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Computed Tomographic Morphometry of Thoracic and Lumbar Pedicles in Central Indian Population

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ABSTRACT

Objective: The objective is to discover the several morphological parameters like pedicle width, pedicle inclination (transverse plane) and chord length of the thoracic and lumbar vertebrae in the Central Indian populace and compare results with other studies. Introduction/Background: The vertebrae are a set of 33 inter-locking bones which form the spinal cord of the body. The vertebrae are divided mainly into 3 different components. The thoracic portion is very complex whereas the lumbar vertebrae remain differentiated by their huge size and nonappearance of costal facets on the body. The basic idea of this study was to review pedicle morphometry and canal capacities of thoraco-lumbar junction using Computerized Tomography (CT) Scan in the standard population of this region. Methodology: This cross-sectional study will be conducted at Jawaharlal Nehru Medical College, Datta Meghe Institute of Medical Sciences, Sawangi Meghe Wardha. The sample size taken will be of 80 CT scans of patients admitted in the hospital for pain in the vertebral column. The inclusion criteria are patients over 18 years of age. The exclusion criteria are patients gone through trauma or having broken/deformed vertebrae. Pedicle width, Pedicle Inclination (Transverse plane) and Chord length of vertebrae were measured and mean values were calculated.

Results: Will be analysed after the study is conducted.

Discussion: Transpedicular fixation allows better instrumentations to manage various spine related problems. For this purpose, pedicle morphometry is compulsory to ensure safe pedicle screw placements and insertion. CT guided imaging is chosen over intraoperative-fluoroscopic imaging because this is tough to perform and constantly dependable anatomical entry points and the path for screw insertion are unavailable.

Conclusion: Will be analysed after the study is conducted.

Key words: Pedicle width, Pedicle inclination (transverse plane), Chord length, Thoracolumbar junction, Computerized

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INTRODUCTION

Vertebrae are the set of 33 distinct and interconnecting bones which makes the spinal cord. Each vertebra has 3 primary parts: a load-bearing vertebral body, a spinal cord-shielding vertebral arch, and ligament-connecting transverse growths. Facet joints link the vertebrae, allowing the spine to have flexibility. Thoracic part of vertebral column is very intricate with two conclusion segments seeming to be transitional zones on the way to cervical i.e., T1 to T3 and lumbar i.e., T9–T12 area. Because of grouping of the slender spinal canal and a significant blood source, the central section is the most critical. The thoracolumbar region of the spine is where biomechanical movement is transferred, hence diseases are most commonly observed there. Trauma (fractures and dislocations are the two most common types), degenerative illnesses and contaminations. The arrangement of the thoraco-lumbar section with transpedicular screws is the greatest existing and prevalent option in the dealing with these ailments.

Vertebral pedicles are tiny, rounded behind protrusion from the larger part of the body, where the lateral and hind exteriors meet. The weight is transmitted in the thoracic and lumbar regions via two erect running columns, the front of which is made by vertebral bodies and intervertebral discs, and the behind column is

made by consecutive formulation of neural arch section (Laminae, facet joins, and ligament complex). The pedicle serves as a strut that transfers weight from the body to the neural arch. The "pedicle isthmus," which is well-distinct as the narrowest region of the pedicle, should have morphometric features found at the level of the "pedicle isthmus," whose measurements signify the minimal span that the screw must have for proper pedicle fixation [1].

The lumbar vertebrae are distinguished via the enormous size, lack of costal surfaces on body, and lack of a transversarium foramen. The spine is brief, with a smooth-edged end. The lumbar vertebrae are 5 in number. The first 4 are typical, whereas the 5th is atypical. The distance between lower articular processes is alike to or larger than the gap between greater articular processes in atypical lumbar (Fifth) vertebra. The transverse processes are bushy, brief and pyramidical in form [2].

The Thoraco-lumbar spinal column (T11, T12, L1, and L2) remains the position amongst the firm thoracic spinal column and elastic lumbar spinal column. Unfortunately, in grown-ups, the portion of the backbone that dismisses at the mechanically sensitive thoraco-lumbar junction contains the principal efferent for all of the lumbo-sacral origins, so canal intrusion can result in catastrophic neural consequences. The thoracolumbar junction's sagittal alignment, pedicle, and spinal canal morphometry are crucial factors that can help with better perception and therapy of thoracolumbar illnesses [3].

The comparison of the surface structures of the vertebra and pedicles is a medical need for the harmless submission of transpedicular screws in later vertebral column arrangements, and it is also employed in diseases such as spinal breakages, irregularity, uncertainty, and degenerative ailment [4].

All 3 columns of the spine are occupied by pedicle screw systems, which can prevent mobility in all planes. Numerous studies have concluded that pedicle screw fixation is a harmless and operative treatment for a variety of spine problems. The pedicle screw-bone intersection is the instrument's toughest point of attachment to the spine, preventing motion in all planes. Internal fixation devices that attach through the pedicles are now accessible in variety of configurations. For the creation and use of implanted devices and spinal tools, precise structural descriptions of the shape and alignment of pedicles are required. The form of the pedicle becomes crucial because it aids in the selection of the best pedicle screw. It is obligatory to determine differences in the morphology of pedicles in males and females [5].

Rapid computers and computed tomography scans (CT) have transformed medical imaging, allowing spine surgeons to undertake CT-based image guided surgical procedure and preventing postoperative complications. The image-guided technology appears to enhance surgical precision and safety when placing pedicle screws. The exactness of pedicle screw alignment with CT-assisted exploration in thoracic and lumbar breakages was assessed using radiographic images and postoperative computed tomography scans [6].

In patients with scoliosis, traumatic damage, or vertebral failure related to contamination, behind complex of the thoracic spine using, hooks, rods and wires has been used effectively to rectify abnormalities and provide solidity. Although transpedicular screw fixation provides solid segmental fixation, there are reservations about its use in the upper thoracic vertebral column. There is accompanying likely danger of neurovascular damage in addition to the fractures of the pedicles. In addition to pedicle fractures, there is a possibility of neurovascular damage [7].

The various studies accessible of thoracic and lumbar vertebral morphometry using Computerized Tomography (CT) examination are very scarce in the world also even fewer from India.

The basic idea of this education will be to examine pedicle morphometry of the thoracic and lumbar vertebrae in the normal inhabitants in this region using a Computerized Tomography (CT) scan [3].

Aim

The purpose of the future study is to measure the morphometry of thoracic and lumbar vertebrae in the Central Indian population.

Objective

The objective is to regulate

Various morphological parameters like pedicle width, pedicle inclination (transverse plane) and chord length of thoracic and lumbar vertebrae in the Central Indian population

Compare the outcomes with various other existing studies.

MATERIALS AND METHODS

Study design

This cross-sectional study will be carried out at Jawaharlal Nehru Medical College, Datta Meghe Institute of Medical Sciences (DMIMS), Sawangi Meghe Wardha. Total of 80 CT scans of patients admitted in the hospital for complains/pain in the vertebral column will be observed for the study. The study will be conducted after getting permission from the ethical committee.

Participants: The inclusion criteria are patients above 18 years of age with normal vertebrae.

The exclusion criteria are the patients who have recently experienced through trauma and having broken and deformed vertebrae.

Total of 80 CT scans will be taken for patients admitted in the hospital for complains/pains in the vertebral column

will be observed for the study.

Variables/Quantitative Variables: Pedicle Width, Pedicle Inclination (Transverse Plane), Chord Length

Measurements: CT scan of Siemens (Somatom Scope Power) of thoracic and lumbar vertebrae (T11, T12, L1, L2) will be taken for the study and following limitations will be measured:

Pedicle width
This is measured to a precision of 0.1mm as the distance between the outer cortex and the outer cortex at the thinnest section of the pedicle.

At the midshaft of the pedicle, the interpedicular distance was measured [5].

Pedicle inclination (In transverse plane)
At mid-body level, the front to back and oblique diameters of the vertebral canal, as well as the canal's surface area, were measured [5].

Chord length
It's the distance between the pedicle's axis to the anterior cortex. It is measured from the evenest section of the behind cortex of the lamina to the frontal cortex end to end to the axis of the pedicle, with an accuracy of 0.1mm [5].

Bias: The potential source of bias be human errors, typing errors while typing the data into excel sheets or random errors. The margin of error can be 10%.

Sample size
Cochran formula for sample size.

$n=(Z^2(\alpha/2)2.P.(1-P))/E2$

Where,

$Z\alpha/2$ is the level of significance at 5% i.e. 95%

Confidence interval=1.96

P=Proportion of patients, pedicle wall violations occur=29%=0.29

E=Error of margin =10% =0.10

$n=1.96^2*0.29*(1-0.29))/0.10^2=79.09$

n=80 patients needed in the study

Study Reference: Siddhartha Avuthu, et al.

Formula Reference: Cochram, et al.

Statistical methods
Information composed from research work was assembled in excel spreadsheets. Descriptive statics such as mean, percentage and range will be used and analysed separately for pedicle width, transverse pedicle angle and chord length at all levels from T9 to L5 in both the genders and results will be tabularized. Additional outcomes will then be compared with earlier works [5].

DISCUSSION

Key Results: A systematic understanding of framework and the typical range of parameters in this region, such as sagittal and oblique pedicle measurement and spinal canal front to back and oblique diameter, are essential gears in optimal care planning. These measurements vary according to the respondent's time of life, sex, physical habitus, and race. Topographical and hereditary factors that contribute to these differences are fine understood. In spite of the abundance of research in the works telling regular thoracic and lumbar measurements, there remains a scarcity of statistics assessing thoraco-lumbar vertebral proportions, particularly in central India [3].

Limitations: Misalignment of pedicle width and screw diameter might result in significant consequences such nerve and vascular injury. As a result, the technique's success is heavily reliant on having the most up-to-date information about pedicle morphology. For stable fixation, a puncture should be placed along the pedicle's axis, integrating the maximum attainable transverse and sagittal pedicle diameters [5].

Furthermore, thoracic screw alignment is further problematic due to the reduced and varying sizes of the pedicles, difficulty to perform intraoperative fluoroscopic imaging as well as the lack of consistently dependable anatomic entry locations and screw installing trajectory. In thoracic and lumbar spine breakages, CT-based image-guided pedicle screw placement has various advantages. When intraoperative fluoroscopy is not used, the radiation introduction to specialists, patients, and OT room staff is minimized, as is the operating time and the risk of infection. Because fluoroscopy adjustments take more time than set up a CT navigation arrangement, CT-aided navigation surgical procedure takes less time than fluoroscopy-assisted surgery. For the reduced size of the pedicle and its closeness to the spinal cord, vena cava, iliac vessels, aorta, azygous veins and neurovascular systems, the risk of screw misplacement is increased [6].

Interpretation: Pedicle screw is implanted through the behind side of the pedicle and into the body of the vertebra frontally during pedicle screw insertion. The ability of the screw to establish and uphold procurement inside the vertebral body is critical to the technique's success. This is determined by the precision with which the screw was chosen, the scope of the pedicle, and the value of the pedicle's bone. Because bigger diameter screws are tougher and produce better results, most specialists prefer to use the largest screw size available for any given pedicle. Inappropriately sized (oversized) screws can cause pedicle cortical perforation or fracture, as well as dural tears, cerebrospinal fluid leaks, and nerve root damage. As a result, knowing the height, thickness, and length of the pedicle helps control the size of the pedicle screw [2].

The thoraco-lumbar spine is the changeover point amongst the additional stiff thoracic spine and the extra elastic lumbar spine. The rib cage's anatomy has a big impact on the thoracolumbar spine's biomechanical qualities. Ribs 3–8 coherent with the sternum anteriorly and to the behind with their accompanying vertebral bodies and oblique processes, as fine as with the

vertebral body above via a lower demi facet, above T10. This position stabilizes the thoracic spine while also increasing its inflexibility by two to three times. The inflexibility of the thoracic spine decreases below this level as the structure transforms into the more dynamic lumbar spine shape [3].

Transpedicular fixation allows for superior biomechanical instrumentation to treat a variety of spine pathologies. Recognize pedicle morphometry to guarantee safe pedicle screw placement, particularly the isthmus, which is the key limiting factor for screw insertion. Anatomical variances can make screw placement challenging, and retrospective investigations have shown that even in skilled hands, damage to the pedicle wall can occur in up to 29% of instances [5].

Three-column stability is provided via transpedicular screw fixation, which has become a cutting-edge treatment for thoracic and lumbar breakage. Yue et al. published a reflective data-based training in 2002, in which transpedicular screw fixation was executed in thirty-two patients with seventy-nine different stages of spinal damage, with a overall of 252 pedicle screws implanted between sections T2-L1. Transpedicular screw fixation may give improved trio-column regulator in the absence of the behind element integrity, as well as inflexible fixation for uneven superior, central, and inferior thoracic spine fractures, with early pain-free fusion results, according to the study. The insertion of pedicle screws is a technically hard surgery with limits. The overall problem rate for the usage of pedicle screws has been found to be between 21% and 27%. Intraoperative complications such as nerve root damage, pedicle fissure, Dural tear injury with CSF leak, visceral wound, and vascular wound from screw over penetration and screw misplacement resulted in neurological impairment in about 10% of cases [6-11].

EXPECTED OUTCOMES/RESULTS

The patients ranged in age from 29-68 years. In the study there are 67 males and 33 females. Pedicle width fluctuated from 3.5 mm to 16 mm with lowermost at L1 and greatest at L5 vertebrae. The lowest mean transverse pedicle width was at T9 (5.81mm) and greatest at L5 (12.74mm). In females pedicle width is lesser tshan that of males at all levels excluding T12 (Male- 6.62mm, Female- 6.96mm). Pedicle inclination angle was in range of -7º to +31º with lowermost at T 12 vertebrae and greatest at L 5 vertebrae. The minimum mean pedicle inclination in oblique plane was at T12 and highest was at L5. Pedicle inclination in transverse plane was somewhat more in males compared to females. Chord length was in range of 23.4mm to 45.7mm with short distance at T12 vertebrae and long distance at L5 vertebrae. The brief mean chord length was at T11 (31.59mm) and the lengthiest was at L5 (40.12mm). Chord length was extra in males as compared to females.

CONCLUSION

Will be analysed after the study is conducted.

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