folia medica

Folia Medica 66(5):618-628
DOI: 10.3897/folmed.66.e135490

Original Article

Schwannomas of the Upper Limb: Clinical Presentation, Preoperative Management and Outcomes of Surgical Treatment

Edoardo Ipponi[1], Elena Bechini[1], Martina Cordoni[1], Fabrizia Gentili[1], Francesco Rosario Campo[1], Fabio Cosseddu[1], Antonio D'Arienzo[1], Paolo Domenico Parchi[1], Lorenzo Andreani[1]

[1] *Department of Orthopedics and Trauma Surgery, University of Pisa, Pisa, Italy*

Corresponding author: Edoardo Ipponi, Department of Orthopedics and Trauma Surgery, University of Pisa, Pisa, Italy; Email: edward.ippo@gmail.com

Received: 25 August 2024 ♦ **Accepted:** 7 October 2024 ♦ **Published:** 31 October 2024

Citation: Ipponi E, Bechini E, Cordoni M, Gentili F, Campo FR, Cosseddu F, D'Arienzo A, Parchi PD, Andreani L. Schwannomas of the upper limb: Clinical presentation, preoperative management and outcomes of surgical treatment. Folia Med (Plovdiv) 2024;66(5):618-628. doi: 10.3897/folmed.66.e135490.

Abstract

Inroduction: Schwannomas are the most common tumors of the peripheral nervous system. Surgical eradication with excision or enucleation is the treatment for symptomatic and large schwannomas.

Aim: Few studies have investigated the clinical outcomes related to the surgical approach to schwannomas. Our study aims to evaluate the clinical and functional results of surgery for the treatment of upper limb schwannomas.

Materials and methods: Twenty-two cases of upper limb schwannomas were surgically treated in our institution between January 2016 and December 2023. All cases underwent preoperative and 6-month postoperative MRI. For each case, we recorded the diagnostic interval (symptom-diagnosis), symptoms (stenosis or sensory deficits, pain, and Tinel test), and both pre-and postoperative functional status (with DASH and MSTS scores). We also recorded complications and local recurrences.

Results: On average, the diagnosis was made 16.7 months after the onset of the first symptom. The mean preoperative MSTS, DASH, and MRC values were 27.9, 5.7, and 4.8, respectively. We had no intra-operative complications. After a mean follow-up of 43.1 months, MSTS, DASH were 29.7/30 and 0.7, respectively. No case developed local recurrences. No case recorded stenosis deficits at the last follow-up. Only one patient developed local paresthesia (9%), while two reported modest dysesthesias.

Conclusions: An adequate surgical approach, possibly preceded by a rapid diagnosis, can significantly improve the symptoms caused by schwannoma, restoring the functionality of the upper limb.

Keywords

deficit, enucleation, functionality, resection, review

INTRODUCTION

The schwannomas, also known as neurilemmomas or neurinomas, are the most common benign soft tissue neoplasms that originate from the peripheral nerve sheath.[1] The most common localizations are head and neck, while the incidence of cases involving upper and lower limbs is significantly lower.[1,2] These tumors often present as slow growing lone masses, and malignant degeneration into neurofibrosarcomas or malignant schwannomas is sporadic, occurring in less than 1% of all schwannomas.[2] Although neurinomas can stay clinically silent, symp-

Copyright by authors. This is an open access article distributed under the terms of the Creative Commons Attribution License (CC-BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

toms may appear and worsen as the tumor volume increases, compressing the native nerve and of the adjacent structures. Eventual clinical manifestations may consist of various combinations of pain, swelling, and alteration of neuromotor or sensitive neurological functionality.[2-4] The Hoffman-Tinel sign, consisting in an induced pain or paresthesia through percussion, is also typically associated with schwannomas.[2-6]

Once anamnestic and clinical findings suggest schwannoma, imaging evidence is necessary to investigate the lesion further. Although ultrasound evaluations can be useful and easy to perform, MRI remains the radiological investigation of choice to identify its nerve of origin and further orient toward the presumptive diagnosis of schwannoma that usually appears as a well-circumscribed and encapsulated mass, a heterogeneous signal.[7]

Once the presumptive diagnosis has been established, surgical treatment is the only available approach to remove the neoplastic mass. Surgeons are called to remove schwannomas as a whole to minimize the risk of local recurrence and preserve the continuity of the involved nerve, especially in the case of major nervous structures. For this reason, the operative treatment of choice is the enucleation of the neoplastic mass when it involves a major nerve or complete resection when the nerve is too thin to be preserved. The enucleation consists of a linear cut of the perineurium and a smooth dissection of the neoplastic mass from the nearby nervous bundles, that should be spared in order to preserve the nerve's post-operative functionality.[8]

Due to the rarity of schwannomas arising from the upper limb, only a few studies available at the moment focus on clinical presentation and prognostic factors.[2-6,8-18] and evaluate the impact of schwannomas and their treatment on patient's upper limb functionality.[19]

AIM

This study evaluates the clinical impact of upper limb schwannomas, focusing on patients' functionality. We also assessed the effectiveness of the surgical approach in reducing patients' symptoms, restoring patients' upper limbs' performance, and increasing their quality of life.

MATERIALS AND METHODS

This single-center retrospective study was conducted according to the ethical standards in the 1964 Declaration of Helsinki and its later amendments.

Our study consisted of a review of all schwannomas arising from the major nerves of the upper limb and treated with surgery in our institution between January 2016 and January 2024.

For each patient, we collected data regarding their age, gender, first symptom associated with the disease, and its date, alongside the date on which schwannoma was diagnosed. We reviewed the tumor's localization in terms of the anatomical segment involved (shoulder, arm, elbow, forearm, wrist, or hand) and the nerve from which the neoplasm originated. The diagnostic interval, corresponding to the time between the onset of the first symptom and the definitive histological diagnosis, was recorded for each patient.

Our patients' pre-operative functional status was evaluated using the Disability of Arm, Shoulder, and Hand (DASH) score and the Musculoskeletal Tumor Society (MSTS) score at the moment of hospitalization. Before surgery, the Medical Research Council (MRC) scale was used to assess the contractile strength of the muscular segments of the treated area, paying particular attention to those innervated by the involved nerve. In parallel, a Tinel-Hoffmann test and a careful examination of the deep and cutaneous sensitivity were practiced on every patient suspected of neurinoma before their intervention.

Each patient underwent a pre-operative MRI (**Fig. 1**), which was used to orientate the diagnosis, guide the surgical planning, and estimate the tumor size.

In the surgical theater, before the surgical incision, lesions were localized under ultrasound guidance, in order to orientate the surgical approach to the tumor. Intra-operatively, the involved nerves were identified and isolated, and schwannomas were carefully enucleated, preserving the continuity of the involved nerves **(Fig. 2).**

Surgical specimens **(Fig. 3)** were examined by our pathologists to confirm the diagnosis of schwannoma using routine histology, histochemistry, and immunohistochemistry techniques.

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.

Postoperative follow-up consisted of serial office visits, clinical evaluations, and postoperative MRIs performed within one month (clinical evaluation only) and later 6 and 12 months after surgery. Further evaluations were scheduled depending on the necessities of each single case.

Each complication with a grade II or higher, according to the Clavien-Dindo classification, was reported. Local recurrences and their eventual treatments were also recorded.

At each patient's latest follow-up, we evaluated the presence of sensitive deficits, repeated the Tinel test, and assessed muscular strength according to the MRC scoring scale. We also recalculated the overall functional status of the treated upper limbs using the MSTS and the DASH score.

Statistical analysis

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

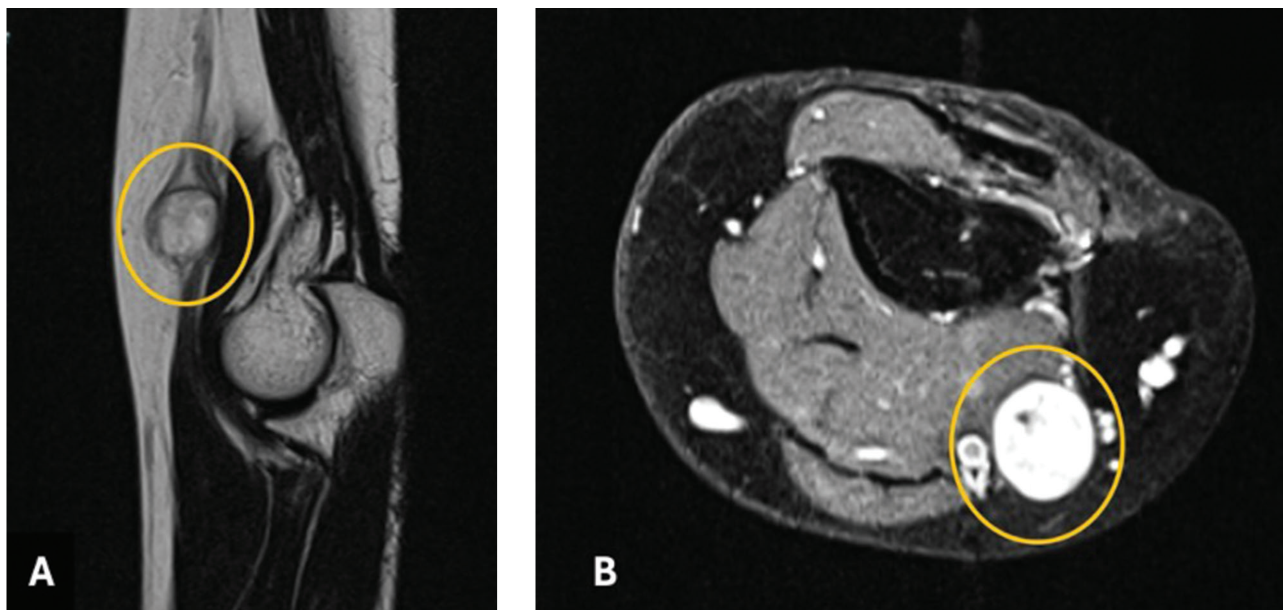

Figure 1. A schwannoma arising from the median nerve, in the anterior elbow. The neoplasm was circled both in a sagittal T1 scan **(A)** and in a transverse T2 scan **(B)**.

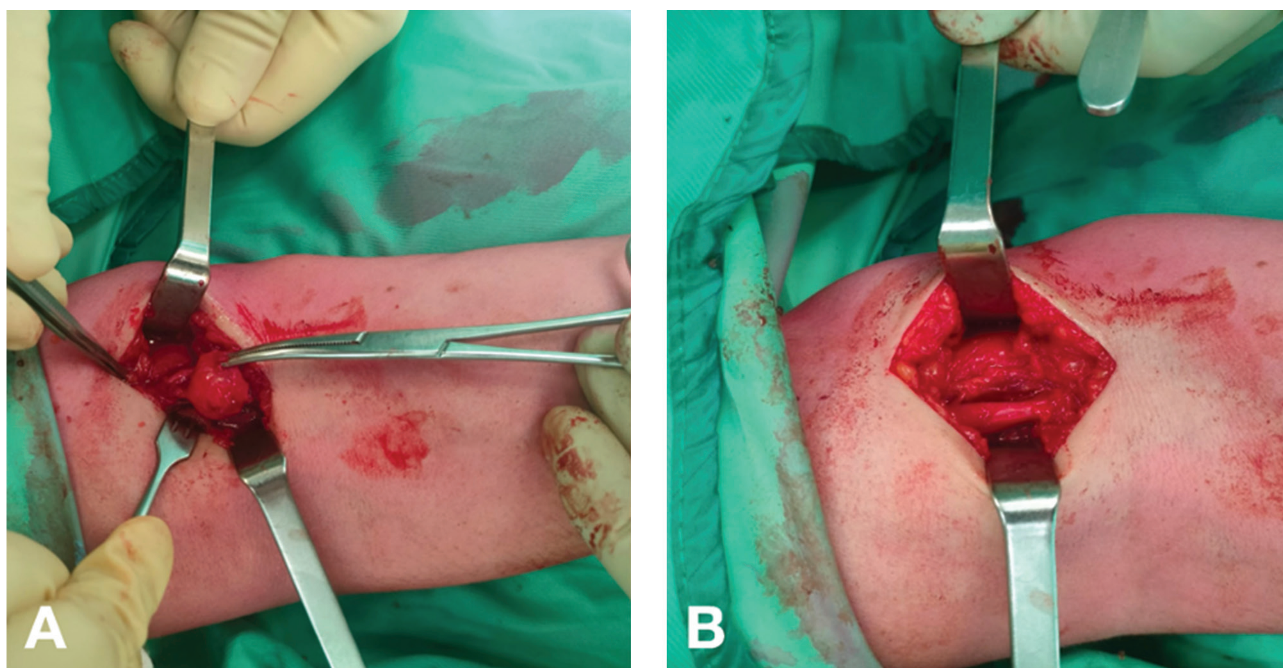

Figure 2. A schwannoma arose from the median nerve, localized in the distal anterior end of the arm. The neoplasm was exposed **(A)** and later enucleated, preserving the anatomical continuity of the nerve itself **(B)**.

RESULTS

Twenty-two consecutive cases of schwannomas of the upper limbs were treated in our institution between January 2016 and December 2023. Our cohort included 11 females and as many males, with a mean age of 54.0 (38–78) at surgery.

Two cases (9%) had their lesion localized in the shoulder girdles, 6 (27%) in their arms and 5 (23%) in their elbows. The forearm was the location of 7 (32%) schwannomas, whereas the remaining two cases were diagnosed with schwannomas in their wrist and hand (9%). The most common nerve of origin for treated schwannomas was the radial nerve (10; 45%), followed by the ulnar (4; 18%) and the median nerve (3; 14%). In the remaining cases, schwannomas arose from the brachial plexus (2; 9%), the musculocutaneous nerve (2; 9%), and the anterior interosseous nerve (1; 5%). A summary of schwannomas' localization is provided in **Fig. 4**.

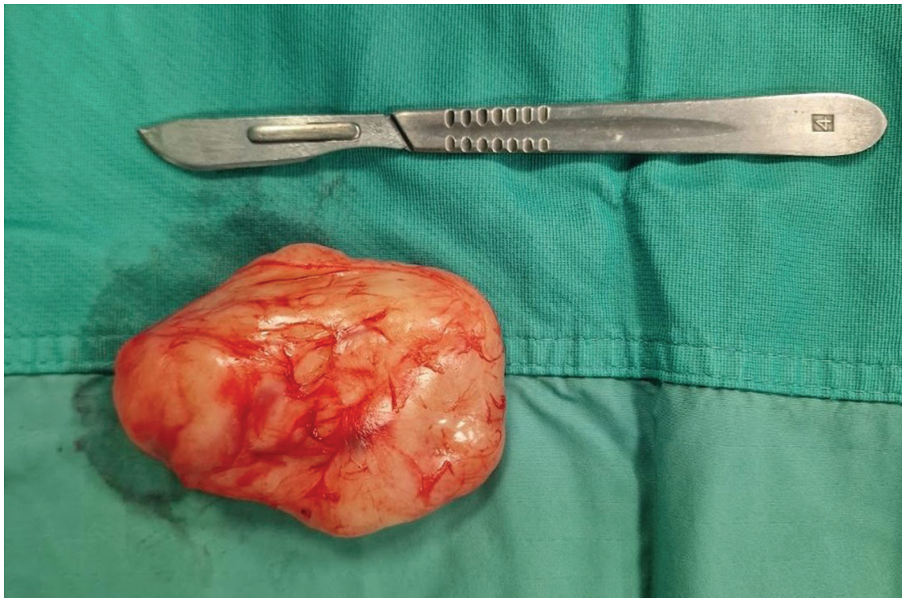

Figure 3. A schwannoma with a larger diameter of 7 cm, put in comparison with a surgical scalpel.

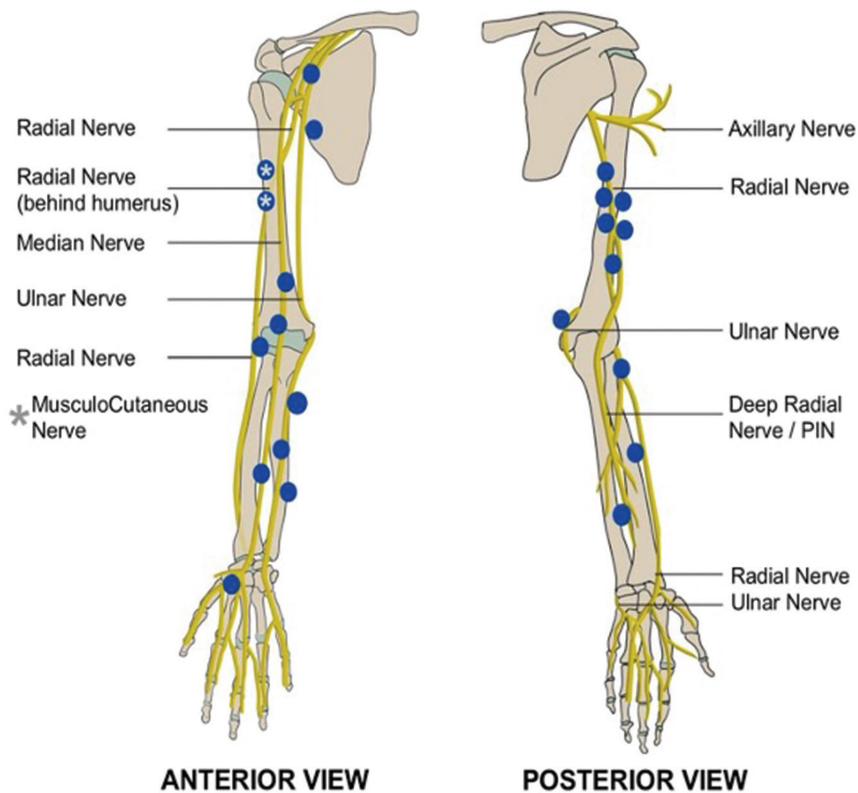

Figure 4. Visual resume of the localization of the schwannomas included in our study.

Only one of our cases (4%) had an incidental diagnosis without any sign attributable to the disease. The remaining 21 cases (96%) were brought to medical attention by the onset of symptoms attributable to the disease. The first symptom was palpable swelling in 19 cases (86%) and pain in the remaining 2 cases (10%). On average, the diagnosis was established 16.7 months after the onset of the first symptom. Eleven cases (50%) had a positive Tinel sign at the moment of patients' hospitalization. According to a two-tailed T Student test, presence or absence of the Tinel sign did not represent a factor that influenced the diagnostic interval. The mean pre-operative MRC score was 4.8 (4-5), as five patients (23%) experienced a mild reduction in their muscular strength. Before surgery, 13 cases (59%) had

Folia Medica

developed dysesthesia or paresthesia; symptoms were mild in 10 (45%) and moderate in 3 cases (14%). The remaining nine patients (41%) did not complain of any sensitive deficit.

The overall functionality of our patients' upper limbs was calculated using the MSTS and DASH scores before surgery. The mean pre-operative MSTS score was 27.9 (21-30), and the mean pre-operative DASH score was 5.7 (0-25).

The size of the neoplasms was assessed using the MRI scans and later confirmed on surgical specimens: the mean larger diameter was 3.8 cm (1.5–11.0). A Pearson correlation test stated that the larger the schwannomas were, the lower the MSTS score and the higher the DASH score was before surgery (p=0.0001).

Intra-operatively, surgeons could successfully enucleate all the treated schwannomas, preserving the continuity of all nerves. Histological evaluations confirmed the diagnosis of Schwannoma in each case.

None of our cases had major intra-operative or peri-operative complications.

The mean post-operative follow-up was 43.1 (6-92). Only one patient (Case 14) complained of increased sensitive deficits after surgery, passing from mild to moderate paresthesia and experiencing hand tingling that was not present before surgery. The sensitivity deficits of all the remaining cases with pre-operative deficits were reduced after surgical treatment, and only two patients (9%) had dysesthesia at their latest follow-up. According to a Fisher Exact test, the rate of sensitive deficits was significantly lower after surgery compared to the pre-operative records (p=0.0011).

No Tinel sign was recorded after surgery. Case 14 was also the only one to maintain a slight muscular strength impairment (MRC 4); the MRC score of the remaining cases was as high as 5.

The mean post-operative MSTS score was 29.7 (24-30). The difference between this value and the pre-operative one was statistically significant, as testified by a Pearson correlation test (p=0.0022).

The mean post-operative DASH score was 0.7 (0-16). According to a Pearson correlation test (p=0.0029), this value was significantly lower than the one recorded before surgery.

None of our cases was diagnosed with a local recurrence through their post-operative intercourse.

The characteristics of our cohort are summarized in **Table 1**.

DISCUSSION

The clinical presentation of the schwannomas of the upper limb can include a large variety of signs and symptoms. Correctly evaluating signs and symptoms attributable to the disease is crucial to starting a proper diagnostic pathway and minimizing the risk of misdiagnosis. Although the number of studies in the literature on this topic is slowly but progressively increasing[2-6,8-19], the distance between the onset of the first symptom and the establishment of a histological diagnosis still represents one of the main issues in clinical practice. The diagnostic interval in our population amounted to 16.6 months, aligning with the most recent studies published in the third decade of the 21st century (12-30) **(Table 2)**.[4,8-11,19] Several other studies dating back to the dawn of the new millennium reported diagnostic delays even longer than 40 months[6,12,13], testifying to the difficulty of obtaining an early diagnosis in upper limb schwannomas. Although the improvements in imaging technologies and an ever more profound knowledge of soft tissue tumors show promise of more straightforward and earlier diagnoses in the future, a better comprehension of signs and symptoms is still crucial in today's approach to upper limb schwannomas. As other authors had already experienced, the most frequent outbreak symptom in our cases was localized swelling.[2,12,14,15] This tendency differs from peripheral lower limb schwannomas, where paresthesia and neurological deficits often anticipate a palpable swelling.[20,21] This difference could be attributable to the fewer subcutis and muscular masses in the upper limb that unveil the schwannomas before it would have happened in the more muscular and hypoderma-rich lower limb. Although not prominent outbreak symptoms, sensitive deficits were documented in most of our cases (59%) during their hospitalization. Our data fall in between a highly heterogeneous and broad spectrum in literature. Some authors, such as Takase et al.[6], Sawada et al.[12], and Knight et al.[2], reported a prevalence of sensitive symptoms or muscular weakness lower than 30%. In particular, Knight et al.[2] carefully evaluated the pre-operative clinical picture in 170 upper limb schwannomas, highlighting a rate of sensory alterations of 4.5% and a rate of muscular weakness as low as 1.6%.

On the other hand, Gosk et al.[5], El Sayed et al.[10], and Istefan et al.[11] had neurological deficit rates higher than 80% in their cohorts. Beyond the variations in prevalence, most authors agreed that neurological symptoms generally present as mild or moderate.[3,4,11,16] Our casuistry confirms this tendency, as none of our cases complained of sensitive or motor deficits of significant entities.

The Tinel sign still represents one of the most iconic and broadly used tests for the clinical assessment of neurinomas. Although our prevalence of 50% ranks among the lowest reported in modern literature for relatively large cohorts (33-100%).[2-6,8-10,12,14-18], it still corroborates the use of the test in everyday clinical practice, considering it is quick, easy to perform, and does not require specific instrumentation.

While several authors described the frequency of single symptoms, modern literature severely lacks evidence about the global impact of schwannomas on upper limb functionality. Few studies have provided evidence based on widely used scoring systems, such as the DASH or MSTS scores. Raj et al.[19] used the DASH score to assess the functional performances of 24 upper limbs treated with surgical resec-

Table 1. A schematic summarization of all the cases included in our cohort.

N	Sex	Age yrs	D.I. mos	Site	Nerve	Size cm	First sign	MSTS Pre	DASH Pre	Tinel sign Pre	MRC Pre	Sens. Deficit Pre	MSTS Post	DASH Post	Tinel sign Post	MRC Post	Sens. Deficit Post	L.R.	FU mos
1	F	58	3	Shoulder	Brachial plexus	5.0	Swelling	27	7	No	5	Mild	30	0	No	5	None	No	81
2	F	38	3	Shoulder	Brachial plexus	7.0	Swelling	21	25	No	4	Moderate	29	0	No	5	Mild	No	6
3	M	77	36	Arm	Musculocutaneous	5.5	Swelling	27	7	Yes	4	Mild	30	0	No	5	None	No	87
4	F	65	18	Arm	Musculocutaneous	2.0	Swelling	30	0	Yes	5	None	30	0	No	5	None	No	7
5	F	51	28	Arm	Radial	5.8	Swelling	27	9	Yes	4	Mild	30	0	No	5	None	No	59
6	M	56	-	Arm	Radial	4.5	None	30	0	No	5	None	30	0	No	5	None	No	48
7	M	65	24	Arm	Radial	2.0	Swelling	30	0	No	5	None	30	0	No	5	None	No	43
8	F	54	36	Arm	Radial	4.0	Swelling	28	7	Yes	5	Mild	30	0	No	5	None	No	37
9	M	60	24	Elbow	Anterior interos-seous	2.0	Swelling	30	0	Yes	5	None	30	0	No	5	None	No	18
10	F	48	24	Elbow	Radial	1.5	Swelling	28	9	Yes	5	Mild	30	0	No	5	None	No	36
11	M	41	18	Elbow	Radial	3.0	Swelling	29	0	No	5	None	30	0	No	5	None	No	30
12	F	45	24	Elbow	Radial	5.0	Swelling	28	2	Yes	5	Mild	30	0	No	5	None	No	21
13	M	59	12	Elbow	Ulnar	1.7	Swelling	30	0	No	5	None	30	0	No	5	None	No	75
14	F	40	6	Forearm	Median	1.5	Swelling	26	14	No	4	Mild	24	16	No	4	Mod-erate	No	27
15	F	59	3	Forearm	Median	1.8	Swelling	26	16	Yes	5	Mild	30	0	No	5	None	No	12
16	F	57	24	Forearm	Radial	4.6	Pain	27	9	Yes	5	Moderate	30	0	No	5	None	No	15
17	M	63	3	Forearm	Radial (superficial)	3.0	Pain	28	2	Yes	5	Mild	30	0	No	5	None	No	18
18	M	45	18	Forearm	Ulnar	1.3	Swelling	30	0	No	5	None	30	0	No	5	None	No	62
19	M	30	12	Forearm	Ulnar	11.0	Swelling	30	0	No	5	None	30	0	No	5	None	No	50
20	F	48	22	Forearm	Ulnar	6.5	Swelling	29	4	No	5	None	30	0	No	5	None	No	32
21	M	78	6	Wrist	Radial (superficial)	3.5	Swelling	28	4	No	5	Mild	30	0	No	5	None	No	92
22	M	41	6	Hand	Median	2.0	Swelling	26	11	Yes	4	Moderate	30	0	No	5	None	No	92

D.I.: diagnostic interval; L.R.: local recurrence; FU: follow-up; mos: months

Table 2. Resume of modern literature about curettage for hand enchondromas. The reported articles are the result of a combined research on the catalogs of PubMed, Scopus and Google scholar, searching for the words “upper limb” or “shoulder” or “arm” or “elbow” or “forearm” or “wrist” or “hand” and “schwannoma”. Only studies published and indexed between 2000 and March 2024 were included in our list. Case reports were excluded.

Article	Year	N	Sites	Nerves	Size cm	Diagn. Interval mos	(Pre) Tinel	(Pre) Pain	(Pre) Deficit	(Pre) MSTS	(Pre) DASH	(Post) Tinel	(Pos) Pain	(Post) Deficit	(Post) MSTS	(Post) DASH	Local Recurr.	FU mos
Maiuri et al.[16]	2001	4	4 Shoulder	4 Brachial Pl.	4.5	8.7	-	50%	25%	-	-	-	0	0	-	-	0	65.1
Takase et al.[6]	2004	20	1 Shoulder 5 Arm 9 Forearm 4 Wrist 1 Hand	4 Ulnar 7 Median 4 Radial 4 Other	1.0–5.5	43.1	80%	30%	20%	-	-	-	-	10%	-	-	-	42.0
Ozdemir et al.[17]	2005	14	4 Wrist 10 Hand	4 Ulnar 10 Median	0.5–7.0	25.0	71%	29%	50%	-	-	0	-	7.1%	-	-	0	151.2
Sawada et al.[12]	2006	13	3 Shoulder 3 Arm 4 Elbow 1 Forearm 2 Wrist 12 Hand	3 Brachial Pl. 2 Ulnar 4 Median 3 Radial 1 Other	2.9	48.0	61%	33%	22%	-	-	-	-	33%	-	-	0	11.3
Knight et al.[2]	2007	170	-	94 Brachial Pl. 35 Ulnar 16 Median 14 Radial 1 Musculocut. 10 Other	3.4	-	81%	31%	6%	-	-	-	2.5%	3%	-	-	1%	12 - 240
Tang et al.[3]	2013	8	2 Shoulder 1 Forearm 3 Wrist 2 Hand	1 Brachial Pl. 3 Ulnar 2 Median 1 Radial 1 Other		-	88%	-	-	-	-	-	-	-	-	-	-	-
Lai et al.[13]	2013	12	1 Shoulder 2 Arm 2 Forearm 3 Wrist 4 Hand	3 Ulnar 9 Median 1 Other	4.4	57	-	-	-	-	-	-	-	36%	-	-	0	21.9
Lee et al.[14]	2014	7	-	2 Brachial Plexus 3 Median 2 Radial	3.0	-	43%	14%	43%	-	-	-	0	27%	-	-	0	37.2

Gosk et al.[5]	2014	32	6 Shoulder 7 Arm 3 Elbow 5 Forearm 4 Wrist 6 Hand	11 Ulnar 5 Median 7 Radial 2 Musculocut. 7 Other	1.0–18.0	-	92%	77%	77%	-	-	8%	0	23%	-	-	0	12+
Adani et al.[18]	2014	34	7 Arm 14 Elbow and Forearm 13 Wrist and Hand	15 Ulnar 9 Median 2 Radial 1 Musculocut. 7 Other		32.0	68%	35%	41%	-	-	-	3%	3%	-	-	0	12
Lee & Yoon[15]	2017	8	Hand	-	3.2	0.5 - 2	12%	50%	-	-	-	-	0	0	-	-	-	-
Galbiatti et al.[8]	2020	14	1 Shoulder 4 Arm 3 Forearm 6 Hand	7 Ulnar 2 Median 3 Radial 1 Musculocut. 1 Other	3.3	-	43%	50%	50%	-	-	-	-	0	-	-	0	-
Zyluk & Owczarska[9]	2021	12	5 Forearm 2 Wrist 5 Hand	2 Ulnar 3 Median 2 Radial 5 Other	-	30	33%	-	-	-	-	-	-	17%	-	-	17%	50.4
El Sayed et al.[10]	2022	63	6 Shoulder 16 Arm 5 Elbow 14 Forearm 10 Wrist 12 Hand	1 Brachial Pl. 15 Ulnar 20 Median 14 Radial 1 Musculocut. 12 Other	1.6	21	55%	50%	80%	-	-	7%	5%	19%	-	-	1%	5
Pertea et al.[4]	2022	17	1 Shoulder 3 Arm 7 Forearm 1 Wrist 5 Hand	7 Ulnar 4 Median 2 Radial 4 Other	0.7–7.5	-	100%	18%	88%	-	-	-	0	0	-	-	0	24
Istefan et al.[11]	2023	30	3 Shoulder 6 Arm 2 Elbow 12 Forearm 7 Hand	10 Ulnar 15 Median 5 Other	1.9	12	-	69%	83%	-	-	-	30%	17%	-	-	3%	3-18
Raj et al.[19]	2024	24	-	4 Axillary 10 Ulnar 7 Median 3 Radial	3.5	15.8	-	72%	31%	-	6.1	-	5.6%	35%	-	6.2	0	69.4
Ipponi et al.		22	2 Shoulder 6 Arm 5 Elbow 7 Forearm 1 Wrist 1 Hand	2 Brachial Pl. 2 Musculocut. 4 Ulnar 4 Median 10 Radial	3.8	16.7	50%	59%	59%	27.9	5.7	0	0	9%	29.7	0.7	0	43.1

tion, obtaining a mean DASH score of 6.1. Our mean DASH score of 5.7 confirms that, although present, the functional impairment attributable to upper limb schwannomas is often limited and generally causes only minor limitations to the ordinary activities of daily living. The same conclusions come from a fair pre-operative MSTS score of 27.9. The lack of overwhelming symptoms and the often-well-preserved functionality could be partially responsible for the relatively long diagnostic interval in upper limb schwannomas.

Surgical resection of the neoplastic mass, performed with careful enucleation from the involved nerve, is a safe procedure, as confirmed by the absence of major intra-operative or peri-operative complications in our cohort.

Its effectiveness, already confirmed by previous studies, was also evidenced in our population by the significant reduction in sensitive symptoms after surgery (p=0.0011). Furthermore, both the MSTS (29.7) and the DASH score (0.7) got significantly better after surgery, marking an almost complete remission of the limitations caused by the disease. This result differs from the findings of Raj et al.[19], who did not experience a significant improvement in patients' functionality after surgery. Our experience suggests that a careful diagnostic and treatment can lead to a total or subtotal remission of most symptoms and signs attributable to schwannomas and successfully restore the functionality of the involved upper limbs.

We acknowledge that our study had some limitations. The rarity of these tumors did not allow us to operate on broader 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.

Despite these limitations, our study provides significant information on the clinical presentation of upper limb schwannomas and the clinical and functional outcomes that follow their treatment with surgical enucleation. To this date, diagnosing the schwannomas of the upper limb may still represent a challenge, especially for those who lack direct experience in this field. However, once a correct diagnosis has been established, surgical resection represents a reliable and effective surgical treatment both to remove the neoplasm and provide symptom relief.

CONCLUSION

The enucleation, performed to preserve the continuity of the nerve, can substantially reduce pre-operative symptoms and restore the upper limb's functionality, allowing patients to return to their previous activities of daily living, thereby increasing their quality of life.

Acknowledgements

The authors have no support to report.

Funding

The authors have no funding to report.

Competing Interests

The authors have declared that no competing interests exist.

REFERENCES

1. Hilton DA, Hanemann CO. Schwannomas and their pathogenesis. Brain Pathol 2014; 24(3):205–20. doi: 10.1111/bpa.12125
2. Knight DM, Birch R, Pringle J. Benign solitary schwannomas: a review of 234 cases. J Bone Joint Surg Br 2007; 89(3):382–7. doi: 10.1302/0301-620X.89B3.18123
3. Tang CY, Fung B, Fok M, et al. Schwannoma in the upper limbs. Biomed Res Int 2013; 2013:167196. doi: 10.1155/2013/167196
4. Pertea M, Filip A, Huzum B, et al. Schwannoma of the upper limb: retrospective study of a rare tumor with uncommon locations. Diagnostics (Basel) 2022; 12(6):1319. doi: 10.3390/diagnostics12061319
5. Gosk J, Gutkowska O, Urban M, et al. Results of surgical treatment of schwannomas arising from extremities. Biomed Res Int 2015; 2015:547926. doi: 10.1155/2015/547926
6. Takase K, Yamamoto K, Imakiire A. Clinical pathology and therapeutic results of neurilemmoma in the upper extremity. J Orthop Surg (Hong Kong) 2004; 12(2):222–5. doi: 10.1177/230949900401200216
7. Kakkar C, Shetty CM, Koteshwara P, et al. Telltale signs of peripheral neurogenic tumors on magnetic resonance imaging. Indian J Radiol Imaging 2015; 25(4):453–8. doi: 10.4103/0971-3026.169447
8. Galbiatti JA, Milhomens GRDS, Bertozzo LG, et al. Retrospective Analysis of 20 patients affected by schwannomas in the upper and lower limbs. Rev Bras Ortop (Sao Paulo) 2020; 55(5):629–36. doi: 10.1055/s-0040-1702962
9. Żyluk A, Owczarska A. Outcomes of surgery for schwannomas of the upper extremity. Pol Przegl Chir 2021; 94(2):49–53. doi: 10.5604/01.3001.0015.5919
10. El Sayed L, Masmejean EH, Lavollé A, et al. Clinical results after surgical resection of benign solitary schwannomas: A review of 150 cases. Orthop Traumatol Surg Res 2022; 108(4):103281. doi: 10.1016/j.otsr.2022.103281
11. Istefan E, Belstock J, Dahlin LB, et al. Surgery of schwannoma in the upper limb - sensitivity and specificity of preoperative magnetic resonance imaging and relation between tumor size and symptoms. BMC Musculoskelet Disord 2023; 24(1):713. doi: 10.1186/s12891-023-06838-4
12. Sawada T, Sano M, Ogihara H, et al. The relationship between pre-operative symptoms, operative findings and postoperative compli-

cations in schwannomas. J Hand Surg Br 2006; 31(6):629–34. doi: 10.1016/j.jhsb.2006.06.008

13. Lai CS, Chen IC, Lan HC, et al. Management of extremity neurilemmomas: clinical series and literature review. Ann Plast Surg 2013; 71 Suppl 1:S37–42. doi: 10.1097/SAP.0000000000000042
14. Lee SJ, Kim Y, Leem D, et al. Ancient schwannoma misdiagnosed as a hemangioma in the ventral tongue. Maxillofac Plast Reconstr Surg 2013; 35:402–7.
15. Lee SJ, Yoon ST. Ultrasonographic and clinical characteristics of schwannoma of the hand. Clin Orthop Surg 2017; 9(1):91–5. doi: 10.4055/cios.2017.9.1.91
16. Maiuri F, Donzelli R, Benvenuti D, et al. Schwannomas of the brachial plexus--diagnostic and surgical problems. Zentralbl Neurochir 2001; 62(3):93–7. doi: 10.1055/s-2001-21793
17. Ozdemir O, Ozsoy MH, Kurt C, et al. Schwannomas of the hand and wrist: long-term results and review of the literature. J Orthop Surg (Hong Kong) 2005; 13(3):267–72. doi: 10.1177/230949900501300309
18. Adani R, Baccarani A, Guidi E, et al. Schwannomas of the upper extremity: diagnosis and treatment. Chir Organi Mov 2008; 92(2):85–8. doi: 10.1007/s12306-008-0049-0
19. Raj C, Amouyel T, Maynou C, et al. Limb schwannoma: Factors for postoperative neurologic deficit and poor functional results. Orthop Traumatol Surg Res 2024; 110(4):103839. doi: 10.1016/j.otsr.2024.103839
20. Andreani L, Ipponi E, Ruinato DA, et al. Schwannomas of the peroneal nerves: Clinical and functional results of surgical treatment. J Musculoskelet Neuronal Interact 2022; 22(1):87–92.
21. Andreani L, Ipponi E, Ruinato AD, et al. Peripheral schwannomas of the tibial nerve: surgical results in a case series. Acta Biomed 2022; 93(1):e2022085. doi: 10.23750/abm.v93i1.11782

Шванномы верхней конечности: клиническая картина, предоперационное ведение и результаты хирургического лечения

Едоардо Ипони[1], Елена Бечини[1], Мартина Кордони[1], Фабриция Джентили[1], Франческо Росарио Кампо[1], Фабио Коседу[1], Антонио Д'Ариенцо[1], Паоло Доменико Парчи[1], Лоренцо Андреани[1]

[1] *Кафедра ортопедии и травматологической хирургии, Университет Пизы, Пиза, Италия*

Адрес для корреспондецнии: Едоардо Ипони, Кафедра ортопедии и травматологической хирургии, Университет Пизы, Пиза, Италия, E-mail: edward.ippo@gmail.com

Дата получения: 25 августа 2024 г. ♦ **Дата приемки:** 7 октября 2024 г. ♦ **Дата публикации:** 31 октября 2024 г.

Образец цитирования: Ipponi E, Bechini E, Cordoni M, Gentili F, Campo FR, Cosseddu F, D'Arienzo A, Parchi PD, Andreani L. Schwannomas of the upper limb: Clinical presentation, preoperative management and outcomes of surgical treatment. Folia Med (Plovdiv) 2024;66(5):618-628. doi: 10.3897/folmed.66.e135490.

Резюме

Введение: Шванномы являются наиболее распространёнными опухолями периферической нервной системы. Хирургическое удаление с иссечением или энуклеацией является лечением симптоматических и крупных шванном.

Немногие исследования изучали клинические результаты, связанные с хирургическим подходом к шванномам. Наше исследование направлено на оценку клинических и функциональных результатов хирургического лечения шванном верхних конечностей.

Материалы и методы: Двадцать два случая шванном верхних конечностей были прооперированы в нашем учреждении в период с января 2016 года по декабрь 2023 года. Во всех случаях была проведена предоперационная и 6-месячная послеоперационная МРТ. Для каждого случая мы регистрировали диагностический интервал (симптом-диагноз), симптомы (стеноз или сенсорный дефицит, боль и тест Tinel), а также как пред-, так и послеоперационное функциональное состояние (с оценками по DASH и MSTS). Мы также регистрировали осложнения и местные рецидивы.

Результаты: В среднем диагноз ставился через 16.7 месяцев после появления первого симптома. Средние значения MSTS, DASH и MRC до операции составили 27.9, 5.7 и 4.8 соответственно. У нас не было интраоперационных осложнений. После среднего периода наблюдения в 43.1 месяца значения MSTS, DASH составили 29.7/30 и 0.7 соответственно. Ни в одном случае не развились местные рецидивы. Ни в одном случае не было зафиксировано дефицита стеноза при последнем наблюдении. Только у одного пациента развилась местная парестезия (9%), в то время как у двух пациентов наблюдались умеренные дизестезии.

Заключение: Адекватный хирургический подход, возможно, предшествовавший быстрой диагностике, может значительно улучшить симптомы, вызванные шванномой, восстановив функциональность верхней конечности.

Ключевые слова

дефицит, энуклеация, функциональность, резекция, обзор