Case report

The necessity to use microsurgical methods and intraoperative monitoring during pathology in tarsal tunnel. Technical report

Konieczność zastosowania metod mikrochirurgicznych i monitoringu śródoperacyjnego w patologii kanału stępu. Technika zabiegu

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A Schwannoma tumour located in the posterior tibial nerve in the tarsal tunnel is extremely rare [1–10], and hence surgery of this pathology also occurs rarely. Schwannoma within the foot, causing pain syndrome, requires differentiation from Morton's metatarsalgia [11]. There are several such cases of surgeries during the 20-year period described in the literature, but intraoperative monitoring techniques and microsurgery are still only an option. Due to the anatomical relationship, nerve vascular supply [12–15] and muscle functions innervated by the tibial nerve, related to the support, foot arch, and effect on the movement pattern [16, 17]. The surgical technique should use methods of microsurgical dissection and intraoperative neurophysiological monitoring in order to ensure safe surgery.

The patient was examined, and he reported a burning sensation around the medial ankle and plantar part, tingling and numbness, and a temporary intensified feeling of irritation perceived as an unpleasant 'current'. Undertaking sports activities became impossible due to foot support and propulsion impairment.

During examination, Tinel's sign, superficial deformation near the medial ankle, and perceptible weakening of the foot muscles and sensation was observed. Imaging diagnostics of the distal part of tibial nerve was performed: sonography (Figure 1) and magnetic resonance imaging (MRI) (Figures 2 and 3). The patient was scheduled for surgery, which was performed using the microscopy technique under general anaesthesia, with monitoring of neurological functions (Figure 4). The left foot was fixed to stabilise the surgical field during the performance of motor potentials and direct stimulation. After the preparation of the field, an arcuate incision of the skin was performed, corresponding to the tarsal tunnel route 70 mm long. During preparation using the microscopy technique, thinning and defragmentation of the superficial layer of the flexor retinaculum of the foot, due to a tumour,

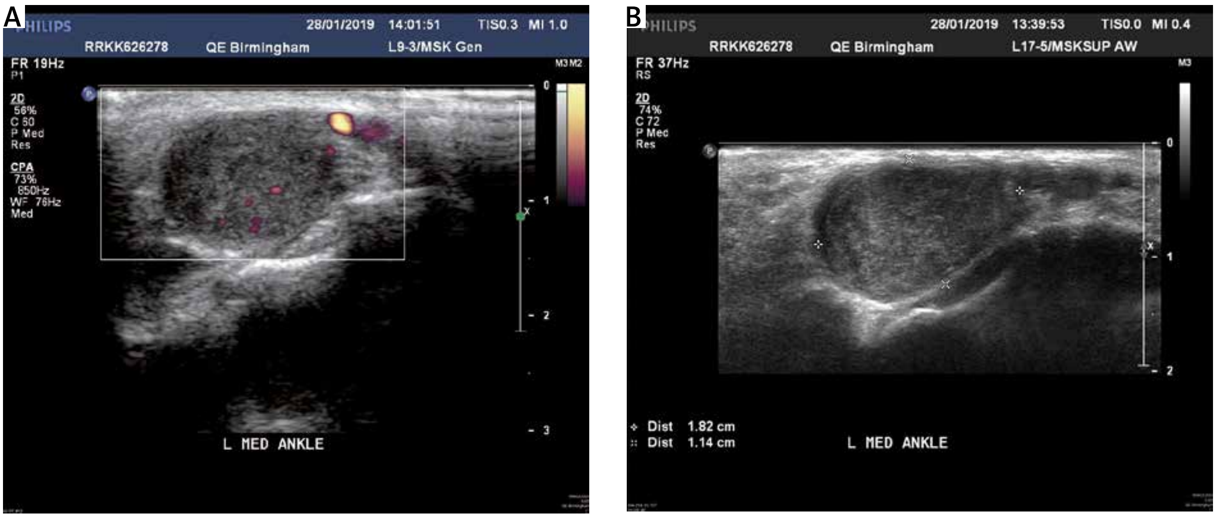

Figure 1. Tumour in the left medial ankle – sonography

Figure 2. Neurinoma sagittal view (T1 tirm)

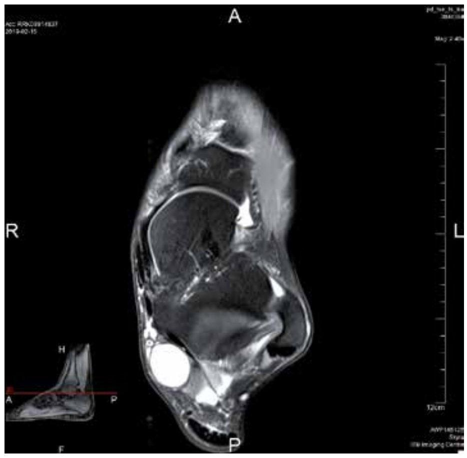

Figure 3. Neurinoma horizontal view (T1 tirm)

was found. On the tumour surface nerve branches were observed going in the direction of the calcaneal tuber. Direct stimulation of these branches was performed, and no motor response was observed. These nerves were taken from the tumour surface, and subsequently the tumour was completely removed and cut off from the vessels and a small nerve fascicle of about 1 mm diameter (Figures 5 and 6). Before the tumour cut off, no motor response was observed from the stimulated nerve fascicle intraoperatively. The tibial artery was located between the midline ankle and the tumour. Under the tumour, after resection, at the bottom, the tibial nerve divided into two branches going into the plantar foot muscles. The branches were identified using direct stimulation. The surgery was carried out without peripheral limb ischaemia. The result of the histopathological examination was a diagnosis of Schwannoma.

IONM was performed on an ISIS Xpress device, with NeuroExplorer software, 2019 version. For the registration of electrical potentials, disposable instruments were used: needle electrodes 15 mm long for foot muscles and 20 mm for other muscles. All the above-mentioned electrodes had touch-proof ends. For intraoperative stimulation (transcranial stimulation) the corkscrew electrodes, also with touch-proof ends, were used and for peripheral nerve the bifurcated fork electrodes were also used. During the surgery, neuromonitoring was applied using different modalities to improve the safety of the surgery and the best possible identification of the nerve structures. For this purpose, an EMG received from the muscles was used: plantar, abductor hallucis, gastrocnemius, soleus. During an EMG recording at a slow pace, the record was analysed from the point of view of the disturbances, which may indicate mechanical, thermal irritation of the peripheral nerve. No responses that could prove a significant mechanical thermal irritation of the nerve were recorded. An EMG with stimulation, bifurcated, fork probe, was used (Figure 7), providing electric parameters up to 3.5 mA, obtaining a response from the abductor hallucis. Motor evoked potentials (MEPs) were also performed after transcranial stimulation, with corkscrew implantation points (needles providing electric current placed subcutaneously) in C3 and C4 in accordance with the international system 10-20 of electrode placement. The amperage was up to 150 mA, and the stimulation was performed using the groups of five impulses 500 microns wide each and with 3 ms intervals between them. MEPs obtained this way were stable during the surgery.

The main anatomical borders for the growth of Schwannoma (intrinsic cause of compression) in the tarsal tunnel are the midline ankle and the layers of the foot flexor retinaculum. The slow growing process of a benign tumour in a narrow anatomical space causes the occurrence of symptomatic tarsal tunnel syndrome, which is an entrapment neuropathy of the tibial nerve [7–9]. Due to troublesome neurological symptoms, the patient is qualified for surgical peripheral schwannoma removal [1, 4–10]. The tibial nerve at the operated anatomical level participates in sensory innervation of the foot plantar side and motor innervation of the muscles responsible for movement of the toes within the plantar flexion, support, and foot arching in an upright position, and maintaining the foot arch. The range of innervation related to the posterior part of the tibial nerve is highly significant and concerns the foot plantar muscles [18]. These involve short and strong muscles, which are divided into three groups: medial, lateral, and intermediate eminence. A disturbance of the functions, disruption of innervation of these muscles, makes normal walking and sporting activities impossible [10, 16–18].

In the initial phase of an operation, during the dissection of a Schwannoma causing tarsal tunnel syndrome, we do not precisely know the anatomical relationships with the main tibial nerve trunk. An initial identification of the morphology of the tibial nerve fibres and determination of the fragmentation scope of

Figure 4. The electrodes of the monitoring system

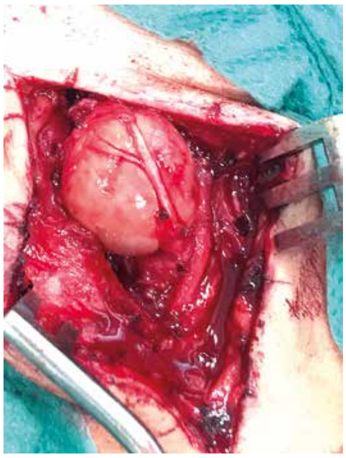

Figure 5. The tumour at the beginning of preparation

Figure 6. The tumour before removal

Figure 7. The probe and intraoperative stimulation

the nerve fascicles by a tumour are especially important. The application of direct stimulation in an operation field according to the suggested parameters using a bifurcated/fork probe makes it possible to precisely determine the trajectory of the nerve fibres. Due to the motor innervation range of the tibial nerve and by maintaining the patient's physical activity [16, 17], we should guarantee modern, intraoperative monitoring of neurological functions. The purpose of the suggested procedure included in the protocol, is the elimination of neurological complications that are the consequences of the performed surgery. Apart from monitoring of the neurological functions, the application of microsurgical techniques during surgery of peripheral nerve pathologies suggested by us is also significant. Tarsal tunnel syndrome may also be caused by vascular aetiology [19]; therefore, during decompression, both neurophysiological monitoring and microsurgery techniques are particularly important [8, 19, 20]. A special aspect involves maintaining vascular supply to avoid secondary, segmental vascular ischaemia of the distal nerve trunk [12–15]. The unpleasant disorder resulting from vascular damage of the distal part of the tibial nerve, which can be a consequence of surgery within the tarsal tunnel, is morbus Haglund, the necrosis of the calcaneus tuber. A precise microsurgical identification of vessels and elimination of surgical techniques in peripheral limb ischaemia can eliminate such risk. The operation in peripheral ischaemia makes neurophysiological monitoring impossible, and anatomical details related to the correct identification of arterial vessels disappear from the operator's field view. In the literature calcaneal bone necrosis can also appear because of the damage of sensory fibres and vegetative nerves. In our opinion, an appropriate microsurgical procedure allows us to avoid this. Pathological processes within the tarsal tunnel, including other causes – e.g. of a vascular aetiology, should not be operated under the limb ischaemia.

The proposed procedure allows us to prevent neurological complications concerning foot muscles participating in support and movement, as well as disorders of blood supply of the tarsal bone osseous tissue, which is difficult to treat. In the literature about surgery of the tarsal tunnel syndrome involving decompression of structures, the monitoring and microsurgery procedures were rarely used. We found just a few papers concerning intraoperative monitoring within the tarsal tunnel [20]. The issue of extended neurophysiological monitoring in peripheral nerve tumour surgery and other pathologies is rarely discussed; the same refers to the application of microsurgical procedures [19–21].

The tarsal tunnel is fragile anatomical region. The vascular supply and the range of innervation related to the distal part of the tibial nerve are highly significant and concern the foot plantar muscles.

The discussed method of peripheral nerve tumour surgery involving the microsurgical technique and intraoperative monitoring should be a standard of surgical treatment.

Conflict of interest

The authors declare no conflict of interest.

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