Chapter 7
Surgical Treatment of Focal Neuropathies

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7.1 Technical Implications

The surgical treatment of focal entrapments predominantly consists of nerve relief and decompression. Entrapment syndromes are lesions in anatomically narrowed regions. First, normally existent anatomical structures can start to irritate the nerve. Second, the site where the nerve pierces a hard fascia can constrict the tissue. Third, the roof of a preformed tunnel can compress the nerve when additional structures within the tunnel develop chronic swelling. Subsequent surgery aims at removing the irritating structure, widening the piercing site, or transecting the ligamentous roof of the preformed tunnel. This kind of surgery remains restricted to the paraneural space. The epineurium and all of its contents remain untouched. Intraneural tissue reactions like fibrosis have to be avoided if at all possible.

In the 1970s, interfascicular neurolysis procedures were favored even in carpal tunnel symptom cases [1]. Thereafter it became quiet again concerning these tendencies; we must suppose that the considerations of Sect. 4.2 gave reason to its re-disappearance.

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Nevertheless a confrontation with an entrapment case which presents a preoperative severe loss of function as well as an unexpected impairment of electrical nerve conductivity is not rare and happens repeatedly. Occasionally during operation the surgeon can then find an unusual thickening and hardening of a nerve segment and has to decide immediately whether to leave the nerve behind with bad prognosis or to start a microneurolysis [2]. During the last few decades, scientific discussions have taken place on the option of stepwise neurolysis in these special cases of fibrosis resp. pseudoneuroma. The fact that such a procedure can increase pain, and even induce a neuropathic pain as previously demonstrated in Sect. 4.2 must not be neglected. Alternatively, when we leave fibrosis behind, chronically manifested motor deficits will probably not improve. Progressed ulnar nerve and tibial nerve neuropathies may intra-operatively present these unpleasant dilemmas.

Compared to entrapments, an iatrogenic focal nerve injury frequently affects for instance the spinal accessory nerve [3]. Further iatrogenic injuries to other nerves can follow screw removal procedures. Function deterioration can occur after bone injury followed by scars in the surroundings, as well as by scars after arterial puncture and hematoma. Sometimes, such injury related focal neuropathies then need more than a simple outside decompression, especially, if the thin spinal accessory nerve is involved as described in Sect. 8.1. If pain is not in the foreground and improvement of motor deficits is particularly required, neurolysis steps have absolutely to be taken into account. The surgeon has to decide immediately because subsequent approaches carry greater risks of worsening. The natural explanation is that the primary surgeon already leaves scar tissue behind. Thus, the primary surgeon bears the entire responsibility.

We therefore do not hesitate to describe the procedure of neurolysis, and in doing so, point out that it is a stepwise procedure [4]. It should be stopped immediately if the microscope shows that fascicles are swelling. The following different neurolysis

steps must not be engaged at any price in order to prevent any following neuroma pain. Under magnification, the epineurium in the intact part of the nerve proximal and distal to the involved area can be incised longitudinally. After that, the external sheath of the epineurium which surrounds the nerve trunk can be removed. As the third step, separating of fascicle groups from each other can start – "interfascicular neurolysis". Our goal has to be to achieve sufficient decompression to enable the axon sprouts to overcome the lesion and reach their target. We must always bear in mind that a fibrosis of connective nerve tissue exerts circular compressing forces on the fibers. As result, a grade II lesion according to Sunderland's classification occurs (see Sect. 3.1). The re-growing capacity of nerve axons starts when these forces are decreased. This factor forms the basis of "neurolysis." We expect increased criticism with regard to these considerations. However, when patients with progressed motor deficits and even without any injury in their history, and without pronounced pain, demand improvement, the surgeon has either to advise and apply or to deny such neurolysis steps. Gender neutral: The surgeon has the responsibility and has to make the final decision; it may be influenced by preoperative discussions with the patient about risks concerning pain. These reservations do not apply to surgeons dealing exclusively with efferent nerves like the spinal accessory, anterior, or posterior interosseous nerves. They are without any pain risk of course (Fig. 7.1).

7.1.1 Conclusions

Focal neuropathies to which we offer surgical treatment are a challenge: no doubt the patient appreciates the surgeon's immediate success; however, the surgical procedure which the physician chooses has primarily to be the suitable and correct one. Secondary corrections with re-exploration comparatively bear higher risk of deterioration. The surgical procedure itself is relatvely easy,

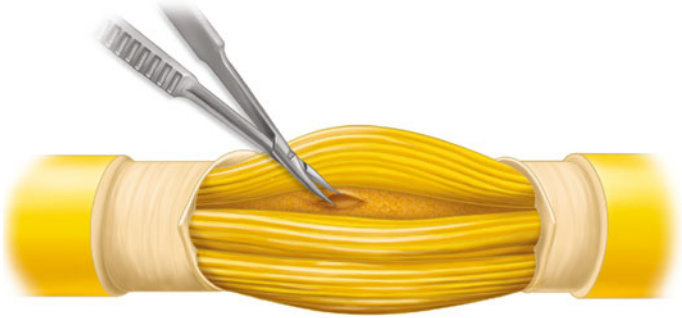

Fig. 7.1 Principles of interfascicular neurolysis which can be applied on severe nerve trauma. The epineurium is pealed away. The remaining interfascicular fibrosis is tried to be removed so that fascicles expand

whereas the pre- and intraoperative decisions to be made are of high responsibility.

7.2 Surgery in Bloodless Field

Do we need a tourniquet to provide a bloodless operating environment in nerve surgery? Our personal opinion is that we do not. Without any doubt, there is need of bloodlessness in hand surgery and in reconstructive surgery (e.g., in tendon transfers with soft tissue perforation from one incision to the next). However, guidelines for hand surgeons, neurosurgeons, and orthopedic surgeons recommend operating in bloodless field, especially with carpal tunnel syndrome and other easy entrapments of the forearm. However, they concede that the question of bloodlessness remains controversial at present. Nevertheless, the question gets more and more import forensically. Pitfalls after median or ulna nerve entrapment surgery almost inevitably lead to litigation. Before criticism arises concerning our opinion, please read the following citations:

1. Stewart in 1987:“Nonetheless, neuropathies following the use of pneumatic tourniquet still occur; sometimes they can be attributed to a faulty aneroid gauge and excessive pressure or to prolonged tourniquet application, but they may happen despite all normal precautions” [5].
2. Sunderland in 1991:“…. The much higher incidence of causalgia following high nerve injuries is due to wounding by high velocity missiles. The severity of the retrograde neuronal changes is known to be proportional to the severity of the injury and its proximity to the cell bodies” (one of the author’s listed nine “characteristic clinical features of causalgia”) [6].
3. Kline and Hudson in 1995: “If an extremity is operated on under tourniquet and the latter is inflated for 60 min or longer, the tourniquet should be left down for 20 min or more before NAP recording is tried. Ischemia and low wound temperature can block successful recordings. In several earlier cases in which recording were done under tourniquet, NAP traces were flat, and yet regeneration, as shown by either histological study or resected segment or subsequent clinical cause, was adequate” [7].
4. Birch in 1998:“Evidently, a paralysis is always produced when an occluding cuff is in position for 30 min or longer. It nearly always recovers spontaneously within a few minutes of the release of the pressure. Sometimes the paralysis is longer lasting; rarely, some of its effects are permanent. The reversible paralysis is that of transient ischemia; the long-lasting paralysis is that of damage to the myelin sheath; the permanent paralysis is that of damage to all elements of the nerve, including the axon, with ischemic damage to muscle” [8].

The term “causalgia” is today synonymous with complex regional pain syndrome (CRPS). The above-mentioned guidelines concerning the carpal tunnel syndrome declare that such a CRPS occurs extremely rarely. Nevertheless, in 7,000 endoscopic carpal tunnel releases, a CRPS was observed 10 times [9].

Further facets are:

- In a regional presentation of rehabilitation medicine in 2009, we were confronted with the fact that one quarter of patients with CRPS had undergone carpal tunnel syndrome surgery; in that special region, surgeons always work under a tourniquet.
- Nerve surgery is difficult when proximal approaches are needed, but it is easy in the forearm. Why should we have to apply a tourniquet where surgery is easier?
- We personally remained absolutely free of CRPS complications since 1981, with strict avoidance of a tourniquet.
- On the other hand: many CRPS I and II patients consulted us. In all cases some kind of surgery had been previously undertaken and always under tourniquet, e.g., osteosynthesis of distal radius fracture or ankle fracture, removal of osteosynthesis material, and release of tarsal tunnel syndrome. Our therapeutic idea to treat these terrible results consisted of nothing but peripheral nerve stimulation (PNS) such as representatively reported in 1996 [10].
- Rat experiments, meantime, underlined the fact that ischemia seems to be mainly responsible for inducing sympathetic reflex dystrophy [11].

Without doubt, several personal opinions have just been expressed, whereas randomized scientific evidence is still lacking.

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