Case report

Phrenic nerve schwannoma as an incidental intraoperative finding. Case report

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A R T I C L E   I N F O

Keywords:
Neurilemmoma
Schwannoma
Phrenic nerve
Neck mass
Surgery
Case report

A B S T R A C T

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...
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 $4.7 \times 2.7 \times 2.5$ cm that originated from the right phrenic nerve was identified in relation to the anterior scalene muscle and the brachial 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 neural 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...
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 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 | Gray circumscribed mass       | Solid mass with multinodularity  |
|                                    | Bright       | Degenerative changes         | Enlarged individual fascicles   |
| Intranuclear growth                |              | In contact with the nerve but not invading it |               |
| Pedicled                           |              |                              |               |
| Components                         | Axons        | Proliferation of mature Schwann cells | Perineural cells |
|                                    | Perineural cells |                              | Axons         |
|                                    | Fibroblasts  |                              |               |
|                                    | Inflammatory components (mast cells, lymphocytes) |                              |               |
|                                    | Non-melaninated (immature) Schwann cells |                              |               |
| Cytological characteristics       | Corrugated cores | Enlarged nuclei               | Thin cells with overlapping elongated cell processes |
| Histological features              | Collagen in a grated carrot pattern | Hyalinized vessels           | Onion bulb pattern |
|                                    | No necrosis  | May or may not have necrosis  | If it is soft tissue, loose fascicles can be seen |
|                                    | Pseudo-meissnerian corpuscles | Fascicular growth pattern | Microcystic or reticular pattern |
| Capule                             | No           | Lymphoid aggregates          |               |
| Positive markers                   | PROT S100    | Yes (type IV collagen)       | No            |
|                                    | Collagen IV  | PROT S100                   | EMA           |
|                                    | CD34         | GFAP                        | Claudin 1     |
|                                    | Neurofilament protein | Podoplanin                 | GLUT 1        |
|                                    | Podoplanin   | Calretinin                  |               |
|                                    | Calretinin   | SOX10                       |               |
| Malignant degeneration             | Yes          | Yes (approximately 2%, especially the melanotic variant) | If it is hybrid |
| association                        | 10% are associated with NF1 | They are associated with NF2 | Hyperplastic polyps |
### 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 Schwannoma | Histological features | IHQ/IHC | Confirmation of IHQ/IHC | Surgical treatment | Radiological confirmation of IHQ/IHC |
|---------------------|-------------|-----|-----|----------|---------------|-----------------|--------------------|----------------------|--------|------------------------|-------------------|------------------------------------|
| Benign schwannoma of the left cervical phrenic nerve | Graham, Thomson, Walker/1998 | 34 | M | No | No | 42 * 25 * 20 mm | Cervical | Antoni A | No | Yes | Yes | Yes | Yes |
| Neurogenic tumor of the phrenic nerve | Walker/1958 | 52 | F | Yes | No | 50 * 38 mm | Thoracic | Antoni A | No | Yes | Yes | Yes | Yes |
| schwannoma de la porcion cervical del nervio frénico. Presentación de un caso y revisión bibliográfica | Sanchez, Jara, Rodriguez/2015 | 73 | F | No | Yes | 4.6 * 2.8 * 2.3 cm | Cervical | Antoni A | No | Yes | Yes | Yes | Yes |
| Schwannoma de la porción cervical del nervio frénico | Sanchez, Jara, Rodriguez/2015 | 62 | M | Yes | No | 4.6 * 2.8 * 2.3 on | Cervical | Antoni A | No | Yes | Yes | Yes | Yes |
| Schwannoma de la porción cervical del nervio frénico | Sanchez, Jara, Rodriguez/2015 | 62 | M | Yes | No | 4.6 * 2.8 * 2.3 | Cervical | Antoni A | No | Yes | Yes | Yes | Yes |
| Schwannoma of the accessory phrenic nerve (supraclavicular) | De Bie et al/2007 | 45 | F | Yes | No | 2.7 cm | Cervical | Mixed (predominantly Antoni A) | No | Yes | Yes | Yes | Yes |
| Provenance and peer review not commissioned, externally peer-reviewed. | | | | | |

### 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**

Provenance and peer review not commissioned, externally peer-reviewed.
Ethical approval

Not applicable, this is not a research project.

Funding

Not applicable.

Guarantor

Rogers Leonardo Baquero García
Álvaro Granados.

We accept full responsibility for the work.

Research registration number

Not applicable.

CRediT authorship contribution statement

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

Declaration of competing interest

The authors have no conflict of interest.

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