The “INT-EX Technique”: Internal to External Approach in Carotid Body Tumour Surgery

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Abstract Carotid body tumours are rare and mostly benign neoplasm. They are slow growing but can evade or exert pressure on neighbouring important neurovascular structures. Hence, surgical resection remains the treatment modality of choice for large tumours partially or completely encasing the carotid arteries. But the surgical resection of these tumours with minimum morbidity is challenging because of their highly vascular nature. Earlier literature has dealt with various aspects of management of carotid body tumours including classification, morbidity, work-up, embolisation and extent of resection. However, the options in techniques of dissection for carotid body tumours have not been elaborated much. Here, we describe a stepwise dissection technique of carotid body tumours from the internal carotid towards the external carotid artery. This surgical technique, named as “the internal to external (INT-EX) technique”, provides better control of bleeding during the surgery, ease of dissection and lesser post-operative morbidity.

Keywords Carotid body tumour · Paraganglioma · Shamblin’s classification · Internal carotid artery

Introduction

Carotid body tumours are non chromaffin paragangliomas [1], arising from small chemoreceptor organs in the adventitia of the common carotid bifurcation (Fig. 1). Even though slow growing, early resection of these tumours is recommended because of incidences of cranial nerve palsies [2] and malignant potential in 2–7% [1]. Meticulous preoperative planning and careful patient selection are essential for successful surgical outcome [3].

Methodology

Seven patients aged 42 to 65 underwent carotid body tumour resection utilising the “internal to external (INT-EX) technique” of dissection from January 2010 to September 2015. In all the cases, the pre-operative workup was done as elaborated in the following (Table 1).

As revealed by the imaging, three out of the seven cases were of Arya and Rao type II [3] (tumour encasing the carotid arteries by <180°, corroborating to Shamblin type I) [4]. Four cases were of Arya and Rao type III (tumour encasing the carotid arteries by >180°, corroborating to Shamblin type II) [3, 4].

Pre-operative embolisation was done in one case with ethylene vinyl-alcohol copolymer (EVOH).

The surgeries were carried out utilising the aforementioned INT-EX technique of dissection. The total time taken for the surgeries ranged from 1 to 2 h. The estimated mean blood loss was 150 ml. All of the patients were followed up till the first year of surgery and had no recurrence.

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Fig. 1 The carotid body tumour in relation to the CCA, the ICA and the ECA, showing Arya and Rao Type II tumour

This technique of dissection of the tumour initially from the internal carotid artery (ICA) and then dissecting towards the ECA is named the INT-EX technique (Fig. 2). This mnemonic describes the INT part representing the internal carotid artery and the EX representing the external carotid system. This dissection technique allows the surgeon to have a better control over carotid arteries and tumour bleeding.

The dissection was done in the following steps:

1. Neck incision was marked and infiltrated. Soft tissue dissection was done as per the conventional way to expose the carotid triangle.

Fig. 2 T2W axial cut MR image of the same case

2. The tumour was delineated in relation to the carotid bifurcation, and the internal and external carotid arteries were exposed.
3. The carotid sheath was dissected to define the white line of Gordon and create a dissection plane starting at the level of the common carotid artery.
4. The tumour was then dissected from the internal carotid artery along the white line of Gordon using mayo blunt dissecting scissors. The dissected tumour capsule was utilised to provide manual counter traction while dissecting it away from the internal carotid artery.
5. After the tumour was dissected and freed from ICA, the dissection of the tumour was carried out towards the external carotid artery. The branches of the external carotid artery feeding the tumour were identified at this time and

Table 1 Pre-operative work-up of the carotid body tumour patients

Pre-operative workup	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7
MR-angiogram	Arya and Rao type II	Arya and Rao type III	Arya and Rao type II	Arya and Rao type II	Arya and Rao type III	Arya and Rao type III	Arya and Rao type III
Balloon occlusion test	Well tolerated	Well tolerated	Well tolerated	Well tolerated	Well tolerated	Well tolerated	Well tolerated
Ga-68-DOTANOC PET scan	Not done	No second paraganglioma	No second paraganglioma	Not done	Not done	Not done	Not done
Serum catecholamine	Non secretory	Non secretory	Non secretory	Non secretory	Non secretory	Non secretory	Non secretory
Urinary VMA	Non secretory	Non secretory	Non secretory	Non secretory	Non secretory	Non secretory	Non secretory
Pre-operative embolisation	Not Done	Done	Not done	Not done	Not done	Not done	Not done

ligated. The tumour was then dissected away from the external carotid artery (Fig. 3).

The rationales behind this dissection technique are the following:

- The internal carotid artery does not have any branches in cervical segment. Thus, an initial dissection of the internal carotid artery is safer, shortens the dissection time overall and prevents its injury at a later step.
- An initial attempt to dissect the tumour from the external carotid artery can potentially injure any of its branches/ numerous feeding vessels, causing dreaded bleeding. A preferable choice would therefore be to dissect the tumour from internal carotid artery first, then towards the external carotid artery.
- In any event of uncontrollable bleeding, the external carotid artery can be safely ligated, leaving the internal carotid artery untouched.
- This technique allows the surgeon to have a better control over carotid arteries and tumour bleeding.
- This approach also helps to involve the vascular surgeons in initial phase if we identify any potential point of difficult dissection necessitating vascular repair of the internal carotid artery or a shunt procedure.

Carotid body tumours being a rare entity involve a learning curve in its dissection on the part of surgeon. It also involves

careful intra-operative evaluation to avoid complications (Table 2). The addition of the INT-EX technique of dissection described here will reduce complications and facilitate ease of dissection.

An initial attempt to dissect the tumour from the external carotid artery can potentially injure any of its branches/ numerous feeding vessels to the tumour. This can divert the efforts and focus of the surgeon in controlling bleeding, leaving the more important dissection of the internal carotid artery for the later hours.

Discussion

There are different surgical techniques of dissecting the carotid body tumours. Each of them has their own merits and demerits. Amongst them, the commoner technique to dissect the carotid body tumour is to address the external carotid artery at the initial steps of the surgery. The dissection is usually initiated from the common carotid artery, and then, the tumour is dissected off the external carotid artery. The internal carotid artery is dissected towards the final step after the external carotid artery is freed from the tumour. However, the authors believe that the dissecting the tumour off the ICA initially would be a more optimal approach (Fig. 4).

The logic behind starting the tumour dissection from the external carotid artery towards the internal carotid artery is that it helps to identify and ligate the feeding blood vessels to the tumour at an initial step. A similar dissection technique has been described by Francesco Spinelli et al. where the authors isolated the origin of the external carotid artery and its distal branches outside the tumour and temporarily clamped all of these vessels after heparin administration [5].

Fig. 3 Pre-operative angiogram of the same patient showing splaying of the ICA and ECA on the left side by the carotid body tumour

Table 2 Intra- and post-operative information of “INT-EX technique” of carotid body tumour surgery

Case	Duration of surgery (min)	Estimated blood loss (ml)	Recovery
1	90	110	Uneventful
2	102	120	Uneventful
3	75	145	Uneventful
4	65	130	Uneventful
5	80	112	Uneventful
6	60	150	Uneventful
7	70	140	Uneventful

Fig. 4 Schematic diagram showing the INT-EX technique of dissecting the tumour away from the ICA towards the ECA

Figure 1: The carotid body tumor in relation to the CCA, ICA and the ECA.

Figure 2: Intex technique of dissecting the tumor away from the ICA towards ECA

Figure 3: The carotid artery after dissection of the tumor.

Issue with External Carotid Artery Approach

The fact that these tumours are very vascular shifts the surgeon's attention towards controlling the feeder vessels first, which commonly arise from the external carotid artery. Thus attempting to dissect the tumour initially from the external carotid artery may result in bleeding of tumour site and disrupting the surgical site and field, which could also lead to increased surgical time.

Ways to Address the Problem

Dissecting the carotid body tumour from internal carotid artery at an initial step can address this issue. The INT-EX technique—internal to external approach—along the white line of Gordon is a safe and effective technique to dissect these tumours.

The rationale behind this dissection technique is that the internal carotid artery does not have any branches in cervical segment. Thus, an initial dissection of the internal carotid artery is safer, shortens the dissection time overall and prevents its injury at a later step. Furthermore, an initial attempt to dissect the tumour from the external carotid artery can potentially injure any of its branches/numerous feeding vessels, causing dreaded bleeding. A preferable choice would therefore be to dissect the tumour from internal carotid artery first, then towards the external carotid artery. In any event of uncontrollable bleeding, the external carotid artery can be safely ligated, leaving the internal carotid artery untouched. Thus, this technique allows the

surgeon to have a better control over carotid arteries and tumour bleeding. This approach also helps to involve the vascular surgeons in initial phase if we identify any potential point of difficult dissection necessitating vascular repair of the internal carotid artery or a shunt procedure.

Lastly, carotid body tumours being a rare entity involve a learning curve in its dissection on the part of surgeon. It also involves careful intra-operative evaluation to avoid complications. The addition of the INT-EX technique of dissection described here will reduce complications and facilitate ease of dissection.

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