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Case report

Phrenic nerve schwannoma as an incidental intraoperative finding. Case report

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ABSTRACT

Introduction and importance: Peripheral neuronal sheath tumors are rare lesions that can arise from the lining of the neuronal axons of any nerve in the body. Schwannomas are usually solitary and encapsulated, slow growing, predominantly benign, with a malignant transformation rate of less than 2% and very low recurrence. The phrenic nerve schwannoma is rare in the neck and usually is asymptomatic.

Case presentation: We present a case of a phrenic nerve schwannoma as an incidental intraoperative finding in the study of a patient with a cervical mass of progressive growth on the right side of the neck in contact with the anterior scalene muscle and pain intermittent. Resection of the mass was done with preservation of the endoneurium. Intraoperative stimulation after resection had a proper functionality of the phrenic nerve. In the follow-up, the patient had not any damage of the function of the phrenic nerve.

Clinical discussion: This tumor is generated by a deficiency of merlin with the consequent cell proliferation. The diagnostic imaging (CT or MRI) are the studies of choice. The differential diagnosis of these lesions has an impact on the presence or absence of oncological disease or progression of a previously treated one. The ideal management is surgical and the anatomical and/or functional preservation of the nerve depend of the tumor infiltration.

Conclusion: The phrenic nerve schwannoma is rare in the neck. The ideal management is surgical, and this pathology must be considered in patients with masses in the Station IV and supraclavicular fossa of the neck.

1. Introduction

Peripheral neural sheath tumors are rare lesions that can arise from the lining of the neuronal axons of any nerve in the body. These lesions are particularly rare in the neck and are usually asymptomatic [1]. The differential diagnosis of these lesions has an impact with respect to the presence or absence of oncologic disease or the progression of a previously treated lesion. In the present article, the presence of a phrenic nerve schwannoma as an incidental finding during the surgical procedure performed in the San José Hospital from Bogotá, Colombia in the context of the study of a patient with a cervical mass is reported. This topic is quite rare in literature and the knowledge of its management and highlights are applicable globally. There are not specific guidelines published in the literature.

In the present document, we present 5 cases of phrenic nerve tumors located in the cervical region identified during the literature search, of which only one is a schwannoma confirmed by immunohistochemistry [14]. The present case is one of the first confirmed reports in Latin America of a phrenic nerve schwannoma located in the neck. This case report has been reported in line with the SCARE 2020 criteria [2].

2. Presentation of case

This was a female patient in the third decade of her life without medical, surgical, family, genetic, allergies and psychosocial history, who consulted on your own to head and neck service of the San José Hospital from Bogotá city, with a 1-year clinical history involving the sensation of a mass in the right cervical triangle with pain intermittent that increases with the movement of the head and neck. In the physical examination, a mass not painful in the right neck was identified. Patient presented with inconclusive extra-institutional images (CT) of a 3 * 4 cm mass on the right side of the neck in contact with the anterior scalene muscle with initial diagnostic of lymph node conglomerate. The ultrasound-guided Tru-cut needle biopsy of the mass documented a

Abbreviations: CT, computerized tomography; MRI, magnetic resonance imaging.

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spindle cell tumor and open surgical resection was indicated for the risk of brachial plexus damage.

The surgical procedure was performed by the head and neck surgeon one month after the initial evaluation, following the recommendations from the anesthesiologist. Prophylactic antibiotic (first generation cephalosporin) was administered according to the institutional protocol. In supine position, with hyperextension of the neck, through a right cervicotomy. Intraoperatively, a solid mobile mass of 4.7 × 2.7 × 2.5 cm that originated from the right phrenic nerve was identified in relation to the anterior scalene muscle and the branchial plexus without infiltrating it (Fig. 1). Resection of the mass was done with preservation of the phrenic nerve endoneurium. Intraoperative stimulation after resection had a proper functionality of the phrenic nerve. There were not complications, and the post-intervention considerations were the pain management and rehabilitation with head and neck movements at home.

Histopathological report of spindle cell tumor without atypia and neural appearance, immunohistochemistry confirming the diagnosis of schwannoma (Fig. 2). In the first month of the follow – up in the San José Hospital from Bogotá city, the patient gives us her Informed consent for this publication using the International Journal of Surgery form (written consent). Patient did not show the presence of paralysis or diaphragmatic herniation at fourth month of postoperative follow-up.

3. Discussion

Nerve sheath tumors are lesions derived mainly from the cellular structures surrounding the peripheral nerve axons. Schwann cells are the deepest cells of the neuronal lining (endoneural) which are connected to each other and to the rest of the layers that line the nerves by means of intercellular tubules with the perineural cells of the neuronal sheath [1,3].

Neurilemmomas, also known as schwannomas, are one of the neuronal sheath tumors. First described by Veroca et al. in 1910 and later morphologically classified by Antoni in 1920 [4], they are relatively common lesions and are the most frequent neural sheath tumors. Table 1 shows the clinical, histological, and morphological characteristics of the most frequent neuronal sheath tumors [3,5].

Schwannomas are lesions that are usually solitary and encapsulated, slow growing, predominantly benign, with a malignant transformation rate of less than 2% [1] and very low recurrence [4]. As previously mentioned, two morphological patterns can be described microscopically. The Antoni A schwannomas are lesions with a compact, regular architecture and dense, avascular spindle cells. They are different from Antoni B lesions which present a disorganized growth that include cystic areas, vascular thickening, vascular hyalinization, and areas where hemorrhage occurs. These morphological variants are anatomically useful since they have no impact on the clinical presentation or prognosis of patients [3,4]. Our case showed an avascular spindle cell pattern with a neuronal component compatible with Antoni A (Fig. 2).

Physiopathologically, these are lesions that are generated by a deficiency of merlin or schwannomin which normally acts as an inhibitor of cell proliferation by stimulating the RAS protein. These lesions can be found in the nerve axons of any body segment. Lesions located in the head, neck, and mediastinum tend to be benign with schwannomas of the VIII cranial nerve being the most frequent [4], unlike schwannomas of the extremities, which tend to be malignant [3,6].

These tumors are clinically asymptomatic [1]. They occur most often in men between the ages of 30 and 60 and may be associated with neurofibromatosis type 2, the Carney complex, schwannomatosis along

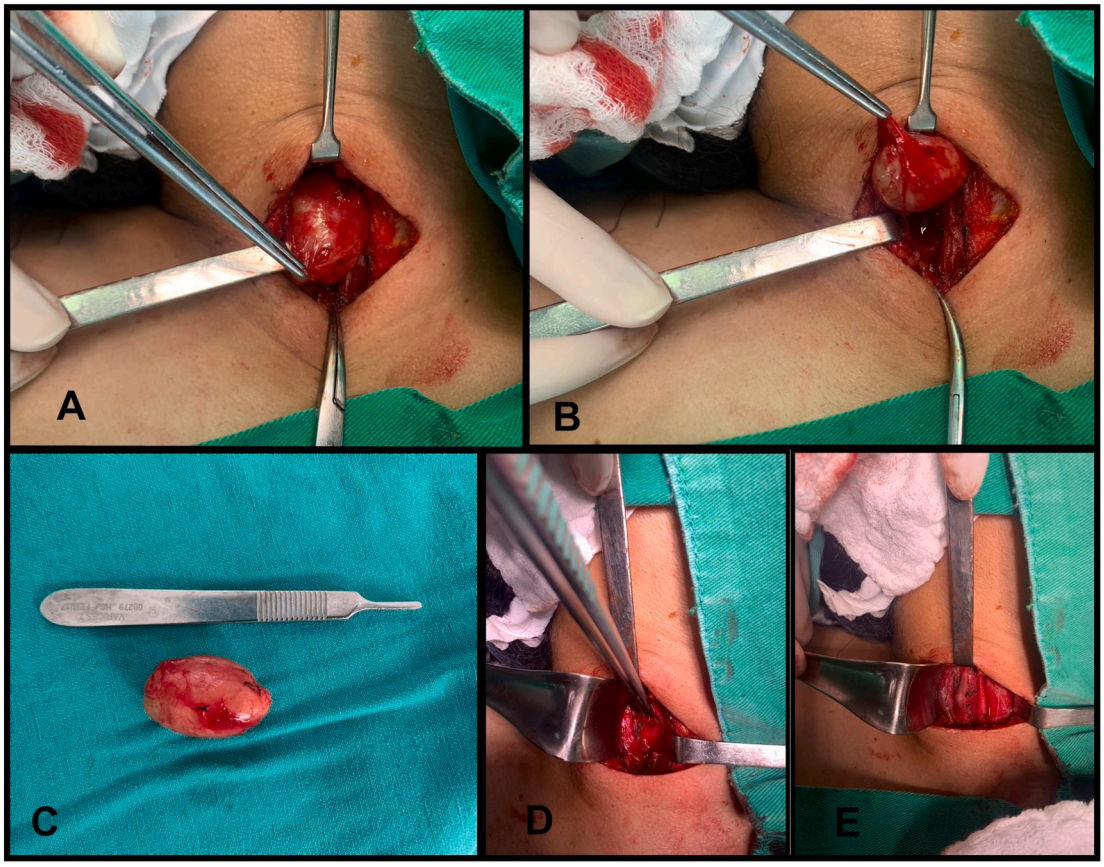

Fig. 1. A–B Circumscribed, smooth-edged, rubbery mass anterior to the middle and posterior scalene muscles and the brachial plexus and posterior to the carotid artery, internal jugular vein and vagus nerve and dependent on the phrenic nerve in situ. C Surgical specimen of approximately 4 cm at its largest diameter; D–E posterior dissection of the mass resection where the anatomical relationships of the mass already described are identified.

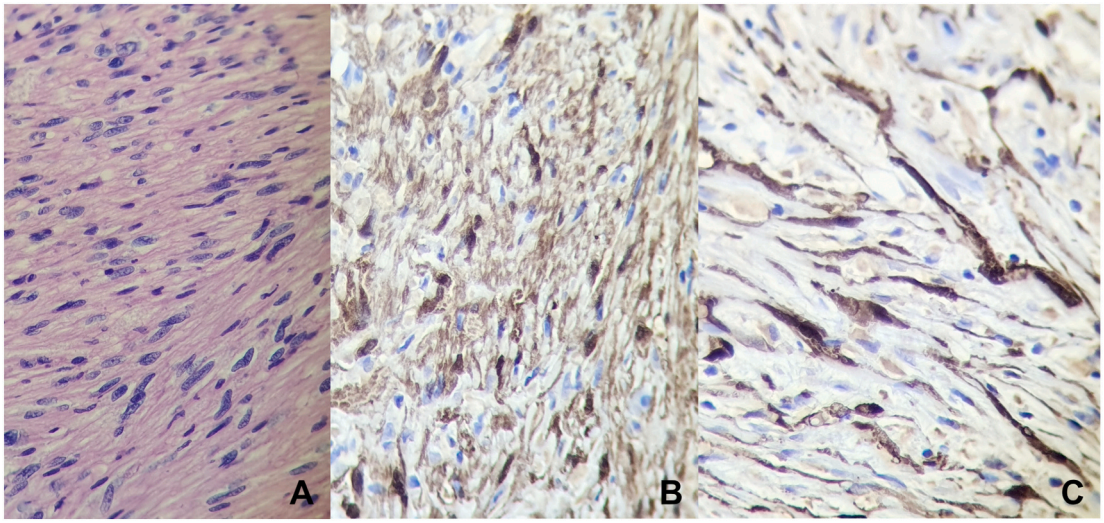

Fig. 2. A. An avascular spindle cell pattern with a neuronal component is seen (Antoni A). B. Immunohistochemistry with a nuclear and cytoplasmic positivity of S100. C. KI-67 marking less than 1%.

Table 1
Table comparing the different neural sheath tumors. NF1: neurofibromatosis type 1, NF2: neurofibromatosis type 2.

Description	Neurofibroma	Schwannoma	Perineurioma
Macro aspect	Off-white surface Bright Intraneural growth Pedicled	Gray circumscribed mass Degenerative changes In contact with the nerve but not invading it	Solid mass with multinodularity Enlarged individual fascicles
Components	Axons Perineural cells Fibroblasts Inflammatory components (mast cells, lymphocytes) Non-myelinated (immature) Schwann cells	Proliferation of mature Schwann cells	Perineural cells Axons
Cytological characteristics	Corrugated cores	Enlarged nuclei Verocay bodies Nuclear hyperchromasia	Thin cells with overlapping elongated cell processes Hemidesmosomes Absence of basal lamina
Histological features	Collagen in a grated carrot pattern No necrosis Pseudo-meissnerian corpuscles	Hyalinized vessels May or may not have necrosis Fascicular growth pattern Vascular ectasia Lymphoid aggregates	Onion bulb pattern If it is soft tissue, loose fascicles can be seen Microcystic or reticular pattern
Capsule	No	Yes (type IV collagen)	No
Positive markers	PROT S100 Collagen IV CD34 Neurofilament protein Podoplanin Calretinin Sox10	PROT S100 GFAP Podoplanin Calretinin SOX10	EMA Claudin 1 GLUT 1
Malignant degeneration	Yes	Yes (approximately 2%, especially the melatonic variant)	If it is hybrid
association	10% are associated with NF1	They are associated with NF2	Hyperplastic polyps

with other syndromes [3,7]. Head and neck schwannomas account for up to 45% of the cases [7]. However, involvement of the phrenic nerve and vagus nerve at the cervical level is uncommon [7,8].

This pathology tends to be asymptomatic and is usually diagnosed in the context of a differential diagnosis in a study of neck masses. Within the symptomatology of phrenic nerve schwannomas, regardless of their location, are vascular obstruction symptoms, dry cough, dyspnea, superior vena cava syndrome, or airway obstruction symptoms and even diaphragmatic paralysis and pneumonia or, less frequently, diaphragmatic eventration [5,7]. In this case, the patient had pain intermittent that increases with the head and neck movement, without symptoms of phrenic nerve damage.

Diagnostic imaging (CT or MRI) are the studies of choice. However, they are incidental findings in the study of patients with masses in the neck and suspected adenomegaly [9]. In our case, the CT images shows an inconclusive image of a 3 * 4 cm mass on the right side of the neck in contact with the anterior scalene muscle probably related with a ganglionic conglomerate.

The histopathological diagnosis is conclusive and generally has definite characteristics (Table 1). If determined preoperatively, it makes it possible to assess the residual functionality of the nerve involved, determine the risk of malignant transformation and of recurrence as well as determine the possibility of resection with nerve preservation based on the degree of infiltration of the nerve axons, which varies from patient to patient [5]. In our case, it was not possible to obtain a preoperative diagnosis, and resection was undertaken based on intraoperative

Table 2
Summary of clinical cases reported to date in the literature. The sociodemographic, clinical and histopathologic characteristics of each of the patients under study are described.

Name of the article	Author/date	Age	Sex	Symptoms	Comorbidities	Mass dimensions	Location of Schwannomas	Histological features	Confirmation of IHQ/IHC	Surgical treatment	Radiological diagnosis
Benign schwannoma of the left cervical phrenic nerve [7]	Graham, Thomson, Woodwards/2008	34	M	No	No	42 * 25 * 20 mm	Cervical	Antoni A	No	Yes	Yes
Neurogenic tumor of the phrenic nerve [13]	Walker/1958	52	F	Yes	No	50 * 38 mm	Thoracic	Antoni A	No	Yes	Yes
Unusual cases of cervical nerves schwannomas: phrenic and vagus nerve involvement [8]	Mevio, Gorini, Sbrocca/2003	61	M	Yes	Yes	3 * 2 cm	Cervical	Mixed - Predominantly Antoni A	No	Yes	Yes
Neurofibromas of the phrenic nerve: a case report and review of literature [5]	Ghali, Srinivasan, Slopis/2016	14	M	Yes	Yes	3.48 * 4.4 cm	Thoracic	–	–	YES	YES
Nerve-sparing schwannoma removal from two infrequent origins [4]	Inzirillo, Giorgetta, Ravalli/2015	62	M	Yes	No	17 * 15 * 13 cm	Thoracic	Antoni A	No	Yes	Yes
Schwannoma de la porción cervical del nervio frénico. Presentación de Caso Clínico [14]	Sanchez, Jara, Rodriguez/2015	73	F	No	Yes	4 * 3 cm	Cervical	Antoni A	Yes	Yes	Yes
Diaphragmatic eventration: An Uncommon Presentation of a Phrenic Nerve Schwannoma [10]	Moinuddeen, Baltzer, Zama/ 2001	68	M	Yes	No	4.6 * 2.8 * 2.3 cm	Thoracic	Mixed - predominantly Antoni A	No	Yes	Yes
Schwannoma of the accessory phrenic nerve [15]	De Bie et al/2007	45	F	Yes	No	2.7 cm	Cervical (supraclavicular)	–	No	Yes	Yes
Preoperative anticipation of origin from MRI scans in cervical phrenic schwannoma [9]	Watanabe, Moriwaki/2005	56	F	No	Yes	2.5 cm * 2.5 cm * 1.5 cm	Cervical	Antoni A	No	Yes	Yes

findings that were later confirmed by the histopathology report.

Phrenic nerve schwannomas, which are extremely rare [8,9], are usually asymptomatic. However, the findings may include the presence of eventration or diaphragmatic paralysis [7,10]. In our case, there was no evidence of this manifestation. There is usually a predilection for mediastinal involvement of phrenic nerve-dependent tumors [4,5,7,8].

We present nine case reports of phrenic nerve neural sheath tumors (Table 2) [4,5,10,13]. Of these, only 5 were cervical (1 case in Latin America) [7–9,14,15]. No prevalent age range was documented; and with respect to gender, three cases were females and two were males. Based on the clinical manifestations, in addition to the sensation of mass, the most frequent symptoms experienced were dyspnea due to diaphragmatic paralysis on the compromised side and pain. However, most patients were asymptomatic. The main diagnostic method was imaging in which masses along the phrenic nerve pathway associated with elevation of the ipsilateral diaphragm were revealed. The pathological confirmation was determined by histological features, mainly the Antoni A pattern but, except for one case, not by immunohistochemistry. Therefore, we can be sure that, of the 5 cases of phrenic nerve tumors located in the cervical region, only one is a schwannoma confirmed by immunohistochemistry. This suggests that the present case is one of the first confirmed reports in Latin America of a phrenic nerve schwannoma located in the neck.

In a case series by Grunstein et al. in 1988, 18 cases of phrenic nerve schwannomas were identified. However, only one of these was located in the neck. This series reported a higher prevalence in older patients [11]. Likewise, Pimpec Barthes et al. published another series of cases of phrenic nerve schwannomas in 1998. However, none of the cases occurred in the neck [12].

The ideal treatment for these lesions is surgical. However, anatomical and/or functional preservation will depend on the degree of tumor infiltration. Ideally, an attempt should be made to preserve the compromised nerve branch. In cases where the compromised nerve is already dysfunctional before surgery or shows no response to intraoperative stimulus, complete resection is indicated. Surgical management could be considered the gold standard that guarantees proper control of the disease and a recurrence of less than 2% in most cases. However, the risk of recurrence depends on the histological subtype with rates of up to 50% in plexiform variants [3,4]. In the follow-up the symptoms referred initially by the patient disappeared (pain with the head and neck movement), and four months after surgery there are no signs of recurrence (evaluated by imagenologic studies); her perspective on the treatment received was favorable because she had disappearance of the symptoms and she was incorporated into their working life.

4. Conclusion

The phrenic nerve schwannoma is rare in the neck. The ideal management is surgical, and this pathology must be considered in patients with masses in the Station IV and supraclavicular fossa of the neck, especially in patients with symptoms of phrenic nerve involvement.

Informed consent

Written informed consent was obtained from the patient during the follow -up for publication of this case report and accompanying images using the International Journal of Surgery form. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Provenance and peer review

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Guarantor

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Álvaro Granados.

We accept full responsibility for the work.

Research registration number

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CRediT authorship contribution statement

Rogers Baquero: Writing - Original draft, visualization, supervision, project administration, review & editing
Julián Jimenez: Investigation, methodology, review & editing
Nathalie Vargas: Conceptualization, investigation
Álvaro Granados: Supervision, project administration.

Declaration of competing interest

The authors have no conflict of interest.

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