

Features of Peripheral Nerves Early Myelination of a Fetus

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Abstract

With aim studying of myelination structural features of the similar peripheral nerves of the upper and lower limbs in an early prenatal ontogenesis, were investigated the musculocutaneous nerve also superficial peroneal nerves. Nerves are studied at 3 - 4-month fetus in the proximal and distal parts. In the proximal part both nerves consist of the fibers intended for an innervation of muscles and skin. Distal part consists of the fibers of an innervation which is consists of only skin and its derivatives. Pieces musculocutaneous and the superficial peroneal nerves were investigated by a light and electron microscopic methods. According to a research, process of myelination of nerve fibers results from the difficult interaction of a neurolemmocyte with an axon. Nerve fibers, the innervating muscles of both the upper and lower limb are exposed to more accelerated myelination, than the fibers supplying skin. The myelin sheath can be formed around an axon with a diameter less than 1 mc. At early stages of myelination are noted the hanging orientation of internal and external mesaxons. The size of a cross cut of unmyelination nerve fibers depend on the size of groups where they are located. In process of increase in amount of nerve fibers in group's diameter of an axon decreases. In a prenatal ontogenesis between thickness of a myelin sheath and diameter of the axon, there is a rectilinear correlative communication. In some cases, divergences from the general regularity are noted. It is characteristic of earlier stages of the process myelination.

Keywords: *Musculocutaneous Nerve; Superficial Peroneal Nerve; Axon; Myelin Sheath; Mesaxon*

Introduction

Features of formation of nerve fiber and its constituents, i.e. myelin sheath and axon is in the sphere of researches of neuromorphologists, neurophysiologists [1-6]. In spite of the fact that the first data on myelin fibers found the reflection in works of authors of the 19th century, but these myelinations belong to the 20th century [7-9,13]. In view of the fact that materials for an electron microscopic research have to be taken for a short time after death moment, the main ultrastructural researches were carried out on animals [6,9,10-12], or on their embryos [13] and in other cases at the human [7,8,12,20]. In some of these works great attention on a ratio of a myelin sheath to an axon was paid and contradictory opinions are expressed [9,11,14-17]. Performing insulator function, the myelin sheath covers the axon, which immediately participates in carrying out a nerve impulse. In this regard the opinion of a number of authors that myelination happens in the nonspecific way under the influence of pressure of the axon to thickness of a myelin sheath [17] deserves a special attention.

Aim of the Work

Considering the above, the main objective of our research is devoted microscopically and electronic microscopically to studying of structural features of myelination of musculocutaneous and the superficial peroneal nerves in an early prenatal ontogenesis.

Materials and Methodology

At 3 - 4-month fetus, the proximal and distal parts musculocutaneous and the superficial peroneal nerves were investigated. In a proximal part both nerves consist of the fibers intended for an innervation of muscles and skin. Distal part consists of fibers for innervation only skin and its derivatives. Pieces musculocutaneous and the superficial peroneal nerves were processed for microscopically (in the example of 46 by the Veygert-Pal method) and an electron microscopically investigation (in the example of 64). For an electron microscopically method pieces of nerves are taken in 90 minutes after death moment. Exemplars of 1 mm³ in size continued to fix in 2.5 - 5% solution of a glutaraldehyde on the phosphate buffer and in 2% OsO₄ solution. Further from the received blocks cuts on an ultra-microtome "Reichert-Lung" and LKB-4800 prepared like for viewing on an electron microscope "JEM-JEOL-100S".

The obtained data underwent morphometric processing, including calculation of arithmetic-mean indexes, their inaccuracy. The reliability of distinctions was estimated by method of fiducially intervals [18].

Results and Discussion

At the earliest stage of the prenatal ontogenesis, at 3 - 4 monthly fetus, the musculocutaneous nerve (a proximal part) has the oval form and cross sectional dimension, which is 155 - 243 mc. The epineurium was developed poorly (thick - 5 - 29 mc). Formation of nerve bunches began. The quantity of them in different cases is from the 2nd to 6, which on degree of saturation were myelin fibers unequal too. Bunches of nerves are usually irregular, the polygonal, extended or oval form, were separated by created perineurium 5 - 7 mc thick. Myelin fibers are located not densely. In separate bunches and in insignificant quantity (45 - 93) and other bunches are almost deprived of them. Usually they are appeared as transparent zone of the considerable size (more than a half of diameter) and occupy peripheral position (Figure 1a).

Proximal part of the superficial peroneal nerves of this age usually spherical in a forms. Diameter is less than it, than in the proximal part of the musculocutaneous nerve is also 120 - 192 mc. Bunches only begin to be formed, they aren't enough - in the numbering 2 - 3. In separate bunches myelin fibers, which are located not densely. The myelination of the distal, i.e. sensing part of both nerves, considerably lagged than the proximal part. First of all, diameters of these are 1.5 - 2.0 times less. Connective tissue structures are thinner, bunches are not created yet, usually consist of a myelin fibers (Figure 1b).

On electron investigation, patterns of proximal parts of the nerve fibers at the different stage of myelination are noted. Nerve bunches are divided into two groups. Some of them appear as transparent with compactness of nerve fibers with a small diameter and a thin myelin sheath, and others unmyelin and in larger groups (Figure 1c). Such groups contain more than 50 (until 230) axons with a diameter of 0.1 - 2.3 mc. In process of increase in amount of nerve fibers in groups, diameter of an axons decreases. In some cases, small groups of axons (from 1 to 6) are noticed to have some impact of the early myelination. The myelin sheath can be formed around an axon with a diameter less than 1 mc. At early stages of myelination, the myelin sheath consists of 2 - 7 lipoprotein layers. In such cases, the internal and external mesaxons, which are in steep orientation, are directed (Figure 1d). In both mesaxons, cytoplasmic structures between plates are kept. In process of completing of the myelin sheath, the provision of mesaxons changes. First of all the internal mesaxon becomes less noticeable. Apparently, formation of new lipoprotein plates and increase in their number promotes more their close-packed arrangement. Naturally, first, the internal mesaxon is squeezed by new plates and becomes less noticeable (Figure 1e).

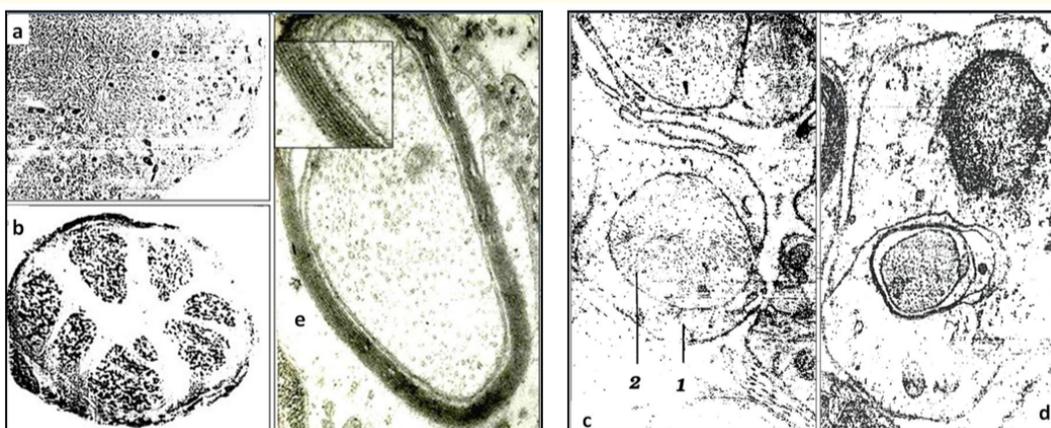


Figure 1: The process of myelination of the musculocutaneous and superficial peroneal nerves.

a: Proximal part of superficial peroneal nerve in 4-month fetus. Microphotogram. Weigert-Pal method; ok. x7, ob. 40 x1,1.

b: Distal part of the superficial peroneal nerve in a 6-month fetus. Microphotogram. Weigert-Pal method; ok. x7, ob. 8 x1,1.

c: Proximal part of the musculocutaneous nerve 6-month fetus; the center of the picture is occupied by an axon, immersed in the Schwann cell; - x8 000; 1- Schwann cell; 2 - axon.

d: Distal part of the musculocutaneous nerve 6-month fetus; round-shaped nerve fibers have a myelin sheath consisting of three lipoprotein plates; inc. - x8000;

e: Proximal part of superficial peroneal nerve in 6-month fetus. Electronogram. The myelin sheath consists of 8 lipoprotein plates; inc. - x30000.

In the investigated period of the prenatal ontogenesis, on electron diffraction patterns of the distal part of both nerves larger groups of unmyelinated fibers and single little myelination fibers appear as transparent.

Usually nerve fibers with a thick myelin sheath have an axon of large diameter. However, in the electron photograms shown that diameter of an axon of the myelin fiber is equal in one case to diameter of the nerve fiber having rather thick myelin sheath. The discrepancy of regularity in rectilinear communication (Figure 2) between thickness of the myelin sheath and diameter of an axon are more characteristic of the fibers, which are at early stages of process of myelination. It can be explained with preservation of cytoplasmatic layers between lipoprotein plates (despite their insignificant quantity) the myelin sheath. In two nerve fibers with the identical thickness of the myelin sheath (1.1 mc), in the first is 3 and in the second 11 lipoprotein plates. At the same time diameter of an axon in the first fiber is equal to 1.5 mc, and in the identified - 1.7 mc. In similar cases between a myelin sheath and an axon the space of cytoplasmatic structures.

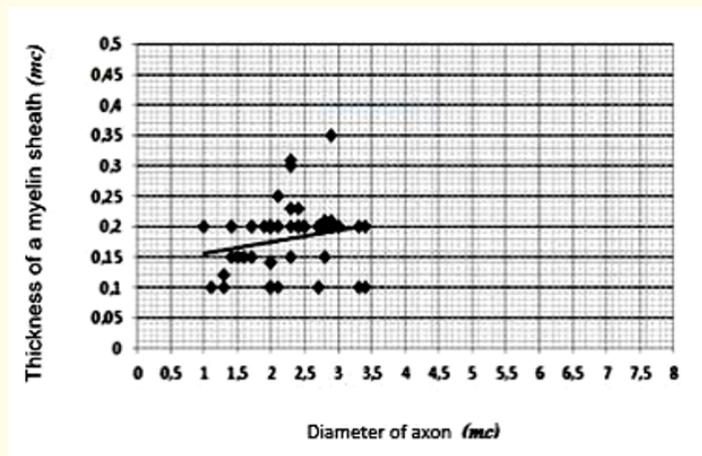


Figure 2: The relation of thickness of a myelin sheath to diameter of an axon in a musculocutaneous nerves of a 6-month fetus.

Conclusion

Nerve fibers, the innervating muscles of both the upper and lower extremities are exposed to be more accelerated myelination than the fibers supplying skin. Process of myelination of nerve fibers results from the difficult interaction of a neurolemmocyte with an axon. The myelin sheath can formed around an axon with a diameter less than 1 mc. At early stages of myelination the steep orientation of internal and external mesaxons is identified. The size of a cross cut of a myelin nerve fibers depends on the size of groups where they are located. In process of increase in amount of nerve fibers in group's diameter of an axon decreases. In a prenatal ontogenesis between thickness of a myelin sheath and diameter of an axon, there is a rectilinear correlative communication. In some cases, divergences from the general regularity are noted. It is characteristic of earlier stages of the process myelination.

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