Nerve compression syndromes of the hand and forearm associated with tumours of non-neural origin and tumour-like lesions

G. Martínez-Villén a,*, J. Badiola a, R. Alvarez-Alegret b, E. Mayayo c

a Department of Trauma and Orthopaedic Surgery (Hand Surgery and Microsurgery Unit), Miguel Servet University Hospital, 50009 Zaragoza, Spain
b Department of Pathology, Miguel Servet University Hospital, 50009 Zaragoza, Spain
c Department of Radiology, Miguel Servet University Hospital, 50009 Zaragoza, Spain

Received 2 June 2013; accepted 2 February 2014

KEYWORDS
Nerve compression; Tumours; Hand; Forearm; Surgery

Summary Nerve compression syndromes caused by non-neural tumours or tumour-like lesions are rare. We retrospectively reviewed 541 consecutive patients operated on by the same surgeon to study nerve compression syndromes in the forearm and hand. There were 414 due to nerve compression and 127 caused by tumours. Twenty-two patients showed compression neuropathy associated with 17 tumours and six tumour-like lesions, with 13 different pathological types. The most common types were fatty and vascular tumours. Twenty-one tumours were extraneural and one was intraneural. The median nerve was affected in nine cases, the ulnar nerve or the dorsal sensory branch of the ulnar nerve in five cases, the posterior interosseous nerve or the superficial radial branch in four cases and the common digital nerves in two cases. There was a concomitant involvement of the median and ulnar nerves in two other patients. Clinically, there were eight different compression neuropathies, of which the most frequent was the carpal tunnel syndrome. The postoperative histology was consistent with preoperative magnetic resonance imaging findings in the vascular and fatty tumours. Pain disappeared completely in 15 out of 16 patients with preoperative pain. All patients had preoperative paraesthesia, which persisted after tumour excision in three patients: attenuated in two patients and unchanged in one. In three patients, we did not observe any change in paresis or amyotrophy. The mean postoperative follow-up was 31 months, without tumour recurrence. The quick Disabilities of the Arm, Shoulder and Hand (DASH) score went from 49.9 points preoperatively to 10.2 points after surgery.

© 2014 British Association of Plastic, Reconstructive and Aesthetic Surgeons. Published by Elsevier Ltd. All rights reserved.

* Corresponding author. Tel.: +34 976765500.
E-mail address: gmartinezvillen@gmail.com (G. Martínez-Villén).
Introduction

Nerve entrapment secondary to space-occupying masses, especially tumours, is rare and may lead to diagnostic and treatment errors due to clinical resemblance to conventional nerve compression syndrome. To date, there have been few studies on this topic with large patient series, and most publications are case reports or small series. Consequently, the incidence, manifestations and outcome of surgical treatment have not been studied in depth.

Patients and methods

We performed a retrospective study between March 2003 and November 2011 on 541 patients operated by the same surgeon (GMV): 414 for a nerve compression syndrome and 127 for tumours of the hand and forearm. The cases of compressive neuropathy related to an intraneural or extraneural space-occupying lesion, histologically different to the nerve, were selected, and their medical records revised. Finally, patients were contacted for a post-operative evaluation.

Preoperative clinical examination was performed; the presence of a palpable or visible mass, pain, neurological deficits and diagnostic tests were recorded. Nerve conduction studies were performed in 18 patients. Location, characteristics and nature of the tumours were analysed in 17 cases using magnetic resonance imaging (MRI), 10 ultrasound, seven radiographs (X-ray), two angiograms, two bone scintigraphies and one computed tomography (CT) scan.

Intraoperatively, when nerve compression occurred in an anatomical canal, this was opened. Tumours adherent to the nerves, enclosing or invading nerves were dissected using magnification. After removal, we recorded the dimensions and histological characteristics of the tumour.

A comparison was made between the preoperative and postoperative clinical features. Grip strength was measured in 15 patients. The subjective results were assessed using the quick DASH in 15 patients. The mean postoperative follow-up was 41.6 (95% 7) months. Seven patients with a mean postoperative follow-up of 8.8 (16–3) months were lost to follow-up or died.

Results

Of the 414 patients surgically treated for a nerve compression syndrome of the forearm and hand, 22 (5.3%) had a non-neural tumour or a tumour-like lesion causing a space conflict. This means that of the 127 patients treated for a true tumour or tumour-like lesion in the same location, 17% presented a compression neuropathy. There were 13 men and nine women, ranging in age from 22 to 80 (average 50.8) years. The left side was affected in 13 cases and the right side in nine. Four of the patients had already undergone surgery, all with the diagnosis of carpal tunnel syndrome (CTS), which was not resolved by surgery.

Casuistic of the series

Table 1 shows the general casuistic of the series, with 23 space-occupying masses collected in the 22 patients studied (one case with two different tumours); and six different nerves involved in the forearm and hand.

True tumours

There were 17 true tumours (74%), with seven different histological types. In this group of tumours, the most affected nerve was the median nerve, followed equally by the ulnar nerve or its terminal branches, and terminal branches of the radial nerve. These tumours were distributed as follows:

Six (26%) were extraneural fatty tumours, with average dimensions of 5.4 \( \times \) 4.3 \( \times \) 2.7 cm. Five were benign (Figures 1 and 2) and one low-grade malignancy (Figure 3). All were excised completely.

Five (21.7%) were benign vascular tumours with average dimensions of 4.9 \( \times \) 2 \( \times \) 1.4 cm. One extremely invasive vascular tumour was intraneural, intrafascicular type II of the classification of Louis and Fortin (Figure 4), and we were not able to remove it, so we only opened the carpal flexor retinaculum. The four remaining vascular tumours were extraneural. One was intramuscular, completely invading the pronator teres (PT) (Figure 5), which was completely removed, with partial invasion of the biceps brachii (BB) and flexor digitorum (FD) with incomplete removal. Another very diffuse tumour spanned the distal forearm and the proximal region of the hand was partially resected. There were two other shallow and well-defined extraneural vascular tumours which were completely removed.

The other true tumours were: two giant cell tumours of tendon sheath (Figure 6), one of them coexisting with a synovial cyst, one synovial chondromatosis, one leio-myoma, one ossifying neuromyopathy (Figure 7) and one sebaceous adenoma. The mean size of this group of tumours was 2.8 \( \times \) 2 \( \times \) 1.5 cm. All of them were extraneural and completely removed. In the ossifying neuromyopathy, the dissection of the tumour required an epineurectomy and a saphenous vein wrapping.

Tumour-like lesions

Six space-occupying masses were tumour-like lesions (26%), with four different histological types. The synovial cysts (Figure 8) and the gouty tophi (Figure 9) were the most common tumour-like lesions, followed by one hypertrophic synovitis and 1 tuberculous granuloma (TB) with abundant ‘rice bodies’ (Figure 10). The global average dimensions of the tumour-like lesions were 4.9 \( \times \) 3.2 \( \times \) 6.5 cm. All were completely removed, apart from some urate residues that remained strongly adherent to the tissue bed. The tumour-like lesions also preferably compressed the median nerve.

Physical examination

In the preoperative examination, all patients reported paraesthesia, simulating eight different canalicular syndromes, of which the most frequent was the CTS. In four cases, we found amyotrophy: three at the thenar area and...
one in the hypothenar area and interosseoi muscles, with highly positive Wartenberg and Froment signs. Eight patients complained of paresis. Globally, isolated median nerve compression was present in nine cases (41%), ulnar nerve or dorsal sensory ulnar branch (DSUB) in five cases (23%), posterior interosseous nerve (PION) or superficial radial branch (SRB) in four cases (18%) and digital nerves in two cases (9%). Concomitant involvement of the median and ulnar nerves was found in two cases (9%).

Eighteen patients had deformity and a palpable mass, three a palpable mass and only one showed no signs of tumour, which was incidentally found during surgery. Sixteen patients reported pain, which in the patient with an intramuscular haemangioma, was relieved with a compression band placed around the proximal forearm.

After surgery, paraesthesia remained unchanged in the patient with the intraneural vascular tumour that was not resected, and was attenuated in two cases. The patient with the ossificans neuropathy had type S3 permanent sensory disturbances in the thumb (scale of the British Medical Research Council). The paresis recovered in five cases and the muscle mass recovered in one case 33 months after tumour excision. Pain disappeared completely in 15 patients and partially in one. In the 21 patients in whom the tumour was resected, no recurrence was seen.

**Diagnostic test**

In 12 patients, the postoperative histological diagnosis was consistent with the preoperative MRI findings. There were five cases with fatty tumours, three cases with vascular tumours, three cases of synovial masses and one case with ossifying neuropathy confirmed by CT and X-ray. Angiography successfully delineated vascular tumours in two patients. Electromyography showed normal results in five (27.7%) patients with neurological symptoms. The mean grip strength was 26.3 (39–14.6) kg in the operated hand and 30.5 (48.6–17) kg in the non-operated. The average

---

**Table 1** Characteristics of the series.

<table>
<thead>
<tr>
<th>Case</th>
<th>Tumour or tumour-like lesion</th>
<th>Location</th>
<th>Nerve compression</th>
<th>Size (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lipoma</td>
<td>Proximal and dorsal forearm</td>
<td>PION</td>
<td>5.5 × 5 × 2.5</td>
</tr>
<tr>
<td>2</td>
<td>Lipoma</td>
<td>First interosseous web of the hand</td>
<td>Collateral digital</td>
<td>6 × 4 × 3.4</td>
</tr>
<tr>
<td>3</td>
<td>Lipoma</td>
<td>Distal forearm and dorsal hand</td>
<td>SRB</td>
<td>5 × 2.6 × 2</td>
</tr>
<tr>
<td>4</td>
<td>Lipoma</td>
<td>Carpal tunnel and palmar hand</td>
<td>Median</td>
<td>5 × 7 × 3.5</td>
</tr>
<tr>
<td>5</td>
<td>Chondroid lipoma</td>
<td>Guyon’s canal</td>
<td>Ulnar</td>
<td>4 × 3 × 1.5</td>
</tr>
<tr>
<td>6</td>
<td>Liposarcoma</td>
<td>Distal forearm</td>
<td>SRB</td>
<td>7 × 4.4 × 3.5</td>
</tr>
<tr>
<td>7</td>
<td>Intraneural haemangioma</td>
<td>Distal forearm</td>
<td>Median</td>
<td>4 × 1.9 × 1.2</td>
</tr>
<tr>
<td>8</td>
<td>Cavernous haemangioma</td>
<td>Distal forearm and carpal tunnel</td>
<td>Median</td>
<td>4.5 × 2.1</td>
</tr>
<tr>
<td>9</td>
<td>Intramuscular haemangioma</td>
<td>Proximal forearm (BB, PT, FD)</td>
<td>Median</td>
<td>14 × 4.3 × 2</td>
</tr>
<tr>
<td>10</td>
<td>Glomus tumour</td>
<td>Distal forearm</td>
<td>SRB</td>
<td>1 × 1</td>
</tr>
<tr>
<td>11</td>
<td>Glomus tumour</td>
<td>Distal forearm</td>
<td>DSUB</td>
<td>0.8 × 0.7</td>
</tr>
<tr>
<td>12</td>
<td>Giant cell tumour of tendon sheath</td>
<td>Guyon’s canal</td>
<td>Ulnar</td>
<td>2.3 × 1.7 × 1</td>
</tr>
<tr>
<td>13a</td>
<td>Giant cell tumour of tendon sheath</td>
<td>Distal forearm and carpal tunnel</td>
<td>Median</td>
<td>1.5 × 1.5 × 1</td>
</tr>
<tr>
<td>14</td>
<td>Synovial chondromatosis</td>
<td>Carpal tunnel</td>
<td>Median</td>
<td>2.5 × 2 × 1.5</td>
</tr>
<tr>
<td>15</td>
<td>Leiomyoma</td>
<td>Hypothenar space</td>
<td>Collateral digital</td>
<td>1.5 × 1</td>
</tr>
<tr>
<td>16</td>
<td>Ossifying tumour</td>
<td>Distal forearm and carpal tunnel</td>
<td>Median</td>
<td>6 × 3 × 1.5</td>
</tr>
<tr>
<td>17</td>
<td>Sebaceous adenoma</td>
<td>Guyon’s canal</td>
<td>Ulnar</td>
<td>3 × 3 × 2.5</td>
</tr>
<tr>
<td>18</td>
<td>Synovial cyst</td>
<td>Ulnar and carpal space</td>
<td>DSUB</td>
<td>1.7 × 1.5</td>
</tr>
<tr>
<td>13a</td>
<td>Synovial cyst</td>
<td>Distal forearm and carpal tunnel</td>
<td>Median</td>
<td>4 × 3 × 2</td>
</tr>
<tr>
<td>19</td>
<td>Tophaceous gout</td>
<td>Carpal tunnel and Guyon’s canal</td>
<td>Median and Ulnar</td>
<td>6 × 5 × 3.5</td>
</tr>
<tr>
<td>20</td>
<td>Tophaceous gout</td>
<td>Carpal tunnel</td>
<td>Median</td>
<td>6 × 3 × 1.5</td>
</tr>
<tr>
<td>21</td>
<td>Proliferative synovitis</td>
<td>Carpal tunnel and Guyon’s canal</td>
<td>Median and Ulnar</td>
<td>7 × 4 × 1.5</td>
</tr>
<tr>
<td>22</td>
<td>TB granuloma</td>
<td>Carpal tunnel</td>
<td>Median</td>
<td>4.5 × 3 × 1.7</td>
</tr>
</tbody>
</table>

PION, posterior interosseous nerve; SRB, superficial radial branch; PT, pronator teres; FD, flexor digitorum; BB, biceps brachii; DSUB, dorsal sensory ulnar branch; TB, tuberculous.

* Tumours in the same patient.

---

**Figure 1** Excision of a lipoma of the proximal forearm through a dorsal approach revealing the posterior interosseous nerve (PION), which was compressed by the tumour.
key pinch strength was 8.3 (12.3–4.9) kg in the operated hand and 9.4 (12–6) kg in the contralateral side. The quick DASH score decreased from a mean of 49.9 preoperatively to 10.2 postoperatively.

Discussion

Compression neuropathies caused by tumours of non-neural origin and tumour-like lesions are rare. Nakamichi and Tachibana reviewed 128 patients with CTS, seven (5.5%) of which had a space-occupying lesion, very similar to the percentage in our study for any nerve compression syndrome in the forearm or hand. One of the oldest reviews of compression neuropathies by non-neural tumours was reported by Barber et al. with 32 cases, 19 of which involved tumours of five different histological types located between the elbow and the hand. More recently, Kim et al. reviewed 146 patients operated over a 30-year period and found 39 tumours with 13 different histological types in the upper extremity. Other publications reported on shorter series or case reports. Our series includes 23 tumours of 13 different histological types, all operated by the same surgeon, making it the largest personal series published to date.

Fatty tumours

Lipomas are the true neoplasms that most frequently cause nerve compression in the upper extremity, but in the past 50 years few series have been described. The usual manifestation is the solitary extraneural lipoma; the intraneural form is rare, and other presentations are well-encapsulated lipomas, diffusely infiltrating fibrofatty tumours, or macrodystrophia lipomatosa. In the forearm and hand, the most common nerve compression syndrome is the PION compression, followed by the median and ulnar nerve compression.
digital nerve compression\textsuperscript{6,12,13} have been rarely described. In our series, we had a lobulated lipoma compressing the collateral digital nerves and five ‘giant fatty tumours’,\textsuperscript{12} including a distinct liposarcoma causing a Wartenberg syndrome by entrapment of the SRB. In extraneural fatty tumours not adherent to the nerve, removal is usually easy and curative. In enclosing and adherent tumours, dissection is more tedious and sometimes only partial enucleation is possible, with risk of recurrence. In intraneural tumours, removal may require resection and nerve graft.\textsuperscript{2,6,7,9–12}

Vascular Tumours

Vascular tumours may also be extra or intraneural. Haemangiomas are benign tumours that occur in 1\% or 2\% of newborns. Intramuscular haemangiomas represent 0.8\% of all benign vascular tumours: 27\% are in the upper extremity, and 80–90\% occur before the age of 30.\textsuperscript{14,15} Our case of intramuscular haemangioma causing median nerve compression syndrome in the proximal forearm is extremely rare. The patient obtained pain relief and paraesthesia by placing a compression band on the proximal forearm, possibly inducing a temporary reduction in tumour size by decreased blood flow. However, this therapeutic response, previously described by Patel et al.,\textsuperscript{16} had no long-term durable effects. Nerve compression by an intraneural haemangioma is very rare. Until 2007, Châtillon et al.\textsuperscript{9} had found 13 published cases, to which they added one.

Figure 5  A) Angiography of an intramuscular cavernous haemangioma. B) Excision of the pronator teres muscle (PT), completely infiltrated by the vascular tumour, compressing the median nerve.

Figure 6  Excision of a giant cell tumour of the synovial sheath (\textsuperscript{*}) compressing the ulnar nerve after its division to form common digital branches of little finger and the motor branch (1) at its entrance through the hamate-pisiform hiatus.

Figure 7  Ossifying neuropathy. Dissection of bony mass surrounding the median nerve (\textsuperscript{*}) and volar aspect of carpal tunnel (black arrows).
Subsequently others were reported\textsuperscript{17–20} to which we add our own. In the upper extremity, the nerve most affected by a haemangioma is the median nerve, usually as a CTS\textsuperscript{3,9,16,18,19,23–25} followed by the ulnar nerve\textsuperscript{3,20} and digital nerves.\textsuperscript{3,17,24} Glomus tumours have a preference for digital nerves\textsuperscript{2} or other superficial nerve branches as the lateral cutaneous nerve in the forearm.\textsuperscript{25} In our series, there were two glomus tumours compressing the SRB and DSUB in the distal forearm, respectively.

Large vascular tumours are difficult to remove, resulting in partial resection and recurrence rates between 18% and 50% for intramuscular haemangiomas,\textsuperscript{15} and a recurrence period of 3 years in intraneural haemangiomas.\textsuperscript{9,16} When total excision without sequelae is not feasible, if the tumour permits it, it is preferable to be conservative. When the excision of a nerve segment is required, it can be reconstructed by nerve grafts.\textsuperscript{2,3,9,18} Another potential risk of vascular tumour surgery is bleeding, which contraindicates fine-needle aspiration biopsy.\textsuperscript{3,9,4}

Other true tumours and tumour-like lesions causing compression neuropathy

Apart from fatty tumours and vascular tumours, the number of other true tumours causing compression neuropathy in the forearm and hand is relatively irrelevant in most reported series. However, some of the cases in our series are important due to their features, as the nerve ossification, called ‘idiopathic heterotopic ossification’,\textsuperscript{26} ‘myositis ossificans-like’\textsuperscript{14,27} or ‘neuritis ossificans’.\textsuperscript{28} This neoplasm should be differentiated from others derived from metaplastic ossification of neoplasm arising within peripheral nerve.\textsuperscript{29} In the few publications of ossifying neuropathy in the upper limb,\textsuperscript{2,27,30–32} the most affected nerve is the median nerve. Surgically, the ossified mass is very adherent with intraneural invasion rendering the excision inadvisable, and resulting in partial excision or section of a nerve segment. In our patient, the excision was complete, with sacrifice of a large epineural area, which was wrapped with saphenous vein.

The synovial cyst is the most common tumour-like lesion, accounting for 17–23% of those in the upper extremity. The ulnar nerve is usually the most affected, although there have been reports of lesions of the radial nerve or their terminal branches.\textsuperscript{33–36} In our patients, the synovial cyst was quantitatively unrepresentative, affecting the SDUB in the ulnar carpal space and the median nerve in the carpal tunnel, the latter associated with a giant cell tumour of the synovial sheath. The deposit of sodium urate crystals in chronic gout is another unusual cause of nerve compression, commonly in the context of CTS. In the series of Phalen\textsuperscript{37} with 654 hands treated surgically for CTS on 439 patients, tophi were found in the carpal tunnel in only two cases (0.45%). The concomitant compression of the median and ulnar nerves has been described occasionally.\textsuperscript{38,39}

In our series, we also found two particular entrapment neuropathies: one caused by a TB granuloma with multiple ‘rice bodies’, discovered intraoperatively, and another by a
synovial chondromatosis. Both masses caused compression of the median nerve in the carpal tunnel. In a review of the literature between 1985 and 2006, 32 cases of CTS and TB infection were published, with a rate of CTS aetiology ranging from 1% to 6% depending on the geographic region. The most common form of TB involvement in the wrist is flexor tenosynovitis, commonly associated with oval corpuscles called ‘melon-seed’ or ‘rice bodies’, present in less than 50%–83% of cases. These bodies have also been observed in rheumatic disease. Our case is very similar to others and therefore we conclude that TB was responsible for <0.3% of nerve compression syndromes of any aetiology located in the forearm and hand. Synovial chondromatosis is another space-occupying lesion also characterised by the presence of nodules, which can ossify mimicking a metaplastic synovium. The most affected area in the upper extremity is the region of the elbow and proximal forearm, with 18 cases of entrapment of the median nerves. Unilateral CTS.4 The presence of a tumour detected by MRI has high sensitivity in diagnosis of fatty tumours, superior to that offered by the radiological sign of Buflalini.1,7 In a study by Capelastegui et al.45 with 134 MRI of tumours and tumour-like lesions of the wrist and hand, the authors found a 94% concordance between the preoperative images of lipomas and their postoperative histology. In our series of six fatty tumours (five of whom were examined with MRI), the match was 100%, including one liposarcoma, whose image showed a fat content of <75% and internal walls thicker than the walls of the lipoma. Gadolinium-enhanced MRI has been shown to be the imaging technique of choice in the diagnosis of vascular tumours, but angiography is preferable for angiographic embolisation, and X-ray and CT for diagnosing phleboliths. In other tumours or tumour-like lesions of the forearm and hand, as synovial cysts or gouty tophi or TB infection, MRI has proven to be an important diagnostic tool, superior to CT. X-ray and CT are most useful in bone or calcified mass. In any case, in these tumours, radiological and clinical elements have a margin of diagnostic error of 2.8–16%, therefore, histologic examination is mandatory. Some studies question the utility of EMG due to a high percentage of wrong results, which in the CTS varies from 10% to 34%.9,30

The similarity between the clinical manifestations of nerve entrapment secondary to space-occupying masses, and other conventional nerve compression syndromes can lead to misdiagnosis. For this reason alone it may be recommended that all nerve compression syndromes be investigated using expensive and complex diagnostic tools. From a statistical point of view, the low percentage of cases with nerve compression by a non-neural tumour does not justify this attitude. Thus, as stated above, physical examination with visible or palpable mass, and the type of paraesthesia, should raise the suspicion of the disease and lead to the selection of the most appropriate diagnostic tool. However, not all patients can be so diagnosed. If surgery is wrongly indicated in a conventional nerve compression syndrome, the tumour is found incidentally during operation. That may be inconsequential if the tumour is easily resectable. Nevertheless, the lack of preoperative planning can be dangerous in other cases, especially with intraneural and vascular tumours.

Conflict of interest/Funding

None.

References

Nerve compression syndromes of the hand and forearm


9. Chaˆtillon CE, Guiot MC, Jacques L. Lipomatous, vascular, and chondromatous benign tumors of the peripheral nerves. Representative cases and review of the literature. Neurosurg Focus 2007;22:


