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Morphometric Study of Typical Cervical Vertebrae in Population of Bihar & its Clinical Implication

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Abstract
Background: *The cervical spine has tendency to high degree of traumatic, degenerative and neoplastic diseases, so it requires frequent surgical intervention. The detailed knowledge of morphometricstudy of vertebral elements is important for development of instrumentation related to cervical spine. Variation in vertebral dimension among different races have been noted.*
Objective: *The objective of this study was to determine the morphometric feature of vertebral elements of typical cervical vertebrae.*
Material and methods: *This is the prospective type of observational study, conducted on 48 dry typical cervical vertebrae (C3, C4, C5, C6) 12 from each level in the department of Anatomy, Indira Gandhi Institute of Medical Sciences, Patna, Bihar, specimen collected from department of Anatomy and also from forensic department. The dimensions of Vertebral body, Pedicle, Lamina, Spinous process, Superior and Inferior articular processes were measured with the help of sliding vernier caliper.*
Results:*Antero-posterior diameter, transverse diameter and height of bodies increases from C3 to C6 except antero-posterior diameter of C4 which is lowest amongst typical cervical vertebrae. Maximum length and width of pedicle was noted in C3 while minimum was in C5. Height of pedicle was maximum at C3 while minimum at C6. Dimension of lamina was maximum at C3 and maximum at C6. Length of spinous process increases from C3-C6 except C4 which had minimum length. Height and width of superior articular process was maximum at C4 while the minimum height and width was noted in C6 and C3 respectively. Height of inferior articular process was maximum at C4 and minimum at C6 whereas width was maximum at C3 and minimum at C5.*
Conclusion: *Morphometry of vertebral elements are different among different races. So this morphometric study would be valuable for successful instrumentation of cervical spine as smaller dimension face a challenge to the surgeon during application of plates and screw.*

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I. Introduction

The skeleton of neck comprises seven cervical vertebrae and these are identified by presence of foramen in each transverse process. The first and second cervical vertebrae are atypical because they have some special features while the seventh cervical vertebra is transitional because foramen transversarium may be absent or duplicated on one or both side. Third, fourth, fifth and sixth cervical vertebrae have common features and they are called the typical cervical vertebrae. The cervical vertebrae are the smallest, they exhibit the greatest range of movement that makes them prone to traumatic and degenerative changes. Typical vertebra consist of anterior vertebral bodyand posterior vertebral (neural) arch. The body of typical cervical vertebrae are small and relatively broad. The vertebral arch consist of narrow ventral part, the pedicle and a broader lamina dorsally. The Transverse process, superior and inferior articular processes project from the junction of pedicle and lamina..The pedicle projects posterolaterally and longer laminaeposteromedially, enclosing large triangular vertebral foramen. Cervical enlargement of spinal cord accommodate in this part of cervical canal. The pedicle attach midway on the posterior surface of vertebral body, so that superior and inferior vertebral notches are of similar depth.The spinous process project dorsally at the junction of two lamina and is short and bifid. The morphometric value of cervical spines are different among different population group [1].

The instrumentation of vertebral column is required for the treatment of cervical instability and for the decompression of neural structures. One of the most frequent procedure for this placement of transpedicular screw [2,3,4,5]. Thorough knowledge of pedicular anatomy is very important to minimize neurovascular complications in transpedicular stabilization of cervical spine [6].Transfacet fixation may be used for cervical column stabilization which is an alternative to transpedicular fixation [7,8].

II. Objective

The main objective of this study is to measure of dimension of vertebral bodies, pedicles, laminae, spinous process, superior and inferior articular processes which is necessary for the spinal surgeons to avoid damage to vertebral artery, spinal cord or nerve roots during fixation intervention involving posterior cervical spine and also reduces the complications caused by transpedicular screw placement.

III. Methodology

This is the prospective type of observational study, which will be conducted on 48 dry typical cervical vertebrae (C1, C2, C3, C4 each 12) in the department of Anatomy, Narayan Medical College, Sasaram, Bihar. The specimen would be collected from department of Anatomy and also from forensic department of Narayan Medical College, Sasaram, Rohtas, Bihar, India. The dimensions of vertebral body, pedicle, lamina, spinous process, superior and inferior articular processes will be measured with the help of sliding vernier caliper.

Vertebral body
Anteroposterior diameter: Distance between anterior and posterior borders of superior surface vertebral body in midline. **Transverse diameter**: Distance between superior borders of two lateralsurface of vertebral bod. **Height**: Midline distance between superior and inferior borders of anterior surface of vertebral body
Pedicle
Length: Distance between anterior limit of superior articular facet to posterior limit of vertebral body. **Width**: Distance between medial and lateral border of pedicle. **Height:** Distance between superior and inferior borders of pedicle
Lamina
Length: Distance between spine and lateral border of superior articular facet. **Height:** Distance betweensuperior and inferior borders of lamina.
Spinous process
Length: Distance from anterior end to the longest tip of bifurcated spine
Superior articular process
Length: Maximum distance between superior and inferior articular process**. Width:** maximum transverse diameter of superior articular process
Inferior articular process
Length: Maximum distance between superior and inferior borders of superiorarticular process**. Width:** Maximum transverse diameter of inferior articular process

IV. Results

A total of 48 dry typical cervical vertebrae were examined in this study. The maximum and minimum antero-posterior diameter was recorded in C6 and C4 vertebrae respectively.

Table 1. Dimension of vertebral body

Vertebra	Anteroposterior diameter	Transverse diameter	Height
C3	14.26±1.75	21.81±1.51	8.50±0.49
C4	13.94±1.65	24.11±1.34	8.72±0.55
C5	14.80±1.54	25.32±1.24	10.62±0.68
C6	16.02±0.89	25.42±1.34	11.35±0.64

Table.2. Dimension of pedicle

Vertebra	Length		Width		Height	
	Right	Left	Right	Left	Right	Left
C3	7.02±0.21	6.91±0.29	5.49±0.59	5.43±0.58	7.42±0.57	7.35±0.49
C4	6.29±0.50	6.34±0.52	4.89±0.48	4.92±0.44	7.20±0.62	7.18±0.58
C5	4.48±0.44	4.43±0.37	3.72±0.61	3.68±0.62	7.09±0.53	7.07±0.53
C6	5.34±0.52	5.38±0.47	3.84±0.50	3.72±0.51	6.61±0.36	6.66±0.33

Table.3. Dimension of lamina

Vertebra	Length		Height	
	Right	Left	Right	Left
C-3	21.69±1.44	21.86±1.40	8.60±1.22	8.53±1.08
C-4	22.24±0.72	22.04±0.60	9.49±1.84	9.56±1.63
C-5	22.72±0.80	22.57±0.85	11.27±1.46	11.42±1.36
C-6	23.29±0.72	23.19±0.56	12.81±1.71	12.82±1.67

Table.4.Length of Spinous process

Vertebrae	Length
C3	10.61±1.06
C4	10.13±0.93
C5	12.31±1.70
C6	14.44±1.48

Table.5.Measurement of superior articular process

Vertebra	Height		Width	
	Right	Left	Right	Left
C-3	10.41±0.90	10.47±0.88	10.87±1.06	10.89±1.10
C-4	11.40±1.26	11.22±0.89	11.56±0.74	11.44±0.77
C-5	10.17±0.67	10.20±0.82	11.32±0.64	11.15±0.74
C-6	10.23±0.99	10.10±.082	11.15±1.05	11.26±0.87

Table.6.Measurement of inferior articular process

Vertebra	Height		Width	
	Right	Left	Right	Left
C-3	11.56±0.79	11.42±0.77	11.50±0.57	11.52±0.58
C-4	11.80±0.77	11.75±0.85	11.37±0.88	11.47±0.85
C-5	10.67±0.89	10.66±0.82	10.80±0.90	10.83±0.79
C-6	9.58±0.80	9.56±0.71	11.46±0.89	11.50±0.71

Fig.1. Anteroposterior diameter of body

Fig.2. Transverse diameter of body

Fig.3. Height of the body

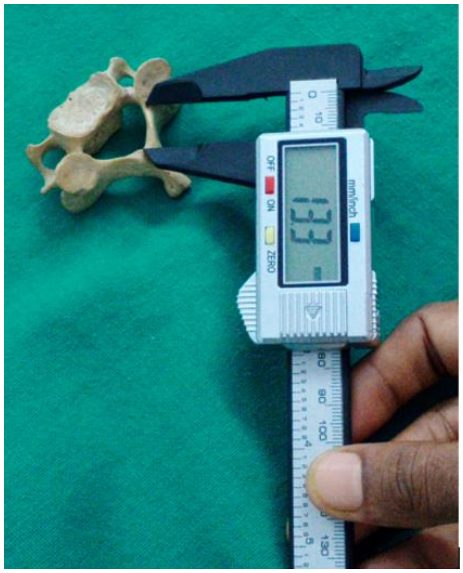

Fig.4. Length of Lamina

Fig.5. Length of spinous process

Fig. 6. Length of superior articular process

Fig.7. Length of Inferior articular process

V. Discussion

Table.7. Showing comparision of dimension of vertebral body

Vertebra	Mahto and Omar (2015)		Bazaldua Cruz et al. (2011)		Present study (2019)		
	APD	TD	APD	TD	APD	TD	H
C-3	13.6±0.18	22.8±0.21	14.68±2.63	19.17±3.04	14.26±1.75	21.81±1.51	8.50±0.49
C-4	14.4±0.15	23.6±0.28	16.36±0.99	20.75±1.86	13.94±1.65	24.11±1.34	8.72±0.55
C-5	15.2±0.21	26.4±0.30	17.45±1.29	20.88±3.73	14.80±1.54	25.32±1.24	10.62±0.68
C-6	15.8±0.19	25.2±0.23	17.47±1.48	22.17±2.17	16.0 2±0.89	25.42±1.34	11.35±0.64

Table.8. Showing comparision of dimension of length of pedicle

Vertebra	Banerjee et al		Rekhaparahar et al		Present study	
	Right	Left	Right	Left	Right	Left
C-3	5.05±1.12	5.19±1.08	7.32±.47	7.34±.45	7.02±0.21	6.91±0.29
C-4	5.54±0.92	5.04±.96	6.28±.79	6.40±93	6.29±0.50	6.34±0.52
C-5	5.37±0.90	4.91±1	4.59±.45	4.57±.51	4.48±0.44	4.43±0.37
C-6	4.62±0.92	5.01±.91	5.01±.52	4.9±.55	5.34±0.52	5.38±0.47

Table.9. Showing comparision of dimension of width of pedicle

Vertebra	Banerjee et al		Rekhaparahar et al		Present study	
	Right	Left	Right	Left	Right	Left
C-3	4.71±0.81	4.71±0.81	5.34±.65	5.32±.65	5.49±0.59	5.43±0.58
C-4	4.76±0.83	4.87±.078	4.65±.38	4.66±.38	4.89±0.48	4.92±0.44
C-5	4.98±0.78	5.09±0.70	3.65±.15	3.66±.15	3.72±0.61	3.68±0.62
C-6	5.34±0.82	5.42±0.80	3.83±.38	3.84±.37	3.84±0.50	3.72±0.51

Table.10. Showing comparision of dimension of height of pedicle

Vertebrae	Gajendranprabavathy et al	Present study	
		Right	Left
C-3	7.50±2.01	7.42±0.57	7.35±0.49
C-4	7.10±0.92	7.20±0.62	7.18±0.58
C-5	7.06±1.87	7.09±0.53	7.07±0.53
C-6	6.80±0.87	6.61±0.36	6.66±0.33

Table.11.Showing comprision of length of lamina

Vertebra	Ensaf et al	Rekhaparahar et al		Present study	
		Right	Left	Right	Left
C-3	18.1±0.27	21.5±.94	21.5±.94	21.69±1.44	21.86±1.40
C-4	18.1±0.27	22.66±.94	22.69±.66	22.24±0.72	22.04±0.60
C-5	18.0±0.29	22.99±.48	22.91±.55	22.72±0.80	22.57±0.85
C-6	18.8±0.36	23.60±1.12	23.48±1.09	23.29±0.72	23.19±0.56

Table.12.Showing comprision of height of lamina

Vertebra	Ensaf et al	Rekhaparahar et al		Present study	
		Right	Left	Right	Left
C-3	16.0±.15	8.63±0.83	8.47±0.76	8.60±1.22	8.53±1.08
C-4	16.2±.12	10.21±0.96	9.96±1.26	9.49±1.84	9.56±1.63
C-5	16.6±.12	12.24±0.77	12.25±0.75	11.27±1.46	11.42±1.36
C-6	16.3±.35	12.84±1.15	12.81±1.07	12.81±1.71	12.82±1.67

Table.13. Showing comparision of spinous process

Vertebra	Bazaldua Cruz et al.	Rekhaparahar et al	Present study
C-3	15.53±3.10	10.80±0.97	10.61±1.06
C-4	15.38±2.61	10.20±1.34	10.13±0.93
C-5	16.63±3.04	12.50±0.96	12.31±1.70
C-6	21.81±5.00	14.64±1.45	14.44±1.48

Table.14. Showing comparision of height of superior articular process

Vertebra	Bazalua C.J.J. et al	Gajendranprabavathy	Present study	
			Right	Left
C-3	10.68±3.39	10.88±2.22	10.41±0.90	10.47±0.88
C-4	11.05±1.09	11.56±2.04	11.40±1.26	11.22±0.89
C-5	11.27±1.15	10.1±2.14	10.17±0.67	10.20±0.82
C-6	10.22±1.66	10.84 1.26	10.23±0.99	10.10±.082

Table.15. Showing comparision of width of superior articular process

Vertebra	Bazalua C.J.J. et al	Gajendranprabavathy	Present study	
			Right	Left
C-3	10.92±2.14	10.64±1.97	10.87±1.06	10.89±1.10
C-4	11.36±1.10	11.40±0.61	11.56±0.74	11.44±0.77
C-5	11.17±1.64	11.56±1.33	11.32±0.64	11.15±0.74
C-6	11.87±2.32	11.06±0.57	11.15±1.05	11.26±0.87

Table.16. Showing comparision of height of inferior articular process

Vertebra	Bazalua C.J.J. et al	Gajendranprabavathy	Present study	
			Right	Left
C-3	11.51±2.93	11.48±0.39	11.56±0.79	11.42±0.77
C-4	11.21±1.81	11.74±0.47	11.80±0.77	11.75±0.85
C-5	9.75±1.89	10.46±0.38	10.67±0.89	10.66±0.82
C-6	9.85±1.48	9.30±0.42	9.58±0.80	9.56±0.71

Table.17. Showing comparision of width of inferior articular process

Vertebra	Bazalua C.J.J. et al	Gajendranprabavathy	Present study	
			Right	Left
C-3	11.37±1.87	11.48±0.37	11.50±0.57	11.52±0.58
C-4	11.31±1.34	11.28±0.49	11.37±0.88	11.47±0.85
C-5	10.08±2.42	10.72±0.24	10.80±0.90	10.83±0.79
C-6	11.94±1.62	11.36±0.4	11.46±0.89	11.50±0.71

VI. Conclusion:

The dimension of vertebral body, spinous process and laminae increases from C3 to C7. The height of pedicle, superior and inferior articular process decreases from C3 to C7. This morphometric characteristics are associated with change from cervical lordosis to thoracic kyphosis curvature and increases cervical column mobility. This morphometric results are important for planning a surgical procedure and selecting appropriate size of instruments.

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