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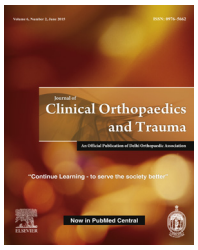

Original Article

Computed tomographic-based morphometric study of thoracic spine and its relevance to anaesthetic and spinal surgical procedures

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ABSTRACT

Background: To collect a baseline computer software aided normative morphometric data of thoracic spine in the Indian population and analyze it to give pre-procedural guidelines to clinicians for safe surgical and anaesthetic procedures in the thoracic spine.
Methods: CT scans of thoracic spine of patients free from spinal disorders were reviewed in a total of 600 vertebrae in 50 patients. Parameters recorded with the help of computer software were pedicle width, length and height, transverse pedicle angles, chord length, canal dimensions, body width and height, spinous process angle and transverse process length.
Results: Pedicle width decreased from T1 (9.27 ± 1.01) to T4 (4.5 ± 0.93) and increased to T12 (8.31 ± 1.83). At T4 76% and at T5 62% of the pedicles were smaller than 5 mm and would not accept 4 mm screw with 1.0-mm clearance. However, at T1 2%, at T11 7% and at T12 8% would not accept a 4 mm screw. Chord length gradually increased in upper thoracic vertebrae and was relatively constant in middle and decreased in lower thoracic vertebrae. Shortest estimated chord length was at T1 (30.30 ± 2.11). On an average, from T1 to T6 and at T11 and T12, a screw length of 25–30 mm could be accommodated and from T7 to T10, 30–35 mm screw length could be accommodated. Transverse pedicle angle decreased from T1 (35.4 ± 2.21) to T12 (−9.8 ± 2.39). Canal dimensions were narrowest at T4/T5 (20.02 ± 1.23) in anteroposterior and 21.12 ± 1.23 in interpedicular diameters. Spinous process angle increased from T1 (30.11 ± 6.74) to T6 (57.89 ± 9.31) and decreased to 16.21 ± 7.38 at T12. Transverse process length increased from T1 to T7 (23.54 + 2.12 to 31.21 + 1.91) and then decreased to 12.11 + 2.3 at T12. Vertebral body dimensions showed increasing trends from T1 to T12.
Conclusions: A thorough knowledge of anatomical and radiological characteristics of the spine and their variations is essential for the clinicians. Data collected in the present study

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provides baseline normative values in Indian population and will help in guiding safe and effective completion of both surgical and anaesthetic procedures in the thoracic spine. Computer software aided morphometric data can help in selecting appropriate size and optimal placement of the implant with minimal procedural difficulties and complications during spine surgery.

1. Introduction

Vertebral column comprising spine and spinal cord is one of the most complex structures of human body. Thoracic part of vertebral column is even more complex with two end segments appearing to be transitional zones towards cervical (T1–T3) and lumbar (T9–T12) region and the middle zone is of utmost importance due to the presence of combination of narrow spinal canal and critical vascular supply.[1–4] Knowledge of morphology of the thoracic spine is essential for the anaesthetic and surgical procedures carried out in this part of the vertebral column, to achieve desired results and to avoid complications.

The thoracic epidural has been widely used for the purposes of anaesthesia and analgesia. Injection into this space can be given as a single shot, intermittent, continuous or under the control of the patient (patient-controlled epidural analgesia (PCEA)). Intermittent or continuous injections into the space are carried out through an epidural catheter. Epidural injection of corticosteroids is one of the most commonly used interventions in managing radicular pain caused by nerve irritation.[5] Thoracic epidural anaesthesia (TEA) followed by postoperative epidural analgesia is increasingly being used for thoracic, upper abdominal, major vascular and cardiothoracic surgery. The objective of thoracic block is not solely to block noxious afferent stimuli from the surgical site, but to impart a bilateral selective thoracic sympathectomy. It is also used for pain management in conditions associated with chronic pain.[6]

The advent and general acceptance of pedicle screw fixation of thoracic spine has made the morphometric analysis of the thoracic pedicle a clinical necessity for all the surgeons practicing this procedure.[7] There are lots of studies that have been conducted on morphometry of thoracic spine using cadaveric specimen either directly or radiographically.[1,8–23] But only few studies, especially in Indian population, have been carried out to quantify thoracic spine morphometric data on CT scanning, the gold-standard for preoperative planning.[1,24–33]

This study aims at collecting and analyzing the morphometry of thoracic spine in a detailed manner in Indian population and comparing with available literature.

2. Materials and methods

This is a prospective study of thoracic morphometric data from 50 patients aged more than 20 years; who underwent CT thorax for other pathologies and were free from spinal disorders. Prior informed consent from the patients was taken. A total of 600 vertebrae were studied from patients of either sex. All the measurements were made directly from the scanner software of the Siemens Somatom Volume Zoom 4 Plus scanner using bone window setting. Axial sections were taken at a 4-mm interval. All the measurements were made by the same investigator to avoid interobserver discrepancy. Using the bone window, the cut section of CT where the right and left pedicles appear largest was selected for the pedicle, canal and transverse process dimensions measurements. Mid-sagittal section of the thoracic spine was used to measure vertebral body dimensions and spinous process angle.

The following measurements were made:

1. Transverse pedicle isthmus width (TPIW): Pedicle's narrowest diameter in transverse plain along the transverse pedicle axis.
2. Pedicle length: measured as the distance along the line drawn from the flattest portion of the posterior cortex of lamina to the posterior cortex of vertebral body along the line parallel to the pedicle longitudinal axis.
3. Transverse pedicle angle (TPA): obtained by measuring the angle between the AP midline axis and the pedicle longitudinal axis.
4. Chord length: measured as the distance along the line drawn from the flattest portion of the posterior cortex of lamina to the anterior cortex of vertebral body along the line parallel to the pedicle longitudinal axis.
5. Canal dimensions: Canal dimensions were measured both in anteroposterior (APD) and interpedicular distance (IPD).
6. Vertebral body width (VBW): The width of vertebral body at middle of the body.
7. Vertebral body height (VBH): Distance between superior and inferior end plates was measured both anteriorly (VBHa) and posteriorly (VBHp).
8. Transverse process length (TPL): Measured from base to tip of the transverse process.
9. Spinous process angle (SPA): Angulation of the spinous process in the sagittal plane.

Collected data were analyzed and compared with other studies.

3. Results

3.1. *Patient demographics*

Fifty scans from 28 men and 22 women were selected for review in the present study. The mean age was 39.27 ± 14.65 years (range from 20 to 70 years). No significant difference was