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Tissue Architecture of Sciatic Nerves in the Euphoretic Jerboa: A Histomorphological Investigation

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Abstract Experimental research includes models of peripheral nervous system illnesses, nerve damage, and regeneration frequently use the sciatic nerve in rats. Still, the sciatic nerve's unusual features and possibility for "dying back" neuropathies call for greater explanation in terms of shape. Using hind limb nerves of rats, researchers have created experimental models of neuropathies. Six male Euphoretic jerboas split into two groups and anaesthetized with ketamine and xylazine in the research. The sciatic nerves were revealed and morphometric measures noted following meticulous anatomical dissection. The sciatic nerve, according to results, first bifurzes into two main branches near the knee joint: the peroneal (sural) nerve and the posterior tibial nerve. It then runs via a deep channel between the dorsal side of the ischium and the sacral bone in the minor pelvis. Indicating the range of nerve functions, historological study found a network of capillaries inside the endometrium, Schwann cell nuclei on the outer edge of the myelin sheath, and varied nerve fibre sizes. Comprising concentric layers of connective tissue that give structural support and protection for the nerve fibres, the perineurium which encases the nerve is Protection of the nerve against mechanical damage depends critically on the epineurium, the outermost layer of connective tissue covering it. Notable are internal vibrations of nerve fibres within the axonal area and around the myelin sheath, presumably connected to mechanical interactions or electrical activity among biological components within the neuron. These results could support comparative studies or investigations on rodent neurological damage and recovery.

Keywords: Nerve, nerve fibers, connective tissue, Euphoretic jerboas

Introduction The sciatic nerve is the one that is most commonly employed in experimental studies involving nerve injury, regeneration, and models of peripheral nervous system diseases. Usually, macroscopic and microscopic data on the sciatic nerves refer to the control groups of these experimental studies, and so it is still necessary to systematize these data through a specific study. The morphology of the sciatic nerve in rats has interested neuroscientists for many decades, and despite an extensive publication in the last decade (1,2), information on normal sciatic nerve data in rats deserves more clarification. If you have problems with the nerves in the brachial plexus or the lumbosacral plexus, they are not at all the same. The adjacent connective tissue is also different. Researchers like to do experiments on the lumbosacral plexus because it is more likely to get diabetic neuropathies, which is the most common disease of the lumbosacral plexus roots in men, and because it is hard to diagnose because of where the roots are located (3,4). The sciatic nerve and its branches are at risk of being the first nerves to develop “dying back” neuropathies due to their length. Moreover, these nerves are less susceptible to traumas that would interfere with the experimental results. Taken together, all these factors have led investigators to develop experimental models of neuropathies using nerves of the hind limbs of rats (5).

Material and Methods

Ethical approval

The project was approved (2258 in 2/9/2024) by the Committee for Research Ethics at the College of

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We divided six male Euphoretic jerboas into two groups: animals weighing between 60 and 100 g (n = 6). The animals were anaesthetized with ketamine and xylazine. After careful anatomical dissection, the sciatic nerves were totally exposed, and proximal (immediately after passing through the major sciatic foramen) and distal (at the popliteal fossa, right away before the terminal branching) segments were removed for histological hematoxylin and eosin processing as well as Masson trichrome stain. For the morphometric study, the images were acquired via a digital camera. Next, we recorded the morphometric parameters, including weight (g) and length (mm). We also recorded the width (mm) and thickness (mm).

Results:

As shown in Figure 1, the sciatic nerve goes to its destination through a deep groove between the dorsal side of the ischium and the sacral bone in the minor pelvis. As it moves away from the sciatic notch, it gets longer between the gluteal and biceps femoris muscles on the underside of the piriformis muscle (Fig. 2). Two millimetres below the piriformis muscle, it goes over the quadratus femoris muscle and into the thigh area in an oblique direction. There is also a short branch that goes to the piriformis muscle and gives nerves to the biceps femoris, semitendinosus, and semimembranosus muscles (Fig. 3). The peroneal (fibular) nerve and the posterior tibial nerve are the two main branches that it divides into once it reaches its termination, roughly 5 millimetres cranial to the stifle joint (Fig. 4). The mean of length and thickness was 45 $\pm$ 0.04 mm and 0.1 $\pm$ 0.00 mm.

A study conducted using a microscope on the sciatic nerve revealed that blood capillaries are located in the endoneurium, Schwann cell nuclei are located peripheral to the myelin sheath, and nerve fibres come in a variety of diameters. When modelling connective tissue, the preneurium (Figure 5) was a component that encompassed the entire nerve, resulting in the formation of concentric layers around it. Additionally, it was possible to observe squamous nuclei of fibroblasts. Although it was not modeled, the epineurium, which is also composed of connective tissue, was observed in close proximity to the preneurium (Figure 6)., it was seen that the axons and the region around the myelin sheath were vibrating internally(Figure.7).

Discussion:

The gross anatomy of the sciatic nerve: The morphology of the sciatic nerve in jerboas and other rodents exhibits a specific trajectory that aligns with the anatomical configuration of the pelvis and thigh (6,7). The sciatic nerve traverses a deep fissure between the posterior surface of the ischium and the sacrum in the pelvis, enabling its extension to the thigh (8). Upon leaving the sciatic notch, the nerve traverses between the gluteus mediums and the biceps femora's on the anterior surface of the piriformis muscle (9,10). This anatomical path guarantees an effective allocation of nerve fibres to the principal muscles of the thigh, including the biceps femora's, semitendinosus, and semimembranosus (11,12). The sciatic nerve bifurcates into two primary branches as it nears the knee joint: the peroneal (sural) nerve and the posterior tibia nerve (13). This split facilitates an exact functional allocation of the nerves in the hind limb, with the peroneal nerve innervating the muscles that govern foot movement, whereas the posterior tibia nerve innervates the leg's extensor muscles (14).

Histological features of the sciatic nerve: Histological analysis revealed a network of capillaries within the endoneurium, which supplied essential nourishment to the nerve fibres(15). Schwann cell nuclei were located in the outer perimeter of the myelin sheath, underscoring their essential role in myelination and the support of nerve fibres. Different nerve fibres have different diameters, which shows the variety of nerve functions (16). Wide fibres help send sensory and motor information quickly, while small fibres are connected to feeling pain and temperature. The preneurium, which encases the nerve, consists of concentric layers of connective tissue that provide structural support and protection for the nerve fibres. In this area, fibro epithelial cell nuclei were also found, which means that cells are still working to keep the connective tissue intact. The epineurium, the outermost layer of connective tissue encasing the nerve, is crucial for safeguarding it against mechanical damage(17).

Internal vibrations of nerve fibres: Noteworthy is the existence of internal vibrations within the axonal area and around the myelin sheath. These vibrations may pertain to the electrical activity of nerve fibres or to mechanical interactions among biological components within the neuron(18). This phenomenon necessitates additional investigation to comprehend its potential physiological function in nerve signal transmission or in preserving the integrity of nerve fibres. The study mostly looked at the jerboa, but the results may be similar to other rodents as well, since the sciatic nerve is similar in structure and function in many rodent species. Nonetheless, minor variations in lengths and diameters may occur depending on the body size and motor function of each species (4,10).

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It is clear that the structure and histology of the sciatic nerve in jerboas are perfectly suited to the sensory and motor functions of the back leg. The intricate histological architecture, which encompasses microvasculature, Schwann cells, and specialized connective tissues, underscores the significance of this neuron in the effective transmission of nerve signals (9). These results give us a better understanding of how the sciatic nerve works in rodents. They may also help with comparative studies or research about neurological injury and recovery.

Conclusion

The study provides an anatomical and histological description of the sciatic nerve, highlighting its course, branching patterns, and structural features. It begins beneath the gluteal and biceps femoris muscles and runs through a groove between the ischium and sacral bone. Key elements include blood capillaries, Schwann cell nuclei, and nerve fibers. The study offers insights for therapeutic and research purposes in neurology and orthopedics, with further research exploring the functional consequences of vibrations and connective tissue layers.

Conflict of interest Authors declare no conflict of interest.

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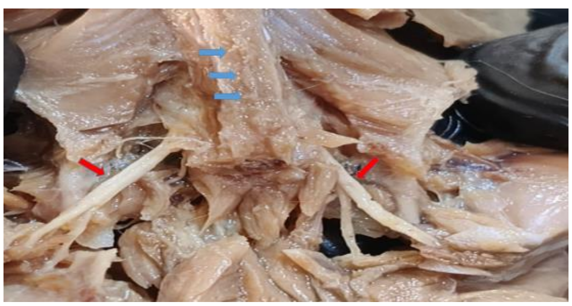

Figure.1 macro anatomical section of sciatic nerve show origin the lumbosacral plexus (blue arrow), right and left sciatic nerve (red arrow)

Figure.2 macro anatomical section show nerves of lumbosacral plexuses: gluteal nerve (weight arrow), obturator nerve (red arrow), sciatic nerve (yellow arrow) and femor nerve (green arrow)

Figure.3 macro anatomical section of hind limb of jerboa show: fibulae fossa (blue arrow), sciatic nerve (yellow arrow),bicepesfemoralis (weight star) and gasteronumus (black star)

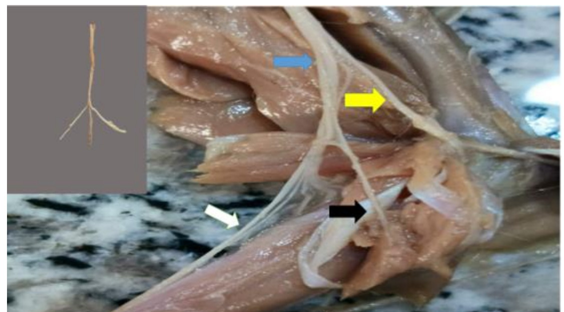

Figure.4. macro anatomical section of hind limb of jerboa show :branched of sciatic nerve (blue arrow),fibular nerve (black nerve),tibia nerve (weight nerve) and (yellow arrow)

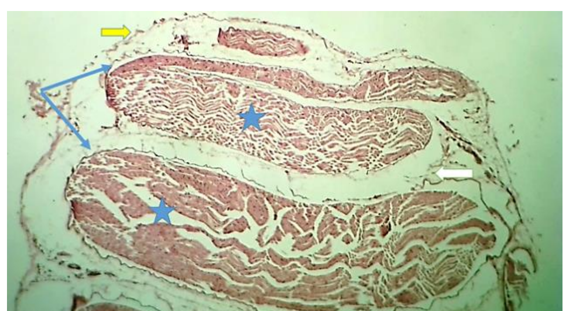

Figure.5 Histological section of sciatic nerve of jerboa show: preneurium (yellow arrow), epineurium (blue arrow), nerve fascicle (blue star) and connective tissue (weight arrow) H&E 40X

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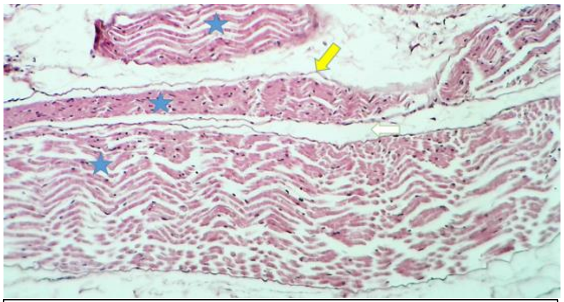

Figure.6 Histological section of sciatic nerve of jerboa show: epineurium (yellow arrow), nerve fascicle (blue star) and connective tissue (weight arrow) H&E 40X

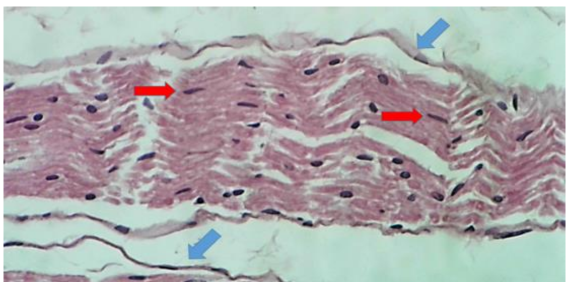

Figure.7 Histological section of sciatic nerve fiber of jerboa show: epineurium (blue arrow), nerve fascicle (blue star) and fibroblast (red arrow) H&E 100X

Figure.8 Histological section of sciatic nerve fiber of jerboa show: Axons , Ranvier node (blue arrow) and Schwan cell (yellow arrow) H&E

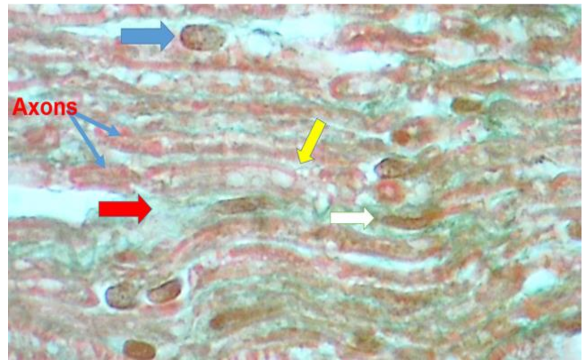

Figure.9 Histological section of sciatic nerve fiber of jerboa show: Axons, Schwan cell (blue arrow), fibroblast (weight arrow), collagen fiber (yellow arrow) and connective tissue (red arrow) Massontrichom 400X

Conflict of interest
There is no conflict of interest in this study as stated by the authors.
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