Efficacy of axillary nerve block in elbow arthroscopic surgery: a randomized trial

Takuro Wada, MDa,*, Masanori Yamauchi, MDb, Gosuke Oki, MDb, Tomoko Sonoda, DDSa, Michiaki Yamakage, MDb, Toshihiko Yamashita, MDa

aDepartment of Orthopaedic Surgery, Sapporo Medical University, Sapporo, Japan
bDepartment of Anesthesiology, Tohoku University, Sendai, Japan
cDepartment of Public Health, Sapporo Medical University, Sapporo, Japan
dDepartment of Anesthesiology, Sapporo Medical University, Sapporo, Japan

Background: The purpose of this study was to evaluate postoperative pain levels after arthroscopic elbow surgery under general anesthesia and to determine whether an axillary nerve block provides additional pain management benefits compared with a portal site injection of local anesthetic.

Methods: Thirty-six patients undergoing arthroscopic elbow surgery under general anesthesia were randomized to either a study group receiving axillary nerve block (Ax group) or a control group receiving portal site injections of local anesthetic (Lo group). During the first 48 hours after surgery, pain visual analog scale (VAS) scores (0-100), total amount of oral analgesics required, and patient satisfaction were assessed.

Results: Among all 36 patients, mean pain VAS scores at rest were 37, 18, and 9 for the first 12-hour period and at 24 and 48 hours after surgery, respectively. The mean pain VAS scores during physiotherapy were 47 and 33 at 24 and 48 hours postoperatively, respectively. No intergroup differences were observed between the Ax and Lo groups at any time point after surgery (P value range, .41 to .87). The mean number of loxoprofen tablets required during the 48-hour study period was 5.1 in the Ax group and 4.5 in the Lo group (P = .90). The Ax and Lo groups had mean overall patient satisfaction scores of 91 and 91, respectively (P = .98).

Conclusions: Postoperative pain levels after arthroscopic elbow surgery could be well managed with oral analgesics and local anesthetic. An axillary nerve block was not found to provide any postoperative pain control benefits.

Level of evidence: Level I, Randomized Controlled Trial, Treatment Study.

Keywords: Elbow arthroscopy; general anesthesia; postoperative pain; axillary nerve block; oral analgesics; local anesthetic

Improved instrumentation and more precise surgical techniques have made elbow arthroscopy a more common procedure and one that is now a safe and effective modality for elbow disease.18 Arthroscopic elbow surgery enables motion exercises to be undertaken early after surgery, which might be beneficial for early functional recovery.
With regard to anesthesia, general anesthesia is usually preferred for patients as it provides complete muscle relaxation throughout the procedure and allows the use of a tourniquet without discomfort. However, the disadvantage is the potential for greater postoperative pain, which can discourage the early initiation of exercise, decrease patient satisfaction, and result in poor clinical outcomes because of delayed rehabilitation.

Arthroscopic shoulder surgery under general anesthesia is often associated with severe postoperative pain. Regional anesthesia techniques, including single-injection or continuous interscalene block and subacromial or intra-articular infiltration analgesia, have been used for postoperative pain control. Single-injection interscalene block is the most commonly used technique and provides better analgesia and reduced opioid-related side effects relative to control groups. However, whether this is superior to other modalities remains controversial. On the other hand, very few studies have been conducted on pain level or pain control after arthroscopic elbow surgery.

The purpose of this prospective randomized clinical study was to evaluate early postoperative pain levels after arthroscopic elbow surgery under general anesthesia and to determine whether an axillary nerve block provides additional pain management benefits compared with portal site injections with local anesthetic. We hypothesized that an axillary nerve block with a long-acting anesthetic might provide additional pain management benefits.

Materials and methods

The study enrolled 41 patients who were older than 20 years and scheduled for arthroscopic surgery of the elbow under general anesthesia. The study design was a prospective, randomized clinical trial conducted from October 2009 through April 2012. Exclusion criteria included previous elbow surgery, allergy to local anesthetics, peripheral neuropathy, proven opioid dependency, and dementia (as assessed by a lack of orientation to person, place, and time).

The patients in this study were routinely admitted to our hospital for 4 days in accordance with the usual practice pattern of the authors’ health care system, in which admission cost is relatively low and patients generally tend to remain hospitalized for longer. One day before surgery, the patients were randomly allocated to 1 of 2 additive local analgesia treatment groups by the anesthesiologist, according to a computer-generated randomization schedule.

All patients received general anesthesia. Study group (Ax group) patients were assigned to receive a supplementary one-time preoperative axillary nerve block administered by anesthesia staff skilled and experienced in the technique. Under general anesthesia, axillary nerve block was performed under real-time ultrasound guidance with nerve stimulation. A short axial view of the target nerves (median nerve, radial nerve, ulnar nerve, and musculocutaneous nerve) surrounded by the axillary artery was visualized by ultrasound imaging (Vivid i; GE Healthcare, Norwalk, CT, USA) for confirming locations of vessels around the nerves by color Doppler mode. A 50-mm 22-gauge insulated needle (Stimuplex; B-Braun-McGaw Medical, Bethlehem, PA, USA) was gently introduced by an in-plane approach toward the edge of each nerve. The needle was connected to a constant voltage nerve stimulator (Stimuplex DIG; B-Braun-McGaw Medical) that was set at 2 Hz with pulse width of 100 milliseconds and current of 0.8 mA. The needle position was considered acceptable if an evoked motor response as a twitch muscle contraction in the affected region was elicited between 0.5 and 0.8 mA. After careful aspiration to exclude intravascular injection, 4 mL of 0.75% ropivacaine was injected for each nerve. The same needle manipulation and injection were performed for every target nerve, and a total of 16 mL of ropivacaine was injected. The expected duration of the block was approximately 12 to 24 hours.

Control group (Lo group) patients were assigned to receive local anesthetic injections for each portal. Under general anesthesia, after positioning and draping, a surgeon injected 1.5 mL of 0.75% ropivacaine into the subcutaneous tissue of each portal before the tourniquet was inflated.

Operative technique

The patient was placed in the lateral decubitus position with the operative side up. A tourniquet was placed on the arm at the midhumeral level and an arm holder was positioned underneath the arm, allowing the elbow to move from 90° of flexion to full extension. Arthroscopic portals, including proximal anteromedial, anterolateral, proximal anterolateral, posterolateral, posterocentral, and soft spot portals, were drawn on the elbow along with the surgical landmarks. The arm was sterilly prepared and draped. The elbow joint was inflated with 15 to 25 mL of normal sterile saline solution through the soft spot portal. For lateral epicondylitis, the joint capsule and pathologic extensor carpi radialis brevis tendon were resected at the lateral epicondyle. A radiocapitellar joint plica impinged into the joint was resected from the anterior and posterior compartments. For osteoarthritis, we used anterior removal of loose bodies and removal of osteophytes from the coronoid process, radial fossa, and coronoid fossa, followed by posterior removal of loose bodies and removal of osteophytes from the posterior olecranon and olecranon fossa as well as the posterior radiocapitellar compartment. If motion was still limited, a capsular release was performed. For rheumatoid arthritis, total synovectomy of the elbow was performed using multiple portals and dividing the elbow into anterior, posterior, and radiocapitellar compartments. For radiocapitellar plica, the anterior portion of the plica was removed through the anterolateral and proximal lateral portals. The remaining plica and localized synovitis were then resected through the posterolateral and soft spot portals.

In both groups of patients, postoperative splints were not used. One day after surgery, elbow range of motion was initiated under the supervision of therapists. Each patient was enrolled in a postoperative rehabilitation regimen appropriate to surgery types.

Outcome measures

In the Ax group, sensory and motor function were evaluated at 2, 12, and 24 hours after surgery. The intensity of the sensory block was assessed at the level of the forearm and hand for the median, ulnar, radial, and musculoskeletal nerves with the use of cold touch with alcohol and a cotton swab. The median, ulnar, radial, and musculoskeletal motor nerve blocks were evaluated by...
assessment of abductor pollicis brevis, abductor digiti minimi, wrist extensor, and biceps muscle strength, respectively, with the use of a 4-point modified Bromage score. Bromage and modified Bromage scores are described in Table I.

Medication intake for both groups was also evaluated during these intervals and recorded. The patients were provided with an oral rescue analgesic, loxoprofen 60 mg, orally 3 times a day as needed. The total number of tablets ingested was recorded for each medication for each interval.

Pain scores were measured with use of a 100-mm visual analog scale (VAS) at rest for the first 12-hour period, at 24 and 48 hours postoperatively, and during each physiotherapy session. Patients were asked to report the worst pain score for the first 12-hour period. Patients also reported a satisfaction score (using a 100-point categorical scale, with 0 indicating no satisfaction with the analgesic modality and 100 indicating complete satisfaction with the analgesic modality) at 48 hours postoperatively.

Symptoms of block-related nerve injuries were assessed by the study investigators just before hospital discharge and by the primary orthopaedic surgeon on the first postoperative office visit, usually 10 to 14 days after surgery. Nurses recorded the number of loxoprofen tablets ingested, and therapists recorded the pain and Bromage scores.

The pain VAS scores at rest for the first 12-hour period after surgery were used as the primary outcome measure. Secondary outcomes included pain VAS scores during physiotherapy, total amount of oral analgesics required, and patient satisfaction.

**Statistical methods**

On the basis of previous studies of shoulder arthroscopy, we hypothesized that we could observe at least a 50% reduction in the pain VAS scores between the Ax and Lo groups. Power analysis (the mean VAS scores of 25 [Ax group] and 50 [Lo group] with a standard deviation [SD] of 20) estimated that at least 12 patients would be required in each group to show a difference at an α level of .05 and with a β value of .08. Student t test was used to determine the significance of group differences in continuous variables, and the χ² or Fisher exact test was used to determine the significance of differences between categorical variables. Wilcoxon signed rank test was used to determine the significance of differences in the blocking effects between nerves in the Ax group.

**Results**

The flow of the 41 patients who participated in the study is presented in Figure 1. Of these, 18 were randomized to the Axillary nerve block for elbow arthroscopy

<table>
<thead>
<tr>
<th>Table I</th>
<th>Bromage and modified Bromage scores</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bromage score</strong></td>
<td>Degree of block</td>
</tr>
<tr>
<td>Grade</td>
<td>Criteria</td>
</tr>
<tr>
<td>I</td>
<td>Free movement of legs and feet</td>
</tr>
<tr>
<td>II</td>
<td>Just able to flex knees with free movement of feet</td>
</tr>
<tr>
<td>III</td>
<td>Unable to flex knees, but with free movement of feet</td>
</tr>
<tr>
<td>IV</td>
<td>Unable to move legs or feet</td>
</tr>
</tbody>
</table>

Ax group and 18 were randomized to the Lo group. Patient demographic profiles and details of the surgical procedures performed are summarized in Table II. The preoperative anesthesia time was significantly longer in the Ax group than in the Lo group. No statistical differences were found between the groups in terms of sex, age, surgery time, or surgery types.

In the Ax group, sensory blockade of the median, ulnar, and radial nerves occurred in 17 of 18 (94%) patients and that of the musculocutaneous nerve occurred in 15 of 18 (89%) patients at 2 hours after surgery. It remained in 33% to 44% of patients, depending on the nerve, at 12 hours after surgery (Fig. 2). Motor block of the median, radial, and musculocutaneous nerves was demonstrated in 17 of 18 (94%) patients and that of the ulnar nerve in 15 of 18 (89%) patients at 2 hours after surgery. It remained in 17% to 56% of patients, depending on the nerve, at 12 hours after surgery (Fig. 3). The sensory or motor blockade was resolved completely at 48 hours after surgery. There were no significant differences in the sensory or motor blocking effects between the nerves at 2 hours after surgery (P value range, .06 to .71). In the Lo group, local anesthetic injections did not cause nerve block except in the infiltrated areas. No patient developed symptoms of block-related nerve injuries.
Among all 36 patients, mean pain VAS scores at rest (±SD) were 37 ± 28, 18 ± 19, and 9 ± 14 for the first 12-hour period and at 24 and 48 hours after surgery, respectively. The mean pain VAS scores during physiotherapy were 47 ± 29 and 33 ± 29 at 24 and 48 hours after surgery, respectively.

Patients in the Ax group showed mean pain VAS scores at rest of 41 ± 28, 17 ± 18, and 7 ± 13 for the first 12-hour period and at 24 and 48 hours after surgery, respectively, and mean pain VAS scores during physiotherapy of 46 ± 29 and 30 ± 27 at 24 and 48 hours after surgery, respectively. Patients in the Lo group demonstrated mean pain VAS scores at rest of 33 ± 28, 18 ± 20, and 10 ± 16 and mean pain VAS scores during physiotherapy of 48 ± 29 and 36 ± 31, respectively, at the same time points. No significant intergroup differences in the mean pain VAS scores were observed at any time point after surgery (P value range, .41 to .87) (Fig. 4).

The mean number of loxoprofen tablets required during the 48-hour study period was 5.1 ± 6.9 in the Ax group and 4.5 ± 9.1 in the Lo group, with no significant difference observed (P = .90).

### Patient satisfaction

Among all 36 patients, the mean satisfaction VAS score (±SD) was 91 ± 15. The Ax and Lo groups showed overall patient satisfaction scores of 91 ± 10 and 91 ± 11, respectively, again with no significant difference observed (P = .98).

### Discussion

We showed that postoperative mean pain VAS scores at rest after arthroscopic elbow surgery were 37 for the first...
12-hour period and 18 at 24 hours after surgery, and those during physiotherapy were 47 at 24 hours and 33 at 48 hours after surgery, levels that could be well managed with oral analgesics. There was no difference between additional axillary nerve block and portal site injection with local anesthetic in terms of pain score, postoperative medication of oral rescue analgesics, or patient satisfaction after elbow arthroscopic surgery. Axillary nerve block was not found to provide any additional pain control benefits in the present study.

Studies of early postoperative pain after arthroscopic elbow surgery have been rare, and we could not find studies that provided postoperative pain VAS scores. Early postoperative pain VAS scores after arthroscopic shoulder surgery, volar plate fixation for a distal radius fracture, and total hip or knee arthroplasty have been reported to range between 30 and 60. Although pain scores at rest during the first 12 hours after elbow arthroscopic surgery were comparable with those for these procedures, the duration of intense pain was shorter. Postoperative pain VAS scores during physiotherapy at 24 and 48 hours after elbow arthroscopic surgery were comparable with those after total hip arthroplasty under continuous lumbar plexus or femoral block or after shoulder arthroscopic surgery under continuous interscalene brachial plexus block. It appears that the pain levels in the present study can be well tolerated as patients in both groups were highly satisfied with their anesthetic modalities.

Arthroscopic shoulder surgery under general anesthesia is often associated with severe postoperative pain that can be difficult to manage. Supplemented regional anesthesia including a brachial plexus block or intra-articular local anesthetic has been used for postoperative pain control. A number of comparative studies have been conducted to assess evidence of the effectiveness of regional anesthesia techniques. Among them, a single-injection interscalene block is the most commonly used technique and was found to reduce postoperative pain VAS scores during the first 24 hours after surgery by up to 50% compared with controls. On the other hand, our study indicated that an axillary nerve block provides no additional pain control benefits after elbow arthroscopic surgery. It is probable that pain intensities are lower in elbow arthroscopic surgery compared with shoulder arthroscopic surgery. In shoulder arthroscopic surgery under general anesthesia and without regional anesthesia, postoperative pain VAS scores during the first 24-hour period after surgery were reported to be between 34 and 55. In addition, this could be due to the so-called rebound pain phenomenon, which has been shown to occur when a perineural single injection or continuous infusion resolves. Indeed, the current patients in the Ax group complained of painful discomfort during recovery from the axillary block.

An axillary nerve block under real-time ultrasound guidance with nerve stimulation may add to the preoperative time. After surgery, the nerve block limits the ability to assess the postsurgical neurologic state. In contrast, local anesthetic injection into the portals is a quick and simple technique. Local infiltration of the long-acting anesthetics can provide both intraoperative and postoperative pain analgesia. This may inhibit the transmission of nervous signals from damaged tissue and reduce neurogenic inflammation through the blockade of the axon reflex and sympathetic efferent.

This study has several limitations. First, we lacked follow-up pain levels beyond 48 hours after surgery, which would have provided a better understanding of the temporal course of pain. A second limitation is the potential for selection bias as a result of the diverse procedures received by patients. We were not able to perform a case matching of pathologic processes because of the small number of patients. The randomization used in this investigation minimizes the systematic introduction of bias, and both groups were predicted to be similar. However, we still need to conduct another study using matched controls. Third, although the axillary nerve block anesthetic technique and intensity were controlled by experienced anesthesiologists and 17 of 18 patients had sensory and motor block at 2 hours after the operation as well as during the recovery within 24 hours, potential variations in anesthetic intensity might have affected postoperative pain intensities. Finally, we evaluated only the worst pain level during the first

![Figure 4](image_url)

**Figure 4** The pain visual analog scale score at rest (VASr) measured for the first 12-hour period and at 24 and 48 hours and the pain visual analog scale score during physiotherapy (VASpt) measured at 24 and 48 hours postoperatively. The vertical bars represent standard deviation. Ax group, group receiving axillary nerve block; Lo group, group receiving portal site injections of local anesthetic.
12-hour period after surgery. Future studies are required to demonstrate the time course of pain during this period.

Conclusions

Postoperative mean pain VAS scores at rest after arthroscopic elbow surgery under general anesthesia combined with portal anesthesia were found to be 33 during the 12-hour period and 18 at 24 hours after surgery, levels that could be well managed with oral analgesics and local anesthetic. A supplementary axillary nerve block was found not to offer additional pain control benefits.

Disclaimer

The authors, their immediate families, and any research foundation with which they are affiliated did not receive any financial payments or other benefits from any commercial entity related to the subject of this article.

References


