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Ultrasound-guided Locoregional Anaesthesia for Carotid Endarterectomy: A Prospective Observational Study

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WHAT THIS PAPER ADDS

- Ultrasound guidance for invasive anaesthetic procedures may improve efficacy, facilitate performance and reduce risk of complications. So far, cervical plexus blockade guided by ultrasound has not been evaluated on patients undergoing carotid artery surgery. The ultrasound-guided locoregional anaesthesia investigated in this study provides good-quality analgesia with limited need for intra-operative supplementation and is an attractive choice for carotid endarterectomy.

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ABSTRACT

Introduction: Ultrasound guidance is increasingly used for invasive anaesthetic procedures to improve efficacy, facilitate performance and reduce risk of complications. Herein, we present a simple approach to ultrasound-guided locoregional anaesthesia for patients undergoing eversion carotid endarterectomy.
Methods: At the level of the base of the carotid bifurcation, the needle was inserted at the lateral border of the sternocleidomastoid muscle and, guided by ultrasound, advanced 0.5–1 cm posterolateral to the carotid artery, where ropivacaine (7.5 mg ml^{-1}) was injected. During retraction of the needle, additional local anaesthetic was administered beneath the sternocleidomastoid muscle and, finally, subcutaneous infiltration along the surgical incision line was performed.
The primary study end point was the amount of additional ropivacaine (7.5 mg ml^{-1}) provided intra-operatively. Secondary measures included the occurrence of puncture-related complications and the adverse effects to locoregional anaesthesia.
Results: Sixty consecutive patients admitted for primary carotid endarterectomy were prospectively included. The volume of administered ropivacaine for locoregional anaesthesia and subsequent intra-operative supplementation was 31.7 ± 3.5 and 1.9 ± 2.5 ml, respectively. There were no conversions to general anaesthesia. Intravascular or subarachnoid injection of local anaesthetic did not occur, and symptoms of local anaesthetic systemic toxicity did not present. Related to the blockade, hoarseness (72%), Horner syndrome (37%), cough (20%), facial palsy (13%) and dysphagia (12%) were observed and resolved on the first postoperative day.
Conclusions: This observational study demonstrates that the described ultrasound-guided locoregional anaesthesia is suitable for eversion carotid endarterectomy and the amount of supplemental anaesthetic during the surgery is low.

Regional anaesthesia for carotid endarterectomy (CEA) is commonly achieved by the use of cervical plexus blockade (CPB). While superficial CPB[1] is a simple subcutaneous infiltration along the posterior border of the sternocleidomastoid muscle (SCM), a deep CPB[2,3] is essentially a paravertebral block of the C2, C3 and C4 spinal nerves. Local anaesthetic (LA) injected between the superficial and deep cervical fascia posteriorly to the SCM is considered to spread towards the roots of cervical nerves and this block is classified as intermediate.[4] By classical approach, LA is administered blindly and the procedure may be a challenging task with potential risk of serious puncture-related complications,

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especially in patients with difficult external anatomical landmarks.

In the past decade, ultrasound guidance for invasive anaesthetic procedures has been increasingly used and become common in daily clinical practice for vascular access and peripheral nerve blocks. Since ultrasonography enables real-time imaging of anatomic structures beneath the skin, needle position and spread of LA, the use of ultrasound may enhance efficacy of the regional anaesthesia and minimise potential risk of puncture-related complications.

Ultrasound-guided blocks of the cervical plexus are described[5,6]; however, these techniques are not evaluated on patients undergoing CEA. We considered an alternative ultrasound-guided approach with LA administered close to the carotid artery and beneath the SCM – the anatomical structures easily visualised by ultrasound. Since the ultrasound-guided central line placement is now a widely accepted practice, most anaesthesiologists are accustomed to using the ultrasound in the neck region, and the technique is easily adoptable by all. Herein, we report the efficacy and the safety of such a method in a prospective observational study design.

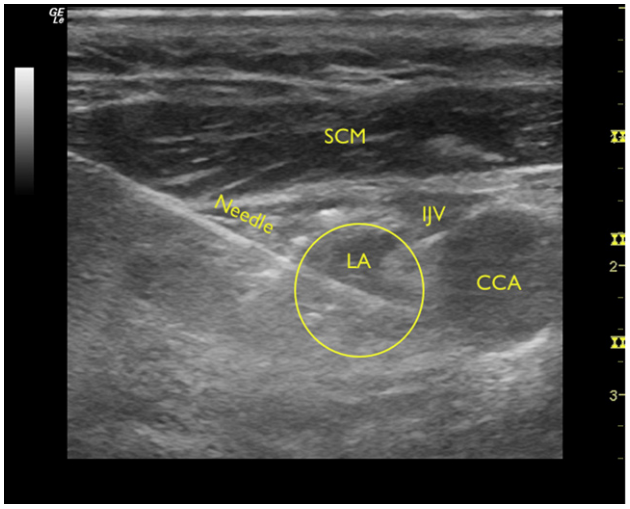

Figure 1. The local anaesthetic injected close to the carotid artery. LA – local anaesthetic (yellow circle), CCA – common carotid artery, IJV – internal jugular vein, SCM – sternocleidomastoid muscle.

Methods

The study was evaluated by The Scientific Ethics Committee of the Capital Region of Denmark (Journal no. H-2-2010-062) and considered as not requiring ethical approval since it was directed to quality control of a clinical procedure, which is part of standard care at our hospital. Informed consent was obtained from all patients.

On patient's arrival to the operating theatre, a peripheral venous line was established and monitoring included peripheral pulse oximetry, 3-lead electrocardiography and invasive blood pressure via a radial artery catheter connected to a monitoring kit (Edwards Lifesciences, Unterschleissheim, Germany) positioned at the level of the heart. For mild sedation during administration of the block, remifantanil was infused intravenously at 0.05 μg kg^{-1} min^{-1}. With the patient positioned supine and the head facing away from the side to be anaesthetised, the skin of the lateral neck was disinfected. Sterilely prepared linear ultrasound probe (12L-RS, 4–12 MHz, GE Healthcare, Wisconsin, USA) was positioned just above the clavicle to identify the common carotid artery (CCA) in B-mode and moved cranially to the base of bifurcation. At this level and at the lateral border of the SCM, the needle (Stimuplex® D 0.71 × 80 mm; B. Braun Melsungen AG, Melsungen, Germany) was advanced in-plane to the ultrasound beam and placed 0.5–1 cm posterolateral to the bifurcation of the CCA scanned in short axis (Fig. 1). Following negative aspiration of blood, ropivacaine (7.5 mg ml^{-1}) was injected to aim for a half-moon-shaped spread of the LA. Upon needle retraction, additional LA was administered beneath the SCM (Fig. 2) and, finally, subcutaneous infiltration along the surgical incision line was performed.

The sensory block at the surgical site was assessed by pinprick with a 24-gauge needle. The surgical incision was made along the anterior border of the SCM and the carotids were exposed by careful dissection. The atheromatous plaque was removed from the lumen of the carotid artery by eversion,[7] which is a standard technique at our centre. During surgery, communication with the patient was maintained at all times and the patient was directed to indicate pain by hand gesture. Reports of pain prompted the surgeon to infiltrate ropivacaine (7.5 mg ml^{-1}) within the surgical field.

The primary outcome measure of the study was the amount of supplemental ropivacaine used by the surgeon for adequate analgesia. Secondary measures included the occurrence of puncture-related complications (subarachnoid and intravascular injection and local anaesthetic systemic toxicity) and the adverse effects to locoregional anaesthesia (breathing difficulty, dysphagia, hoarseness, coughing, Horner syndrome, facial palsy and arm weakness). The survey of patient and surgeon satisfaction with provided anaesthesia was conducted for the first 40 cases (very satisfied, satisfied, less satisfied and unsatisfied).

Statistical analysis was performed using SPSS version 19 statistical software (SPSS Inc., Chicago, IL, USA). The Mann–Whitney *U* test for continuous non-parametric data and Pearson's chi-square test for categorical data were used to compare the group of patients who required intra-operative supplementation and those who did not. Data are presented as means ± standard deviation (SD) for continuous data and numbers (percentage) for categorical data. A value of $P < 0.05$ was considered as statistically significant.

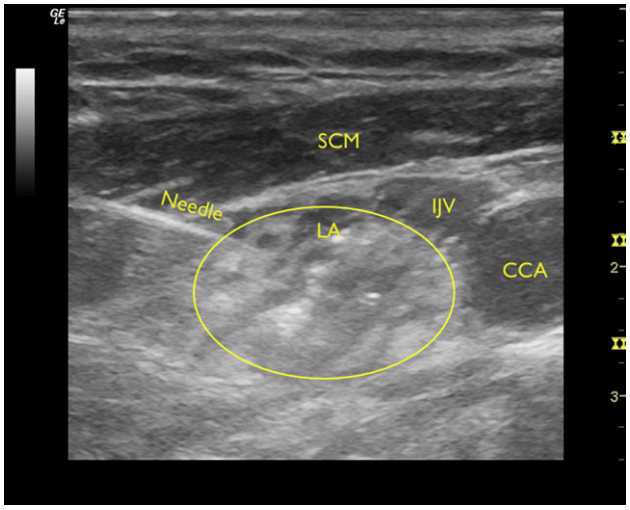

Figure 2. Diffuse spread of local anaesthetic injected beneath the sternocleidomastoid muscle. LA – local anaesthetic (yellow circle), CCA – common carotid artery, IJV – internal jugular vein, SCM – sternocleidomastoid muscle.

Table 1
Patients' characteristics.

Age (years)	67.2 ± 8.6
Male	44 (73%)
Female	16 (27%)
Body mass index (kg/m^2)	27.2 ± 4.4
ASA II	22 (37%)
ASA III	38 (63%)
Arterial hypertension	40 (67%)
Coronary artery disease	14 (23%)
Diabetes mellitus	11 (18%)
Chronic obstructive pulmonary disease	9 (15%)
Previous myocardial infarct	8 (13%)
Heart valve disease	4 (7%)
Renal disease	2 (3%)
Heart insufficiency (EF < 35%)	1 (2%)
Mono anti-platelet therapy	19 (32%)
Dual anti-platelet therapy	41 (68%)
Left side of surgery	23 (38%)
Right side of surgery	37 (62%)

Values are mean ± SD or number with percentage.

Results

From July 2009 to August 2010, 60 consecutive patients in American Society of Anesthesiologist physical status classification Class II and III (Table 1) underwent CEA under ultrasound-guided locoregional anaesthesia (UGLRA). All patients were symptomatic with carotid-territory transient ischaemic attacks or minor strokes and had carotid artery stenosis ranging from 50% to 95%. None of the patients had prior irradiation or intervention on the neck and there were only primary CEA. For stroke prevention, mono (32%) or dual (68%) anti-platelet therapy was given to all patients.

The mean total volume of ropivacaine (7.5 mg ml^{-1}) administered for UGLRA was 31.7 ± 3.5 ml and distributed as follows: 10.9 ± 3.0, 12.7 ± 3.2 and 8.6 ± 2.6 ml for the paracarotid infiltration, beneath the SCM, and along the surgical incision line, respectively. Procedural time was approximately 3–5 min excluding prescanning and preparation time.

Following the blockade, surgery was initiated within 23 ± 6 min and subsequently administered volume of additional ropivacaine (7.5 mg ml^{-1}) was 1.9 ± 2.5 ml per procedure. There were no conversions to general anaesthesia. Intra-operative supplementation with LA was required in 47% of patients ($n = 28$). Administered dose of ropivacaine for the UGLRA was similar in the group of the patients who required supplementation and those who did not (32.1 ± 4.2 vs. 31.3 ± 2.9 ml, $P = 0.733$). There was no difference in body mass index ($P = 0.953$), age ($P = 0.994$), sex ($P = 0.391$), ASA score ($P = 0.886$), operating time ($P = 0.067$) and side of surgery ($P = 0.887$) between the two groups (Table 2).

The test for aspiration of blood was negative in all cases. There was no evidence of intravascular or subarachnoid LA injection and local anaesthetic systemic toxicity did not occur. Adverse effects to locoregional anaesthesia are presented in Table 3. Hoarseness occurred in most patients, but it was tolerated, as was the case with dysphagia. Some patients felt the need to cough, but it did not affect the surgery. When the patients were re-examined on the day following surgery, all adverse effects were fully recovered.

Patient and surgeon satisfaction score with UGLRA is presented in Table 4.

An intra-operative shunt placement was required in one case. One patient died as a result of intracerebral haemorrhage associated with cerebral hyperperfusion syndrome. Other postoperative complications included one ischaemic stroke, one acute myocardial infarction and two episodes of bleeding. No postoperative infections were registered at the 6-week check-up.

Table 2
Comparison of variables between the group of patients who required intra-operative supplementation with ropivacaine and those who did not.

Variable	Supplementation required ($N = 28$)	Supplementation not required ($N = 32$)	P-value
Ropivacaine (7.5 mg) for UGLRA (ml)	32.1 ± 4.2	31.3 ± 2.9	$P = 0.733$
BMI (kg/m^2)	27.3 ± 4.3	27.1 ± 4.6	$P = 0.953$
Age (years)	66.9 ± 8.3	67.5 ± 9.0	$P = 0.994$
Male/Female	22/6	22/10	$P = 0.391$
ASA II/III	10/18	12/20	$P = 0.886$
Operating time (min)	77	67	$P = 0.067$
L/R side of surgery	11/17	12/20	$P = 0.887$

Values are mean ± SD or number.

Table 3
Adverse effects to locoregional anaesthesia.

Hoarseness	43 (72%)
Horner syndrome	22 (37%)
Cough	12 (20%)
Facial palsy	8 (13%)
Dysphagia	7 (12%)
Breathing difficulty	0
Arm weakness	0

Values are number with percentage.

Discussion

At our hospital, the standard of care for CEA is regional anaesthesia, except the cases, when a patient is not able to comply or refuses to be awake during surgery. In 2009, we replaced blind technique of the traditional combined deep and superficial CPB by an ultrasound-guided approach. Subsequently, it was our clear impression that the amount of supplemental LA provided by the surgeon became substantially lower.

The present study of 60 consecutive patients was conducted following a learning period of 10 patients and demonstrated that the topical anaesthetic supplementation was required in almost half of the cases (47%); however, the mean volume of additional LA per procedure (2 ml) was quite low. Intra-operative administration of LA was mainly due to pain/discomfort in the upper part of the operation field or at the mandibular angle as a result of a surgical traction. In comparison, the incidence of anaesthetic supplementation during CEA reported in the literature[8–11] varies from 32% to 100% at a volume raging from 7 to 10 ml. Disadvantages of supplemental administration of LA in considerable amount include prolonged operative time and provoked tissue oedema that aggravates the surgical conditions. In addition, patient anxiety due to lack of adequate analgesia may lead to further unnecessary administration of LA that increases the risk of local anaesthetic systemic toxicity.

The administered dose of ropivacaine (7.5 mg ml^{-1}) for the UGLRA was not standardised and depended on patient characteristics and co-morbidity, but did not exceed 40 ml. We did not observe any symptoms of local anaesthetic systemic toxicity.

Local infiltration of the carotid sheath during surgery is often needed, as it has a cranial nerve supply from vagal nerve branches

Table 4
Patient and surgeon satisfaction score with provided anaesthesia.

	Very satisfied	Satisfied	Less satisfied	Unsatisfied
Patient	22 (55%)	16 (40%)	2 (5%)	0
Surgeon	27 (67.5%)	13 (32.5%)	0	0

Values are number with percentage.

and the superior root of the ansa cervicalis, which are not anaesthetised by the classical CPB.[12] Based on this fact, we considered, that LA delivered close to the carotid sheath is reasonable and may improve the efficacy of the locoregional anaesthesia. Furthermore, Roessel et al.[13] noted that in ultrasound-guided high interscalene brachial plexus block for CEA with spread of anaesthetics towards the carotid artery there is limited need for supplemental LA. Although no changes in heart rate were observed during injection of LA close to the bifurcation of the CCA, awareness must be raised as potential stimulation of the carotid sinus can provoke bradycardia. Conversely, preoperative paracarotid infiltration with LA may be protective in the course of surgical dissection and manipulation.

Using human cadavers, Pandit and colleagues[14] demonstrated that the deep cervical fascia is permeable. Therefore, we considered that LA injected beneath the SCM enters the deep cervical space and affects C2–C4 spinal nerve roots. Such a cervical plexus block, when LA is delivered below the superficial cervical fascia, is classified as intermediate.[4] Nevertheless, administration of LA by the described technique in the close proximity of the operation field may act as pure local infiltration.

In the neck region, the density of the blood vessels and nerves is high, and a peripheral nerve block that is guided by external body landmarks involves a potential risk for puncture-related complications. Although inadvertent subarachnoid and intravascular injection of LA was found in only 0.25% of the patients subjected to classical deep CPB,[15] it is a serious complication that may have a consequence for postoperative morbidity and mortality. In addition, in a prospective study of 1000 superficial and deep CPB, Davies et al.[16] reported that aspiration of blood occurs in 30%. The majority of the patients undergoing CEA are usually treated with antiplatelet drugs and puncture of the blood vessels could lead to local haemorrhage that might affect the surgical conditions. Systemic reviews[17,18] demonstrate that ultrasound guidance for peripheral nerve blocks in patients undergoing orthopaedic surgery can reduce the incidence of vascular puncture. In the present study, the test for aspiration of blood was negative in all cases and this technique may be considered as safe even in patients on dual antiplatelet therapy.

The most of transient adverse effects related to the locoregional anaesthesia are probably caused by LA administered close to the carotid artery, where the recurrent laryngeal nerve and cervical sympathetic branches are affected. Thus, the use of LA at lower concentration and/or volume for the paracarotid infiltration may decrease the incidence of adverse effects. At the moment, we use ropivacaine 5 mg ml^{-1} and our impression is that the quality of the block remains the same while adverse effects seem to be reduced. Given the high incidence of hoarseness (72%) associated with this blocking technique, it would be reasonable to consider preoperative laryngoscopy to evaluate function of the vocal cords in case of prior irradiation or surgery on the contralateral side of the neck.

Conclusions

This observational study demonstrates that the described UGLRA is suitable for eversion CEA and the amount of supplemental LA during the surgery is low. Randomised clinical trials need to be conducted to compare efficacy and safety of this technique with traditional CPB that is guided by anatomical landmarks.

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Conflict of Interest

None.

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