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A cadaveric study for comparison of dorsal pedicular diameter in Indian males and females

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Abstract

Introduction: A cadaveric study for comparison of dorsal pedicular diameters in Indian males and females. Morphometric study of pedicles of spine of dorsal region is thus relevant and critical for proper placement of the transpedicular screw to avoid inadvertent penetration of pedicular wall.

Material and Methods: It's a observational study done at a tertiary health care centre in which 30 cadavers were studied using posterior midline approach. Direct measurements were taken on the vertebra with using a sliding vernier caliper

Results: Thirty cadavers were studied out of which 23 were males and seven were females. I studied vertical as well as horizontal diameter at the middle of pedicle and calculate mean of these two and did comparison between Indian males and females. When compared with males of the same height, females have thinner pedicles. This means the average diameter of the pedicular screws which is safe for the males at the particular level cannot be considered safe for females of the same height and age.

Conclusion: On the basis of this study we have idea about average screw size for male and female at particular level to avoid untoward complication of current pedicular system. In males average diameter goes on increasing from D1 to D12 with highest at D12 -5.6mm while lowest at D2 and D3 i.e. 4.5 mm. In females we found average diameter goes on increasing from D1 to D12 with highest diameter at D9 i.e. 5.2mm and lowest at D2 i.e. 4.2 mm. As compared to the males females have thinner pedicles.

Keywords: dorsal spine, pedicular screw, Indian population

1. Introduction

Measurement of bone or any part of human body provides accurate knowledge about morphology of the structure which helps the clinicians, in diagnosing and treating various diseases [1]. Due to present lifestyle and with its speed, it has resulted in increase in the incidence of assaults on the vertebral column in the form of different spinal pathologies such as prolapsed inter vertebral discs, spondylolisthesis, spondylosis, fractures. The growing need of various orthopaedic procedure as a part of treatment of above pathologies demands accurate knowledge of measurements of the vertebra. The present study was undertaken with the view to study dorsal region pedicles. Posterior spinal instrumentation is a time honored method of spinal fixation.

In several studies, researchers demonstrated fusion rates of 90% or greater with pedicle screw fixation [2]. However along with this benefit a number of complications associated with pedicle screw fixation were reported. The most devastating complication related to pedicle screw is neurological injury secondary to misplaced screw abutting or transecting a nerve. So with the use of pedicle screw system it becomes imperative that a causal relationship between the screw and neurological complication be ruled out.

Morphometric study of pedicles of spine of dorsal region is thus relevant and critical for proper placement of the transpedicular screw to avoid inadvertent penetration of pedicular wall. Accurate anatomical description of the shape and orientation of dorsal pedicles are necessary for use of implantable devices and spinal instrumentation techniques [3]. Studies have been already conducted in white and a few non-whites population. However, only very few studies have been conducted in Indian population. Moreover, many studies have not reported all the morphometric dimensions related to pedicle screw placement.

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2. Materials and Methods

This is an observational study. The study was carried out at the tertiary health care center in India. For this study, 30 cadavers, ranging from 15yrs to 80 yrs post embalmed were selected without any deformity or previous history of trauma in spine. Cadavers showing obvious deformity in the spine or a fractured spine were excluded from this study. Cadavers were dissected using the midline posterior approach so as to expose the spine upto the lumbar region. The facet joints and the vertical bony crest just below it were cleared of the soft tissue. Direct measurements were taken on the vertebra with using a sliding vernier caliper.

Vertical Height of pedicle was noted by a sliding vernier caliper and divider. The points just opposite each other on the upper and lower margins of pedicles, in the vertical plane on its lateral aspect, where the diameter was maximum were considered. First record was taken on right pedicle and then on left. Pedicle Width was measured by taking deepest point on the lateral and medial aspect of each pedicle. The thickness was measured at these points, at right angles to the long axis of pedicle. First reading was taken for right pedicle and then for the left.

3. Results

In this study we studied thirty cadavers out of which twenty three were males, seven females. I found there is significant difference in anatomy of Indian male and female. I studied

vertical as well as horizontal diameter at the middle of pedicle and calculate mean of these two and did comparison between Indian male and female (Table 1). I observed that there is significant difference in anatomy of pedicle in male and female population.

When compared with males of the same height females have thinner pedicles. This means the average diameter of the pedicular screws which is safe for the males at the particular level cannot be considered safe for females of same height and age (Table 1 & 2). We found that at D1, D2, D3, level the mean pedicular diameter for females was 4.3 mm, 4.2 mm, 4.3 mm respectively while it was 4.6 mm, 4.5 mm, 4.5 mm for the males (Table 1). Hence 4 mm screws are safe in males while they should be carefully used in females in the upper dorsal vertebrae.

At D4, D5, D6 level the average pedicular diameter were 4.6 mm, 5.2 mm, 5.4 mm for males while they were 4.5 mm, 4.5 mm, 4.5 mm respectively for females. Hence 4mm as well as 4.5mm screws are safe to use in both population.

At D7, D8, D9 level the average pedicular diameter were 5.4 mm, 5.3 mm, 5.4 mm for males while 4.5 mm, 4.5 mm, 5.2 mm respectively for females. Hence 4 mm as well as 4.5 mm screws are safe to use in both population. At D10, D11, D12 region average diameter in males were 5.5 mm, 5.6 mm, 5.6 mm respectively and 4.7 mm, 4.7 mm, 4.7 mm respectively in females. Thus one can use 5 mm screws in males but in only 4 mm screws are suitable.

Table 1: Comparison between male and female pedicular diameters

Mean	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12
Male	4.6	4.5	4.5	4.6	4.9	5.2	5.4	5.3	5.4	5.5	5.6	5.6
Female	4.3	4.2	4.3	4.5	4.5	4.5	4.5	4.5	5.2	4.7	4.7	4.7

Table 2: Comparison between diameters of various age groups

AGE Group	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12
20-40	4.3	4.3	4.4	4.5	4.5	4.6	4.8	4.8	5	5.3	5.5	5.6
41-60	4.4	4.4	4.6	4.6	4.7	4.9	4.9	5.2	5.3	5.5	5.6	5.8
61-80	4.5	4.5	4.6	4.7	4.8	4.9	5	5.3	5.3	5.6	5.7	5.8

4. Discussion

Since very long time we are using pedicular screws for fixation of fracture vertebrae, Koch's spine, and many other pathologies. Many studies have been carried out on pedicular diameters of thoracic spine in white population and they manufacture pedicular system as per their requirement but very few studies have done on Indian population though it shows wide diversity from short Assamis to tall Punjabis.

Among available literature Berry *et al.*, (1987) studied thirty vertebral columns and he selected T2, T7, T12 and L1 to L5^[4]. He studied with help of vernier caliper and monometer. He calculated diameter as well as direction of selected vertebrae. In 1988, Krag *et al.*, studied lower thoracic and lumbar vertebrae. It was CT scan aided study but in this study errors due to magnification and thickness of slice were not justified^[5]. Scoles *et al.*, (1988) employed the recourses of the Haman and Todd osteological collection at Cleveland Museum of natural history. He selected thoracic and lumbar vertebrae of fifty vertebral columns^[6]. He concludes posterior element anatomy is highly variable and unpredictable. Linear measurement were carried out by vernier caliper and protractor. Angular measurements was done using a goniometer. Indian thoracic pedicle diameters for the first time with the help of CT Scan and cadavers in 480 vertebral samples. He concludes 4 mm screws are carefully used in mid thoracic region while 5 mm screws can be used in upper and

lower thoracic region as well as 25 to 30 mm screws are safe in upper and lower thoracic region.

Shankar Acharya *et al.*, (2010) studied Indian and white population and concludes that there is significant difference in the pedicular diameters in these two populations^[7]. He suggested that pre-operative software based morphometric data should be collected if possible for pre-operative planning to avoid inadvertent complication.

The results in our study is consistent with the above studies in respect to increase in diameter from upper dorsal to lower dorsal vertebrae and statistical significant difference in pedicular diameters of Indian male and female patients.

5. Conclusion

On the basis of this study we have idea about average screw size for male and female at particular level to avoid untoward complication of current pedicular system. In males average diameter goes on increasing from D1 to D12 with highest at D12 -5.6mm while lowest at D2 and D3 i.e. 4.5 mm. In females we found average diameter goes on increasing from D1 to D12 with highest diameter at D9 i.e. 5.2mm and lowest at D2 i.e. 4.2 mm. As compared to the males females have thinner pedicles.

In females 4 mm screws are suitable in upper thoracic region while in lower thoracic region 4.5 mm screws are better. In males 4mm screws are suitable from D1 to D5 region while

lower region 4.5 mm screws can be used.

6. Consent

Written informed consent was obtained from each patient included in the study.

7. Conflict of interests

There is no conflict of interests to be declared.

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