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Original Research Article

VARIATIONS IN THE DIMENSIONS OF SUB AXIAL VERTEBRAE AND ITS CLINICAL SIGNIFICANCE

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ABSTRACT

Introduction: cervical vertebrae are the upper most vertebrae in vertebral column. They are more prone to damage during road traffic accidents. Their dimensions are important for various spinal surgical procedures to access the spinal cord for decompression procedures.

Aim and Objective: Variations in the dimensions of sub axial vertebrae is of very important for spinal surgical procedures like Transpedicular screwing, Laminectomy, Foraminectomy, Transcorporeal Micro decompression surgery. The present study was done in the C3–C7 vertebrae of south Indians to know the Mean values of various dimensions of sub axial vertebrae.

Materials and Methods: The present study was done in 60 sub axial vertebrae, which were done in Rajah Muthiah Medical College, Chidambaram. Dimensions of Body (Antero posterior Length, Transverse Length & Height), Pedicle (Height, Length & Width), Lamina (Length, width & Height), Foramen Transversorium (Antero posterior Diameter, Transverse Diameter), Spinous process (Length) were studied.

Main outcome measure: Variations in the dimensions of body, pedicle, lamina, Spinous process, Foramen transversorium were observed.

Result: The Mean values of dimensions of vertebral body, lamina, pedicle, Foramen Transversorium & Spinous process were measured. Dimensions of body was maximum at C6 level. Length of pedicle was maximum at C3, Minimum at C6. Height & width of pedicle gradually increase from C3 to C7. Height of Lamina was maximum at C6, Length & width of Laminae was gradually increases from C3 to C7.

Conclusion: This study will provide the knowledge about dimensions of sub axial vertebrae in South Indian population. This will be helpful for spinal Surgeries & Radiological Interpretations.

KEY WORDS: Sub axial cervical vertebrae, Transpedicular fixation, Laminectomy, Foramenectomy.

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INTRODUCTION

The cervical vertebrae are seven in number; They developed from sclerotome around notochord. The cervical part of vertebral column presents a curvature which is formed around 3 – 4 months after birth. When the infant learns to erect its

head. Normally there are 2 primary curvatures – thoracic and sacral curvatures. The other two secondary curvatures are cervical & lumbar; cervical curvature is formed during 3 – 4 months after birth; Lumbar curvature formed when the baby learns to walk.

The cervical vertebrae, the smallest of the movable vertebrae are typified by a foramen in each transverse process. Among 7 vertebrae 1, 2, 7 are having special features, so they are called as atypical vertebrae other 4 vertebrae are typical vertebrae they have common features.

The typical cervical vertebrae has a body, pedicles, lamina, spinous process, Transverse process, superior and Inferior articular processes, and foramens in the transverse process. The mature transverse process is formed by fusion of costal element with body and true transverse process [1]. The cervical curvature has its important functions. Due to fracture and disorders of cervical Spine serious damages may occur, approximately 5 to 10% of unconscious patients who come to emergency unit as a result of motor vehicle accidents or fall have a major injury to cervical spine. More Cervical spine fractures occur at 2 levels one at C1 – C2 level, other at C6 – C7 Level.

Cervical Spine can be viewed as 3 columns:

Anterior: Includes anterior longitudinal ligament, Anterior 2/3 of body. Middle: Includes posterior 1/3 of body & Posterior longitudinal ligament, IV discs. Posterior: Contains all bony elements pedicles, lamina, transverse process, spinous process [2].

If one column is disrupted; other columns may provide sufficient stability to prevent spinal cord Injury. If 2 columns are disrupted, the spine may move as 2 separate units, increases the possibilities of spinal cord injury .Most of the injuries causes unstable spinal cord. In treatment of spinal cord instability and decompression of neurological structures, many procedures are followed like Kyphoplasty, Vertebroplasty, Vertebral column instrumentation and placement of Transpedicular Screws; The size and dimensions of various parts of vertebrae may vary one from another. It also varies among various population. The morphometric dimensions like vertebral body's Antero posterior(AP) length, Transverse(T) Length, Height, Foramen Transversorium's Length, breadth, width, Lamina length, width, Pedicle's length , width, length of spinous process of our study will be useful to spinal surgeons for their spinal fixation procedures. Many people spent their precious time in studying the dimensions of sub axial vertebrae. Our present study will provide knowledge about dimensions of cervical vertebrae in south Indian population.

MATERIALS AND METHODS

Sixty dry human sub axial vertebrae of unknown sex and age has been collected from Rajah Muthiah Medical College & Hospital, Annamalai Nagar, Chidambaram. Normal intact vertebras were only taken for the study. Damaged and fractured vertebras have been excluded. The dimensions of body, lamina, pedicle, spinous process, Foramen Transversorium were measured using spreading and gliding caliper. The measurements we observed were following:

Body:

AP length: Distance between anterior and posterior surface of body at midline (fig. 1).

Transverse length: Distance between two lateral surfaces of the vertebral body (fig. 1).

Height: Distance between superior & inferior borders of vertebral body at midline (fig. 3).

Pedicle:

Length*:* Distance between the anterior limit of superior articular facet and posterior limit of the vertebral body(fig 2)

Width: Distance between the medial & lateral borders(fig 2).

Height: Distance between superior & inferior border of pedicle (fig 2)

Lamina:

Length: Distance between the spinous process and lateral border of superior articular process(fig 2)

Height*:* Distance between superior & inferior borders of lamina (fig 2)

Width: Distance between medial & lateral borders. (fig 2)

Spinous process: Length*:* Distance from superior border to tip of the spinous process.(fig 2)

Foramen Transversorium:

Anterio posterior and transverse diameter of Right & Left side has been measured(fig 1)

Statistical analysis: Statistical analysis was done for each measurement. Mean and standard deviations were performed using SPSS Ver.20.

RESULTS

Sixty sub axial vertebrae were studied. The differences for all the evaluated parameters between right and left side were found insignificant except Foramen transversorium.

Bodies: Transverse length of the body was maximum at C6 and minimum at C3; AP length of body was maximum at C6 minimum at C3. But Height of body gradually increases from C3 to C7 (Table 1).

Pedicles: Pedicle length was maximum at C3, minimum at C6; the pedicle height and width gradually increases from C3 to C7.(Table 2)

Laminae: Laminae length gradually decreases from C3 to C7; but Lamina height was minimum at C3 and Maximum at C6; width of lamina was minimum at C5, maximum at C3.(Table 3)

Spinous Process: Length of spinous process was maximum at C3, Minimum at C7.(Table 4)

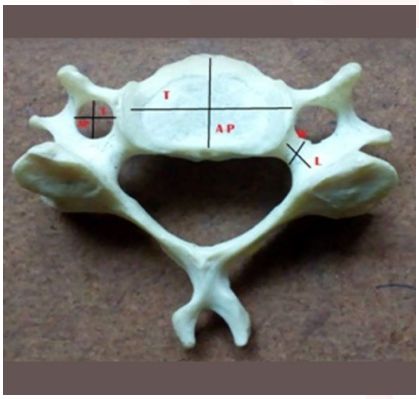

Fig.1: Dimensions of Body ,Pedicle & Foramen Transversorium.

Fig. 2: Dimensions of Lamina & Spinous Process.

Fig. 3: Dimension of Body Height.

AP- Anterior Posterior Length, L – Length,
T- Transverse Length, B- Breadth, H- Height, W- Width

Table 1: Dimensions of Vertebral bodies.

Vertebrae	Transverse Length		AP Length		Height	
	Mean	SD	Mean	SD	Mean	SD
C3	18.17	1.193	11.25	1.138	10.92	0.793
C4	20.5	1.08	13.2	1.989	10.3	0.675
C5	21.36	0.924	14.27	1.191	11.18	1.471
C6	25.08	2.61	15.17	1.586	12	1.348
C7	22.73	1.123	13.47	0.915	12.33	0.816

Table 2: Dimensions of Pedicle.

Vertebrae	Length		Height		Width	
	Mean	SD	Mean	SD	Mean	SD
C3	6.83	1.03	4.67	0.778	4.33	0.492
C4	5.8	0.632	4.9	0.876	4.3	0.823
C5	5.27	1.009	4.55	0.688	5	0.755
C6	4.83	1.528	6.08	1.165	6.42	1.379
C7	5.47	1.246	6.93	0.799	6.13	0.834

Table 3: Dimensions of Laminae.

Vertebrae	Height		Length		Width	
	Mean	SD	Mean	SD	Mean	SD
C3	9.5	1	15	1.206	3.75	0.622
C4	10.9	0.738	14.5	1.354	3	0.661
C5	12.18	1.328	14.36	1.69	2.36	0.505
C6	13.83	2.125	13.83	1.115	3.25	0.861
C7	11.8	1.014	13.07	1.668	3.4	0.507

Table 4: Dimensions of Foramen Transversorium & Spinous Process.

Vertebrae	AP Diameter				Transverse Diameter				Length of Spinous	
	Mean		SD		Mean		SD		Mean	SD
	RT	LT	RT	LT	RT	LT	RT	LT		
C3	5.42	5.75	0.669	1.138	6.75	6.58	0.622	0.996	14.33	1.969
C4	5.7	5	0.949	0.471	7	6.4	0.667	1.35	17.4	2.366
C5	5.27	5.45	1.191	0.82	6.73	6.18	0.786	7.57	17.91	2.427
C6	5	5.83	2.629	1.337	5.33	6.92	2.708	1.78	25.92	4.379
C7	5.67	5.2	0.617	0.941	7.07	7.47	1.28	1.407	26.73	2.12

Table 5: Comparison of body dimensions with previous studies.

Vertebrae	Bazaldua cruz et al [10]		Gajendran prabavathy et al [11]		Present study	
	T	AP	T	AP	T	AP
C3	19.17±3.04	14.38±2.63	22.8±0.101	13.18±0.33	18.17±1.193	11.25±1.138
C4	20.75±1.86	16.36±0.99	23.54±0.26	14.4±0.29	20.50±1.08	13.2±1.98
C5	20.88±3.73	17.45±1.29	26.46±0.51	15.4±0.29	21.36±0.924	14.27±1.49
C6	22.17±2.17	17.49±1.48	25.42±0.38	16.34±0.53	25.08±2.61	15.17±1.586
C7	23.44±3.48	17.42±1.33	26.12±3.76	16.12±0.57	22.73±1.123	13.47±0.955

Table 6: Comparison of pedicle Dimensions.

Vertebrae	Bazaldua cruz et al [10]			Gajendran prabavathy et al [11]			Present Study		
	Length	Width	H	Length	Width	H	Length	Width	H
C3	5.9 ±0.24	2.8 ± 0.10	NA	5.27 ± 1.37	5.14 ± 2.2	NA	6.85 ± 1.03	4.33 ± 0.49	4.67 ± 0.778
C4	6.14±1.21	-	NA	23.54±0.26	4.47±1.08	NA	5.8±0.63	4.3±0.823	4.90±0.876
C5	4.46±0.70	-	NA	26.46±0.51	4.55±0.98	NA	5.27±1.0	5 ± 0.773	4.55±0.688
C6	5.36±0.39	-	NA	25.42±0.38	4.84±1.17	NA	4.83±1.528	6.42±0.379	6.08±1.165
C7	5.44±0.5	4.96±0.37	NA	21.20±0.5	4.20±0.54	NA	5.47±1.246	6.13±0.834	6.95±0.799

Foramen transversorium: AP and transverse length of Foramen transversorium of both sides was measured; AP length of FT on RT side was maximum at C4 but on left side it was maximum at C6; Transverse length of FT on RT side was maximum at C7, it was also maximum at C7 on left side (Table 4).

DISCUSSION

The Anatomical details and dimensions of cervical vertebrae are very important for cervical Spine instrumentation like Trans pedicle screwing [3]. Many Authors have explained about various dimensions of cervical vertebrae by studying CT scan, Direct measurements in bone specimens (Abuzayed et al [3], pankaj & Nepal et al [4], Sandeep saluja et al [5], Chen chun et al [6],Partha sarathy Banerjee et al [7]). They have spent their valuable time in these analyses. But there are variations in the dimensions due to life style changes, genetic makeup, geographic factors and also varies in the races (yusof et al [8]). Our present study will provide knowledge about the dimensions of sub axial vertebrae in south Indian population. In our present study transverse length of body was minimum at C3 maximum at C6 (Table 1).Body height was minimum at C4, maximum at C7(Table 1) . These body dimensions were in concurrence with Ephrahim et al [9] study. In Bazaldua C.J.J et al [10] study transverse length of body increases gradually from C3 to C7. According to Gajendran prabavathy et al [11] body height was minimum at C3, maximum at C7. The body height dimensions were varied from Gajendren prabavathy et al [11] study. Variations in the dimensions of body are important for many surgical procedures like Decompression Surgeries to remove disc or to remove bony spur which compresses spinal cord. It is also useful during corpectomy procedure where removal of entire body is done to gain access to disc material, also for transcorporeal micro decompression (TCMD). TCMD procedure accesses the cervical spine from front of Neck. The morphometry of cervical vertebral pedicles was studied by Kayalioglu et al. [12] In that study greatest pedicle length was at C3.

In our present study pedicle length was maximum at C3 Minimum at C6 level .But pedicle width gradually increases from C3 to C6 level. Pedicle height was also gradually increases from C3 to C6 level. These dimensions were varied from previous studies [11,12]. These may be due to geographical factors, food habits, and environmental conditions.

The pedicle dimensions will be useful for selecting the screw size in transpedicular screwing techniques [Abumi et al [13], Bozbuga et al [14], Ludwig et al [18].

The morphometry of cervical vertebra which was studied by Gajendran Prabavathy et al [11] where maximum pedicle length was noted at C3, Minimum pedicle length was noted at C5, This was in variance with our present study.

The Lamina dimensions are very important for laminotomy (where making hole in lamina to create more space for spinal cord), laminectomy where removal part or all of lamina to reduce pressure on spinal cord & also in laminoplasty procedure [15,16,19,20]. These are all decompression procedures frequently used for the treatment of cervical spondylosis, mylopathy, tumors of spinal medulla (wang et al [16]). In our present study the maximum lamina length was at C6, was minimum at C3; the maximum lamina height was at C3, minimum lamina height was at C7.

According to Bazaldua et al [10] the length of spinous process was minimum at C3 and maximum at C7.In our present study spinous process length was minimum at C3, it gradually increases from C3 to C7 was maximum at C7. Spinous process dimensions are important for decompression procedures from behind.

According to Richa gupta et al [17] foramen transversorium AP length was minimum at C3,maximum at C6.Transverse length was minimum at C3, maximum at C5.In our present study AP length was minimum at C6,maximum at C4 and transverse length was minimum at C6,maximum at C7.These dimensions were varied from previous study.

The dimensions of foramen Transversorium are very important for foraminotomy procedure where Intervertebral disc or a bony spur is pressing on a Nerve as it exits through the foramen, a foraminotomy may be done. This is making the opening of the foramen larger, so the Nerve can exist without being compressed.

CONCLUSION

The dimensions of body and spinous process were increased from C3 to C6. But laminae length decrease gradually from C3 to C7.Pedicle length was gradually decreases from C3 to C6. But pedicle width and height gradually increases from c3 to c6. These results were varied with previous studies. This may be due to nutrition factors and environmental conditions. These results will be helpful in spinal fixation surgeries, decompression surgeries and also useful for orthopaedicians to diagnose and interpret radiological images.

Conflicts of Interests: None

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