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Dorsal rootlet ganglion: First report

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ABSTRACT

Introduction: Dorsal root ganglia of spinal nerves are developed from neural crest cells (NCCs). NCCs are originated from neuroectoderm at the neurosomatic junction. Separation of NCC from the edges of neural folds involves local disruptions of basal lamina and disappearance of intercellular junctions.

Aim: To determine the existence of ganglia over the dorsal rootlets of all the spinal nerves.

Materials and Methods: A number of 25 formalin-fixed adult human cadavers were utilized for the study. Of 25 cadavers, 18 were male and 7 were female. Removal of spinal cord was done by conventional spinal cord dissection method (posterior approach) as per Cunningham's manual.

Results: This study shows that ganglia are present in the dorsal rootlets of spinal nerves. The dorsal rootlet ganglia are identified in the dorsal rootlets of cervical region and also in the cauda equina region.

Conclusion: This study will be a stimulant in the field of clinical embryology, neuroanatomy, anesthesia, etc., to find the reason and importance of their existence. This may be considered as a special adaptation for a specific sensation.

Key words: Dorsal rootlet ganglion, dorgal root ganglion, inter-segmental sensory ganglion

INTRODUCTION

Dorsal root ganglia (DRG) of spinal nerves are developed from neural crest cells (NCCs).[1] NCCs are originated from neuroectoderm at the neurosomatic junction. Separation of NCCs from the edges of neural folds involves local disruptions of basal lamina and disappearance of intercellular junctions.

These NCCs migrate to various parts of the body. Their migration is along the cell-free pathways filled with extracellular matrix. First appearance of NCCs are seen at the time of 3½ weeks. Neural crest cell formation persists up to 4½ weeks in the regions of brain development and much longer in the regions of spinal cord development.

NCCs are arranged in a continuous sheath along the dorsolateral aspect of the neural tube. NCC migration in spinal cord depends on the development of somites. Depending on the somites, NCC becomes segmented and migrates ventrally.

In spinal cord, NCC first takes part in the formation of pia mater and then participates in the formation of DRG of spinal nerves. After the formation of dorsal spinal root ganglia, it successively forms sympathetic trunk, sympathetic ganglia, sheaths around the roots, etc.

NCCs usually arise from the dorsolateral part of neural tube (dorsal keystone). However, in coccygeal region, they may even emerge from the ventral aspect of the neural tube. In chick embryo, it is found that the migration of NCC in initial stage is an active process; afterward, the basal lamina of dermatomyotome is used as a migratory substrate.

Neurons developing in the spinal ganglia are at first bipolar in nature and later they are transformed into pseudounipolar cells. These pseudo-unipolar neurons have two processes.: one toward the alar lamina of the developing spinal cord and another toward the periphery. The process toward alar lamina constitutes dorsal rootlets and the peripheral process forms the dorsal root of spinal nerve. The process toward the alar lamina reaches the dorsal horn well before when compared to the peripheral process to reach sensory peptides. Thus, peripheral tissue is not taking part in directing the termination of central process.

Aim

The aim of this study was to determine the existence of ganglia over the dorsal rootlets of all the spinal nerves.

MATERIALS AND METHODS

A number of formalin-fixed adult human cadavers were utilized for the study. Of 25 cadavers, 18 were male and 7 were female. Removal of spinal cord was done by conventional spinal cord dissection method (posterior approach) as per Cunningham's manual.

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Specimen 1

This specimen shows dorsal rootlet ganglion (DRLG) in the cervical region. There are 10 dorsal rootlets present in the second cervical segment. A ganglion is identified on the right side fifth dorsal rootlet of the second cervical segment. It is unilateral and absent on the left side [Figure 1a and b).

The microstructure of the ganglion was prepared using hematoxilin and eosin staining method. It reveals many small groups of pseudounipolar neurons surrounded by satellite cells. Nucleus present in the cell bodies of neurons is faintly stained and centrally located. Nucleus shows prominent nucleolus. Each group is separated from other by bundles of nerve fibers [Figure 1c].

Specimen 2

This specimen is a male cadaver showing the presence of many ganglia on the dorsal rootlet of sacral segments. In the cauda equine, around 4 ganglia were identified. These ganglia are of different sizes [Figure 2a-e).

Specimen 3

This specimen is a female cadaver showing the presence of ganglia on the intersegmental connection between dorsal rootlet of first and second cervical segment on the right side. It is unilateral and absent in the left side [Figure 3a, b].

DISCUSSION

This study shows that 2 male cadavers of 18 showed DRLG. The existence of DRLG in males as per our study is around 11%. One female cadaver of seven showed DRLG. The existence of DRLG in females as per our study is around 14%. Total existence of DRLG in the study sample is around 12%.

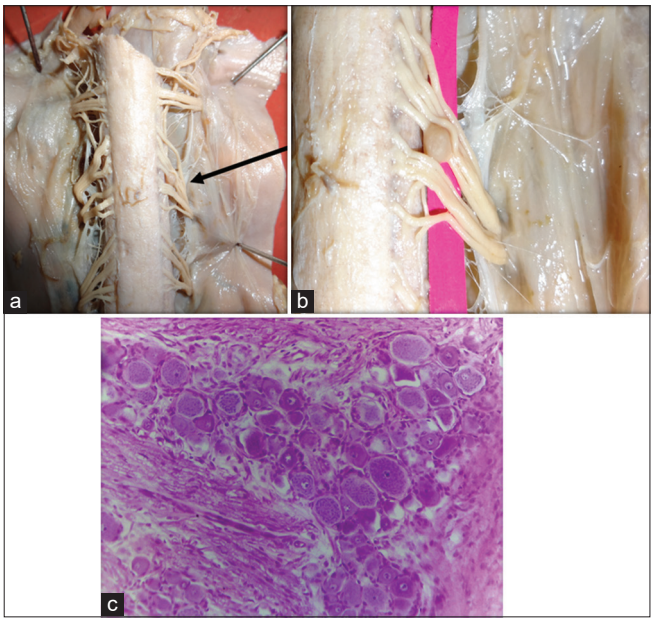

Figure 1: (a) Black arrow showing a ganglion in the dorsal rootlet of the right side of second cervical segment, (b) closer view of the ganglion on the fifth rootlet of second cervical segment, (c) histology of the dorsal rootlet ganglion

Two cadavers showed solitary DRLG in cervical spinal segments. One cadaver showed four DRLG of different sizes in cauda equina. No DRLG was identified in other spinal segments.

There are no previous reports available. This study is the first to report the existence of DRLG.

RESULTS

This study shows that ganglia are present in the dorsal rootlets of spinal nerves. The DRLG are identified in the dorsal rootlets of cervical region and also in the cauda equina region.

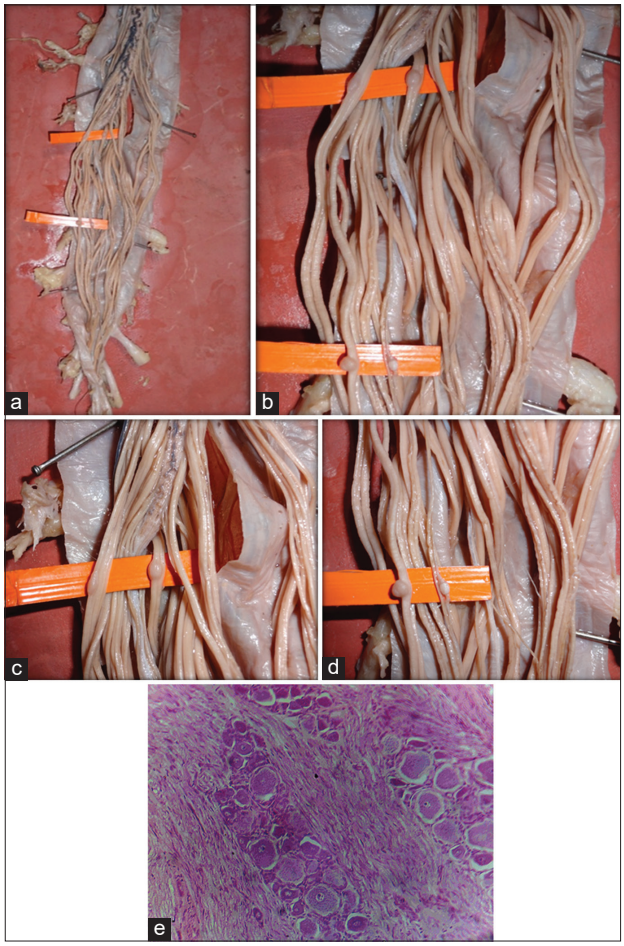

Figure 2: (a) Caudal portion of spinal cord showing dorsal rootlet ganglions (DRLG), (b) closer view of the above, (c) closer view of upper half of above picture, (d) closer view of lower half of above picture, (e) histology of the DRLG

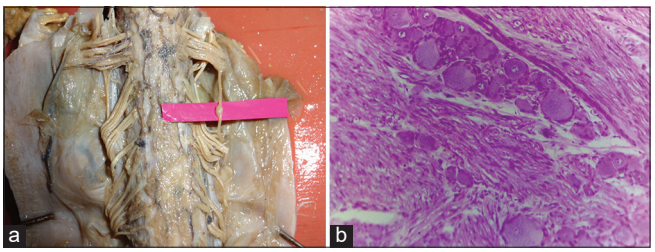

Figure 3: (a) Showing dorsal rootlet ganglion (DRLG) on intersegmental connection between C1 and C2, (b) histology of the DRLG

CONCLUSION

The presence of DRLG may be due to any one of the following reasons: Migratory delay of NCCs, irregular migration of NCCs, delayed development of small fragment of NCCs, any delay in genetic expression, movement of DRG cells toward the spinal cord due to pull (any ascent) of dorsal rootlets into the substance of the spinal cord, etc.

This study will be a stimulant in the field of clinical embryology, neuroanatomy, anesthesia, etc., to find the reason and importance of their existence. This may be considered as a special adaptation for a specific sensation.

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