International Journal of scientific research and management (IJSRM)
||Volume||2||Issue||11||Pages||1604-1607||2014||
Website: www.ijsrm.in ISSN (e): 2321-3418

Study of Microstructure of Typical Cervical Vertebrae Pedicle

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ABSTRACT

A thorough knowledge of cervical anatomy1 and proficient instrumentation skills are therefore mandatory. The cervical vertebrae are typified by a foramen in each transverse process. The pedicles project posterolaterally. Pedicles are short, thick, rounded dorsal projections from the superior part of the body at the junction of its lateral and dorsal surfaces, so that the concavity formed by its curved superior border is shallower than the inferior one.Study of 5 cadaveric typical (C3-C6) cervical vertebrae pedicles was done on both sides to understand microstructure of pedicles of cervical vertebrae. It was observed that the pedicle cortex was a tubular bone composed of prominent cancellous matrix surrounded by cortical shell. Trabeculae in the cervical pedicles were plate like and isotropic. Cortical bone shell was composed of well-developed lamellar structure lacking proper haversian system. To define the thickness of the medial and lateral cortex, cortical bone was traced along the medial and lateral walls. Medial cortex was observed to be thicker than the lateral cortex. This finding explains the reason for significantly higher frequency of lateral pedicle wall perforation than medial wall perforation during any kind of instrumentation like screw insertion in the region of pedicle. So, for any kind of intervention in the pedicle, direction of the device inserted should be directed medially.

Key words: cervical; vertebrae; pedicle; microstructure; typical

INTRODUCTION

A thorough knowledge of cervical anatomy1 and proficient instrumentation skills are therefore mandatory. The cervical vertebrae are typified by a foramen in each transverse process. The pedicles project posterolaterally and the longer laminaeposteromedially, enclosing a large, roughly triangular vertebral foramen. Pedicles are short, thick, rounded dorsal projections from the superior part of the body at the junction of its lateral and dorsal surfaces, so that the concavity formed by its curved superior border is shallower than the inferior one. Vertebrae are internally trabecular with an external shell of compact bone perforated by vascular foramina. The shell is thin on discal surfaces but thicker in the arch and its processes. The trabecular interior contains red bone marrow and one or

two large ventrodorsal canals for the basivertebral veins. In one of the previous studies (1), the internal architecture of cervical spine pedicles was investigated by thin sectioning and digitization of radiographic images. This study provided quantitative information on the internal dimensions like cortical shell thickness of the superior, inferior, lateral and medial walls and the cancellous core height, width and cortical shell thickness of the middle and lower cervical pedicles.

MATERIAL & METHODS:

Study of 5 cadaveric typical (C3-C6) cervical vertebrae pedicles was done on both sides to understand microstructure of pedicles of cervical vertebrae in department of Anatomy, Government medical college and hospital, Chandigarh. The left and right pedicles of typical cervical vertebrae (C3-C6) were cut off at pedicle-vertebral body junction and pedicle-facet junction by reciprocal hand saw. A longitudinal nick was placed on the lateral surface to distinguish medial and lateral aspects of the pedicle. After fixation, tissue was placed for 6-8 weeks in EDTA decalcifying solution. Solution was changed every 7th, 14th and 21st day. Then, it was checked for decalcification. The slides were kept in incubator at 37˚C overnight for drying and stained with Harris's Haematoxylin stain. Subsequently they were examined under binocular microscope.The tissue was deparaffinized with xylene in two changes of 15 minutes each. Then, it was hydrated by passing through descending grades of alcohol and rinsed with distilled water and stained with eosin.

RESULTS

Vertical sections of decalcified pedicles stained with haematoxylin and eosin were observed to be composed of cancellous bone surrounded by cortical bone. Superolateral side of the pedicle was identified by nick in that portion. It was observed that the pedicle cortex was a tubular bone composed of prominent cancellous matrix surrounded by cortical shell. Trabeculae in the cervical pedicles were plate like and isotropic. They were observed to have greater thickness and number and had less spacing in the network than the other vertebrae. Cortical bone shell was composed of well-developed lamellar structure lacking proper haversian system. To define the thickness of the medial and lateral cortex, cortical bone was traced along the medial and lateral walls. Medial cortex was observed to be thicker than the lateral cortex (Figure 1).

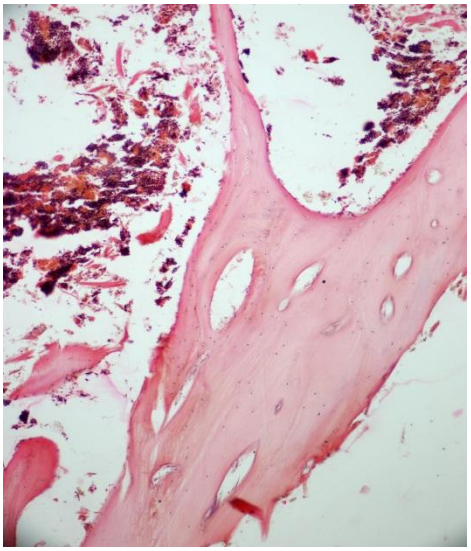

Figure1. Figure showing medial pedicle cortex

The determination of the endosteal border of the cortical bone was made based on the continuation of the organized dense bone, in which an osteonal structure could be seen. The arrangement of the osteons in the lateral and medial regions

did not seem uniform which may be due to change in alignment of osteons in the lateral and medial regions (Figure 2)

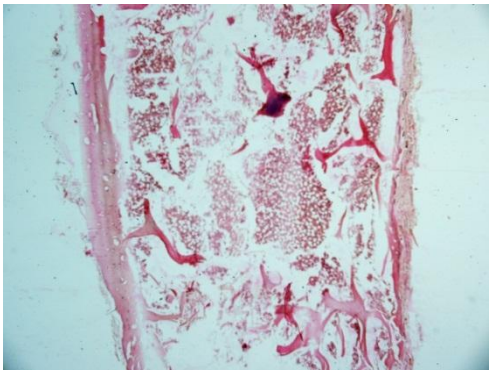

Figure 2.Figure showing medial pedicle cortex thicker than the lateral pedicle cortex

The bony trabeculae were separated by a labyrinth of interconnecting spaces containing bone marrow filled with haematopoietic cords separated by wide sinusoids and adipocytes.In both males and females, mean thickness of medial and lateral pedicle cortex was observed. Thus, in both the genders medial cortex was observed to be thicker than the lateral one.

DISCUSSION

In the current study, cortical bone thickness was observed on the lateral and medial aspect of the pedicle. One of the previous studies (4) observed the medial and lateral cortical thickness in Malaysian population using CT scan. The mean medial wall thickness of men ranged from 1.25 mm at C3 to 1.46 mm at C2. In women, it ranged from 1.28 mm at C5 to 1.72 mm at C2. These differences between genders were not significant. The mean lateral wall thickness of men ranged from 0.80 mm in C7 to 0.90 mm in C6. Another study(5) also supported the above observations by stating that a distinct characteristic of human cervical pedicles is that the lateral pedicle wall adjacent to the vertebral artery is always thinner than the medial wall. Observations made in current study, were similar to those of previous studies conducted in other populations. In the current study, authors also observed medial cortical thickness to be significantly greater than the lateral cortical thickness ($p < 0.05$). This finding explains the reason for significantly higher frequency of lateral pedicle wall perforation than medial wall perforation during any kind of instrumentation like screw insertion in the region of pedicle. Thus, it can be concluded thattranspedicular screw fixation using screw poses a higher risk of lateral cortical breach. The surgeons should keep this in mind when probing pedicles and placing screws.Miller et al (6) conducted a study to determine if the incidence and severity of pedicle violations resulting from transpedicular screw placement could be reduced by direct determination of the superior, medial and inferior borders of the pedicle. In this study, the transpedicular screw was positioned 30˚-45˚ posterolateral to anteromedial in the transverse plane and angled towards the superior third of the vertebral body in the saggital plane. 3 mm screws of proper length were placed in the tapped holes. In addition, the anatomic relationship of the screw to the dura, vertebral artery, or nerve root was identified. The gross results of the violations and their direction and grade were noted. In this study, it was advised that the screw dimensions and its size must be matched with the individual pedicle to reduce the chance of the cortical violation. Also, it was advised that the ideal diameter of a screw should be slightly less than the medio -

lateral diameter of the individual pedicle. The use of screws with large dimensions increases the chances of violating the pedicle, which could possibly lead to damage of the spinal cord or vertebral artery (6). So, for any kind of intervention in the pedicle, direction of the device inserted should be directed medially.

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