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STRUCTURAL ANATOMY

Current occurence of intraspinal intradural and extradural communicating branches in the spinal canal

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ABSTRACT

THE AIM of this work is to point out the intraspinal anatomical current occurrence interconnections between intradural and extradural nerve roots and their possible participation in radiculopathy.

METHODS: The anatomical study was performed in 43 cadavers with a mean age of 53.7. All intradural and extradural rami communicantes between nerve roots were excised and examined histologically for the presence or absence of nervous tissue.

RESULTS: Anatomical preparations revealed intradural and extradural rami communicantes in 9 cases (20.9 %), mostly in the cervical region in 5 cases and by plexus formation variations in 5 cases. Multiple extradural rami communicantes were observed in 6 cases (13.95 %), including the simultaneous occurrence of multiple intradural and extradural ones in 5 cases (11.6 %).

CONCLUSIONS: This study allowed us to identify and describe unpublished intraspinal current occurrence intradural-extradural rami communicantes of nerve roots and their interrelationships throughout the spinal canal with their potential influence on the clinical picture *(Tab. 1, Fig. 4, Ref. 25)*. Text in PDF *www.elis.sk.*

KEY WORDS: intraspinal nerve roots, intradural nerve roots, extradural nerve roots, nerve roots variations.

Introduction

To our knowledge, no study has reported current occurens interconnections between intradural and extradural nerve roots in the cervical, thoracic, and lumbosacral region in reference to a normal, prefixed, or postfixed type of brachial and lumbosacral plexuses.

Most of the papers on the intraspinal variations of nerve roots dealt with extradural anatomical variations of lumbosacral nerve roots (1 – 17).

The present study was undertaken to determine if there is any relationship between the level and concentration of intradural-extradural root interconnections with their potential influence on the clinical picture.

Materials and methods

The anatomical study was carried out in 43 fresh cadavers without congenital or detected abnormalities, tumour diseases, orthopaedic deformities and spinal operations within 24 hours from the death. The study included 32 men (74.4 %) aged 30 to 75 years and 11 women (25.6 %) aged 45 to 77 years. The subjects had died from a violent death, most often in car accidents, when the spine had not been damaged. The study was conducted with approval with the ethics committee.

In the prone position, we separated paravertebral muscles from processus spinosi and laminas on both sides from the cervico-cranial transition to the sacrum. Processus spinosi were removed using bone punches and Stryker´s saw. Laminas on both sides, as well as parts of articular projections, were removed with the Kerisson rounger. Such "roofing off" allowed the direct visualization of the spinal canal without damaging the spinal cord and nerve roots. A wide laminectomy from cervico-cranial transition to the sacrum revealed the whole spinal canal to examine each cervical, thoracic, lumbar, and sacral nerve root from its protrusion out of the spinal cord to its exit from the spinal canal through the foramen intervertebrale and hiatus sacralis. Subsequently, we made a longitudinal incision of the dura and we removed it entirely from the spine and nerve roots. The nerve roots were cut distally from the spinal ganglion to allow direct visualization of the spinal cord, conus medullaris, and spinal nerve roots. The exposed segments of the spinal cord and nerve roots were examined, monitored and reviewed, including a detailed examination of the intradural and extradural rami communicantes.

The type of the plexus was defined by subtracting from the root C2. Specification of the type of plexus was carried out on the basis of the formation of intradural and extradural roots.

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Results

In 9 cases (20.9 %), current occurrence extradural and intradural rami communicantes between the nerve roots were observed (Fig. 1, Tab. 1). Mostly in cervical region 5 cases. Extradural anastomosis occurred in the spinal canal before its emergence from the spinal foramen. The anastomosis occurred at the preganglionic level about 1 cm outside the dura sac.

Multiple extradural rami communicantes were observed in 6 cases (13.95 %) (Fig. 2), including the simultaneous occurrence of multiple intradural and extradural ones in 5 cases (11.6 %). In the cervical region in 3 cases (Fig. 3) and in 2 cases in the lumbosacral region. They occurred more frequently by plexus formation variations (5 cases). Rami communicantes were mostly – in 6 cases – unilateral. The histological examination confirmed the neural tissue (Fig. 4).

Discussion

Most of the papers on the intraspinal variations of nerve roots dealt with extradural anatomical variations of lumbosacral nerve roots (1 – 17). They revealed the extradural rami communicantes ranging from 1% to 25% of cases. In our study, it was in 2 cases (4.6 %).

Comparing our anatomical findings with previous results of other authors (5, 10, 11, 14), it appears that a percentage rate was lower, and the types of extradural variations were partially different.

To our knowledge, no study has reported current occurence between intradural and extradural communicating branches between nerve roots in the cervical, thoracic, and lumbosacral region in reference to a normal, prefixed, or postfixed type of brachial and lumbosacral plexuses.

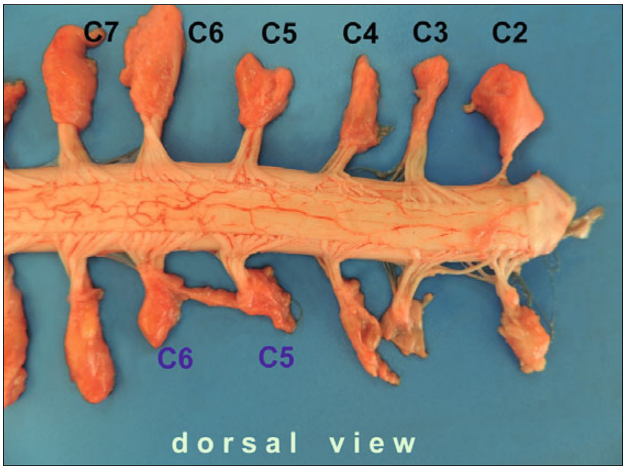

Fig. 1. Dorsal view, intradural ramus communicans between the roots C2–C3 dx. Extradural ramus communicans between the roots C5–C6 dx.

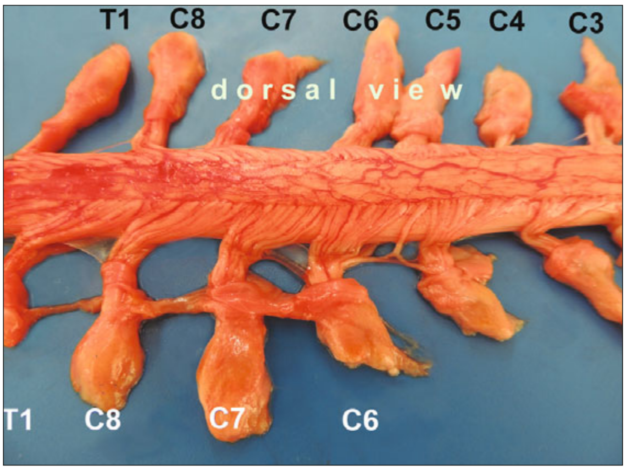

Fig. 2. Dorsal view, intradural ramus communicans between the roots C5–C6 dx. Extradural rami communicantes between the roots C6–C7–C8–T1 dx.

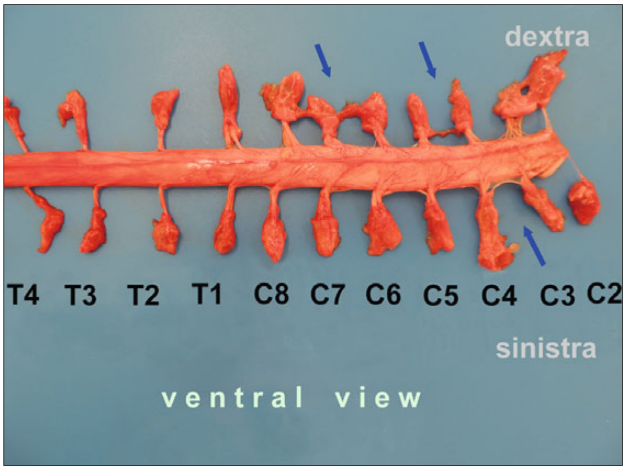

Fig. 3. Ventral view, intradural ramus communicans between the roots C3–C4 sin. Extradural rami communicantes between the roots C4–C5 dx and C6–C7–C8 dx.

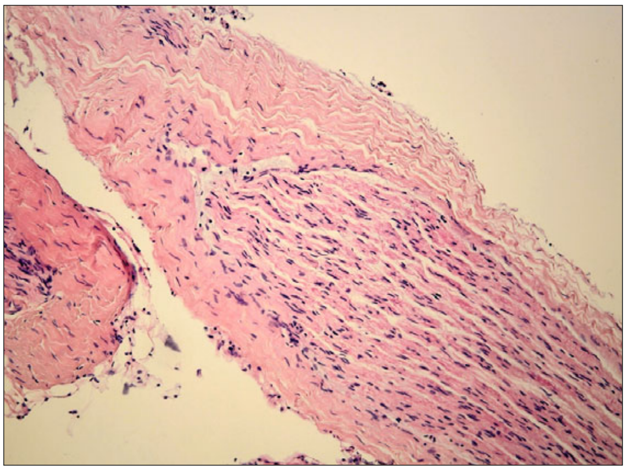

Fig. 4. Longitudinal section of the nerve with perineurium, no inflammation, fibrosis, 200x HE.

Tab. 1. Current occurrences of intraspinal intradural-extradural rami communications.

Plexus type	Number	Number intraspinal extradural anastomosis	Intraspinal intradural--extradural rami communicantes			Simultaneus multiple intradural-extradural rami communicantes			Multiple extradural single intradural rami communicantes			Single intradural and extradural ramus communicans		
			C	T	LS	C	T	LS	C	T	LS	C	T	LS
Normotype	30	4	2	1	1	2	–	1	–	–	–	–	1	–
Prefix. type	9	3	2	–	1	1	–	1	–	–	–	1	–	–
Postfix. type	4	2	1	1	–	–	–	–	1	–	–	–	1	–
Total	43	9	5	2	2	3	0	2	1	0	0	1	2	0

Prefix. – prefixed, Postfix. – postfixed, C – cervical, T – thoracic, LS – lumbosacral

Current occurrence extradural and intradural rami communicantes between the nerve roots were observed in 9 cases (20.9 %).

Multiple extradural rami communicantes were observed in 6 cases (13.95 %), including the simultaneous occurrence of multiple intradural and extradural ones in 5 cases (11.6%). In the cervical region in 3 cases and in 2 cases in the lumbosacral region. They occurred more frequently – 5 cases by the plexus formation variations. Rami communicantes were mostly – in 6 cases – unilateral.

Interneural interconnections may cloud clinical interaction (1, 18, 19).

Embryologic evidence can account for the frequent occurrence of intradural variations. The aetiology of this abnormalities – variations is unknown. One hypotesis is the defect of the nerve roots migrations during the first four weeks of embryonic development (20, 21).

Symptoms of radiculopathy may manifest intraspinal variations of nerve roots even in cases of the absence of pressure on nerve roots (5, 6, 9, 22). Some papers are based on surgical findings (23); others are based on anatomical studies (9, 12). Their incidence ranges from 1.3% found during the operation (6) to 2–6.7 % detected by imaging methods before surgery (9, 11, 16, 22), and from 8.5 % to 30 % during the study of cadavers (6, 22).

They can be the cause of failure in operations of discs (11).

Variations themselves can cause pain. The spinal cord is mobile during normal flexion and extension. Therefore, larger traction forces may be produced with variations in nerve roots, as well as with normal movements of the spinal column (24).

Stretch-induced nerve root injury may be related to changes in the length of the spinal canal and in the length of the nerve root. The perineurium and endoneurium have considerable mechanical strength and serve to protect neural tissues against mechanical forces. However, the intrathecal nerve roots do not have such a protective sheath (19, 25). Excessive flexion of the torso during variations surgical procedures may be one of the risk factors for injury of the tethered roots in the presence of intrathecal pathologies (1). Therefore, the current occurrence intraspinal intradural and extradural communicating branches between nerve roots are vulnerable to mechanical stretch, including operative manoeuvres and trauma.

Our study is affected by some factors such as strong regional focus, and a small number of cadavers. This limitation affects the interpretation of our data quality, and the ability to generalise our findings.

Conclusion

Anatomical preparations revealed a higher incidence of current occurence intraspinal intradural and extradural communicating branches mainly by the plexus formation variations and between cervical roots.

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