Clavicle fractures are common, and there has been a recent increase in surgical fixation of displaced fractures. General anesthesia is traditionally preferred for these operations because regional anesthesia can be challenging. This is partly due to a complex nerve innervation in this region, which makes the correct choice of nerve block difficult. The objective of this study was to evaluate the efficacy of a combined interscalene brachial plexus block and superficial cervical plexus peripheral nerve block as anesthesia for clavicle surgical procedures. Ten midshaft clavicle fractures were surgically repaired using a combination of an ultrasound-guided interscalene brachial plexus block and a superficial cervical plexus peripheral nerve block as the primary anesthetic. All patients underwent surgery successfully using regional anesthesia with light sedation, without the need for rescue opioids or rescue local anesthesia. No adverse events were recorded. This case series describes a successful peripheral nerve block combination that can be used for clavicle surgery.

Keywords: Brachial plexus block, cervical plexus block, clavicle, general anesthesia, local anesthesia.

Clavicle fractures are very common injuries. They account for 2.6% of all fractures and 44% of injuries to the shoulder girdle. It has been suggested that the high frequency of fractures could be explained by the bone’s superficial location and thin shaft. Most fractures occur on the middle third (midshaft) of the bone. Furthermore, shaft fractures are more likely to be displaced compared with fractures of other parts of the clavicle.

Lately there has been an increase in operative fixation for clavicle fractures. Our hospital treats approximately 270 clavicle fractures per year, and according to operative case logs the incidence of surgical repair increased from 13% to 18% in the 2014 to 2017 period.

Anesthesia for clavicle surgery has traditionally consisted of general anesthesia. However, regional anesthesia for upper limb surgery represents several advantages over general anesthesia, including better postoperative analgesia, less nausea and vomiting, more hemodynamic stability, fewer side effects, and a favorable complications profile. Peripheral nerve blocks can result in less postoperative opioid consumption, which might lead to a shorter hospital stay and improved patient satisfaction.

One reason for not using regional anesthesia for clavicle surgery may be the unclear description of peripheral nerve innervation of the clavicular area, in particular, the midshaft region of the clavicle.

There are suggestions that the clavicle is innervated by nerves deriving from either the interscalene brachial plexus (ISBP) or the superficial cervical plexus (SCP), or from a combination of nerves from both plexuses. This complex innervation represents a challenge for the anesthesia provider when it comes to selecting the correct nerve block, leaving general anesthesia as the most conservative alternative.

In this study, we present a case series in which 10 midshaft clavicle fracture operations were performed successfully using a combination of an upper ISBP and SCP nerve block as anesthesia in lightly sedated patients. This study adheres to the CAse REport (CARE) guidelines.

Case Summary
The study was approved by the hospital’s institutional review board before the study started. Written informed consent was obtained from all the included patients. The study period was between September 2016 and January 2018.

All patients above the age of 18 years with a midshaft clavicle fracture who were admitted when the first author (C.G.F) was on duty were recruited if they did not present with any of the exclusion criteria. Exclusion criteria included risks of pulmonary decompensation due to phrenic nerve palsy or worsening of an existing neurologic condition with the use of a nerve block. After receiving information concerning the choice between

Combined Interscalene Brachial Plexus and Superficial Cervical Plexus Nerve Block for Midshaft Clavicle Surgery: A Case Series

Caroline G. Fugelli, MD
Erling Tjelta Westlye, MD
Hege Ersdal, MD, PhD
Kristian Strand, MD, PhD
Conrad Bjørshol, MD, PhD
regional or general anesthesia before the operation, all (n = 10) gave consent to regional anesthesia.

The surgical technique consisted of internal fixation of the fracture with a plate.

Methods of Block
The first and second authors (C.G.F. and E.W.), both experienced in ultrasound-guided peripheral nerve blocks, performed all the included procedures. The patient’s neck was scanned using a 7.5-MHz linear, 5-cm ultrasound probe (SonoSite Edge, Fujifilm SonoSite Inc). The transducer was moved until both the upper ISBP and the SCP were obtained in a short-axis position in the same view (Figure 1a). A 50-mm, echogenic, nonstimulating needle was used (Ultraplex, B Braun; Figure 1b). The upper ISBP was defined as the upper/middle trunk of the brachial plexus (Figure 1c). The SCP was localized under the posterolateral belly of the sternocleidomastoid muscle (Figure 1d). With the patient in a supine position, the needle was inserted in a lateral-to-medial direction, in-plane technique, with the injection target lateral to the upper ISBP (Figure 1c). Following initial injection, the tip of the needle was withdrawn and redirected toward the SCP, where an additional injection was performed (Figure 1d). The nerve block consisted of only one needle pass. The local anesthetic (LA) administered was ropivacaine, 7.5 mg/mL (Table). Sensory block was confirmed with a cold temperature test (Figure 2).

Patients were sedated intraoperatively with a propofol infusion to an Observer’s Assessment of Alertness and Sedation (OAA/S) Scale score of 3 or 4, aiming for a cooperative, spontaneously breathing patient. Propofol sedation was discontinued in time for the patient to be fully awake at the end of surgery.

If patients were awake and pain free after surgery, they were moved directly to the ward. Intraoperative respiratory assistance, postoperative respiratory decompensation, and Horner syndrome or hoarseness, were registered in the anesthesia, postoperative care, or ward medical records.

Results
All patients underwent surgery successfully using peripheral regional anesthesia, without additional intraoperative opioids or rescue LA.

The Table presents patient characteristics, the volume of LA used for the nerve block, and the time interval from the performed nerve block until the end of surgery. No complications were recorded. Nine patients were transferred directly to the ward after the operation. One patient was observed for 35 minutes in the postoperative care unit but did not receive any opioid or oxygen supply during this observation period.

Discussion
In this report, we present a case series using a combination of an upper ISBP and SCP nerve block for anesthesia in open fixation of midshaft clavicle fractures. To our knowledge, this study is the largest case series to date using a uniform combination of ultrasound-guided upper ISBP and SCP block. Our results imply that this approach could be a good alternative for patients who have considerable risk associated with general anesthesia or simply do not want general anesthesia. Because 9 patients were transferred directly to the ward without observation in the postoperative care unit, it seems likely that the
block also can provide excellent postoperative analgesia. Furthermore, our study findings suggest that this combination is sufficient for operative fixation of the clavicle, also in the proximal part of this bone.

Limited data exist on regional anesthesia for surgery on the clavicle. The data that do exist are provided mostly as letters or correspondence, and a few case reports, with no consistent peripheral nerve block description. Nerve block combinations suggested are as follows: ISBP and SCP,6 low ISBP and SCP,7 suprACLavicular brachial plexus and suprACLavicular nerve,8 ISBP between upper/middle trunk and SCP,9 and selective C5 through C6 nerve root block combined with SCP.10

It is believed that the SCP is responsible for the sensation of the fascia and skin over the clavicle, but it has been suggested that the suprACLavicular nerve (C3 through C4) arising from the SCP might mediate sensation from bony parts of the proximal clavicle. Several authors support the view that an SCP can be sufficient for analgesia, but not to anesthetize the entire clavicle and perform surgery.4,11

Whether the clavicle is innervated by the cervical plexus or the brachial plexus is still unclear. Description of the innervation of the deeper structures varies in the literature, and some data link it to nerve roots or nerves that are part of the ISBP. It has been reported to derive from the C5 root through the suprACLavicular nerve.12,13 Others suggest that it is necessary to block several nerves from the C5/6 and C7 roots to be sufficient for surgery. Nerves such as the axillary, the subclavian, and the long thoracic nerve could contribute to both sensory and deeper innervation of the distal half of the clavicle.4,10,14

As discussed earlier, a uniform description of where the ISBP should be blocked has not been established. Injection of LA adjacent to the ISBP is associated with a risk of unintentional spinal or epidural block.14 Ultrasound guidance may reduce this risk. Salvadores de Arzuaga et al10 reported that they targeted the roots when performing the ISBP block. However, dural sleeves can extend into the cervical nerve roots, and some authors argue that LA should not be placed at a level where the tubercles can be identified because of the risk of unintentional spinal or epidural blockade.14 It has been shown that 5 mL of LA injected at the C5 nerve root using ultrasound guidance in human cadavers could spread intrathecal and to the phrenic nerve.15 Therefore, we believe it is safer to perform a block more distant to the C5 root (upper ISBP block), with less risk of proximal spread to the intrathecal area, because this has been shown to provide comparable anesthesia.15

Tran et al4 pointed out that the effect of an SCP block is somewhat variable. Carried out at the C6 level (at the level of the cricoid cartilage), LA may diffuse to the underlying interscalene groove and surreptitiously block the brachial plexus. Flores et al16 recommended to perform

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD), y</td>
<td>47.2 (23-65)</td>
</tr>
<tr>
<td>ASA classification, mean (SD)</td>
<td>1.2 (1-2)</td>
</tr>
<tr>
<td>Weight, mean (SD), kg</td>
<td>76.5 (59-120)</td>
</tr>
<tr>
<td>Volume of ropivacaine, 7.5 mg/mL, for nerve block, mean (SD), mL</td>
<td>30.8 (25-35)</td>
</tr>
<tr>
<td>Time from performed nerve block to end of surgery, mean (SD), min</td>
<td>137 (79-190)</td>
</tr>
</tbody>
</table>

Table. Patient Demographic and Perioperative Characteristics of Nerve Block and Patient Flow

Patient Demographic and Perioperative Characteristics of Nerve Block and Patient Flow

Continuous variables (ie, age, ASA classification, weight, volume of local anesthesia, time from performed nerve block to end of surgery) are presented as mean (SD).

**Figure 2. Fracture, Nerve Block, and Surgical Characteristics of 10th Patient in Case Series**
(a) Preoperative radiograph of the clavicle fracture. (b) Postoperative radiograph after fixation of the fracture with a plate. (c) After ISBP and SCP block is performed, the drawn stippled line shows sensory block. Solid line represents the planned surgical area. (d) Intraoperatively, the surgeon presents the components of the fracture, with no reported discomfort from the patient. (e) Intraoperatively, the open surgical field after the fracture has been fixed with a plate.

Abbreviations: ISBP, interscalene brachial plexus; SCP, superficial cervical plexus.
the block at the C4 level (upper pole of thyroid cartilage) and with 5 mL or less of LA to avoid concomitant brachial plexus block by penetration of the prevertebral fascia. A direct communication between subcutaneous fat, connective tissue in the neck, and the prevertebral layer beneath the deep cervical fascia has been suggested. From an anatomical point of view, this area has not been completely elucidated. Current data support the concept of deeper neck compartments potentially communicating directly with the subcutaneous tissue. This anatomical pathway can explain why a SCP block has been reported to lead to blockade in the deeper compartments of the neck, such as stellate ganglion block (Horner syndrome) or recurrent laryngeal nerve block. In addition, if large amounts of LA are used or the needle is put to medially, phrenic nerve palsy can occur. The phrenic nerve originates predominantly from the C4 nerve root and rests underneath the prevertebral layer above the anterior scalene muscle. To reduce the incidence of all these complications, we suggest minimizing the volume of LA, the needle placement at the C4 level, and needle-tip placement maintained just underneath the SCM belly.

In the present study, the volume of LA for both nerve blocks was based on recommendations from previous publications. We injected 8 to 15 mL of LA for the SCP block. Acquainted by mentioned precautions, a smaller volume is probably sufficient; however, no adverse events were recorded for our patients. Furthermore, we did not adhere strictly to the C4 level, because we wanted to target the SCP and upper ISBP in the same view to minimize needle passes. Importantly, we performed the nerve blocks at the most cranial level, where we could get a sufficient view of both plexuses. The anatomy in the neck region is variable, and the use of ultrasound is of great advantage by identifying anatomical structures and the spread of LA, thus preventing excessive spread of the anesthetic and reducing the incidence of adverse effects.

In conclusion, our case series supports the efficacy of a uniform combination of an upper ISBP and SCP nerve block as anesthesia for surgical fixation of midshaft clavicle fractures. We believe that regional anesthesia is a safe and important alternative for this group of patients. It suffices as sole anesthesia as well as provides excellent immediate postoperative analgesia. Moreover, because 9 of 10 patients bypassed the postoperative care unit, our results indicate a benefit concerning operation logistics. Further investigations with larger sample sizes are needed to evaluate the minimum LA volume and incidence of adverse effects.

REFERENCES

AUTHORS
Caroline G. Fugelli, MD, is a senior consultant and chief of the Orthopedic/Neurosurgical Department of Anesthesiology, Stavanger University Hospital, Stavanger, Norway. Email: Fucal@usn.no.

Erling Tjelta Westlye, MD, is a resident in the Department of Anesthesiology, Stavanger University Hospital.

Hegre Ersdal, MD, PhD, is a senior consultant in the Department of Anesthesiology, Stavanger University Hospital.

Kristian Strand, MD, PhD, is a senior consultant and chief of the Intensive Care Unit, Department of Intensive Care Medicine, Stavanger University Hospital.

Conrad Bjørshol, MD, PhD, is a senior consultant in the Department of Anesthesiology and project manager at The Regional Centre for Emergency Medical Research and Development (RAKOS), Prehospital Medicine
Clinic, Stavanger University Hospital. Dr Bjørshol also is an associate professor in the Department of Clinical Medicine, University of Bergen, Bergen, Norway.

DISCLOSURES
The authors have declared no financial relationships with any commercial entity related to the content of this article. The authors did not discuss off label use within the article.