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Original Research Article

Combined Intermediate Cervical Plexus Block with Superficial Cervical Plexus Block: Ultrasound Guidance for Carotid Endarterectomy: A Report of 9 Cases

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Abstract: Carotid artery lesions are a major cause of ischemic stroke. General anesthesia for carotid endarterectomy requires costly neurological monitoring, which is often unavailable in certain settings, such as that of this study. This work evaluates the feasibility and benefit of ultrasound-guided regional anesthesia (RA) combining intermediate and superficial cervical plexus blocks. This was a prospective descriptive study conducted over 13 months, including 9 patients. The RA technique, under ultrasound guidance, combined a pericarotidial infiltration, an intermediate cervical block, and a superficial block with cutaneous infiltration, using 0.5% bupivacaine. The primary endpoint was the quality of the sensory block. RA was complete in 89% of the tested territories. Additional sedation-analgesia was required for 3 patients (33%). No serious complications occurred. Minor adverse effects (cough, hoarseness) were transient. Postoperative analgesia was satisfactory. In conclusion, this combined ultrasound-guided block is a viable and safe alternative to general anesthesia for carotid surgery in resource-limited settings, allowing for continuous clinical neurological monitoring. The choice of technique should be individualized.

Keywords: Regional Anesthesia, Cervical Plexus Block, Ultrasound Guidance, Carotid Endarterectomy, Neurological Monitoring.

INTRODUCTION

Carotid artery lesions are one of the main causes of ischemic stroke [1]. They manifest as stenosis leading to a narrowing of the internal carotid artery lumen. Historically, cervical vascular surgery was performed exclusively under general anesthesia. While this technique meets surgical requirements, it nevertheless necessitates complex neurological monitoring such as near-infrared spectroscopy (NIRS), transcranial Doppler, or bispectral index (BIS) to compensate for the patient's lack of awareness.

However, these monitoring devices are mostly expensive and unavailable in our practice setting. Furthermore, regional anesthesia (RA) remains relatively uncommon in our departments. Therefore, the main objective of our work was to conduct a preliminary study evaluating the feasibility and benefits of ultrasound-guided cervical plexus block during carotid surgery.

MATERIALS AND METHODS

Framework and Study Design

This preliminary, prospective, and descriptive study was conducted in the operating theater of the Thoracic and Cardiovascular Surgery Clinic (CTCV) at the Fann University Hospital. Over a 13-month period (April 2024 – June 2025), we included all patients scheduled for carotid surgery. Exclusion criteria included altered consciousness, refusal of regional anesthesia, or technical difficulties with ultrasound imaging.

Perioperative Protocol

After detailed information was provided about the technique, risks, and discomfort associated with positioning, informed consent was obtained. In the operating room, after establishing intravenous access and standard monitoring (5-lead ECG, SpO2, NIBP), patients were positioned supine with their heads turned to the opposite side. Strict asepsis with povidone-iodine was applied to the cervical area.

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Ultrasound-Guided Regional Anesthesia Technique

Under ultrasound guidance (protected probe, coronal view), we performed a combined regional anesthesia technique using 0.5% bupivacaine. The procedure comprised three successive steps:

1. Peri-carotid infiltration: Injection of 5 to 10 ml into the carotid sheath, under the deep cervical fascia.
2. Intermediate cervical block: Reorientation of the needle between the deep cervical and prevertebral fascia for the injection of 7 to 15 ml.
3. Superficial block and cutaneous infiltration: Injection of 7 to 10 ml under the superficial cervical fascia, supplemented by a subcutaneous infiltration (5 to 7 ml) along the incision, from the ascending ramus of the mandible to the anterior border of the sternocleidomastoid.

Intraoperative Monitoring and Analgesia

Constant verbal contact allowed for continuous neurological monitoring. In case of persistent pain, the surgeon administered a local infiltration of 2% lidocaine. Systemic sedation-analgesia (midazolam/fentanyl) was introduced at the anesthesiologist's discretion if necessary.

Post-Operative Follow-Up

Patients were routinely transferred to the intensive care unit immediately postoperatively. Pain was assessed using the Numerical Rating Scale (NRS). Morphine titration (2 mg every 5 minutes) was planned for an NRS score > 5. The standard analgesic protocol combined paracetamol (1 g/6 h) with nefopam (20 mg/6 h) or tramadol (100 mg).

Evaluation Criteria

- Primary criterion: Quality of sensory block in the territories of the inferior occipital, transverse cervical and supraclavicular nerves (assessed at 15 and 30 min). Failure was defined as conversion to general anesthesia.
- Secondary criteria: Use of local anesthesia or additional sedation; complications related to the puncture (hematoma, vascular puncture); specific adverse effects (cough, hoarseness, Horner's syndrome, facial paralysis); postoperative pain (EN > 3) and surgeon's level of satisfaction.

RESULTS

Patient Flow and Demographic Characteristics

Of the 22 patients scheduled for carotid endarterectomy during the study period, 13 were excluded for the following reasons: communication difficulties (n=6), refusal of regional anesthesia (n=5), and difficulties with ultrasound localization (n=2). Ultimately, nine patients were included, representing a frequency of 40.9%. The mean age of the series was 54 years (median: 59 years; range: 29–70 years). All patients presented with symptomatic stenosis following an ischemic stroke. The main associated comorbidities were hypertension, epilepsy, and asthma. The majority of patients were classified as ASA 2 (n=8), while only one was classified as ASA 3. The mean time between the ischemic event and the procedure was 6 months (range: 3–12 months).

Operating Data

Surgical indications included the treatment of atherosclerotic stenosis (n=7) and the treatment of carotid webbing (n=2). The mean operative time was 90 minutes, with a mean carotid clamping time of 24 minutes. The mean volume of local anesthetic administered was 27 ml.

Efficacy and Tolerability of Regional Anesthesia

Anesthesia was complete in 89% of the areas tested. Additional sedation and analgesia were required for three patients (33%): two received a combination of midazolam and fentanyl, and one received midazolam alone.

Regarding safety, no vascular punctures, local anesthetic toxicity, or intraoperative bradycardia were reported. Adverse events were minor: paroxysmal coughing (n=5) and hoarseness (n=3). No symptomatic phrenic nerve palsy was noted.

Post-Operative Follow-Up

Postoperative analgesia was judged satisfactory, with a pain score (NRS) of less than 3 in 6 patients upon admission to intensive care.

DISCUSSION

Carotid surgery is recommended in symptomatic patients when: the degree of stenosis is at least 50%, life expectancy is at least 2 to 3 years, and the complication rate is less than 6% [3]. In asymptomatic carotid stenosis, Déglise *et al*., [4]. The criteria included a degree of stenosis > 70%, a life expectancy of at least 5 years, male sex, and a surgical complication rate of less than 3%. In our series, all patients were symptomatic, contrasting with the small proportions of symptomatic patients reported in various studies found in the literature, particularly in Western countries. Indeed, in the GALA study [5] , 38% of patients who underwent endarterectomy under regional anesthesia were asymptomatic, 20% had experienced a stroke, 21% a transient ischemic attack (TIA), while 12% had experienced transient ischemic attack (TIA). This disparity could be explained by greater availability of diagnostic tools and better access to healthcare in general. Furthermore, apart from ischemic events, carotid stenosis is silent or even paucisymptomatic. The only clinical sign that may be transient ischemic attack (TIA) is amaurosis. Finally, there is only one vascular surgery department in the entire country of Senegal, with a weekly schedule of only one or two carotid surgery

cases, which can make access to carotid surgery difficult. The department's workload also affects the time between the ischemic event and surgery. Thus, over an 8-year period from 2006 to 2014, Sow *et al*., [11], collected data on 64 patients, while more recently, Ahonoukoun *et al*., [2], collected data on 14 patients over a 13-month period from January 2022 to 2023. Considering the increased prevalence of carotid atherosclerosis, as reported in Kabre's work [12] , where, out of 200 carotid arteries examined, more than 62% had a positive carotid atherosclerotic status, this activity, given that it is the only vascular surgery service in the country, can create long waiting lists, lengthening the time before surgery. However, data on the time between the initial surgical consultation and scheduling, as well as between scheduling and the actual surgery, would have allowed for a discussion of this parameter. In our series, this delay was at least 3 months with an average of 6 months, whereas shorter delays between the ischemic event and surgery appear to be more beneficial. Indeed, Naylon [6], was one of the first with Rothwell in 2004 [7], to demonstrate that the benefit of carotid endarterectomy is greatest within the first 15 days. In the NASCET and ECST studies [8, 9] , patients operated on within 14 days following a transient ischemic attack (TIA) or non-disabling stroke had an absolute reduction in stroke risk of 30.2% compared to patients receiving delayed treatment. The approach recommended by most teams is to perform endarterectomy between days 7 and 14 after the stroke, as described in European and American guidelines [10] .

Regarding the amount of local anesthetic, Halstead's work [13], highlighted the effects of the local anesthetic concentration and volume on the anesthesia achieved and its duration. Since then, hundreds of publications have focused on this order, aiming for maximum efficacy with minimal risk. Aside from considerations of efficacy and failure, the cervical plexus block is more similar to the interscalene block (ISB), with which it shares, to some extent, the proximity of the diffusion space. The ISB targets the brachial plexus, which innervates the shoulder and upper limb. It also carries the risk of diaphragmatic paralysis due to anesthesia of the phrenic nerve. This risk stems from the direct emergence of the phrenic nerve from the C4 nerve root and the potential for local anesthetic diffusion. It shares this risk with the cervical plexus block. Weiss *et al*., [14], reported the case of a patient who experienced acute respiratory distress a few minutes after a deep cervical plexus block (with 40 ml of 0.5% ropivacaine) for carotid endarterectomy, requiring conversion to general anesthesia. In retrospect, the authors determined the respiratory distress to be caused by a combination of ipsilateral recurrent laryngeal nerve paralysis induced by the anesthetic block and pre-existing asymptomatic paralysis on the contralateral side. In regional anesthesia practice, with regard to single injections, the volume is the main determinant of phrenic nerve paralysis due to extension of the local anesthetic to the phrenic nerve [15, 16] . Junca *et al*., [18], therefore compared 0.5% bupivacaine and ropivacaine. 0.75% for cervical plexus block in forty patients scheduled for carotid artery surgery. These patients were randomly assigned to two groups, each receiving a superficial and a deep block with 30 ml of one of two local anesthetic solutions. The authors concluded that bupivacaine 150 mg provides effects comparable to those of a higher dose of ropivacaine 225 mg, but with less postoperative analgesia and higher plasma concentrations. Calderon *et al*., [19], used an average volume of 30 ml of ropivacaine 5% for an intermediate cervical plexus block, with a range of 20 to 45 ml. In our study, the average volume of local anesthetic was 27 ml. The question of volume reduction in the cervical plexus block is all the more relevant given that Pandit *et al.,* [17], suggested that the cervical fascia may be porous to local anesthetics. Some authors, in fact, limit themselves to an intermediate cervical plexus block alone, without a superficial cervical block, using only infiltration along the incision line. In our series, one patient received local infiltration by the surgeon, and a sedation-analgesia rate of 33% was observed despite complete anesthesia in 8 patients during the block evaluation. Emblematically, local anesthetic infiltration is performed at the level of the carotid body in carotid surgery. Thus, in a study on the effects of general or regional anesthesia on cerebral metabolism, the carotid sinus was anesthetized with 2 ml of 1% lidocaine before complete mobilization of the carotid artery in all patients. Furthermore, all patients received 2 mg of midazolam before induction of general anesthesia or the cranial block [20, 21] . This infiltration is performed with 1% or 2% lidocaine or prilocaine. Its purpose is to suppress or limit the effects of manipulation, clamping, and revascularization of the carotid body. In addition to this infiltration, it is very often necessary to supplement local anesthesia, particularly in the upper areas below the mandible. Sensory afferents from branches of the 5th ^{cranial} nerve are suggested by some authors to explain this additional anesthetic [19]. This supplementation may be justified by the duration of the surgery (on average 90 minutes in our series), the discomfort related to the position adopted during surgery, the stress associated with open neck surgery, and individual patient factors. Calderon *et al*., reported that 52% of patients in their series received additional infiltration by the surgeon with an average volume of 10 ml of 2% lidocaine. 12% of patients received topical application of 5% lidocaine intraoperatively. Approximately 35% of patients in the same study received sedation-analgesia with either remifentanil or midazolam [19] . Martusevicius *et al*., reported that of 60 patients who underwent regional anesthesia, 28 required sedation-analgesia, representing 46% [22] . These data suggest that this additional anesthesia does not indicate a failure of the technique. It may even be a component of it. The same applies to the side effects related to the cervical plexus block. They are all transient and disappear spontaneously upon the removal of the anesthetic block. In our series, several

side effects were noted following the block. Indeed, 5 out of 9 patients experienced a coughing fit after the puncture. A third of the patients complained of hoarseness. Two patients (22%) experienced facial paralysis, and one case of Horner's syndrome was observed. Martusevicius *et al*., reported 72% hoarseness, 20% cough, 13% facial paralysis, and 37% Horner's syndrome [22] . In contrast, Calderon and his team [19], found a lower prevalence of these side effects compared to earlier studies: 28% hoarseness (32 patients), 9% cough, 5% facial paralysis, and 4% Horner's syndrome. The authors report that the incidence of adverse events was lower in their study due to the anterior approach used for the puncture. They concluded that a randomized trial comparing the anterior and posterior approaches would be warranted. However, lower volumes and concentrations of local anesthetics were used, particularly in the paracarotid artery. This had already been mentioned in the work of Martusevicius [22] . The authors questioned the cause of these effects and hypothesized that ropivacaine deposition in contact with the carotid artery, where the vagus nerve and cervical sympathetic branches pass, might be responsible. They then hypothesized that reducing the concentrations and volumes of ropivacaine would lead to fewer adverse effects. However, Umbrain [23], compared ropivacaine solutions of 0.75%, 0.5%, and 0.375% for performing cervical plexus block during endarterectomy. The incidences of cough and hoarseness were similar in all groups despite the different concentrations.

This study reveals that regional anesthesia, particularly the combined cervical plexus block (intermediate and superficial) for carotid surgery, is a preferred option, offering patient safety without compromising surgeon comfort during the procedure. In our practice setting, where neurological monitoring equipment is unavailable, it also allows for clinical neurological surveillance, enabling timely and appropriate decision-making. This neurological monitoring should be a determining factor, encouraging the less hesitant use of cervical plexus blocks, which are currently performed only occasionally. However, given the current literature and the lack of evidence demonstrating the superiority of one technique over another, we propose a case-by-case discussion of technique selection and a selection of candidates for the combined cervical block based on well-defined criteria. This choice could be guided by the patient's overall health, their neurological status at the time of surgery, and the availability of equipment specifically designed for regional anesthesia.

CONCLUSION

In conclusion, this preliminary study demonstrates the feasibility and value of ultrasound-guided combined cervical plexus block as an alternative to general anesthesia for carotid endarterectomy, particularly in resource-limited settings. This technique offers acceptable safety, with generally minor and transient adverse effects. Its main advantage lies in maintaining continuous and simple clinical neurological monitoring through intraoperative verbal contact, compensating for the lack of sophisticated monitoring equipment. It also provides satisfactory postoperative analgesia. The choice of this regional anesthesia technique should be individualized, guided by the patient's condition, neurological status, and the availability of the necessary equipment.

ABBREVIATIONS : ALR: Regional Anesthesia; ASA: American Society of Anesthesiologists; CVA: Cerebrovascular Accident; IVA: Ischemic Stroke; TIA: Transient Ischemic Attack; BIS: Bispectral Index; CHNU: National and University Hospital Center; CTCV: Thoracic and Cardiovascular Surgery Clinic; ECG: Electrocardiogram; ECST: European Carotid Surgery Trial; EN: Numerical Rating Scale; GALA: General Anesthesia versus Local Anesthesia for Carotid Surgery; HTA: Hypertension; NASCET: North American Symptomatic Carotid Endarterectomy Trial; NIRS: Near-Infrared Spectroscopy; NIBP: Non-Invasive Blood Pressure; SpO2: Pulse Oxygen Saturation

Conflicts of Interest: None

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