MANAGEMENT OF PERIPHERAL NERVE INJURIES

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By

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الله

بسم الله الرحمن الرحيم

وقل اعملوا فسيرى الله عملكم ورسوله والمؤمنون

«صدق الله العظيم»

بسم الله الرحمن الرحيم

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AIM OF THE WORK

The aim of this work is to review the management of cases with peripheral nerve injuries.

The work is in a form of an essay where a review of literature regarding peripheral nerve injuries will be given. The: Anatomy, histology, physiology, pathology, clinical picture, investigation and different method of management of peripheral nerve injuries will be reviewed.

CONTENTS

INTRODUCTION

INTRODUCTION

The repair of peripheral nerves has had a long and erratic history. Inadequate and inaccurate concepts of the physiology of peripheral nerves had deterred and delayed surgical treatment of lesions of nerves for many years.

In the Hippocratic period failure to distinguish between peripheral nerves and tendons lead to considerable confusion and the concept was advanced that a divided nerve would not unite whatever therapy was employed.

Arabic physician in the ninth and tenth centuries were the first to attempt union of divided nerves by sutures. In subsequent development of western medicine during the middle ages, the techniques was largely ignored and attempts at nerve repair were extremely rare. Until the nineteenth century, it was widely believed that nerves would regenerate spontaneously and that manipulation and suture would cause convulsion or delay this recovery.

Physiological investigations as those of *Gruick Shank* and *Haighton* in the end of the eighteenth century finally demonstrated the recovery of nerve function was dependent upon down-growth of axons from the proximal end of the nerve to the appropriate end organs peripherally.

Recognition of this was slow even as late as *1873* when *Hueter* described repair of divided nerves by sutures placed in the epineural sheath. This technique with some refinements remains the standard method of repair up till now.

In 1882, Mikulikz and what was now even termed the sling suture, or a suture placed through the proximal and distal ends of the nerve for apposition.

During World War I, several reports in French literature emphasized the value of early exploration and of neuroma resection and sheath suture. Nerve grafts, first used by *Foerster in 1916* were rarely successful.

In World War II, great numbers of peripheral nerve injuries were treated surgically under the guidance of *Seddon* and *Guttman* [*1947*]. Factors affecting outcome were more closely studied and marked improvement was achieved with refining the techniques of repair.

The possibility that nerve fascicles could be aligned and sutured has been suggest as early as *1917 by Hashimoto. Sir Sydney Sunderland* [*1945*], studied the intraneural topography and discussed the possibility of fascicular repair. He thought, however, that this approach would only have a limited application.

Introduction of magnification by operating microscope into peripheral nerve surgery was first described by *Jacobson* [*1963*], a general surgeon and *Smith* [*1964*], a famous plastic surgeon.

Millesi in 1972, introduced interfascicular nerve grafting technique and different reports claimed better results than those of fascicular repair or epineural repair under tension.

Braun [*1966*], *Ellis* [*1967*] *and Seddon* [*1968*] stated that they found no benefit of micro techniques over other methods. Despite some resistance, micro surgical techniques in peripheral nerve surgery is flourishing [*Millesi, Samii et al., and others*].

REVIEW OF LITERATURE

ANATOMY AND HISTOLOGY OF PERIPHERAL NERVES

The nerves of peripheral nervous system communicate with certain parts of brain stem (cranial nerves) or the spinal cord (Spinal nerves) and branch all over the body. Within one nerve, the individual anatomical units are the nerve fibers. These themselves contain one or more individual conducting units, the axons. The axson vary from a few milimeters to a meter in length.

The perinuclear cytoplasm of some nerve cells extends beyond the central nervous system as a filamentous process of variable length and thickness. Those processes from the neurons of sympathetic ganglia and anterior horn cells of spinal cord are axons. Those connected with posterior root ganglia neurons are dendrites. both are histologically indistinguishable and for this reason the general term axon is applied.

Nerve fibers:

Histollogically, peripheral nerve fibers may be divided into myelinated and unmyelinated varieties on the basis of absence or presence of myelin sheath. The fiber is composed of a single core of axoplasm.

It is bounded by semipermeable membrane called axolemma, this is surrounded by a basement membrane, which in turn, is encircled by myelin sheath laid down by shwann cells.

The axoplasm:

The axoplasm is a viscous fluid enclosed in a surface membrane, the axolemma, which is about 65-80 A° thick. It is composed of two opaque layers separated by a light inner space [*Elfvin, 1968; Webster, 1974*].

Contained in the axoplasm are neurotubules, neurofilaments which represent its main constituents, mitochondria, endoplasmic reticulum, and granular and vesicular structures. The neurotubules are approximately 200 A° in diameter and have a dense rim surrounding central core. The neurofilaments are finer 70-100 A° in diameter.

Weiss and Mayer, (1971), have introduced the concept of continuos neurotubules growth and replacement. Where by, the tubules originate in cell body as protein subunites and are then bond to form a linear sequence which coils to form a tubular structure.

The later is carried distally with the advancing axonal column. At the periphery, subunits of the tubules are released and then fragmented into vesicles or are dissipated by dissolution. In non-myelinated fibers neurotubules out number neurofilaments the reverse arrangement is found in myelined fibers [*Freide and Samorajski, 1970*]. Micro tubules are essential to axoplasmic Flow [*Davison, 1970*] and may actually be connected to the central cell's nucleus.

Axonal excitability seems to be a function of axoplasmic flow, and without intact intracellular ultra structures, excitability is lost [*Spancer et al., 1973*]. Slow, rapid and retro grade phases of axoplasmic flow have been demonstrated with axons [*Samson, 1971*].

It is interest that certain cytoplasmic structures and organelles are not found in the axon e.g. the golgi apparatus, no rough surfaced endoplasmic reticulum and no free ribosomes or polysomes.

The Nerve sheath:

Electron microscopic studies have shown that most axons larger than 1 µn are myelinated. The myelin sheath is formed by many concentric double layers of schwann cell membrane.

The cell membrane is tightly wound and the inner or protoplasmic surface of the membrane become fused together, forming the dense and thicker lamellae of the myelin sheath seen in electron micrographs. The less dense lamellae is formed by the outer surface of the membrane. The sheath is not continuous but is interrupted at either ends of schwann cells.

A gap usually exists between adjacent schwann cells, this gap is termed the node of Ranvier.

The internodal distance varies between 400 and 1500 µm, depending on the fiber diameter and species. It were first described by *Ranvier in (1871).* [*D.N.Landon, 1975*]. The annular constriction and schmidt-lanterman incisures serving to divide up the myelin tube and prevent its displacement by local mechanical forces or gravity [*Ranvier, 1878*]. These conclusion were contested by a number of Ranvier's contemporaries and successors : *Nageotte, (1922).*

Occasionally, areas of incomplete fusion of the schwann cell membrane occur and small amount of schwann cell cytoplasm are trapped between the membrane. The areas of incomplete fusion are called [*Schmidt 1974; Laterman, 1877*] clefts, their significance is not understood.

This gap provides a potential channel of variable with in continuity with extra cellular space along the entire length of the cytoplasmic spiral, and has been shown to be accessible to Lanthanum ions if these are added to the solution bathing the exterior of the fiber [*Hall and Williams, 1971*].

Unlike their larger counterparts, several unmyelinated nerve fibers may be contained within the folding of a single schwann cell. The invested axon appear in cross section to be suspended by a short segment of the invaginated outer membrane. The nerve fibers have been classified according to size Axon which rang from 12-22 μm are designated as A-alpha, from 5-12 μm as A-beta, from 2-8 μm as A-gamma and from 1 to 5 μm as A-delta. Preganglionic sympathetic fibers are less than 3 μm in diameter and are designated as B-fibers. All of the above are myelinated nerve fibers. The smallest axons [0.1- 0.3 μm] are the c-fibers and are un-myelinated.

Erlanger and Gasser, (1973), have proven that the nerve conduction velocity is proportional to the square root of the fiber diameter. Erlanger and Gasser also noted slower conducted peaks that are carried by autonomic B-fibers and un-myelinated C-fibers [*Robert, 1988*].

In *1943, Lloyd* introduced a classification using Roman numerals from I through IV in descending order of size. Type I and type II fibers correspond to large diameters between 6 and 20 μm that consist of motor fibers and larger sensory fibers group III, or A-delta axons have diameters of 1 to 6 μm and sub-serve pain conduction. Group IV contain C-fibers which are smaller un-myelined nerves that carry delayed-pain input and the B-fibers which are preganglionic autonomic axons [*Robert, 1988*].

A rough estimate of the conduction velocity of a given axon can be obtained by multiplying the fibers diameter by 6 thus a typical large group I motor nerve with diameter of 15 μm will conduct at velocity of about 90 m /s [*Robert, 1988*].

Table showing the relation between total fiber diameter and conduction velocity.

Fiber	Function	Diameter	Conduction velocity m/sec
A	Proprioception, somatic, motor touch, pressure motor to muscle spindle pain,temp.,touch	12-20 5-12 3-6 2-5	70-120 30-70 15-30 12-30
B	Preganglionic automatic	3	3-5
C	Pain, reflex response Post ganglionic	0.4-1.2 0.3-1.3	0.5-2 0.7-2.3

Peripheral nerve trunks:

In their passage to the periphery, nerve fibers not run in dependent courses as single unite but they are collected into bundles or funiculi with which are associated other tissues and structures to form peripheral nerve trunks. The component parts of peripheral nerve trunks are the nerve fibers, the funiculi, the connective tissue, the blood vessels, the lymphatics and nervi- nervorum.

Funiculi:

A funiculus is a bundle of nerve fibres invested by a thin but strong sheath of connective tissue, the perineurium. It is uncommon for human peripheral nerves to be composed of a single funiculus.