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Comparison of retrocarotid and caudocranial dissection techniques for the surgical treatment of carotid body tumors

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Objective: **Carotid body tumors (CBTs) are rare neoplasms. Complete surgical resection is the curative therapy and is considered the therapeutic gold standard. This study compared the retrocarotid dissection (RCD) technique with the standard caudocranial dissection (SCCD) technique in operative time, blood loss, vascular or nerve injuries, and hospital stay.**

Methods: **A retrospective review was conducted of patients with CBTs who underwent surgical treatment with the RCD technique at the National Institute of Medical Sciences and Nutrition "Salvador Zubirán" in Mexico City from July 2007 to January 2013. This cohort was compared with an historical cohort treated with standard SCCD from 1995 to 2007 at the same institution.**

Results: **A total of 68 procedures (41 SCCD, 27 RCD) were performed in 68 patients (91% women) with a mean age of 54 years (standard deviation [SD], 15 years). According to the Shamblin classification, 6 CBTs were type I (9%), 35 were type II (51%), and 27 were type III (40%). Comparative analysis identified mean blood loss of 480 mL (SD, 380 mL) in the RCD group and 690 mL (SD, 680 mL) for the SCCD cohort ($P < .31$). The mean procedural time was 172 minutes (SD, 60 minutes) for the RCD group and 260 minutes (SD, 100 minutes) for the SCCD group ($P < .001$). Hospital stay was significantly shorter for the RCD group with an average of 5 days (SD, 2 days) compared with 9 days (SD, 6 days) for the SCCD cohort ($P < .0001$). Cranial nerve deficit occurred in 17 patients, consisting of six transient nerve palsies in the RCD cohort and 11 in the SCCD group. Postoperative cerebrovascular accidents occurred in three patients in the SCCD cohort, with none observed in the RCD group. This translates into a rate of 22% of postoperative neurologic complications for the RCD cohort and 34% in the SCCD group ($P < .08$). Significant differences in intraoperative vascular injuries were not observed.**

Conclusions: **The RCD technique is a safe and viable option for the surgical resection of CBTs. In our experience, this approach was associated with a significant decrease in procedural time and hospital stay. (J Vasc Surg 2015;62:958-64.)**

The carotid body is an ovoid structure located in the periadventitial tissue of the carotid artery bifurcation.[1] Along with other head and neck paraganglia, the carotid body responds to hypoxia, hypercapnia, hypoglycemia, and extracellular acidosis inducing hyperventilation.[2] Exposure to chronic hypoxia leads to enlargement of the carotid body by increasing glomus cell clusters and causing angiogenesis; this response may occur in patients with hypoxic cardiopulmonary diseases or in people living at a high altitude.[3]

A clinically enlarged carotid body is known as a carotid body tumor (CBT).[4-6] In 65% to 95% of patients, CBT is considered sporadic and related to chronic or intermittent hypoxia,[7] and the remaining patients have a hereditary form of the disease.[6,8] The incidence of CBT has been estimated at one in 30,000 to 100,000 in the general population.[9,10] These tumors have malignant potential (6%-12.5%) and tend to grow and invade locally, causing symptoms[11]; therefore, the mere presence of a CBT is considered an indication for treatment.

Owing to its complex anatomical location in the vicinity of important vessels, cranial nerves, and increased vascularity, the surgical resection of CBT remains a challenge and is associated with important complications secondary to blood loss and neurologic injuries. For decades, there have been many attempts to decrease the neurologic and vascular complications associated with surgical treatment, including careful preoperative planning, introduction of sensitive imaging modalities, modifications in surgical techniques, and adjunctive procedures such as selective preoperative embolization, radiotherapy, and intraoperative cerebral monitoring.[4] Despite all of these efforts, published reports still show heterogeneous

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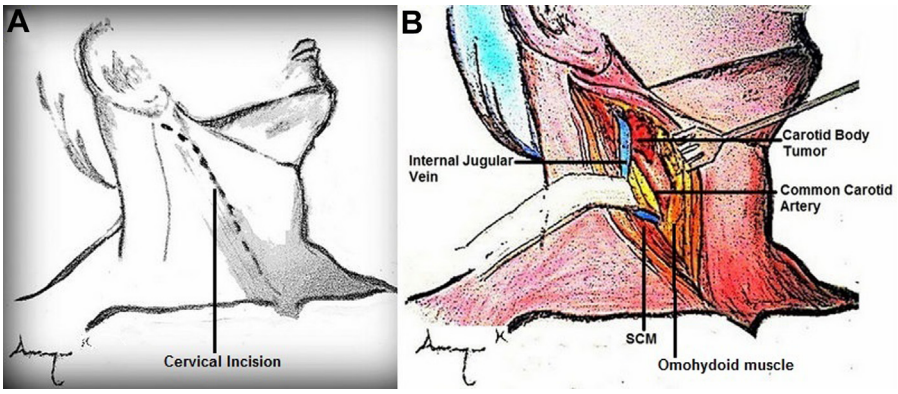

Fig 1. A, The patient's head is turned away from the surgical site and a cervical incision centered over the carotid bifurcation and parallel and anterior to the sternocleidomastoid muscle is made. The incision is carried through the platysma and down to the carotid sheath. **B,** The sternocleidomastoid muscle and the jugular vein are pulled laterally. The patient's position, incision, approach to the carotid sheath, control of the common carotid artery (CCA), identification of the hypoglossal nerve, and ligation of the facial vein are carried in the same way in both the standard caudocranial dissection (SCCD) and retrocarotid dissection (RCD) techniques.

outcomes regarding the optimal surgical approach, intraoperative parameters, and complication rates.

Since 2007, the Section of Vascular Surgery and Endovascular Therapy at the National Institute of Medical Sciences and Nutrition "Salvador Zubirán" (INCMNSZ) has developed and adopted modifications to the surgical technique for CBT resection. We refer to this approach as the retrocarotid dissection (RCD) technique. The present study describes and compares this novel approach with the standard caudocranial dissection (SCCD) technique in operative time, intraoperative and postoperative complications, and hospital stay.

METHODS

The INCMNSZ Institutional Review Board approved this study and waived the requirement for patient consent.

Study design. Patients with the diagnosis of CBT who underwent surgical treatment with the RCD technique from July 2007 to January 2013 at INCMNSZ were retrospectively reviewed. This cohort was compared with an historical group of patients who underwent CBT resection with the SCCD technique from 1995 to 2007. Before 2007, a senior vascular surgeon performed all CBT resections with the SCCD technique. After 2007, all resections using the RCD technique were performed by a different vascular surgeon (C.A.H.). Demographic variables, preoperative data, intraoperative variables, CBT-specific features, outcomes, and follow-up were recorded.

Study setting. INCMNSZ is an academic medical center that is a tertiary referral facility serving a catchment area of ~20 million people, located at an altitude of 2240 meters (7350 feet).

Statistical analysis. Descriptive statistics for demographic variables was conducted. Categoric data were analyzed with the Fisher exact test, and the Mann-Whitney *U* test and analysis of variance (ANOVA) were used to compare continuous variables. All tests were performed using STATA 9.0 software (StataCorp LP, College Station, Tex), with a 95% significance level and 80% statistical power.

SCCD technique. A rolled sheet is place underneath the patient to facilitate neck extension, and the patient's head is turned away from the surgical site. The neck, mandible, ear, and upper chest are sterilely prepared as well as the occipitotemporal region posterior to the ear for the possibility of requiring a higher exposure.

A cervical incision centered over the carotid bifurcation and parallel and anterior to the sternocleidomastoid muscle is made (Fig 1, *A*). The incision is carried through the platysma and down to the carotid sheath. The sternocleidomastoid muscle and the jugular vein are pulled laterally with self-retaining retractors (Fig 1, *B*). Proximal control of the common carotid artery (CCA) is obtained just above the omohyoid muscle. Upon recognition of the tendon of the digastric muscle, the hypoglossal nerve is identified and encircled with a vessel loop. The surgeon then ligates the common facial vein, and subadventitial dissection of the CBT is carried upward in a caudocranial direction and anterior to the vessels from the bifurcation until total resection is achieved (Fig 2).

RCD technique. The RC approach uses the same patient's position, incision, approach to the carotid sheath, control of the CCA, identification of the hypoglossal nerve and ligation of the facial vein as described for the SCC approach. Dissection of the CBT starts below the bifurcation, with the use of bipolar cautery to control feeding vessels (Fig 3, *A*).

Once the CBT is released from the bifurcation (Fig 3, *B*), the external carotid artery (ECA) is gently rotated laterally, and the surgeon pulls the CBT from behind the ECA, achieving posterior luxation of the proximal end (Fig 4). The posterior luxation allows better visualization of the subadventitial plane of Gordon and Taylor, thus making the dissection faster and reducing the risk of vascular injury (Fig 5, *A*). The resection