

Peripheral schwannomas of the tibial nerve: surgical results in a case series

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Abstract. *Background and aim of the work:* Schwannomas of the lower limb are uncommon benign tumors and those arising from Tibial Nerve are particularly rare. We report our experience on the topic, with particular attention to clinical presentation and lower limbs overall functionality before and after treatment. Our aim is to assess clinical impairment caused by the tumor and evaluate the effectiveness of surgical treatment. *Materials and methods:* Time between symptoms outbreak and diagnosis, as well as pre-operative tumor size were evaluated for each case. Pre-operative and post-operative overall lower limb functionality were assessed using both MSTs and LEFS scores. Sensitive symptoms and muscular strength were also evaluated before and after surgery. *Results:* 7 patients were included in our study. The mean follow-up was 22.9 months. Average diagnostic delay was 8 months and tumor size was 29.3mm. Before surgery each patient had positive Hoffmann-Tinel sign and an at least mild paresthesia, 57% of our cases had slight reduction of muscular strength. Pre-operative MSTs score was 24.4 and LEFS score was 64.7. Tumor size and diagnostic delay were associated with pre-operative functionality. No major local complication was recorded during or after surgery. Each patient with pre-operative sensitive or motorial deficit benefited the effects of surgical treatment. *Conclusions:* Our cases suggest early diagnosis could reduce the impact of the disease on patients' activities of daily living and quality of life. Surgery, for its part, represents a safe and reliable approach to Tibial Nerve schwannomas with good chances of clinical and functional remission. (www.actabiomedica.it)

Keywords: Schwannoma, Neurinoma, Tibial Nerve, Enucleation, Functionality

Introduction

Schwannomas, also known as neurilemmomas or neurinomas, are benign soft tissue neoplasms. They are the most common tumor of the peripheral nerve sheath and arise from the Schwann cells, the glial cells that constitute the myelin sheath (1). Schwannomas are more frequent in the fourth decade of life without any sex preference and often present as lone masses, although cases with neurofibromatosis can have multiple and earlier presentations (2).

Tumor is usually well-encapsulated, isolable from the nearby tissues and slow growing. Malignant degeneration is extremely rare, since only 1% of all

schwannomas tend to transform into neurofibrosarcomas or malignant schwannomas. (3). Most common localizations are head and neck, especially at the level of the brachial plexus and spinal nerves, while the incidence of cases involving upper and lower limbs is significantly lower (4-5). Although they can stay clinically silent for months or even years, symptoms may appear and worsen as the volume of the tumor increases, resulting in an increasing compression pressure exerted on the native nerve and of the adjacent structures. Eventual clinical manifestations may therefore consist in various combinations of pain, swelling and alteration of neuromotor or sensitive neurological functionality. Alongside with a correct anamnesis,

physical examination is essential in order to enter the correct diagnostic path. Especially when they involve superficial nerves, Schwannomas can manifest as round or ovoid tumefactions, painful to pressure and mobile side to side, but not in the vertical axis of the limb (3). Hoffman-Tinel sign, which consists in an induced pain or paresthesia through percussion, is often associated with schwannomas, varying in sensitivity and specificity depending on the extent of compression of the nerve of origin. In reason of the low incidence and the often late onset of symptoms, it is not uncommon to see diagnostic delays of several months, in which patients are unsuccessfully treated with analgesics in the absence of a correct diagnosis (6).

Once anamnestic and clinical findings suggest the presence of schwannoma, accurate imaging investigations are mandatory to get a better comprehension of the nature of the disease. Radiographs can be performed to rule out any bony involvement or abnormalities, but MRI remains the radiological investigation of choice to confirm the presence of a schwannoma and to identify its nerve of origin (7). MRI generally shows a well-circumscribed and encapsulated mass with a heterogeneous signal and little or no surrounding edema. However, although MRI play an important role in presumptive diagnosis, definitive diagnosis can only be made after histological examination.

Once diagnosis is established, surgical treatment is the only available approach to remove the neoplastic mass. On the surgical field, schwannomas macroscopically appear as homogeneous ovoidal masses, with a well-defined capsule that separates them from the surrounding tissues and the native nerve. Surgeons are called to remove the whole tumor in order to minimize the risk of local recurrence, but should simultaneously be conservative on the surrounding healthy tissues.

The extreme rarity of schwannomas arising from the Tibial Nerve caused a severe limitation of studies about the topic in literature. The few studies available at the moment rarely focus on clinical presentation, prognostic factors or pre-operative and post-operative functionality (6, 8-12). In this paper we report our experience in surgical treatment of Tibial Nerve schwannomas, evaluating tumours' dimensions alongside with cases' diagnostic timing, symptoms, and overall lower limb functionality. The aim of our study is to provide a

first careful examination of the impact the disease had on the patient before and after treatment. We evaluated the impact of supposed prognostic factors such as tumor size and diagnostic delay in order to assess their effect on clinical presentation. In parallel we carefully examined symptoms and their effects on patients' functionality and their activities of daily living. We compared pre-operative presentation and post-operative outcomes to better comprehend the entity of functional impairment caused by tibial nerve schwannomas and estimate the effectiveness of surgical treatment.

Materials and Methods

This single-center retrospective study was approved by our local ethics committee and performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. All patients gave their written consent. Our study consisted of a review of all the patients who were diagnosed and treated surgically for schwannoma of the tibial nerve in our institution between June 2016 and June 2020.

For each patient we collected data regarding their age, gender, first symptom associated with the disease and its date, alongside with the date in which schwannoma was diagnosed. We reviewed the date and the type of surgery performed. Pre-operative and post-operative functional status of our patients was assessed with both the Lower Extremity Functional Scale (LEFS) score and the Musculoskeletal Tumor Society (MSTS) score respectively at the moment of hospitalization before surgery and at their latest follow up. Muscular strength was evaluated before and after surgery and was classified according to the Medical Research Council (MRC) scale for muscle strength (13-15). In parallel, Tinel test and a careful examination of the deep and cutaneous sensitivity in the areas innervated by the tibial nerve were performed to every patient with suspect of neurinoma before their intervention and were repeated at patient's latest follow-up (16). For each patient pre-operative MRI was taken and used to orientate the diagnosis, aid surgical planning and estimate the tumor size. Each neoplasm resected underwent histological examination by a

pathologist to confirm the diagnosis of schwannoma. Postoperative follow-up consisted of serial office visits, clinical evaluations and post-operative MRIs. Cases were routinely visited 1, 3 and 9 months after surgery, while subsequent visits were scheduled depending on the needs of every single individual. During clinical examinations we evaluated the sensitivity of the cutaneous areas as well as the strength of the muscle groups innervated by the tibial nerve. Pressure was exerted on the area where the schwannoma was resected in order to assess the presence of the Tinel sign. LEFS and MSTS scores were calculated according to the combination of data observed and reported by the patient.

Each complication with grade II or higher according to the Clavien – Dindo Classification was recorded (17).

Statistics. Statistical analysis was performed using Stata SE 13 (StataCorp LLC, College Station, TX). Statistical significance was set at 0.05 for all endpoints.

Results

7 patients underwent surgery to treat schwannomas of the tibial nerve in our institution between June 2016 and June 2020. They were 4 females (57.1%) and 3 males (42.9%), with a mean age at surgery of 52.7 (35–75) years. None of our cases had an accidental diagnosis, since every case was brought to medical attentions by the onset of symptoms attributable to the disease. The first symptom referred was paresthesia in 5 cases (71.4%) and a palpable tumefaction in the posterior leg in 2 cases (28.6%). On average, diagnosis

was made 8 (3–15) months after the onset of the first symptom.

According to pre-operative MRI images, the mean tumor dimension considering its major diameter, was 29.3 (21–35) mm. Before surgery, each of our 7 patients developed paresthesia: its entity was mild in 1 case (14.3%), moderate in 3 (42.9%) and severe in the remaining 3 (42.9%). The Hoffman – Tinel sign was strongly positive in all the 7 patients (100%).

Pre-operative muscular strength of the deep and superficial muscular compartments of the leg was evaluated and classified according to the MRC scoring scale. The mean pre-operative MRC score was 4.4 (4–5), with 4 of our 7 cases (57.1%) that suffered slight reduction of muscular strength (score 4, see Tab. 1).

Overall pre-operative functionality was assessed using the MSTS Score for lower limbs and the LEFS score, whose mean values were respectively 24.4 (20–27) and 64.7 (46–71) (Tab. 1).

All our cases underwent complete excision of the neoplasm by enucleation (Fig. 1). None suffered from major complications during surgery or in the immediate post-operative period. All of our patients were treated with oral integration of lipoic acid, citicoline and vitamins B for 30 days after surgery in order to obtain an antioxidant, neurotrophic and neuroprotective effect.

The mean follow-up was 22.9 (9–57) months. None of our cases developed major complications (grade II or higher according to the Clavien – Dindo classification) through the post-operative course. One patient (14.3%) (case 4) was diagnosed a local recurrence 45 months after the intervention due to the return of mild paresthesia and positive Hoffman-Tinel

Table 1. Pre-operative picture of our case series

N	Age (y)	Site	Diagn. Delay (m)	Size (mm)	First Symptom	PreOp Tinel	PreOp Sensitiv E Deficit	PreOp MRC	PreOp MSTS	PreOp LEFS
1	50	Tibial N.	7	30	Paraesthesia	+	Moderate	4	26	71
2	48	Tibial N.	9	29	Tumefaction	+	Mild	5	27	70
3	75	Tibial N.	5	23	Tumefaction	+	Severe	5	26	67
4	46	Tibial N.	3	21	Paraesthesia	+	Moderate	5	27	71
5	44	Tibial N.	15	35	Paraesthesia	+	Severe	4	20	46
6	35	Tibial N.	8	34	Paraesthesia	+	Severe	4	22	63
7	71	Tibial N.	9	33	Paraesthesia	+	Moderate	4	23	65

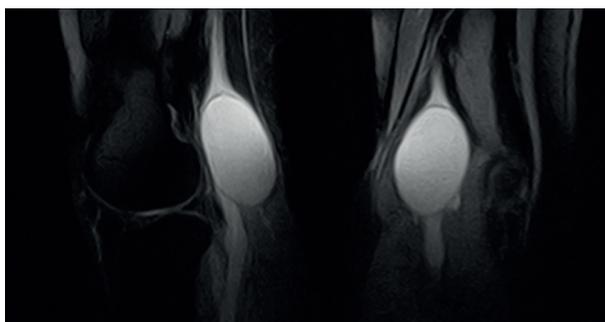


Figure 1. Pre-operative MRI showing size and location of the tibial nerve schwannoma (in white).

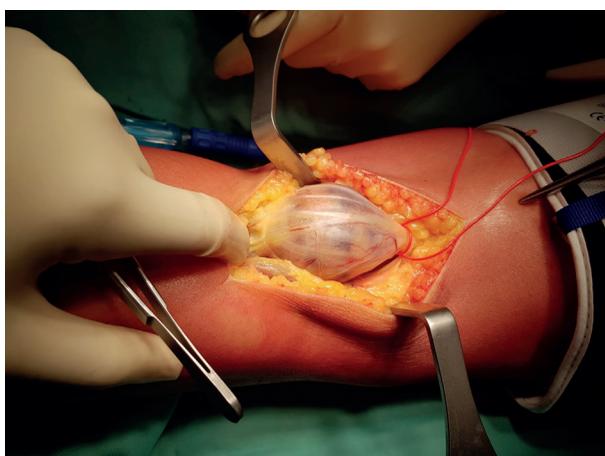


Figure 2. Intra-operative view of a schwannoma that arises from tibial nerve.

test after a long period of apparent good health. The other cases did not show any clinical or imaging sign of local disease after surgery. Apart for the patient who had local recurrence, the other 6 (85.7%) did

not complain of paresthesia through their whole post-operative course. 3 of them (42.9%) reported episodes of paresthesia in the weeks that followed surgery, but these episodic symptoms solved spontaneously within 5 weeks. At the last follow-up, Hoffman-Tinel sign was present only in case 4 (14.3%). Compared to the pre-operative findings, each patient reported a reduction of their sensitive symptoms after the intervention.

Post-operative muscular strength was completely restored in each patient. Hence, the MRC score was therefore 5/5 in all the cases (100%); the mean value therefore improved by 0.6 compared to the one recorded pre-operatively.

At the latest follow-up each patient's MSTS score was 29.7 (28-30), a value 5.3 (1-10) higher than the mean pre-operative score. The mean post-operative LEFS score was 78.6 (74-80), 13.9 (3-33) higher than the one reported before surgery. Both scores testified an at least slight increase of each patient's lower limb functionality.

Clinical and functional results of our population are summarized in Table 2.

Statistical analysis defined a significant positive correlation between diagnostic delay and tumor size at the moment of procedure ($r=0.834$; $p=0.020$). Neoplastic mass dimension, for its part, had a statistically significant negative correlation with patients' pre-operative MSTS scores ($r=-0.809$; $p=0.028$). Although the correlation between pre-operative diameter and LEFS scores was also strongly negative ($r=-0.617$), our limited number of cases did not allow sufficient statistical significance ($p=0.140$).

Table 2. Comparison between pre-operative conditions and post-operative outcomes.

N	PreOp TINEL	PreOp Sensitive Deficit	PreOp MRC	PreOp MSTS	PreOp LEFS	Post Op TINEL	PostOp Sensitive Deficit	Post Op MRC	Post Op MSTS	Post Op LEFS	Compl.	Loc. Rec.	FU (m)
1	+	Moderate	4	26	71	-	None	5	30	80	None	None	57
2	+	Mild	5	27	70	-	None	5	30	80	None	None	36
3	+	Severe	5	26	67	-	None	5	30	80	None	None	16
4	+	Moderate	5	27	71	+	Mild	5	28	74	None	Yes	26
5	+	Severe	4	20	46	-	None	5	30	79	None	None	9
6	+	Severe	4	22	63	-	None	5	30	80	None	None	12
7	+	Moderate	4	23	65	-	None	5	30	77	None	None	14

Com.= Complications, Loc. Rec.= Local Recurrence

Tumor size also showed a positive correlation with post-operative functional recovery assessed with the differential MSTS score ($r=0.870$; $p=0.011$). A similar association was found with post-operative functional recovery evaluated with the differential LEFS score ($r=0.681$), although statistical analysis could not establish a sufficient statistical correlation ($p=0.092$). The differential between pre-operative and post-operative MSTS and LEFS scores also had a statistically significant positive correlation with patients' diagnostic delay (respectively $r=0.825$; $p=0.022$ and $r=0.884$; $p=0.008$).

Surgery significantly decreased the prevalence of Hoffmann-Tinel test ($p=0.005$).

Discussion

Schwannomas arising from the tibial nerves are extremely rare and poorly described in literature.

Despite their low incidence, in the majority of cases the presence of these benign lesions could be recognized with a careful clinical evaluation. In patients with suspect of tibial nerve schwannoma due to a nodule of new onset, peripheral nerve deficits or a combination of the two, examiners should carry out the evocation of the Hoffman-Tinel sign that provides a first clinical orientation in differential diagnosis (18). In our experience, each case presented a strong pre-operative positivity to the Hoffman-Tinel test, confirming it as a high sensitivity sign as already testified in literature (3).

A quick recognition of this and other typical signs of the disease is essential to shorten the time of the diagnostic process. In our population delay between the onset of symptoms and the definite diagnosis in particular was significantly associated with tumor size. This suggests that an early diagnosis could be crucial to prevent excessive volume increase and thereby the worsening of clinical presentation. In fact, our data also corroborate the hypothesis that the size of schwannomas negatively affects patients' pre-operative lower limb functionality, since large tumor masses represent a serious threat to patients' functionality and quality of life.

Once diagnosis is established, surgical approach represents the main therapeutic option for tibial nerve schwannomas. Surgery may consist of excision or intracapsular enucleation of the lesion after incision of

the epineurium. Although the total excision reasonably seems a better strategy to avoid possible recurrence, considering the benign behavior of Schwannomas and their globally low recurrence rate (11, 19). In our surgical experience we found intracapsular enucleation to be a safe and a reliable procedure, which allows to spare the parent nerve and preserve the neurological function. Reliability was testified in particular by the fact that no case of major local complications occurred to our patients. Furthermore, only one of our cases had local recurrence in a relatively long follow-up, confirming the low incidence already described in literature (3).

Surgery represents the key to reduce and potentially solve symptoms and functional impairment caused by tibial nerve schwannomas. This is supposed to be particularly true for larger tumors and when compressive symptoms occur, such as sensitive and/or strength deficiency. In fact, our patients with larger tumors were the ones that benefited the most from surgical treatment, although a slight to marked decrease of pre-operative symptoms was recorded as a general trend in our population. A further point of reflection lies in the fact that functional recovery was more evident in those patients who had late diagnosis, as thought to point out that an adequate surgical intervention could at least partially compensate delays in the diagnostic phase.

Overall, all of our patients showed symptoms relief and good functional outcomes after surgery, with improvements in both MSTS and LEFS scores, sensitivity and muscular strength.

We acknowledge our study had some limitations. The rarity of these tumors did not allow us to operate on wider populations, which partially limited the statistical significance of some of the data associations we wanted to investigate at the beginning of our research. Another limitation is represented by the retrospective nature of our study, which did not allow the complete standardization of the post-operative follow-up procedures for each patient.

Our results, although obtained with a small population, do not find matchings in literature, because of the rarity of tibial nerve schwannomas and the consequential paucity of studies on this topic. Previous studies gave little or no attention to the lower limb functionality of patients affected by this disease; our

results may therefore represent a first attempt to focus not only on anatomical, pathological and surgical aspects, but also on the effects that the tumor and its treatment cause to patients' everyday life.

In conclusion, even if further studies with larger populations are necessary, our results suggest that early diagnosis could play an important role in minimizing clinical presentation in schwannomas of the tibial nerve. Surgical enucleation with careful dissection from the tibial nerve of origin, for its part, should be considered a reliable and safe treatment, in light of the good post-operative reduction of symptoms and functional restoration.

Conflicts of interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

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