REVISTA
MEXICANA DE
ANGIOLOGÍA

PERMANYER

Check for updates

ORIGINAL ARTICLE

# Technique modification proposal for carotid body tumors resection: trans-bulb dissection technique (TBD)

## *Propuesta de modificación para la resección de tumores del cuerpo carotídeo: técnica de disección transbulbar*

*Enrique Santillán-Aguayo[1]*, Verónica Carbajal-Robles[1], and Érick Gómez-Apo[2]*

*[1]Department of Angiology and Vascular Surgery, Centro Médico Dalinde; [2]Department of Pathology, Hospital General de México Eduardo Liceaga. Mexico City, Mexico*

## Abstract

*In the literature there are several described techniques for the resection of carotid body tumors, such as the standard caudocranial dissection, the modified standard (craniocaudal dissection) and recently introduced retrocarotid dissection. All of these with favorable technical and clinical outcomes. We propose a novel modification called the trans-bulb dissection technique; the result of our progressive experience treating such cases, with the aim to reduce blood loss, operative time and hospital stay. This approach focuses on avoiding and minimizing the use of suture material, and only requiring bipolar energy, Pott's scissors, without sutures. With promising postoperative outcomes as good as the other ones: short operative time, one-day post-of hospital stay and approximately 100 milliliters of blood loss in Shamblin II tumors. Additionally, with promising results even in glomus vagal Netterville-Glasscock II, with vagus nerve preservation.*

***Keywords:*** *Carotid body tumors. Glomus vagal. Paragangliomas. Trans-bulb dissection.*

## Resumen

*En la literatura existen varias técnicas descritas para la resección de tumores del cuerpo carotídeo, como la disección caudocraneal estándar, la disección estándar modificada (disección craneocaudal) y la disección retrocarotídea de reciente introducción. Todo ello con resultados técnicos y clínicos favorables. Proponemos una modificación novedosa, llamada técnica de disección transbulbo; resultado de nuestra experiencia progresiva en el tratamiento de estos casos, con el objetivo de reducir la pérdida de sangre, el tiempo operatorio y la estancia hospitalaria. Este enfoque se basa en evitar y minimizar el uso de material de sutura, y solo requiere energía bipolar, tijeras de Pott, sin suturas. Con resultados postoperatorios prometedores tan buenos como los anteriores: tiempo operatorio corto, estancia hospitalaria de un día y aproximadamente 100 mililitros de pérdida de sangre en tumores Shamblin II. Además, con resultados prometedores incluso en glomus vagal Netterville-Glasscock II, con preservación del nervio vago.*

***Palabras clave:*** *Tumor de cuerpo carotídeo. Glomus vagal. Paragangliomas. Disección transbulbar.*

***Correspondence:**
Enrique Santillán-Aguayo
E-mail: ensagu5@hotmail.com

Date of reception: 06-05-2022
Date of acceptance: 14-10-2022
DOI: 10.24875/RMA.22000020

Available online: 15-12-2022
Rev Mex Angiol. 2022;50(4):145-149
www.RMAngiologia.com

## Background

Two hundred and seventy-seven years have been passed since the first identification of carotid body tumors (CBT) by Albrecht Von Haller and nearly 140 years since the first successful resection report in the literature in 1903 by Scudder[1]. There are perfectly recognized two planes for dissection, the sub-adventitial plane described by Gordon Taylor in 1940[2] and the periadventitial plane; and three techniques described, the standard caudocranial dissection (SCCD), modified standard dissection (craniocaudal dissection [CCD])[3], and recently described and reported the retrocarotid dissection (RCD)[4]. All of them excellent, viable, and safe options, RCD proving a significant decrease in procedural time and hospital stay.

Risk factors might include chronic hypoxemia, caused either by high altitudes or sleep apnea, considered a non-inheritable factor, and more frequently the inherited factors, constituting 35% of all CBTs; primarily genetic, but novo germline mutations may be as well the cause[1]. Exome analysis of 52 CBTs revealed potential driver mutations in 21 genes with many samples with more than one mutation (6-8 mutations per megabase [Mb]), but 41% with no mutation identified, authors suggesting the very much likely possibility of the cumulative effect of several not highly pathogenic mutations[5].

Given the fact that paragangliomas are not very often surgically treated by vascular surgeons, at least in Mexico, there are many options to prevent internal carotid damage, with good variable results, including pre-operative protective stenting of the internal carotid artery[6,7], embolic techniques previous resection (endovascular or percutaneous)[8,9], and the best non-drug dependent post-procedure option: technique modifications and improvements, as mentioned before, like the RCD[4,10] and this time ours.

There is no doubt that SCCD, CCD, and RCD are thrice well, this last one with significant decrease in procedural time and hospital stay in author's experiences[4]. Nonetheless, we propose a new modification based on a trans-bulb approach (TBD) with bipolar energy, Pott's scissors, no sutures, and anterior luxation of the tumor, with results as good as all of the others, in our own experience, with low operation time, hospital stay, and around 100 mL blood loss in two Shamblin II tumors, with promising results even in Glomus vagale.

This new technique is the result of the progressive experience treating such cases, trying to diminish blood loss, operation time, and hospital stay focusing on whatever needed to prevent using sutures, situation we consider is one of the main reasons operation time and blood loss is high, ergo hospital stay, and potentially nerve damage or cerebrovascular accident, as we have seen that the usage of this technique has prevented all of the times severe manipulation of the internal or common carotid artery and any nerve like the vagus.

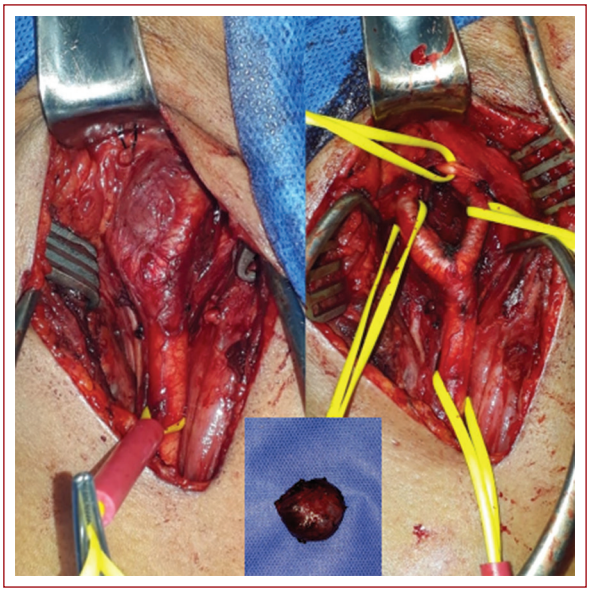

**Figure 1.** Left: Carotid body tumor, Right: Trans-bulbar dissection technique (TBD). *Left.* Bulb. *Right.* Through the bulb, we can observe the bipolar energy applied to permit the luxation of the tumor, which once achieved; surgeon can separate both internal and external carotid arteries. We decided to control both arteries as those were our initial experience but if succeed, we will be able not to do it once identification of the dissection plane. In the upper aspect of the tumor is the hypoglossal nerve. *Down.* Bipolar energy was applied directly to the tumor preventing arterial damage.

## Technique

The patients had agreed to allow the author to publish their case details and images. This technique uses the standard surgical technique for carotid approach, either with transversal or longitudinal incision. Vascular control required (common, internal, and external carotid arteries). The surgeon will only use bipolar energy, Pott scissors, and no sutures (Fig. 1). It is essential to use bipolar energy otherwise it will not be possible to avoid sutures. We suggest using Pott scissor due to its fine tip and its angle, it could be done with Iris scissors too; however, the sharp tip and absence of angle require

more caution. Metzenbaum scissors or Kelly grippers are not recommended, because the tip is too gross and it might damage the tissue.

TBD: Dissection begins through the carotid bulb (Figs. 1 and 2) applying bipolar energy 2 or 3 times and cutting with Pott scissor's, creating the dissection plane. Most of the time the bipolar energy will be enough to let the plane go, occasionally observing gross black tissue which will necessary be cut with Pott scissors, allowing to continue over the plane. Through a caudocranial dissection, it continuous on and on until liberating the part of the tumor attached to the bulb. After the bulb is liberated, it is necessary to luxate the tumor within internal and external carotid arteries. It is done with the first finger through the back of the carotid bifurcation, provoking the anterior luxation of the tumor, and exposing the dissection plane attached to the internal and external carotid arteries; this maneuver lets us grab the tumor with the fingers (sometimes is needed a gauze because the tumor can be slippery) to move it as needed to expose the plane to follow (sometimes dissection must continue if luxation is still not possible). In this moment, the tumor is attached to the internal and external carotid arteries (and the posterior aspect of the tumor), creating the dissection plane between them. Most of the plane of the tumor will only be cut with the bipolar cautery, and if necessary, with Pott scissors. The process will be repeated until a cranial nerve crosses the superior, anterior, or inferior aspect of the tumor and separated by the same means. Once the tumor is separated from the internal and external carotid artery and cranial nerves; then, the surgeon will grab the tumor completely and pull upward to repeat the process posteriorly through the bulb, until complete excision. The surgeon must be careful with the body of the tumor otherwise it will be punctured, and heavy blood loss can obscure and interfere.

## Cases

Case 1 is a female, 63 years old with history of hypertension and a right neck tumor, asymptomatic, resection concluded a Shamblin II tumor. Case 2 is a 61-year-old female with history of hypertension, overweight, and a palpable tumor in the right neck and Case 3 is a 39-year-old female with no other history than a progressively growing tumor in the right neck. All of the patients had 2 days hospital stay, the 1st day for the surgery, and the second one the discharge. None of the patients experienced peri-procedural complications such as a vascular injury, cerebral vascular accident (CVA), or severe nerve damage, not even in the Glomus vagal Netterville-Glasscok II, after nerve dissection and preservation were achieved. Total blood loss was equal in Cases 1 and 2: 100 mL, Case 3 had 600 mL of total blood loss, but within the 2nd h. Partial blood loss was 85, 50, and 540 mL, respectively (during 2nd h), the third case had a higher blood loss, specifically during the 2nd h. Tumor resection time was 20, 15, and 40 min, and skin to skin time (operation time) was 108, 90, and 160 min, in cases 1, 2, and 3, respectively (Table 1).

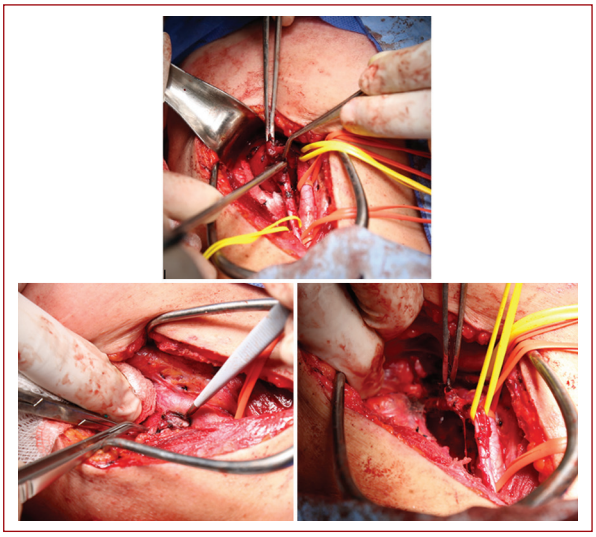

**Figure 2.** Glomus vagal. *Up.* Glomus vagal previous vagus nerve liberation. *Left.* TBD technique in glomus vagal (patient 3, Table 1), through carotid bulb, no sutures, only bipolar energy applied, we can observe initial dissection from de internal carotid artery, in this patient tumor was just attached to that artery. *Right.* Vagus nerve preserved intact through TBD technique.

## Discussion

We had presented three perioperative results using this new technique, with results as good as RCD, CCD, and SCCD, even in a glomus vagal (Fig. 2), with vagus nerve preservation (Fig. 3 and Table 1). These results are promising when compared to different authors like Paridaans et al.[3] reporting SCCD (mean blood loss 129 mL), and CCD (mean blood loss 281 mL), or Hinojosa et al.[4] RCD (mean operation time 172 min SD 60 and mean blood loss 480 mL SD 380), and SCCD (mean operation time 260 min SD 100 and mean blood loss 690 mL SD 680) or Ikeda et al.[11] mean operation time 262 min, blood loss 229 mL, and Carpio et al.[12] mean blood loss 486 SD 240 mL. Considering mean

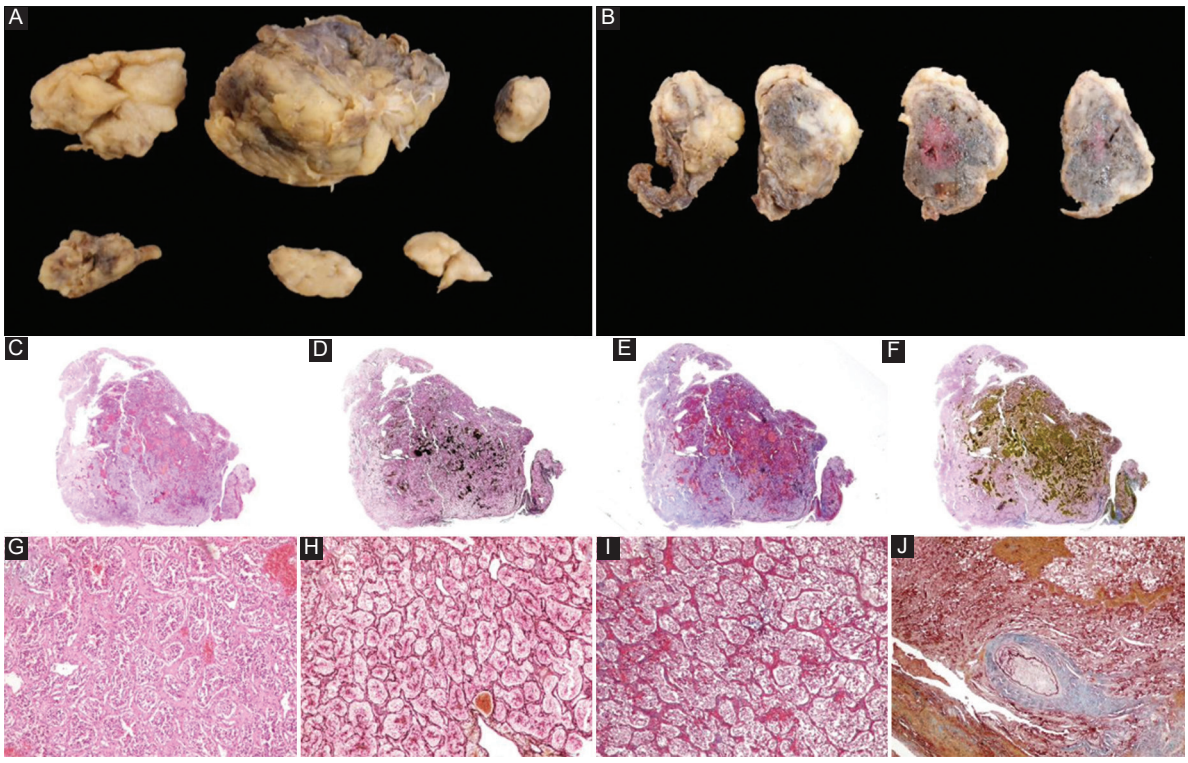


**Figure 3.** Histopathology (Glomus vagale). **A:** external surface of the received specimens is irregular in shape, the surface is rough and nodular, light brown, and focally dark in color. **B:** cutting surfaces of the larger specimen are solid, the center is sore reddish-brown, and the periphery is light brown and soft to the touch. **C-F:** panoramic micrographs of the lesion with H and E, reticulum, Masson's trichome, and elastic fibers stains. **G-I:** H and E, elastic fibers, and Masson`s trichrome stains (×100), the "zellballen" pattern is appreciated, **J:** elastic fiber stain (×40), a neoplasm adjacent to a vessel with arterial characteristics is identified due to the presence of the elastic fiber layer and the tunica media. There is no evidence of the vagus nerve.

operation time (skin to skin time), all of our patients were below 160 min, and blood loss in Shamblin II patients was 100 mL, with a 540 mL in the third case due to the proximity to the jugular foramen and compromise of the vagus nerve, after preserving it. The 2nd h is the moment when the resection of the tumor occurs, which is why it presents more blood loss than the 1st h as it is related to the surgical approach to the carotid sheath. This is the main reason why the third patient lost 6 times blood than the others, as the tumor was enveloping the vagus nerve near the jugular foramen (Table 1).

Surgeons may use many variations over the standard technique, with no doubt surgery requires long-term experience; however, another potential benefit we consider is to facilitate learning in unexperienced surgeons once plane identification is achieved, because the usage of technology devices allows us to improve surgical results, reducing the experience factor, with the slightest chance to procedure related complications on the short- or long-term basis, such as stents, coils, or even radiotherapy.

This technique has limitations for the inclusion of only Shamblin II tumors; nonetheless, we consider that it can be transposed to Shamblin I due to the technical complexity, and potentially to Shamblin III cases, because a Netterville-Glasscock II tumor can be that challenging too. There is no doubt longer case series are needed too, so we can eventually compare between techniques. We suggest to the vascular community and surgeons participating in the treatment of CBTs, the reporting standards presented by Hinojosa et al.[4], and our paper to facilitate future observational and experimental studies regarding this topic. We add to the suggested report the split of the operation time to: skin to skin time as equal, and tumor resection time, as well as blood loss into the 1st and the 2nd h as registered in the clinical file by the anesthesiologist or nurse, as the second blood

**Table 1.** Surgical data

| Variable | Cases | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Shamblin/size, cm | II/2.5 × 2 × 2 | II/2 × 2.5 × 2 | II/4 × 3 × 3* |
| Tumor resection time, min | 20 | 15 | 40 |
| Skin to skin time, min | 108 | 90 | 160 |
| Hospital stay (days)** | 2 | 2 | 2 |
| Blood loss (1st h), mL | 15 | 50 | 60*** |
| Blood loss (2nd h), mL | 85 | 50 | 540**** |
| Nerve damage | XII mild, transient | No | XII mild, transient |
| Vascular injury | None | None | None |
| CVA | None | None | None |

*Netterville-Glasscock.
**Hospital stay include operation day and 1 post-operative day.
***Blood loss within 2 1st h.
****Blood loss within 3rd h, CVA cerebrovascular accident.

loss hour represents the tumor resection time, allowing us in the future to compare techniques using controlled variables.

## Funding

This research has not received any specific grant from agencies in the public, commercial, or for-profit sectors.

## Conflicts of interest

The authors declare no conflicts of interest.

## Ethical disclosures

**Protection of human and animal subjects.** The authors declare that no experiments were performed on humans or animals for this study.

**Confidentiality of data.** The authors declare that they have followed the protocols of their work center on the publication of patient data.

**Right to privacy and informed consent.** The authors have obtained the written informed consent of the patients or subjects mentioned in the article. The corresponding author is in possession of this document.

## References

1. Knight TT Jr., Gonzalez JA, Rary JM, Rush DS. Current concepts for the surgical management of carotid body tumor. Am J Surg. 2006;191:104-10.
2. Gordon- Taylor G. On carotid tumours. Br J Surg. 1940;28:163-72.
3. Paridaans MP, van der Bogt KE, Jansen JC, Nyns EC, Wolterbeek R, van Baalen JM, et al. Results from craniocaudal carotid body tumor resection: should it be the standard surgical approach? Eur J Vasc Endovasc Surg. 2013;46:624-9.
4. Hinojosa CA, Ortiz-Lopez LJ, Anaya-Ayala JE, Orozco-Sevilla V, Nunez-Salgado AE. Comparison of retrocarotid and caudocranial dissection techniques for the surgical treatment of carotid body tumors. J Vasc Surg. 2015;62(4):958-64.
5. Snezhkina AV, Lukyanova EN, Kalinin DV, Pokrovsky AV, Dmitriev AA, Koroban NV, et al. Exome analysis of carotid body tumor. BMC Med Genomics. 2018;11:17.
6. Piazza P, Di Lella F, Bacciu A, Di Trapani G, Mimoune HA, Sanna M, et al. Preoperative protective stenting of the internal carotid artery in the management of complex head and neck paragangliomas: long-term results. Audiol Neurotol. 2013;18:345-52.
7. Hurtado-López LM, Fink-Josephi G, Ramos-Méndez L, Dena-Espinoza E. Nonresectable carotid body tumor: hybrid surgical procedure to achieve complete and safe resection. Head Neck. 2008;30:1646-9.
8. Yang TH, Ou CH, Yang MS, Lee YC, Yeh LR. Preoperative embolization of carotid body tumor by direct percutaneous intratumoral injection of N-butyl cyanoacrylate glue assisted with balloon protection technique. J Chin Med Assoc. 2011;74:91-4.
9. Janakiram TN, Nadakkavukaran J, Sharma SB, Sathyanarayanan JD. A hybrid approach towards successful resection of a huge carotid body paraganglioma using coil embolization and traditional surgical techniques. Indian J Otolaryngol Head Neck Surg. 2019;71:136-9.
10. Hinojosa CA, Anaya-Ayala JE, Olivares-Cruz S, Laparra-Escareno H, Trolle-Silva A, Angeles-Angeles A. Malignant shamblin III carotid body tumors resected with use of the retrocarotid dissection technique in 2 patients. Tex Heart Inst J. 2018;45:92-5.
11. Ikeda A, Shiga K, Katagiri K, Saito D, Miyaguchi J, Oikawa SI, et al. Multi-institutional survey of carotid body tumors in Japan. Oncol Lett. 2018;15:5318-24.
12. Carpio CÓ, Sánchez NN, Turnbull IC, Serrano LJ. Disminución de morbi-mortalidad en el manejo del tumor de cuerpo carotídeo, tendencias actuales y experiencia en México. Rev Mex Angiol. 2010;38:145-8.