Ultrasound-guided regional anesthesia for carotid endarterectomy induces early hemodynamic and stress hormone changes

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Objective: **Locoregional anesthesia is an effective method for evaluating cerebral function during carotid endarterectomy (CEA). Landmark-guided regional anesthesia (RA) is currently used for CEA and can provoke substantial perioperative hypertension. Ultrasound-guided RA (US-RA) is a new method for performing RA in CEA; however, the effect on sympathetic activity and blood pressure is uncertain. This study assessed early sympathetic activity during CEA in US-RA compared with general anesthesia (GA).**

Methods: **Patients were prospectively randomized to receive US-RA (n = 32) or GA (n = 28) for CEA. The primary end point was the change in systolic arterial blood pressure after induction of anesthesia (just before starting surgery) comparing US-RA with GA. We also recorded heart rate and analyzed concentrations of plasma blood hormones, including cortisol, metanephrine, and normetanephrine at five different times. Creatinine kinase, troponin I, and N-terminal pro-B-type natriuretic peptide were analyzed to detect potential changes in cardiac biomarkers during the procedure.**

Results: **Systolic arterial blood pressure (mean ± standard deviation) increased significantly in US-RA patients compared with GA patients even before surgery was initiated (180 ± 26 mm Hg vs 109 ± 24 mm Hg; $P < .001$), then remained elevated during the entire surgery and returned to baseline values 1 hour after admission to the postoperative anesthesia care unit. Heart rate (US-RA: 78 ± 16 beats/min, GA: 52 ± 12 beats/min; $P < .001$) and cortisol levels (US-RA: 155 ± 97 μg/L, GA: 99 ± 43 μg/L; $P = .006$) were also significantly higher in the US-RA group after induction of anesthesia. Other values did not differ.**

Conclusions: **The US-RA technique for CEA induces temporary intraoperative hypertension and an increase in stress hormone levels. Nevertheless, US-RA is a feasible, effective, and safe form of locoregional for CEA that enables targeted placement of low volumes of local anesthesia under direct visualization. (J Vasc Surg 2015;62:57-67.)**

Carotid endarterectomy (CEA) has well-defined indications established from the results of large randomized prospective trials and may be performed using regional anesthesia (RA) or general anesthesia (GA).[1-3] The large randomized, multicenter clinical General Anaesthesia versus Local Anaesthesia for Carotid Surgery (GALA) trial showed equal safety and efficacy for RA performed by landmark-guided superficial or deep cervical block compared with GA.[4]

Although RA allows direct neurologic monitoring during cross-clamping and consequently prevents unnecessary placement of shunts, significant intraoperative hypertension has been described in patients undergoing landmark-guided RA as opposed to GA.[5]

That administration of local anesthetics (LAs) below the carotid bifurcation may cause reflex hypertension is already known. This knowledge is mainly based on fundamental physiologic experiments in animals.[6] In contrast, data on reflex hypertension caused by locoregional anesthetics for CEA under real-life conditions in the operating room are rare.[5,7] Ultrasound (US)-guided locoregional anesthesia is a more up-to-date and advanced method for CEA allowing the directly visualized injection of LAs beneath the carotid bifurcation.[8] Hemodynamic and stress hormone changes during CEA under US-RA are unknown, and no randomized controlled trial has evaluated them compared with GA. Consequently, the aim of this study was to assess early sympathetic activity during CEA in US-RA or GA.

The primary outcome measure was the change in systolic blood pressure (SBP) after performing US-RA or after induction of anesthesia (t1) compared with baseline (t0) in patients undergoing CEA. The null hypothesis was that there would be no differences between groups.

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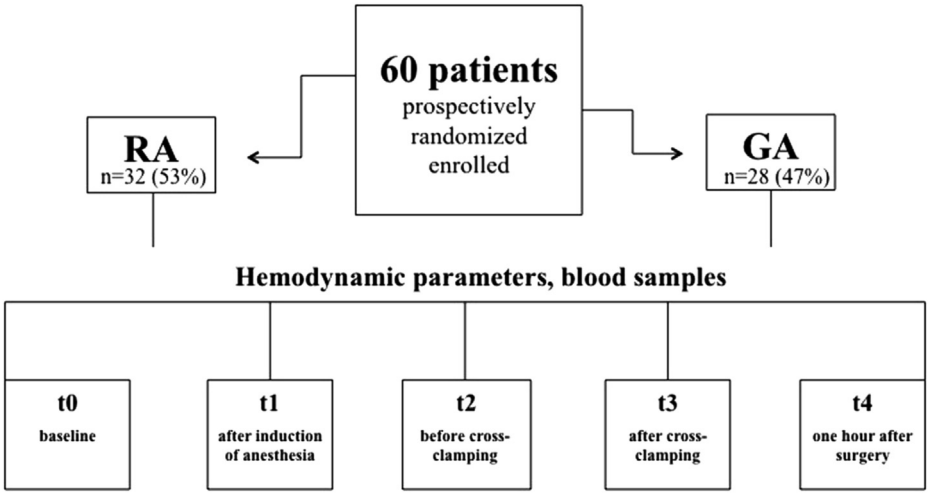

Fig 1. Study flow chart. *GA*, General anesthesia; *RA*, locoregional anesthesia; *t*, time.

METHODS

The Innsbruck Medical University Ethics Committee approved this study (UN4601; 309/4.22), and written informed consent was obtained.

Patient selection and study design. A computer-generated list was used to prospectively randomize 60 consecutive patients scheduled for elective CEA to receive US-RA or GA. Two persons not involved in the design and processing of the study were responsible for randomization. Enrollment of patients started in March 2012. The trial was not registered because in Austria because registration is not required for studies that do not involve medicinal products.

Patients diagnosed with symptomatic and asymptomatic stenosis of the internal carotid artery between March 2012 and June 2013 were included. Exclusion criteria were age <18 years, emergency surgery, or lack of consent. Antihypertensive medication was not discontinued before surgery. All involved anesthesiologists and surgeons were equally familiar with both anesthetic techniques.

Routine management. β-Blockers were given on the day of surgery. Calcium-channel blockers, angiotensin-converting enzyme inhibitors, and nitrates were discontinued on the day of surgery. Patients in both groups received identical sedation before induction of anesthesia with oral midazolam (0.05 mg/kg), 30 minutes before going to the operating room.

On arrival in the operating room, a 20-gauge radial artery catheter was placed on the contralateral side to the surgery along with two peripheral venous catheters. Standard monitoring included heart rate (HR), peripheral pulse oximetry (oxygen saturation), capnography, three-lead electrocardiography, SBP, mean arterial pressure, and diastolic arterial blood pressure measured invasively by a radial artery catheter connected to a monitoring kit (Edwards Lifesciences, Unterschleissheim, Germany) positioned level with the heart. All data were recorded on a computer-based anesthesia recording system (integrated Datex-Ohmeda monitor system; Instrumentarium Corp, Helsinki, Finland).

Hypertension (defined as SBP values >20% above baseline) and tachycardia (HR >100/min) were treated with the α-receptor antagonist urapidil and the β-blocker metoprolol, respectively, aiming for baseline values ±5% to 10%. Hypotension (defined as SBP values <20% of baseline) was treated with supplemental doses of atropine (0.1 mg/kg) and the α-receptor agonist phenylephrine (1 μg/kg), aiming for baseline values ±5% to 10%.

US-RA was performed by US-guided intermediate cervical plexus block.[8] The skin was infiltrated along the posterior border of the sternocleidomastoid muscle with 8 mL lidocaine (2%) and the carotid artery just beneath the bifurcation was visualized sonographically with a 6- to 13-Hz M-Turbo linear array transducer (SonoSite, Bothell, Wash). A SonoPlex Stim cannula (Nano Line 22-gauge × 80 mm [Pajunk; Pajunk GmbH, Geisingen, Germany]) was inserted in the direction of the carotid artery using the lateral-to-medial in-plane approach.[5] After negative aspiration, 10 mL ropivacaine (0.5%) was injected beneath the carotid bifurcation; only one pass with the needle was required (Video 1, online only). A further 10 mL ropivacaine (0.5%) was injected while the needle was retracted beneath the sternocleidomastoid muscle (Video 2, online only). The administrated doses of 20 mL ropivacaine (0.5%) were standardized for all patients. After anesthesia was induced and the patient was positioned, remifentanil (0.04-0.06 μg/kg/min) was continuously administered to achieve conscious sedation during the surgical procedure. A squeaking tool was fixed in the patient's contralateral hand to monitor motor function during the surgical procedure.

GA was induced with fentanyl (5 μg/kg), propofol (1.5-2 mg/kg), and rocuronium (0.6 mg/kg) and