END-TO-SIDE NEURORRAPHY IN RECONSTRUCTION OF LARGE POSTTRAUMATIC DEFECTS OF PERIPHERAL NERVES

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INTRODUCTION

The lack of qualitative functional results of nerve reconstruction after large posttraumatic injuries of extremities is a challenge for surgeons to develop better techniques. In some circumstances, the traumatic lesions of peripheral nerves of the upper extremity cannot be resolved by direct suture. Since the last century, end-to-side neurorraphy have been regarded as a potential reconstruction alternative.¹ The theoretical support of this method is the regenerative capacity of peripheral nerve tissue. It seems that through lateral bud a donor nerve could branch outside its usual territory to compensate the lack of proximal end of the injured nerve.²⁵

The aim of a peripheral nerve reconstruction is to provide a good functional result. The nerve grafts are a classic solution for defects more than 3 cm, but the results are often unsatisfactory.³⁶ The end-to-side neurorraphy could optimize the functional results.

Apparently the first case of end-to-side suture has been published by Despres in “Gazette Hebdomadaire de Medicine” (Paris, 1876). He had performed insertion of the median nerve through the ulnar fibers. In 1985
and then latter in 1903 Balance has described the section of injured facial nerve followed by end to side connection to accessory nerve or hypoglossal nerve.1

The developing of microsurgical techniques has emphasized the epiperineural neurorraphy and the end- to-end fascicular neurorraphy.6,7 The modern view about the end-to-side neurorraphy consists in the absence of donor nerve axon section. A suture between the distal end of the injured nerve and the donor nerve with or without epineural window can be done afterwards.8,9

Viterbo et al have performed experimental studies in rats in order to estimate the efficiency of end-to-side neurorraphy without epineurial window and to evaluate the role of the epineurial sheath in lateral axon growing. The distal end of divided peroneal nerve has been sutured to the tibial nerve by end-to-side neurorraphy without epineurial window. The results have been evaluated with electric stimulation of sciatic nerve followed by the observation of tibial muscles response before and after the section of peroneal nerve below neurorraphy. Also the histological evaluation of the number of axons in transversal sections through tibial and peroneal nerves above and below suture have been performed. The histologic examination of the muscles and the mioctometry has completed the evaluation. The authors have concluded that end-to-side neurorraphy is a valuable method that allow the growing of lateral axon into the sutured nerve, the conduction of electric stimuli and the maintenance of muscle trophism.10,11

It was also obvious that the epineural sheath does not stop the functional axons traversing and that the donor nerve is not affected by the lateral bud of the axons. Based upon these experimental data, Viterbo applied the end-to-side neurorrhaphy in facial nerve paralysis with good morfofunctional results.12,13

In another experimental study in rat, Viterbo F et al (1995) compared, in the same animal, end-to-side neurorrhaphy without epineurium removal with end-to-side neurorrhaphy with epineurium and perineurium removal. This study proved that the two neurorraphies (with and without perineurium) did not show any difference regarding morphological and electrophysiological features studied. This is very important because it has proved that end-to-side neurorraphy can be used without harming the donor nerve.14

Mennen (1998) has demonstrated good results in non-human primate and in human patients.15

When neither end-to-end neurorraphy nor nerve grafts are available for restoration of the nerve continuity following nerve damage, end-to-side neurorrhaphy is an alternative. End-to-side anastomosis supplies a degree of peripheral nerve regeneration without any evident function loss of the donor nerve. However, new studies must be performed for improving regenerative capacity of the technique.16

The end-to-side neurorrhaphy has been therefore used for paralysis of brachial plexus and sural nerve.17,18

CASE REPORTS

In our clinic we have performed end-to-side neurorrhaphy in eight patients: in three cases end-to-side neurorrhaphy of ulnar nerve to undamaged median nerve (two patients operated in emergency conditions and one patient after four weeks) and in five patients end-to-side neurorrhaphy of ulnar nerve to repaired median nerve with graft from the proximal end of ulnar nerve (four patients operated in emergency conditions and one patient after three months). The functional recovery has been appreciated by using clinical tests (sensitive and motor rehabilitation) and laboratory tests (nerve conduction velocity) by electric stimulation at six months, one and two years after surgery.

We are presenting in detail three of our cases. Case 1 and 2 have been solved with immediate reconstruction and with good postoperative results and case 2 with late reconstruction with satisfactory results. According to the type, complexity and gravity of injuries the appropriate anastomosis has been chosen.

Case 1

A 42 years old male patient suffered an accident with an oscillating saw. He presented with a complex traumatism in the medium third region of the right forearm with the section of the ulnar artery, of the median nerve with an 8 cm defect, of the ulnar nerve with a 3 cm defect, the section of the musculotendinous tissues and a Gustillo type III B fracture of the ulnar diaphysis. He underwent osteosynthesis and mioraphy in the emergency room. Due to the large defects of ulnar and median nerves, the reconstruction of median nerve was performed using a graft from ulnar nerve and termino-lateral neurorraphy between the distal ends of both nerves.

The operation draft is presented in Figure 1. Figures 2 to 4 illustrate the main steps of the surgical procedure.

Figures 5 to 8 present the morfofunctional recovery after six months and one year.
Case 2

A 33 years old male patient suffered an accident with an oscillating saw. He was admitted with a complex traumatism in the medium third region of the left forearm with the section of the ulnar artery, of the median nerve, with a 6 cm defect, of the ulnar nerve, with a 5 cm defect, and the section of the musculotendinous tissues. He underwent teno- and mioraphy in the emergency room. Due to the large defects of ulnar and median nerves and to the intense contamination of the wound the nerve reconstruction has been delayed. After two months the reconstruction of median nerve with a graft from ulnar nerve and
termino-lateral neurorraphy between the distal ends of both nerves has been performed.

Figures 9, 10 illustrate the intraoperative findings.

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Figure 9. Preoperative aspect.

Figure 10. Intraoperative aspect.

Figure 11. Postoperative aspect after one year.

Figure 12. Postoperative aspect after one year.

Figure 13. Postoperative aspect after one year.

Figures 11 to 13 present the morfofunctional recovery after one year.

Case 3

A 48 years old male patient suffered an accident with an oscillating saw. He presented with a complex traumatism in the inferior third region of the left forearm with the section of the ulnar artery, of the median nerve, with a 6 cm defect, of the ulnar nerve, with a 5 cm defect, the section of the musculotendinous tissues and a III B type Gustillo fracture of the ulnar diaphysis.

In the emergency room he underwent osteosynthesis, tenoraphy, mioraphy, neurorraphy of the median nerve and termino-lateral neurorraphy of the distal end of ulnar to the median nerve.

Figures 14,15 are illustrating the pre and intraoperative aspects.

Figure 16 shows the successful end-to-side neurorraphy for motor function (12 months after surgery).

Figure 14. Preoperative aspect.

Figure 15. Intraoperative aspect.

Figure 16. Postoperative aspect after one year.
CONCLUSIONS

End-to-side neurorraphy as a potential reconstruction alternative is based on the assumption that through lateral bud a donor nerve could branch outside its usual territory to compensate the lack of proximal end of the injured nerve. End-to-side neurorraphy is a valuable method that allows the growing of axon lateral into the sutured nerve, the conduction of electric stimuli and the maintenance of muscle trophism. Moreover it seems that the donor nerve is not affected by the lateral bud.

The benefits of this technique could be the increase of the number of regenerated axons and of the selectivity for precise movements. It can be used in the case of incomplete and or recent paralysis, but it can not be performed if the donor and acceptor nerve has different medullar origin.

The timing of this reconstructive alternative is dictated by the complexity of nerve injuries and the presence of other damaged tissues. Considering the cases of our study the functional recovery was better when the reconstruction was immediate, the patient was younger and patients’ attendance to the sensory re-education program after surgery has been completed. No differences were found between the recovery of ulnar and median nerves.

The type or anastomosis was elected after the careful evaluation of the lesions, the context of their appearance and the general status of the patient. The identification upon presentation of the functional neurosurgical conditions permits to perform or assist with simple, emergent and complex functional neurosurgical procedures related to associated functional disorders.

In conclusion, the end-to-side neurorraphy is beneficial because:
- The conduction of electric stimuli and the passage of axons from the lateral surface of donor nerve are achieved;
- The functional recovery of the distal segment of the divided nerve is allowed;
- The presence of epineurium does not affect the axon recovery or the passage of electric stimuli;
- Reinnervation could be obtained through lateral surface of healthy donor nerve;
- The lateral growing of axons into the sutured nerve, the conduction of electric stimuli and the maintenance of muscle trophism are allowed;

Termino-lateral neurorraphy could be used successfully in the surgical treatment of peripheral nerves. With or without perineural window, the termino-lateral neurorraphy showed the same morphologic and electrophysiological result.

For a good result it is also important an adequate postoperative immobilization, to prevent tension and kinking at the suture side, an intensive postoperative rehabilitation program and patient cooperation. Collaboration with movement neurologists and neurophysiologists is important to sustain the recovery after surgery.

Termino-lateral suture is a very good therapeutic alternative that is performed in well selected clinical cases by respecting the principle “Primum non nocere”.

REFERENCES


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