Nerve Regeneration in the Centrocentral Anastomosis

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The centrocentral anastomosis (CCA) can be defined as an end-to-end microsuture among the fascicles of the central stump of a severed peripheral nerve, with an interposed autologous nerve graft between each pair of fascicles. This technique was developed by Samii [4, 5] in an attempt to reduce the size of terminal neuromas and subsequently to achieve control of neuroma and postamputation pain.

Clinical and Experimental Studies

Some clinical studies, involving small groups of patients, have shown the disappearance or alleviation of chronic pain in cases of stump pain with a CCA performed after resection of amputation neuromas and also when the CCA is carried out following resection of painful terminal neuromas if functional motor or sensory recuperation is not the objective. Centrocentral anastomosis has been used in the prevention of painful neuromas after emergency or elective amputations. In the event of limb amputation CCA can be performed among fascicles of the main nerves of the extremity. In hand surgery, following finger amputations, CCA is carried out between dorsal and palmar collateral nerves. However, these encouraging clinical results [2–6] should be carefully evaluated, taking into consideration that one-third of patients with painful neuromas can be cured or improve in the long term with a simple neuroma resection, and that only a small percentage of patients develop some type of postamputation pain, even years after surgery.

On the other hand, experimental studies have shown that CCA reduces the size of terminal neuromas resulting from transection of sciatic nerves in rats and rabbits [1–4]. We have examined the role of CCA on the time course of autotomy following experimental transection of sciatic nerves in rats [1], considered by many authors as a valid experimental model of chronic pain. We found that CCA significantly reduces the autotomy behavior in rats when the procedure is performed immediately after nerve transection or following neuroma resection.

With these clinical and experimental data it is tempting to speculate that the decrease of autotomy score in chronic pain animal models and pain control in patients with neuroma or postamputation pain is achieved by reducing the size of terminal neuroma. These kinds of pain have been related to many
physiopathological causes, but we believe that peripheral factors may play a major role in their pathogenesis. In fact, electroneurophysiological studies have shown aberrant properties in axon sprouts of rat sciatic neuromas as the result of sprout growing into a foreign chemical and cellular environment. Thus, the results of CCA could be explained if we consider that regenerated axon sprouts which cross the suture line penetrate into the nerve graft where they grow freely isolated and protected from the scar. If the graft is not interposed, and the terminal stumps of fascicles are sutured end-to-end, the axon sprouts of the fascicles cannot penetrate into the contralateral, occupied endoneural tubes, and a true neuroma in continuity is formed.

**Regeneration in the Centrocentral Anastomosis**

In addition to this clinical interest, the CCA itself is an interesting experimental model to study the peripheral nerve regeneration as the regenerating axons grow into the nerve graft from both ends lacking peripheral motor or sensory targets to reach. With the aim of investigating this, a simple model of CCA was developed in rats by suturing the peroneal and sural branches of the sciatic nerve. A 5-mm nerve portion taken from the peroneal branch was used as interposed graft (Fig. 1). The animals were operated on using a microsurgical technique. In most animals 10/0 Ethilon was used as suture material, but

![Fig. 1a, b. Operative photographs of a completed simple centrocentral anastomosis. The sural and peroneal branches of the sciatic nerve of the rat are anastomosed. A nerve graft taken from the peroneal nerve is interposed](image-url)