The Intersegmental Anastomosis of the Posterior Spinal Nerve Rootlets of the Thais

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ABSTRACT

Objective: To demonstrate the percentages of the type as well as the frequencies of the rootlet anastomoses in all levels of the spinal cord of the Thais.
Methods: Spinal cords and meninges were dissected from the vertebral columns of 42 Thai cadavers at the Department of Anatomy, Faculty of Medicine Siriraj Hospital. The dura and arachnoid maters were carefully dissected along the median plane longitudinally to expose the spinal cord posteriorly. The posterior nerve roots, rootlets and cauda equina were carefully exposed for a clear vision. Each of the spinal cords was examined throughout its length looking for posterior rootlet anastomoses.
Results: The percentages of intersegmental anastomosis between posterior rootlets were 45, 3, 29 and 23% in the cervical, thoracic, lumbar and sacral segments, respectively. Three types of intersegmental anastomosis, 1a, 1b and 2 were recorded.
Conclusion: Intersegmental anastomosis of the posterior nerve rootlets was observed in every segment of the spinal cord; the highest incidence was found in the cervical segment. The findings in this study suggest a variable range of dermatome distribution at a higher extent than previously thought.

Keywords: Spinal rootlets anastomosis

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The variation of the pattern of the nerve plexus formation such as the brachial plexus as well as the distribution of the peripheral nerves contributes to the difference in dermatome patterns.[1] The presence of anastomoses between the cervical posterior rootlets of the spinal cord was described[4], and considered to be a potential factor in causing deviations from normal dermatome patterns. Cervical nerve rootlets anastomoses have clinical significance regarding posterior rhizotomy for the relief of pain.[4] The patterns of the interconnections between posterior rootlets of adjacent segments in the human spinal cord were also described.[3] The study revealed that the posterior rootlet anastomoses were best developed in the upper cervical region, absent in the thoracic region and present again in the lumbosacral region.[3] Studies of the nerve rootlets anastomosis were also carried out in other vertebrates such as in the monkey, dog, cat, ox and in the rabbit.[4] The anastomoses found in such animals were also in the cervical and the lumbosacral regions and absent in the thoracic region.[4] Patients with posterior rhizotomy of the tenth and eleventh thoracic dorsal roots were reported to have irregular bands of anesthesia and the anesthetic area did not reach the posterior midline. It is therefore suspected that posterior nerve rootlet anastomosis is also present in the thoracic region. Only one article reported the presence of posterior rootlet anastomosis in the thoracic region in humans. This study was aimed at finding posterior rootlet anastomoses in Thai cadavers, focussing on the thoracic anastomosis. Variability of the anstomosis in cervical and lumbosacral segments and subsequent dermatome distribution was also included.

MATERIALS AND METHODS

Spinal cords together with meninges were dissected out from vertebral columns of 42 Thai cadavers at the Department of Anatomy, Faculty of Medicine Siriraj Hospital. The dura and arachnoid mater were carefully opened longitudinally from the posterior side of the cord along the median plane to expose the spinal cord, posterior nerve roots and cauda equina. All parts of the spinal cords were carefully examined throughout the whole length for posterior nerve rootlet anastomoses. Numbers and patterns of the anastomosis were recorded.

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RESULTS

Intersegmental anastomosis of posterior spinal rootlets between rootlets of adjacent spinal cord segments was found. The lowermost rootlets of the cephalic cord segment and the uppermost rootlets of the caudal cord segment were connected by tiny nerves. The intersegmental anastomosis can be divided into two patterns.

The first pattern is a simple non-branched intersegmental anastomosis. This pattern is characterized by a fine single nerve connecting neighboring rootlets, and could be further divided into two subtypes according to the positions of the intersegmental connection. The posterior rootlets are divided into the central and peripheral parts. The central part is from the origin of the rootlet to the point of its exit from the dura. The peripheral part is the part that extents out from the dura. Type 1a of the anastomosis is the one that connects the central parts of two neighbouring rootlets and Type 1b pattern is that connects between the central and peripheral parts of two neighbouring rootlets. Some of these intersegmental connections are peripherally located and close to the dura mater, and thus could be missed.

Type 2 pattern is branched or Y-shaped intersegmental connection, and is characterized by the presence of a fine branched nerve connecting neighboring rootlets.

Out of 42 spinal cords, the anastomosis was found in all specimens in the cervical, lumbar and sacral segments, but only eleven specimens in the thoracic segment. Numbers and percentages of each type at each level of spinal segment from 42 spinal cords are in Table 1.

DISCUSSION

The inconsistencies in the formation of nerve plexuses and in the ultimate distribution of peripheral nerves are well known and recognized as variable in considerations relating to segmental cutaneous innervations. Charts illustrating dermatomes over the surface of the body reflect latitude that may not be entirely ascribable to the methods employed in plotting them.[1] The intersegmental anastomosis between posterior spinal rootlets in human spinal cord has been described by Schwartz[2] and Pallie.[3] Human spinal cords were reported to have different types of anastomosis and their arrangement between two sides were not similar. The asymmetrical pattern and some variation in the form of these anastomoses in humans has also been reported.[2-4]

Schwartz[2] has described the presence of anastomoses between the cervical posterior rootlets and considered them as a further potential factor causing deviation from normal dermatome pattern in the areas innervated by the cervical posterior roots. Moreover, he has shown clinical evidence that such anastomotic connections were of surgical significance in the operation rhizotomy for the relief of pain.

In this study the posterior rootlets anastomoses occur more often in the cervical and the lumbosacral regions than the thoracic region. This may be due to several reasons such as the neural crest migration, the presence of cellular interganglionic bridges, the linear growth of the spinal cord from birth to adult and the arrangement of the skin area and musculature.

The migration of neural crests from a particular axial level to the outlying arch is followed by axonal growth of motor neurons of the same level. This furnished a mechanism whereby segmentation in the tube may be matched to that of the outlying structures.[9] Thus the forming of the cervical and lumbosacral plexus of the ventral rami of the spinal nerves might influence the anastomosing of the rootlets. Struter[6] observed that, by the 20th day, the ganglion crest of the hind brain and spinal cord divided longitudinally into right and left halves. At the 4th week each ganglion is

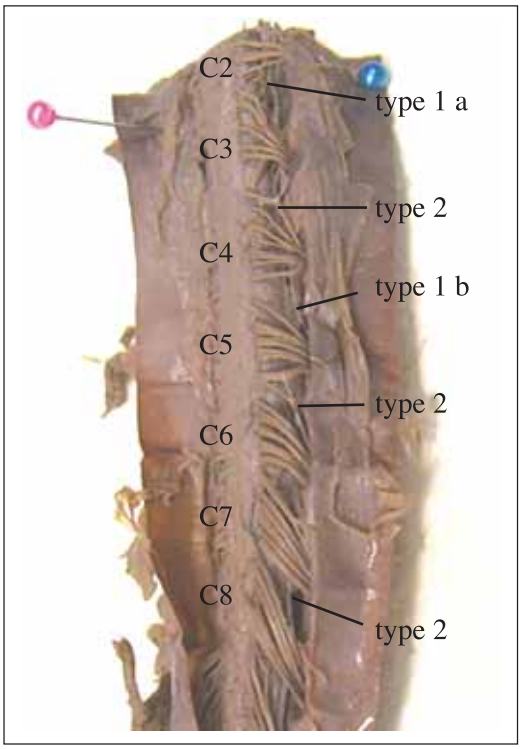


Fig 1. Dissected cervical segments of spinal cord shows 3 types of posterior nerve rootlet anastomosis. (C_2 - C_3 = type 1a, C_3 - C_4 = type 2, C_4 - C_5 = type 1b, C_5 - C_6 = type 2 and C_7 - C_8 = type 2)

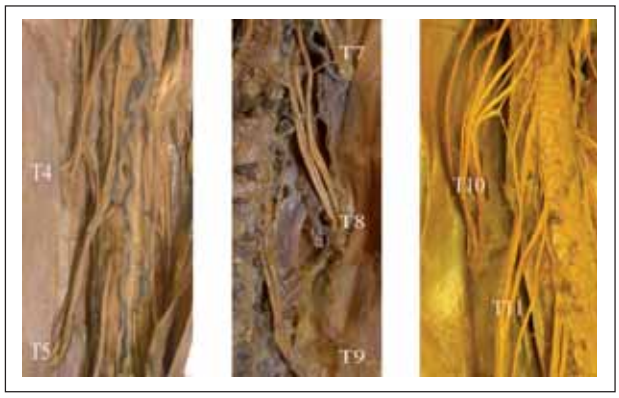


Fig 2. Dissected thoracic segments.



Fig 3. Dissected lumbosacral segments.

TABLE 1. Numbers and percentages of each type at each level of spinal cord segment from 42 spinal cords.

Number of sets of anastomosis from 42 spinal cords				
Level	**Type 1a**	**Type 1b**	**Type 2**	**Total**
C_2 - T_1	82	97	75	254 (45.4%)
T_1 - L_1	9	4	6	19 (3.4%)
L_1 - S_1	70	4	87	161 (28.8%)
S_1 - C_0	44	0	81	125 (22.4%)
Total	205 (36.7%)	105 (18.8%)	249 (44.5%)	559 (100%)

connected to the adjacent ganglion by a bridge that disappears at the end of the 5th week. As rootlets increase in length, the presence of an unbroken bridge of neural crest tissue may provide the posterior rootlets intercommunication during the embryonic life.[3]

The spinal cord grows more rapidly at the thoracic segment than the cervical and lumbosacral segments.[4,7] That factor may result in more intersegmental anastomoses in the cervical and lumbosacral segments, compared to the thoracic segments. However, Moriishi[11] reported 7% of posterior rootlet anastomosis in the thoracic region.

Sensory cells in a dorsal root ganglion, by mean of anastomotic filaments distal to the ganglion, send their peripheral processes to the proper dermatome, while the central processes enter the proper segment by Lissauer's tract. There are considerably overlapping in the cutaneous nerve distribution. The intersegmental anastomosis of posterior rootlets are central processes of sensory cells in dorsal root ganglia. This arrangement is like an extramedullary intersegmental anastomosis while Lissauer's tract serves as the intramedullary anastomosis. Findings in this study may contribute to a wide ranges of dermatome variability in human.

CONCLUSION

The percentages of intersegmental anastomosis of the posterior rootlets of the spinal cord are approximately 45, 3, 29 and 23 in the cervical, thoracic, lumbar and sacral cord segments respectively. The anastomoses in the thoracic segment is very rare as reported in most by studies. The anastomosis can be divided into three patterns, the central to central (1a), the central to peripheral (1b) and the Y-shaped connection (type 2) between adjacent rootlets. Type 2 is the most common (45%) while type 1a is 37% and 1b is 19%.

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