



Locoregional Anesthesia for Carotid Endarterectomy: Identification of Patients with Intolerance to Cross-Clamping

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■ **OBJECTIVE:** During carotid endarterectomy (CEA), carotid cross-clamping is performed to allow for artery incision and plaque removal. A small subgroup of patients can tolerate carotid occlusion for only a few seconds, if at all, without presenting neurologic deficit. These patients are described as having “cross-clamp intolerance.” The purpose of this study was to demonstrate the safety of locoregional anesthesia in identifying patients with cross-clamp intolerance and factors associated with this condition.

■ **METHODS:** From August 2008 to May 2010, 115 consecutive patients were submitted to CEA under locoregional anesthesia at the Santa Casa de Belo Horizonte; the procedure was performed by the main author. Patients who showed intolerance to internal carotid artery (ICA) occlusion for <30 seconds were considered to have cross-clamp intolerance.

■ **RESULTS:** Among the 115 participating patients, 9.6% (11 patients) showed intolerance to ICA occlusion and developed deficits in <30 seconds (i.e., these patients presented cross-clamp intolerance). The factor that was associated with cross-clamp intolerance was the mean degree of contralateral carotid stenosis, which was 57.5% for those who presented intolerance and 27.8% for those who tolerated ICA occlusion.

■ **CONCLUSION:** Locoregional anesthesia is a safe method for identifying patients with cross-clamp intolerance. Patients with cross-clamp intolerance present contralateral stenosis that is greater on average than patients who readily tolerate carotid artery occlusion.

Carotid endarterectomy (CEA) is considered a safe and effective method to prevent stroke in the short and long terms in patients with severe internal carotid stenosis.¹ During CEA, carotid cross-clamping is performed to allow for artery incision and plaque removal. However, the role of CEA is mainly related to its safety (i.e., the low incidence of periprocedural and postprocedural complications). Carotid cross-clamping causes blood flow reduction to the circle of Willis, and some patients show no tolerance to cross-clamping. In these cases, use of a temporary shunt is required.^{2,3} The time required to insert the shunt is usually well tolerated⁴; however, there is a small subgroup of patients who can tolerate carotid occlusion for only a few seconds, if at all, without presenting neurologic deficit. These patients are described as having “cross-clamp intolerance.” For these patients, the time taken to insert the shunt is critical.⁵

The purpose of this study was to demonstrate the safety of locoregional anesthesia in identifying patients with cross-clamp intolerance and factors associated with this condition.

METHODS

Patients

This was a retrospective study in which medical records were reviewed. One-hundred and fifteen consecutive patients were submitted to CEA under locoregional anesthesia at the Santa Casa de Belo Horizonte from August 2008 to May 2010. The procedure was performed by the main author (Dr. Marcos Dellaretti). Thirty-nine patients were female and 77 male. Patient age ranged from 45 to 90 years old, with a mean of 70 years old. Regarding their anesthetic classification, according to the American Society of Anesthesiologists, 52 patients were classified as class III and 63 class II. The criteria for indicating surgical treatment followed the

Key words

- Carotid endarterectomy
- Carotid stenosis
- Intolerance to cross-clamping
- Regional anesthesia

Abbreviations and Acronyms

ACT: Activated clotting time
CEA: Carotid endarterectomy
ICA: Internal carotid artery

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Citation: World Neurosurg. (2016) 87:61-64.
<http://dx.doi.org/10.1016/j.wneu.2015.11.097>

Journal homepage: www.WORLDNEUROSURGERY.org

Available online: www.sciencedirect.com

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recommendations of the American College of Cardiology Foundation and American Heart Association.¹

Seventy-seven patients were symptomatic, 58 of whom presented with ischemic stroke in the region of the treated artery and 19 with transitory ischemic stroke. The degree of stenosis of the treated carotid artery ranged from 60% to 99%, with a mean of 87%. Thirty-eight patients were asymptomatic, and the degree of stenosis ranged from 50% to 99%, with a mean of 87%.

Anesthetic Technique

All patients were monitored for intra-arterial pressure (radial artery), electrocardiogram, pulse oximetry, capnography, and activated clotting time (ACT). They were all operated on while being administered acetylsalicylic acid.

Locoregional blockade was performed as follows: the patient was placed with the head slightly extended and rotated to the side contralateral to the blockage. The midpoint of the posterior edge of the sternocleidomastoid muscle was located, and the anesthetic was injected along the upper edge, in the cranial and caudal direction, and on the medial surface of the muscle using a 22-gauge needle. The anesthetic used was 30 mL of 0.375% bupivacaine without a vasoconstrictor.

Surgical Technique

An incision was made in the anterior edge of the sternocleidomastoid muscle and extends from the lower neck region to the tip of the mastoid process. Once the common carotid sheath was identified and before initiating the dissection, the patient was fully heparinized with 1 mg of heparin per kg of body weight. Heparinization was monitored by ACT, which should ideally be more than 200 seconds.⁶

Arterial dissection was initiated at the common carotid artery and continued toward the bifurcation. Following exposure of the common, internal and external carotid arteries and the superior thyroid artery, an internal carotid artery (ICA) occlusion tolerance test was performed, wherein the ICA was occluded with a clamp for 2 minutes. During this time, the anesthesiologist tested the muscle strength of the contralateral upper and lower limbs and speech, vision, etc. If the patient tolerated ICA occlusion for 2 minutes, the operation proceeded normally. In cases where patients showed intolerance to ICA occlusion for 2 minutes but showed tolerance for more than 30 seconds, the operation continued with the use of a shunt. Patients who showed intolerance to ICA occlusion for less than 30 seconds were considered to have cross-clamp intolerance.⁷

The arteriotomy began in the common carotid artery and extended into the internal carotid artery until the distal portion of the atheroma plaque. The plaque was then progressively resected.

Arteriorrhaphy was performed with continuous suture using arterial 6.0 Prolene. Before closing the last points, the clamps were progressively removed and reapplied so that blood flow eliminated small fragments, clots, or air bubbles. Next, the process of finally withdrawing the clamps was initiated: The first clamp removed was that of the external carotid artery, then the common carotid artery, allowing blood to flow toward the external carotid artery for about 2 to 3 minutes. Finally, the ICA clamp was removed.

The ACT was then performed again to evaluate the need for reverse heparinization. When the ACT was >200 seconds, half the

heparin dose was reversed. When the ACT is <200 seconds, reversal is not recommended. A drain with mild suction was left in the subcutaneous, and the wound was sutured in layers.

DATA ANALYSIS

MedCalc software (Ostend, Belgium) was used for data analysis. For variables in which the mean was evaluated, such as the degree of stenosis and patient age, the analysis of variance test was used. When evaluating categorical variables, such as patient sex, side of surgery, presence of contralateral critical stenosis (>70%), and occurrence of complications, the chi-square test was used, and in cases in which the value of one of the variables was <5, the Fisher test was used. P values were considered statistically significant when <0.05.

RESULTS

Incidence of Patients Presenting Cross-Clamp Intolerance

Among the 115 participating patients, 9.6% (11 patients) showed intolerance to ICA occlusion and developed deficits in <30 seconds (i.e., these patients presented cross-clamp intolerance).

Influence of Cross-Clamp Intolerance on Patient Evolution

Among the 115 patients who participated in the study, 107 were submitted to endarterectomy. The 104 patients who showed tolerance to ICA occlusion were submitted to carotid endarterectomy. Among the 11 patients who presented cross-clamp intolerance, in 3 the surgical procedure continued with the use of a shunt, while in 8 cases, the procedure was discontinued and the patients were referred for angioplasty with stent placement.

The overall morbimortality was 2.7%. One patient died due to contralateral ischemic stroke to the treated artery (0.9% mortality), and 2 patients suffered ipsilateral ischemic stroke and presented serious sequelae up to being discharged from hospital (1.8% morbidity).

In patients with cross-clamp intolerance, morbidity was high, such that 2 of the 3 patients in whom the surgical procedure was continued presented complications. Both cases had ipsilateral stroke. In contrast, among patients showing tolerance to ICA occlusion, morbimortality was only 0.9% ($P < 0.0001$).

Factors Associated with Patients Presenting Cross-Clamp Intolerance

Analysis of the factors that might be associated with cross-clamp intolerance showed no association with patient sex or age. Eight of the 76 male patients and 3 of the 39 female patients presented cross-clamp intolerance ($P = 0.87$). Regarding age, the mean age of patients presenting cross-clamp intolerance was 71.9 years old, while for those who showed tolerance to ICA occlusion it was 70.1 years old ($P = 0.51$).

In relation to the side of surgery, of the 59 patients submitted to right endarterectomy, 4 presented cross-clamp intolerance, while for the 56 patients submitted to left endarterectomy, 6 presented intolerance ($P = 0.46$).

Considering symptomatology, 5 of the 38 asymptomatic patients presented cross-clamp intolerance, while 6 of the 77 symptomatic

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