dyspnea were observed in group S. In group C, no significant change was observed in the 20 minutes prior to surgery.

There was no difference between groups in variables such as blood pressure, heart rate, or oxygen saturation during the operation (Table 3). There was no difference between groups in terms of patient blood pressure or heart rate for one hour in the PACU (Table 4). The means ± SDs of the VAS in groups S and C were 4.63 ± 1.49 and 4.16 ± 1.27, respectively, for one hour

after the operation; there was no difference between groups ($P > 0.05$; Fig. 2). The means ± SDs of the total fentanyl required in groups S and C were 86.25 ± 46.22 μg and 80.00 ± 39.40 μg for one hour after the operation; there was no difference between groups ($P > 0.05$; Fig. 3). There was no difference between groups with regards to blood pressure or heart rate for 48 hours in the ward. There was also no difference in analgesic requirements (Table 5) or VAS between groups, which were observed for 48 hours (Fig. 4).

Discussion

In this study, we examined the effects of ultrasound-guided SGB on acute pain after arthroscopic shoulder surgery. This prospective, randomized, observer-blinded study showed there was no difference between the SGB (group S) and control (group C) groups in terms of VAS, vital signs, and analgesic requirement for the 48 hours after arthroscopic shoulder surgery.

SGB is used widely in the treatment of chronic neuropathic pain of the upper limbs, head, and neck (10). Its aim is to block the pain cycle by blocking sympathetic nerves, and to recover the balance of normal somatic sensation through rehabilitation of the pain region (10). The sympathetic nervous system (SNS) contribution to the pathogenesis of chronic pain is well known (10) but its role in acute pain is unclear. Recently some studies reported that SGB showed beneficial effects in acute pain management postoperatively, which differed from the results of our study (9,11).

McDonnell et al (9) reported the successful use of ultrasound-guided SGB for the management of postoperative pain in 4 patients who underwent open reduction and internal fixation operations after humeral shaft fractures. They emphasized that SGB had the potential to provide analgesia after a major upper limb

Table 2. *Sign of sympathetic block and preoperative pain score in the SGB group.*

	SGB*(N = 20)		*P*-value
	Before SGB	After SGB	
Temperature(°C)			
Ipsilateral	34.1 ± 2.6	35.7 ± 1.8*	0.00
Contralateral	33.9 ± 2.9	34.2 ± 3.0	0.13
VAS	2.7 ± 2.5	1.1 ± 1.8*	0.04
Conjunctival flushing (n)	0	20 (100%)	
Ptosis (n)	0	20 (100%)	

Values are presented as mean ± SD. Conjunctival flushing and ptosis were indicated as number of patients (%). *$P < 0.05$ as compared with pre-SGB. SGB: stellate ganglion block. Ipsilateral: the side on whichthe SGB was conducted. Contralateral: the opposite site of which the SGB was conducted. VAS: visual analogue scale

Table 3. *Intraoperative variables in each group.*

	Measured time	Group S (n = 20)	Group C (n = 20)	*P*-value
MBP (mmHg)	Baseline	91.9 ± 14.3	94.9 ± 15.8	N-S
	10 min	98.9 ± 18.1	96.2 ± 17.8	N-S
	30 min	89.4 ± 11.3	88.2 ± 11.8	N-S
	45 min	88.4 ± 11.6	82.6 ± 10.7	N-S
	60 min	84.7 ± 10.5	81.2 ± 7.9	N-S
HR (rate / min)	Baseline	80.7 ± 15.6	75.7 ± 12.2	N-S
	10 min	82.6 ± 15.1	76.9 ± 12.6	N-S
	30 min	79.4 ± 14.2	74.2 ± 9.9	N-S
	45 min	81.2 ± 13.4	71.9 ± 10.7	N-S
	60 min	81.3 ± 10.5	72.7 ± 8.7	N-S
Saturation (%)	Baseline	98.3 ± 0.8	98.5 ± 0.8	N-S
	10 min	98.5 ± 0.9	98.6 ± 0.7	N-S
	30 min	98.3 ± 0.8	98.8 ± 0.8	N-S
	45 min	98.3 ± 0.7	98.6 ± 0.7	N-S
	60 min	98.2 ± 0.7	98.3 ± 0.7	N-S

Values are presented as the mean ± SD. No statistical difference between 2 groups ($P > 0.05$). NS : No statistical differences.

operation, and suggested that their report supported the hypothesis that the SNS is involved in the pathogenesis of acute pain (9). Also, sympathetic irritation is known to increase nociceptive spike traffic in skin exposed to chemicals that induce burns or pain or in the case of increased calcium levels (12-14). Pain is not only sensed by peripheral nociceptors, but includes the involvement of responses in the brain via the neuroendocrine and autonomic nervous system (15,16). The sympathetic nervous system also has important roles in controlling arteriole basal tone of the vascular bed in acute inflammation and neurogenic inflammation (9). For these reasons, McDonnell et al (9) reported that SGB, a sympathetic block, played an important role in controlling the acute pain that occurred after the upper limb operation.

However, our results differed from the studies above (9,10). Traditionally, somatic nerve block, such as the interscalene block, was carried out for the management of pain after shoulder surgery (2). This requires relatively large amounts of local anesthetic, and the block of sensory and motor function lasted for several hours, which became a disadvantage because it delayed early assessment of sensory motor function. However, ultrasound-guided SGB allows low doses of local anesthetics to be used, and does not induce sensory motor block, which has the advantage of faster sensory motor function assessment than the somatic nerve block, if SGB can achieve appropriate analgesia postoperatively (9). Based on this information, we conducted our study in patients who were undergoing arthroscopic shoulder surgery, and found that SGB did not reduce postoperative pain. Our findings are consistent with a report that demonstrated that lumbar sympathetic block did not

Table 4. *Postoperative variables and total fentanyl requirement(μg) in each group in PACU.*

PACU	Time	GroupS (n = 20)	Group C (n = 20)	*P*-value
MBP (mmHg)	Baseline	105.2 ± 12.0	94.9 ± 17.5	N-S
	15 min	106.6 ± 13.2	95.2 ± 15.7	N-S
	30 min	16.3 ± 12.8	94.3 ± 15.1	N-S
	45 min	106.7 ± 12.4	95.9 ± 15.3	N-S
	60 min	103.9 ± 11.6	97.3 ± 14.9	N-S
HR (beats/min)	Baseline	83.2 ± 1.9	73.3 ± 8.2	N-S
	15 min	76.1 ± 8.6	67.8 ± 10.4	N-S
	30 min	73.6 ± 10.1	66.1 ± 8.3	N-S
	45 min	73.2 ± 8.6	64.9 ± 8.2	N-S
	60 min	73.3 ± 8.8	68.0 ± 9.8	N-S
Fentanyl requirement (μg)		80.0± 39.4	86.3 ± 46.2	0.32

Values are presented as the mean ± SD. No statistical difference between two groups ($P > 0.05$). NS: No statistical differences.
PACU: Post Anesthetic Care Unit

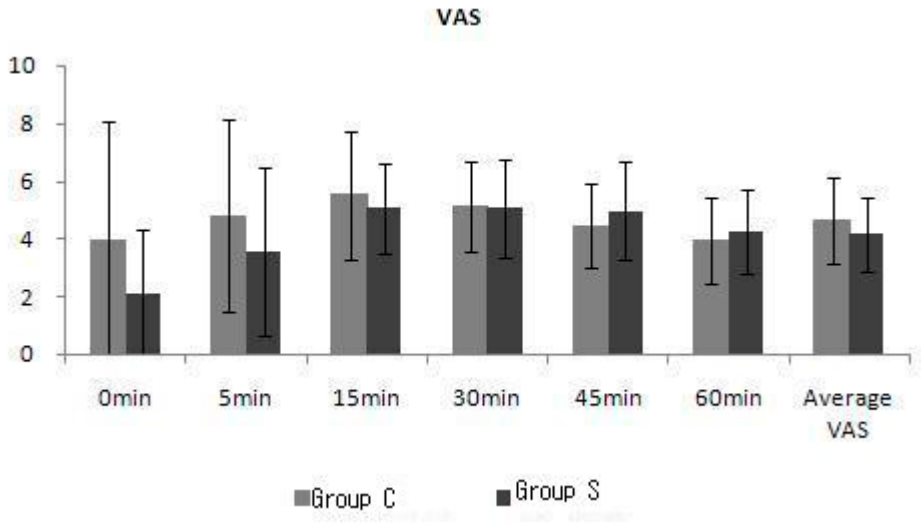

Fig. 2. *VAS measured for one hour in the recovery room. Data are expressed as the mean ± SD. No statistical difference was seen between groups S and C ($P > 0.05$).*

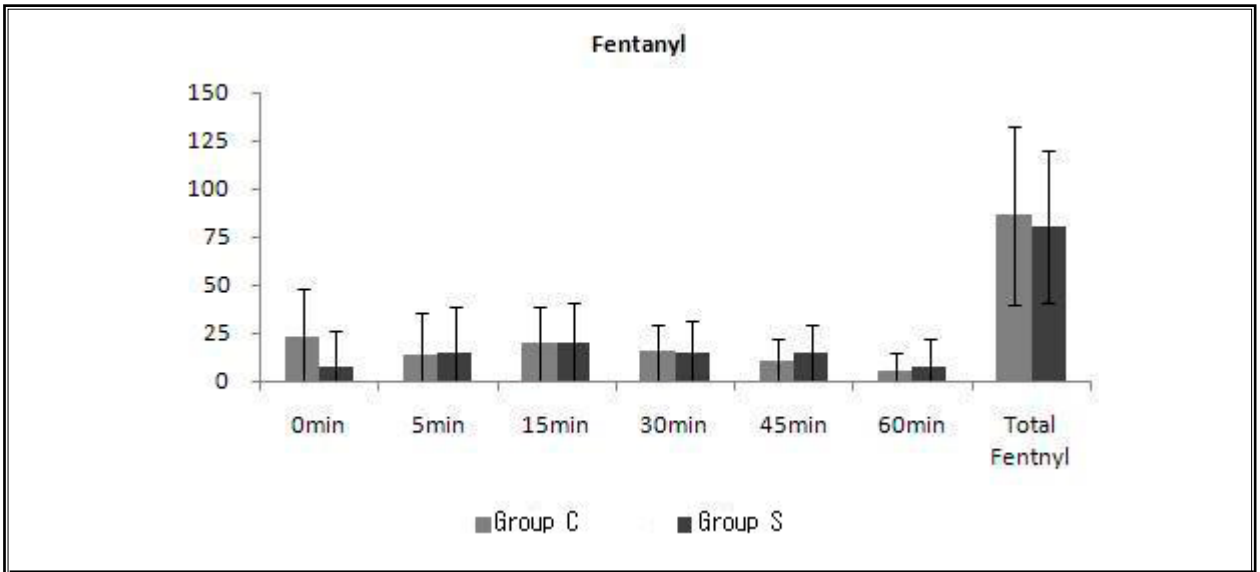

Fig. 3. *Postoperative fentanyl requirement in the recovery room. Data are expressed as the mean ± SD. No statistical difference was seen between groups S and C (P > 0.05).*

Table 5. *Postoperative variables and total administered tramadol in ward.*

Ward	Time	Group S	Group C	*P*-value
MBP (mmHg)	0 hr	92.0 ± 6.61	92.2 ± 6.7	N-S
	2 hr	91.5 ± 7.05	89.2 ± 9.1	N-S
	6 hr	87.0 ± 8.23	87.7 ± 9.1	N-S
	12 hr	87.5 ± 7.71	89.0 ± 8.9	N-S
	24 hr	89.0 ± 8.99	93.5 ± 10.6	N-S
	36 hr	91.0 ± 8.17	91.2 ± 8.7	N-S
	48 hr	92.9 ± 8.36	92.7 ± 10.1	N-S
HR (rate / min)	0 hr	72.7 ± 6.19	72.4 ± 8.3	N-S
	2 hr	74.6 ± 8.24	73.2 ± 8.5	N-S
	6 hr	75.6 ± 8.10	76.3 ± 9.7	N-S
	12 hr	74.8 ± 7.60	75.6 ± 7.8	N-S
	24 hr	75.3 ± 7.23	73.7 ± 7.8	N-S
	36 hr	75.1 ± 10.10	73.5 ± 8.2	N-S
	48 hr	76.1 ± 7.68	74.8 ± 6.0	N-S
Patient numbers received tramadol		2.3 ± 2.3	2.1 ± 1.7	N-S

Values are presented as the mean ± SD. No statistical difference between 2 groups ($P > 0.05$).
NS: No statistical differences

reduce acute inflammatory pain (17). According to this report, injured tissue nociceptors, after inflammatory change, are sensitized due to sympathetic activity (18-20); thus hyperalgesia can be prevented by sympathectomy (21). However, in normal tissue, sympathetic activity does not excite or modulate nociceptors, and sympathetic fibers do not transmit afferent information from the skin (17), which is why lumbar sympathetic block does not reduce acute inflammatory pain. Also, there is a study reporting that the acute pain due to the administration of hyperosmolar saline solution was not reduced by SGB (22). There are other neurophysiological studies in animals that suggest limitations of acute pain management by sympathetic block. In

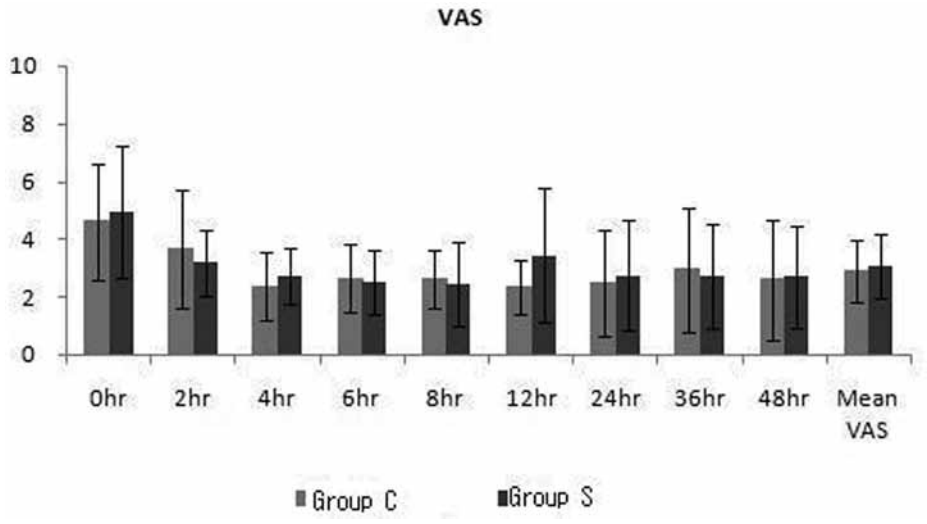

Fig. 4. *VAS from one to 48 hours after surgery. Data are expressed as the mean ± SD. No statistical difference was seen between groups S and C (P > 0.05).*

rabbits, electrical stimulation to the sympathetic did not increase C-fiber neurological activity on noxious mechanical or thermographic stimulation (23,24). In rats and rabbits, the administration of noradrenaline did not affect spike traffic at the C-fiber or Aδ-fiber due to bradykinin or stretching (19,25). Also, in micrographic recordings, sympathetic irritation did not cause a change in response in cutaneous polymodal C-fibers (26). Similar to those reports, our study suggests that preoperative sympathetic block could not reduce acute postsurgical pain.

However, if the sympathetic nervous system is actually related to pathogenesis of postoperative acute pain, we might question whether the SGB in this study was performed inappropriately. In this study, SGB was conducted under ultrasound guidance, and the change in temperature and the presence of Horner's syndrome were observed to assess the appropriateness of the block. Sixty-five percent of patients complained of chronic pain and their VAS was reduced after SGB; this was possibly due to the analgesic effect from the sympathetic block for their chronic shoulder pain (10). However, even though the decrease of VAS is proved to be meaningful from a statistical perspective, it's not considered as significant from the clinical perspective. It's because we cannot exclude the possibility of placebo effect and the mean VAS score is decreased only from 2 to 1.

Horner's syndrome was present in all patients (100%) and 60% of patients presented a difference of 1.5°C or more between the change in the ipsilateral side compared with the contralateral side; the procedural side had a mean (SD) temperature increase of 1.56 (0.86)°C.

The success rate of complete sympathetic block in SGB has been reported in various cases, and the observation of Horner's syndrome and a difference of 1.5°C or more between the ipsilateral and contralateral sides are considered important in the assessment of SGB (27). Also, the ultrasound-guided subfascial injection technique allows for a successful block with a small dose of local anesthetics, with fewer complications (28-30). Considering the results after the block and the procedural methods, SGB in this study appears to have been performed appropriately. If the SGB was appropriate and this block has an effect in pain reduction, then other factors may have compromised the effect. In particular, in arthroscopic rotator cuff repair, epinephrine is used after the dilution in irrigation fluid to reduce bleeding and secure a clear view (31), and the effects of epinephrine, absorbed systematically or locally, on SGB are unknown. In damaged or burned tissues, pain is exacerbated due to sympathomimetics such as noradrenaline, and pain is reduced by sympathetic blockade (22). In a previous case (9), it appeared that epinephrine was not used as an open reduction and internal fixation was

carried out for a humerus fracture. Epinephrine-mixed irrigation fluid is generally used in shoulder arthroscopy to reduce bleeding (31), and further study is required on the effects of epinephrine on pain and any systemic effects.

This study had several limitations. First, the placebo-controlled comparison could not be made, because performing SGB with normal saline was not permissible in the control group for ethical reasons. However, bandages were attached on all the patients' necks prior to the induction of anesthesia, so that the physician who assessed the patients after the surgery was not able to differentiate between groups. Second, there is a possibility that study blinding has been influenced by the preoperative differences in temperature, conjunctival flushing, and ptosis present in the group S patients which were not found in the group C patients. However, since the average anesthetic time was over 150 minutes, the differences in temperature, conjunctival flushing, and ptosis caused by preoperative SGB were not observed in either group postoperatively. Furthermore, the influence on study blinding by postoperative evaluation seems to have been minimal since it was conducted by physician who has not performed SGB.

Third, study patients were arthroscopic shoulder surgery patients, so they underwent a less invasive procedure and likely experienced less pain than open surgery for upper limbs in the previous study (9); additionally, the effect of sympathetic block is unknown in major upper limb surgery. Further studies are necessary to evaluate the role of sympathetic block according to the severity of pain in surgery.

Conclusion

In summary, we found that ultrasound-guided SGB prior to arthroscopic shoulder surgery did not reduce acute postoperative pain. Although this study found negative results, SGB is a relatively simple procedure, is easy to assess early sensory motor dysfunction after surgery, and may reduce adverse events seen in other nerve blocks. Thus, it is important to better understand the effects of SGB on acute pain and to apply it clinically after further research.

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