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Growth cones in the superior cervical sympathetic ganglion in human foetus aged 23 weeks

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Ultrastructural study was conducted on the superior cervical sympathetic ganglia in human foetus aged 23 weeks. It was shown that in investigated foetus the nerve fibres in the ganglion were in different phases of myelination. Also growth cones, which present evidence of still growing fibres, were observed.

key words: human neuroembryology, superior cervical ganglion, growth cone

INTRODUCTION

The growth cone is both a sensory structure that receives directional cones from the environment and a motor structure whose activity leads to axon elongation during development. The growth cones are actively growing tips of all branches of axons and dendrites [2].

Growth cones are guided by at least four different mechanisms: contact-mediated attraction, chemoattraction, contact-mediated repulsion and chemorepulsion [1, 5, 7].

The sensory capability of the growth cone depends in large part on its filopodia. These rod-like structures, rich in actin, are highly motile. Their membranes have receptors for the molecules, which serve as directional cues for the axon.

The superior cervical ganglion appears early in human development and it is formed by the coalescence of three or four ganglia. It contains synapses between preganglionic and postganglionic neurones [4]. It is an important structure for the innervation of the head and neck.

The aim of the present study is to trace the growth cones in the superior cervical ganglion in human foetus aged 23 weeks. This proves that the nerve fibres are still growing in the second half of the intrauterine period.

MATERIAL AND METHODS

Investigations were performed on superior sympathetic cervical ganglia removed from foetus aged 23 weeks (C-R length 220 mm). The superior cervical ganglia were dissected in 1.2% solution of glutaraldehyde. Pieces of ganglia were stained with 1.2% glutaraldehyde for 1 hour and then placed in 2% glutaraldehyde for 2 hours. The fixatives were buffered to pH 7.4 with cacodylate. The material was postfixed in 1% osmium tetroxide for 1 hour. Thin and semithin sections were made on Reichert ultramicrotome. Semithin sections were stained with toluidine blue and thin sections were rendered contrasty with uranyl acetate and lead citrate. Thin sections were inspected with Opton EM 10 and Philips electron microscopes.

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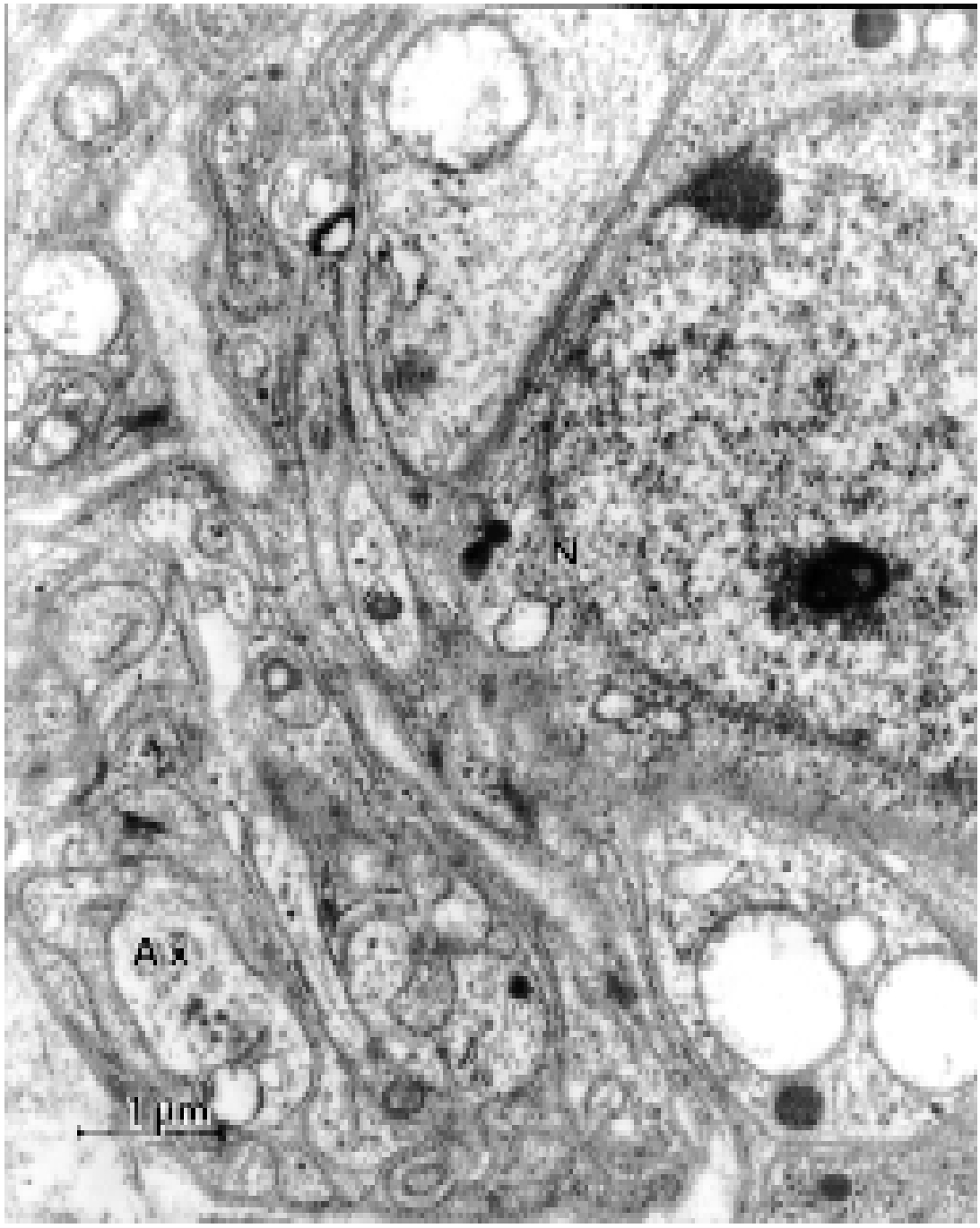

Figure 1. Bundles of axons in superior cervical ganglion of human foetus 220 mm C-R length; Ax — axon, N — neuroblast.

RESULTS

In the investigated foetus the superior cervical ganglion is composed of ganglion cells, and of bundles of axons surrounded by neurolemmocytes (Fig. 1). The bundles of axons are separated from each other by endoneurial spaces containing collagenous fibres and fibroblasts (Fig. 2, 3).

In this foetus the process of myelination is in different phases. Although many nerve fibres are already well myelinated, fibres in the beginning of myelinogenesis are found (Fig. 2, 3). The well myelinated fibres present a compact myelin sheath possessing up to 20 myelin lamellae. The myelinating axons at the

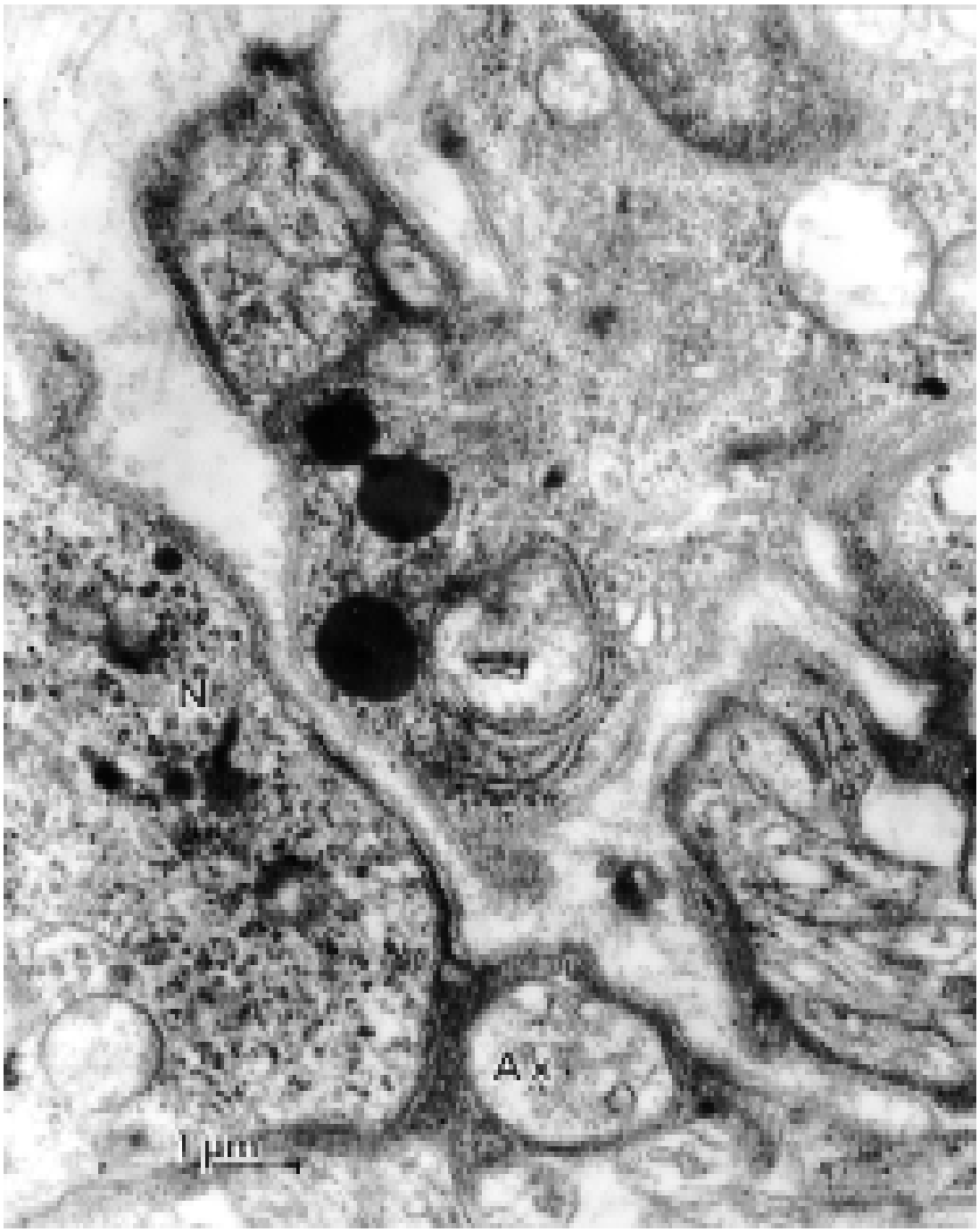

Figure 2. Part of superior cervical ganglion of human foetus aged 23 weeks; Ax — axon, N — neuroblast.

very beginning of myelination have one or one and a half turns of lemmocyte processes (Fig. 2–4).

In the superior cervical ganglion within the bundles of axons the growth cones are also present (Fig. 5, 6). They are large profiles containing mitochondria, microtubules, neurofilaments, cisternae of smooth endoplasmic reticulum, and growth cones vesicles. At the leading edge and along the sites of growth cones, fingerlike processes (filopodia) and marked sheets of membrane (lamellipodia) are observed. Some filaments are organized into tight bundles, which are rarely seen in axons and form the core of filopodium (Fig. 6). Mem-

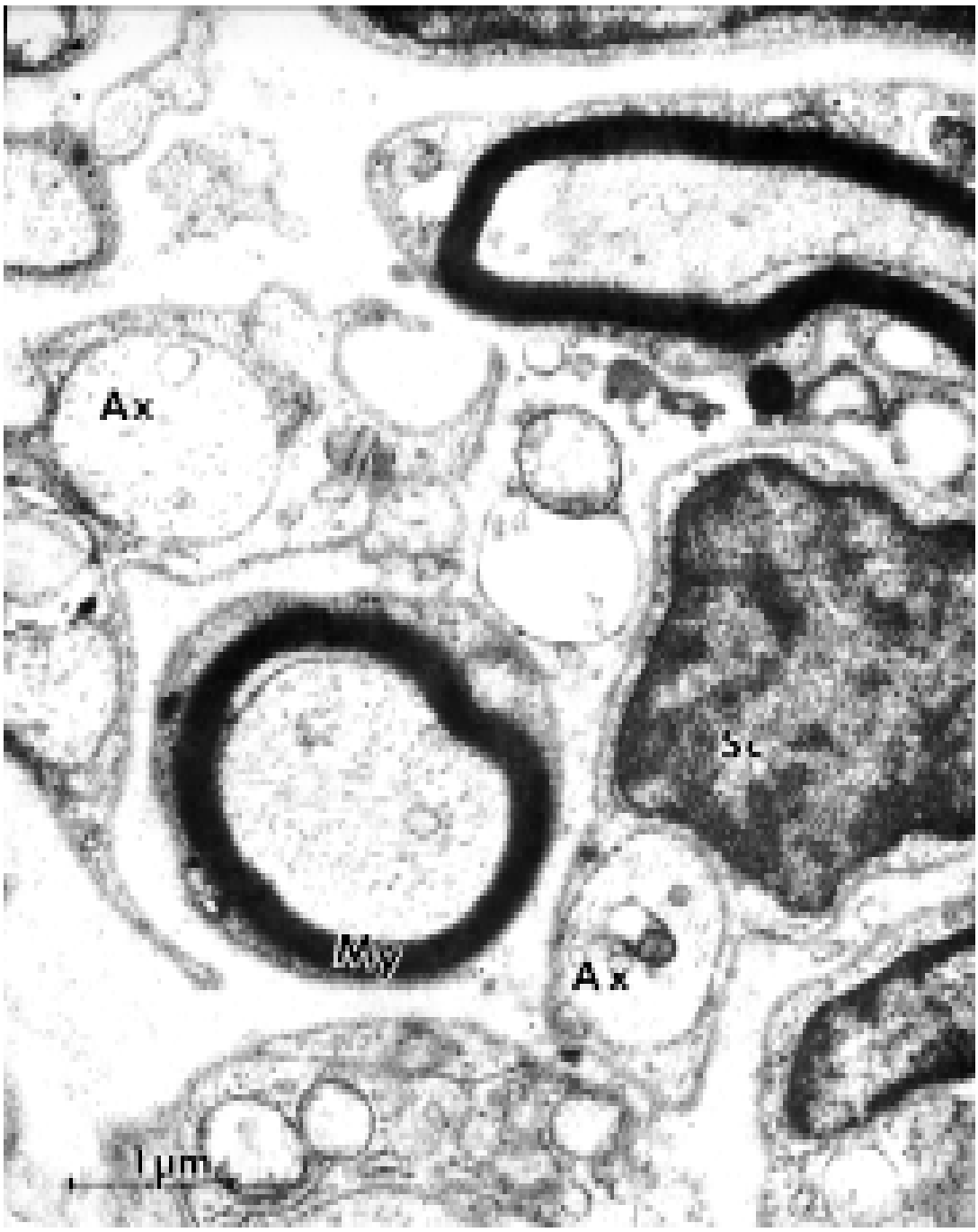

Figure 3. Various phases of myelination in superior cervical ganglion of human foetus aged 23 weeks; Ax — axon, My — myelin sheath, Sc — Schwann cell.

brane vesicles accumulate in the central region of the growth cones. The organised bundle of microtubules, which is characteristic of axons, ends in the base or neck of the growth cone.

This gives evidence that in the investigating period of development an intensive growth of neurites in superior cervical ganglia is still taking place.

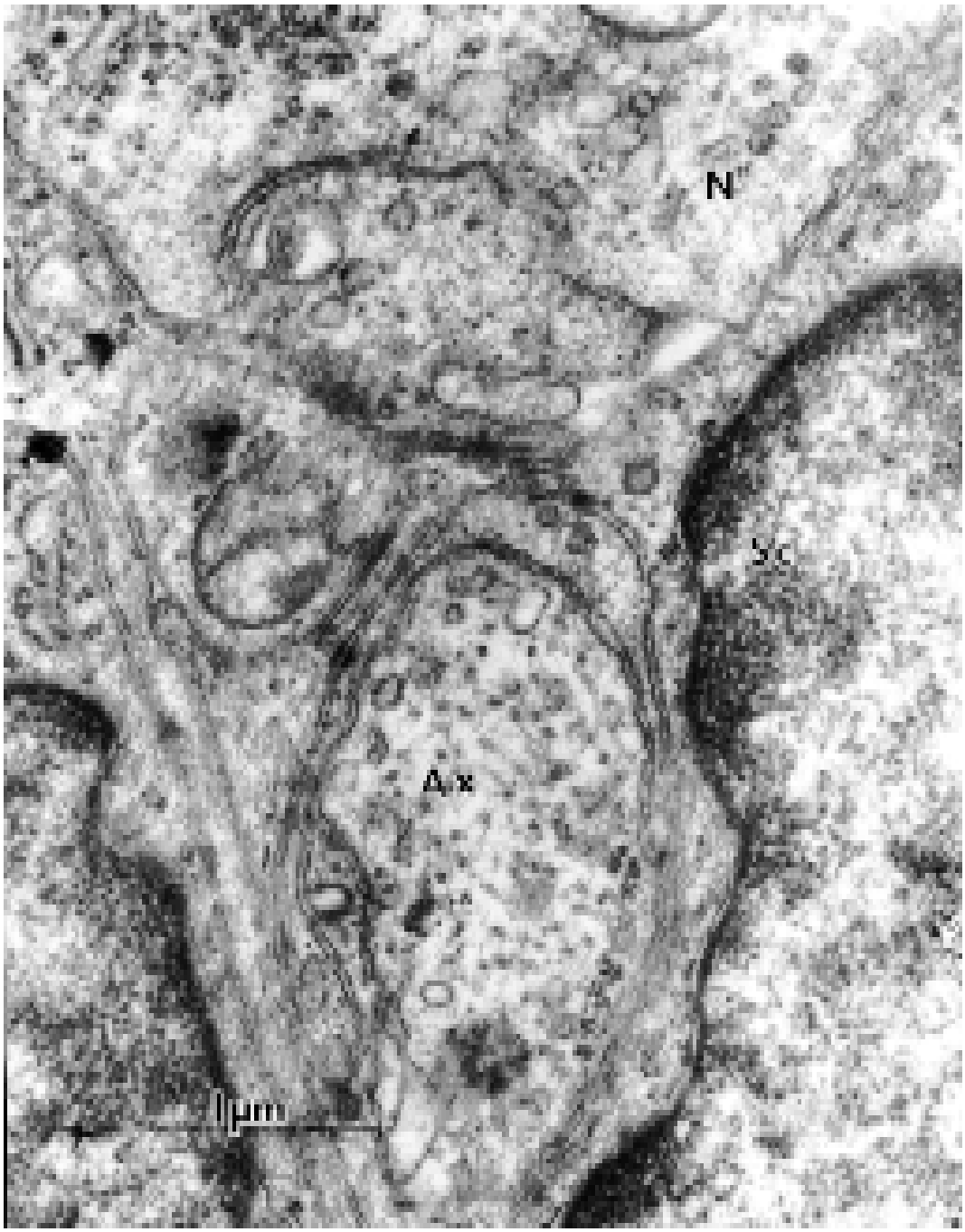

Figure 4. Myelinating axon and Schwann cell in superior cervical ganglion of human foetus aged 23 weeks; Ax — axon, N — neuroblast, Sc — Schwann cell.

DISCUSSION

The growth cone determines the direction and pattern of neurite growth. It is a highly motile structure at the end of growing axons and dendrites whose movement is largely actin-based [8].

The pathways along which axons grow provide a large number of diverse molecular cues to guide axons to their targets, and the axons possess exquisitely specific receptors to recognize and interpret these cues [3]. The sensory capability of the

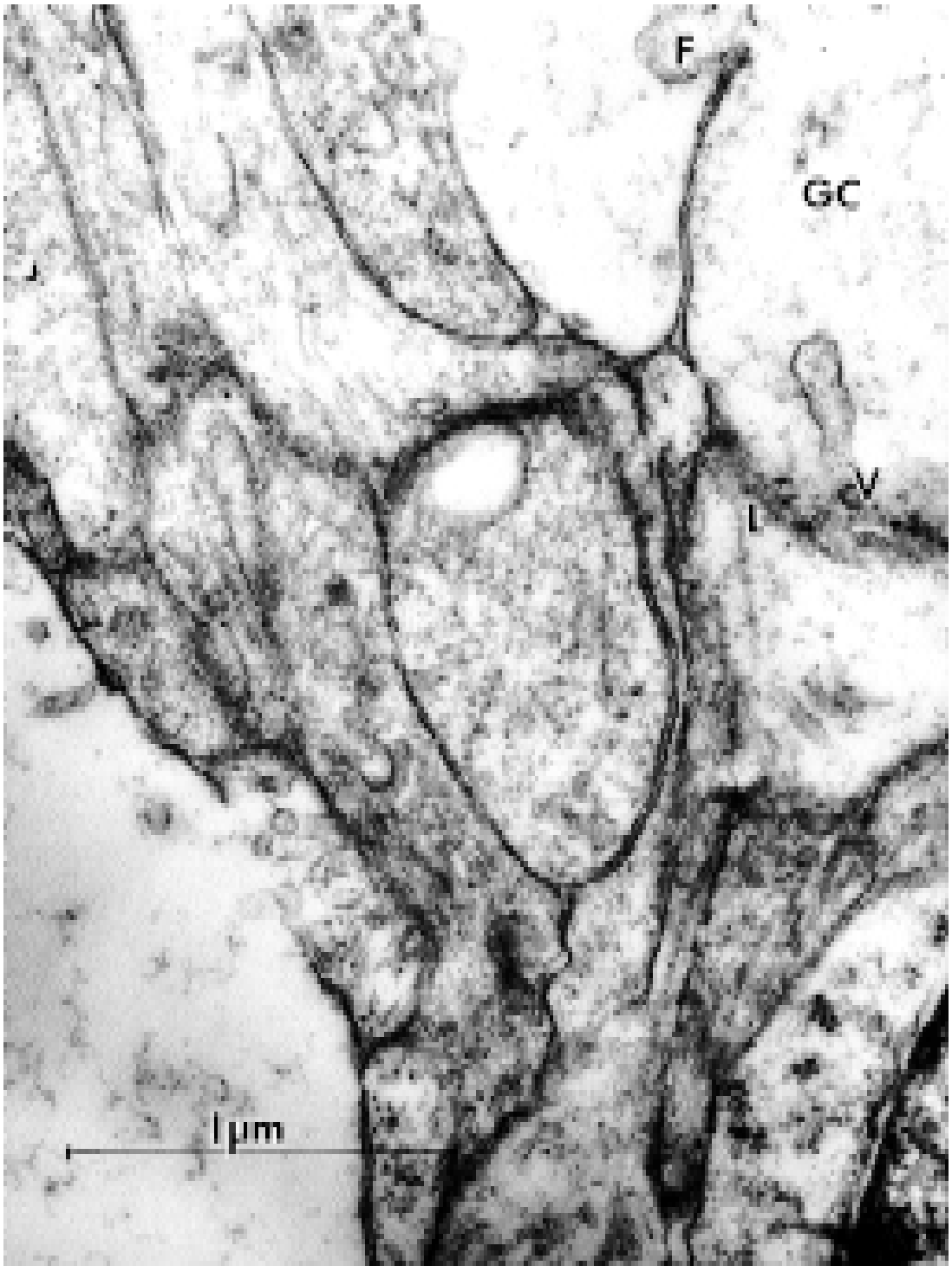

Figure 5. Growth cones in the superior cervical ganglion of human foetus aged 23 weeks; F — filopodium, GC — growth cone, L — lamellipodium, V — growth cone vesicle.

growth cone depends in large part on its filopodia [6].

Performed study has shown that the nerve fibres elongate in the second half of the intra-uterine period. It is impossible to differentiate these fibres into preganglionic or postganglionic. It is also evident that the myelination is still in progress.

The structure of the growth cones in the superior cervical sympathetic ganglion resembles that of the spinal cord [9, 10].

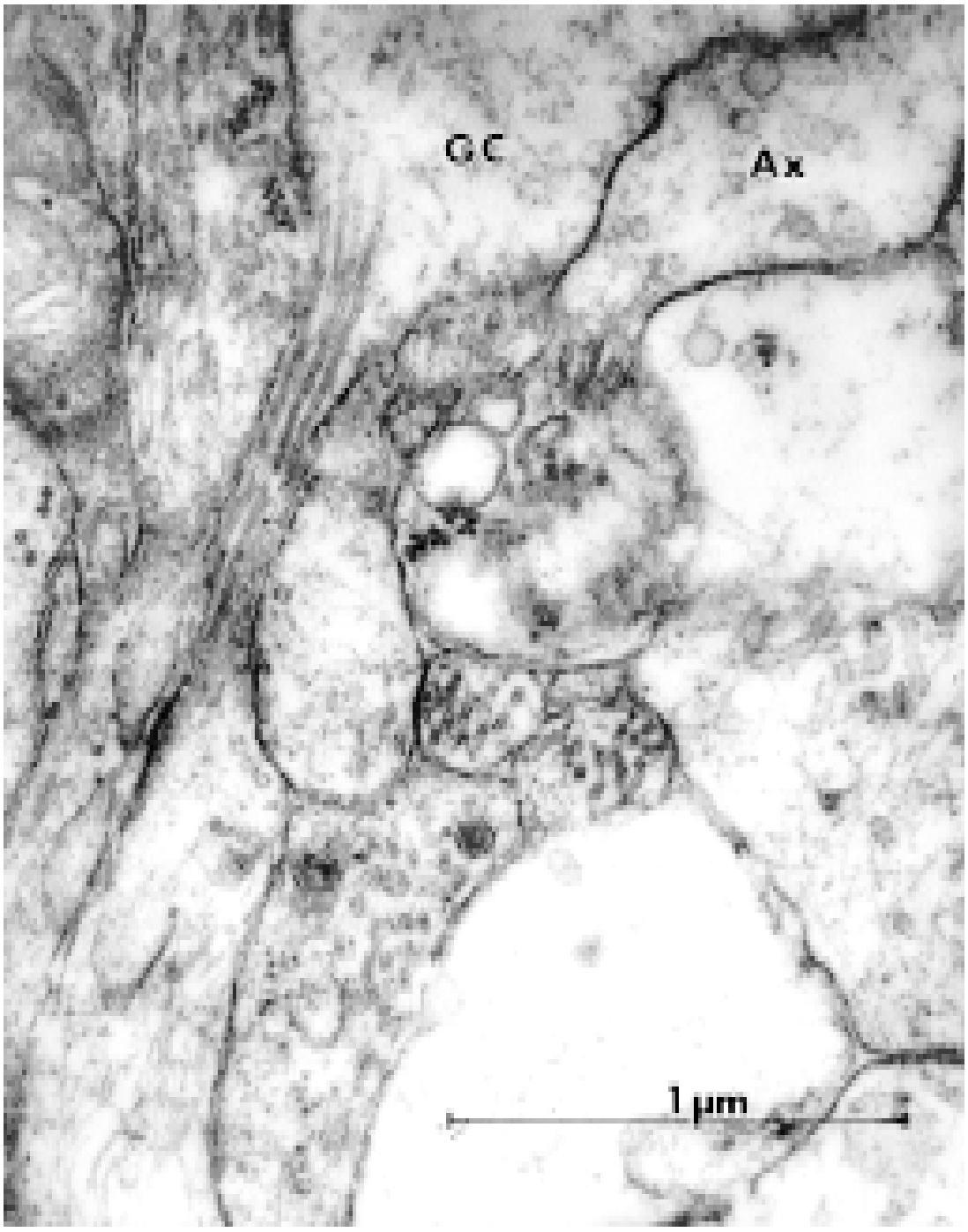

Figure 6. Growth cones in the superior cervical ganglion of human foetus aged 23 weeks; Ax — axon, GC — growth cone.

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