



MORPHOMETRIC STUDY OF ARTICULAR FACETS OF HUMAN ATLAS VERTEBRAE IN INDIAN POPULATION

Anatomy

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ABSTRACT

Human's first cervical vertebrae has been given the name on a Greek god atlas. As God Atlas is supposed to hold the earth on his shoulder, same way this vertebra sub serves the function of weight bearing of our head on itself because of our erect posture. Aim of the present study is to provide morphometric data of articular facets of atlas of Indian population, which are essential in screw fixation procedures of craniovertebral joints. Length of superior and inferior articular facet was measured as maximum anteroposterior diameter of articular surfaces. Width of superior and inferior articular facets was measured as maximum transverse diameter of articular surfaces. All the measurements were performed using a Vernier caliper accurate to 0.1 mm. In the present study length of superior articular facet was found to be 22.7 ± 1.44 mm on left side while 22.1 ± 1.50 mm on right side and width of superior articular facet was found to be 11.8 ± 1.12 mm on left side while 11.7 ± 1.02 mm on right side. Length of inferior articular facet was found to be 14.8 ± 1.06 mm on left side while 14.4 ± 1.21 mm on right side and Width of inferior articular facet was found to be 13.5 ± 0.91 mm on left side while 12.8 ± 0.75 mm on right side. The observations made in the present study may be helpful to neurosurgeons who routinely operate close to important structures such as nerve roots and vertebral artery in the atlanto-occipital area. This data will also be helpful to decide the proper screw size for spine surgeons during c1-c2 posterior fixation also.

KEYWORDS

Articular Facet, Atlas, Atlantoaxial Joint, Atlanto-occipital Joint

INTRODUCTION:

Human's first cervical vertebrae has been given the name on a Greek god Atlas. As God atlas is supposed to hold the earth on his shoulder, same way this vertebra sub serves the function of weight bearing of our head on itself because of our erect posture. Lateral masses of atlas provide enough support and strength to withhold the weight of head. Occipital condyles of skull transmit all the weight of skull to superior articular facet of atlas and they make atlanto-occipital joint. Nodding movement of head also occurs on this joint. The atlanto-occipital joint produces flexion and extension of head. The range of flexion and extension movements of head is 15 degree. Through inferior articular facet, atlas is articulated to axis vertebrae forming lateral atlantoaxial joint. The lateral atlantoaxial joint is a synovial joint of plane variety. The stability of atlanto axial joint is maintained by transverse atlantal ligament, fibrous capsule, ligamentum nuchae and alar ligament. The normal range of atlanto axial rotation is 40 degree. In this craniovertebral joint assembly, any instability might lead to severe basilar insufficiency or other neural symptoms and which might need reduction of instability and fixation procedures using screws. Aim of the present study is to provide morphometric data of articular facets of atlas of Indian population, which are essential in screw fixation procedures of craniovertebral joints.

Material and method: This observation study was carried out on 250 dried adult human atlas vertebrae procured from Department of Anatomy of Rajkiya Medical College, Jalaun; MLN Medical College, Allahabad; Hitech Medical College and Hospital, Bhubaneswar and Index Medical College, Indore from year 2015 to 2020. Any specimen having fracture, gross evidence of congenital or acquired vertebral pathology, or gross osteophytes was excluded from the study. Length of superior and inferior articular facet was measured as maximum anteroposterior diameter of articular surfaces. Width of superior and inferior articular facets was measured as maximum transverse diameter of articular surfaces. (Figure-1, 2)



Figure-1 Measurement of length of articular facet



Figure-2 Measurement of width of articular facet

All the measurements were performed using a Vernier caliper accurate to 0.1 mm. All data were represented as mean \pm SD in mm, followed by comparison with the data of other studies using unpaired 't' test. The difference was taken as significant, if the p value was ≤ 0.05 .

Observation:

Table-1 Measurement of articular facets

Specimen	Facet	Parameter	
Atlas	Superior articular facet	Length in (mm) (Mean \pm SD)	
		Right	Left
		22.21 ± 2.76	22.72 ± 2.55
		Width in (mm) (mean \pm SD)	
	Right	Left	
	11.64 ± 1.85	11.84 ± 1.56	
	Inferior articular facet	Length in mm (mean \pm SD)	
		Right	Left
14.47 ± 2.38		16.22 ± 1.50	
Width in mm. (mean \pm SD)			
Right	Left		
12.91 ± 1.39	13.72 ± 1.47		

DISCUSSION:

During C1-C2 posterior fixation technique, screws used for atlas vertebrae are directed towards anterior tubercle passing obliquely inside thick lateral masses of atlas. Data of dimensions of articular facets for that specific population are helpful tool to judge the proper screw size for the procedure.

Table-2 Comparison of length of superior articular facet of left side atlas with other studies

Present Study in(mm)	Other Studies	Number of Vertebra	Measurement in mm (Mean±SD)	Unpaired T test	
22.7± 1.44 (250 atlas)	Sengul et al ³ (2006)	40	18 ± 3.2	t=15.47	P=0.0001
	Gosavi et al ⁴ (2012)	100	21.02±2.52	t=7.82	P=0.0001
	Rekha P. et al ⁵ (2014)	75	18.20±2.50	t=19.63	P=0.0001
	Jasveen K. et al ⁶ (2014)	50	20.86±1.97	t=7.71	P=0.0001
	Salahuddin et al. (2015) ⁷	30	21.84±2.11	t=2.92	P=0.0038
	Sutha(2016) ⁸	50	21.48±2.27	t=4.90	P=0.0001
	Rekha BS. et al ⁹ (2016)	100	22.26±2.19	t=2.20	P=0.0282
	Nitixa P et al ¹⁰ (2016)	100	20.86±1.97	t=9.66	P=0.0001
	Kayalvizhi et al ¹¹ (2017)	50	19.95±2.03	t=11.43	P=0.0001

On comparison of measurement of length of superior articular facet left side with the findings of Sengul et al (2006)³, Jasveen k. et al (2014)⁶, Rekha P. et al (2014)¹⁰, Salahuddin et al. (2015)⁷, Sutha (2016)⁸, Rekha BS. et al(2016)⁹, Nitixa P et al (2016)¹⁰, and Gosavi et al (2012)⁴ it was noticed that all the above parameter showed differences from their study, which was found to be statistically significant (p<0.05).

Table-3 Comparison of length of superior articular facet of right side atlas with other studies

Present Study in(mm)	Other Studies	Number of Vertebra	Measurement in mm (Mean±SD)	Unpaired T test	
22.1±1.50 (250atlas)	Sengul et al ³ (2006)	40	19.9± 3.4	t=6.09	P=0.0001
	Gosavi et al ⁴ (2012)	100	21.04± 2.39	t=3.28	P=0.0011
	Rekha P. et al ⁵ (2014)	75	17.80±2.03	t=19.95	P=0.0001
	Jasveen K. et al ⁶ (2014)	50	20.73±1.68	t=5.77	P=0.0001
	Salahuddin et al. (2015) ⁷	30	22.13±2.26	t=0.09	P=0.9276
	Sutha(2016) ⁸	50	22.2±2.56	t=0.37	P=0.7077
	Rekha BS. et al ⁹ (2016)	100	22.33±2.14	t=1.13	P=0.2555
	Nitixa P et al ¹⁰ (2016)	100	20.73±1.68	t=7.45	P=0.0001
	Kayalvizhi et al ¹¹ (2017)	50	20.56±1.91	t=6.31	P=0.0001

On comparison of measurement of length of superior articular facet right side with the findings of Sengul et al (2006)³, Jasveen k. et al (2014)⁶, Rekha P. et al (2014)¹⁰, Nitixa P et al (2016)¹⁰, and Gosavi et al (2012)⁴ it was noticed that all the above parameter showed differences from their study, which was found to be statistically significant (p<0.05)except the findings of the length of superior articular facets of right side in the study of Salahuddin et al. (2015)⁷, Sutha (2016)⁸ and Rekha BS. et al (2016)⁹, where difference was not significant.

Table-4 Comparison of width of superior articular facet of left side

Present Study in(mm)	Other Studies	Number of Vertebra	Measurement in mm (Mean±SD)	Unpaired T test	
11.8±1.12 (250atlas)	Sengul et al ³ (2006)	40	9.8 ± 1.5	t=9.96	P=0.0001
	Gosavi et al ⁴ (2012)	100	10.47 ±1.61	t=8.79	P=0.0001
	Rekha P. et al ⁵ (2014)	75	8.33±1.55	t=21.39	P=0.0001
	Jasveen K. et al ⁶ (2014)	50	11.39±1.5	t=2.22	P=0.0270

Salahuddin et ⁷ al. (2015)	30	12.19±1.58	t=1.71	P=0.0873
Sutha(2016) ⁸	50	11.74±1.71	t=0.31	P=0.7543
Rekha BS. et al ⁹ (2016)	100	12.1±0.6	t=2.53	P=0.0117
Nitixa P et al ¹⁰ (2016)	100	11.39±1.5	t=2.79	P=0.0055
Kayalvizhi et al ¹¹ (2017)	50	10.66±2.79	t=4.82	P=0.0001

On comparison of measurement of width of superior articular facet left side with the findings of Sengul et al (2006)³, Jasveen k. et al (2014)⁶, Rekha P. et al (2014)¹⁰, Nitixa P et al (2016)¹⁰, Gosavi et al (2012)⁴ and Rekha BS. et al(2016)⁹, it was noticed that all the above parameter showed differences from their study, which was found to be statistically significant (p<0.05)except the findings of the width of superior articular facets of left side in the study of Salahuddin et al. (2015)⁷ and Sutha (2016)⁸ where difference was not significant.

Table-5 Comparison of width of superior articular facet of right side

Present Study in(mm)	Other Studies	Number of Vertebra	Measurement in mm (Mean±SD)	Unpaired T test	
11.7 ±1.02 (250atlas)	Sengul et al ³ (2006)	40	9.6 ± 1.9	t=10.46	P=0.0001
	Gosavi et al ⁴ (2012)	100	10.36 ± 1.72	t=8.99	P=0.0001
	Rekha P. et al ⁵ (2014)	75	7.80±1.29	t=27.3	P=0.0001
	Jasveen K. et al ⁶ (2014)	50	11.21±1.82	t=2.65	P=0.0001
	Salahuddin et ⁷ al. (2015)	30	11.82±1.79	t=0.55	P=0.5814
	Sutha(2016) ⁸	50	11.49±1.62	t=1.16	P=0.2356
	Rekha BS. et al ⁹ (2016)	100	12.0±0.6	t=2.75	P=0.0062
	Nitixa P et al ¹⁰ (2016)	100	11.34±1.82	t=2.34	P=0.0197
	Kayalvizhi et al ¹¹ (2017)	50	11.19±2.2	t=2.55	P=0.0112

On comparison of measurement of width of superior articular facet right side with the findings of Sengul et al (2006)³, Gosavi et al (2012)⁴, Jasveen k. et al (2014)⁶, Rekha P. et al (2014)¹⁰, Nitixa P et al (2016)¹⁰, and Rekha BS. et al(2016)⁹, it was noticed that all the above parameter showed differences from their study, which was found to be statistically significant (p<0.05)except the findings of the width of superior articular facets of right side in the study of Salahuddin et al. (2015)⁷ and Sutha (2016)⁸ where difference was not significant.

Table-6 Comparison of length of inferior articular facet of left side

Present Study in(mm)	Other Studies	Number of Vertebra	Measurement in mm (Mean±SD)	Unpaired T test	
14.8±1.06 (250atlas)	Sengul et al ³ (2006)	40	17.5 ± 2.4	t=11.98	P=0.0001
	Gosavi et al ⁴ (2012)	100	16.50 ± 1.67	t=11.38	P=0.0001
	Rekha P. et al ⁵ (2014)	75	14.27±1.78	t=3.19	P=0.0016
	Jasveen K. et al ⁶ (2014)	50	17.70±1.60	t=16.05	P=0.0001
	Salahuddin et al. (2015) ⁷	30	16.67±1.84	t=8.30	P=0.0001
	Sutha(2016) ⁸	50	17.15±1.50	t=13.25	P=0.0001
	Rekha BS. et al ⁹ (2016)	100	17.82±2.35	t=16.58	P=0.0001
	Nitixa P et al ¹⁰ (2016)	100	17.77±1.53	t=20.70	P=0.0001
	Kayalvizhi et al ¹¹ (2017)	50	16.95±1.01	t=13.19	P=0.0001

Table-7 Comparison of length of inferior articular facet of right side

Present Study in(mm)	Other Studies	Number of Vertebra	Measurement in mm (Mean±SD)	Unpaired T test
14.4±1.21 (250atlas)	Sengul et al ³ (2006)	40	17.1± 2.6	t=10.73 P=0.0001
	Gosavi et al ⁴ (2012)	100	16.57± 1.9	t=12.73 P=0.0001
	Rekha P. et al ⁵ (2014)	75	14.84±2.17	t=2.24 P=0.0001
	Jasveen K. et al ⁶ (2014)	50	17.54±1.50	t=16.05 P=0.0001
	Salahuddin et ⁷ al. (2015)	30	16.24±1.44	t=7.70 P=0.0001
	Sutha(2016) ⁸	50	17.37±1.65	t=14.83 P=0.0001
	Rekha BS. et al ⁹ (2016)	100	17.9±1.61	t=22.14 P=0.0001
	Nitixa P et al ¹⁰ (2016)	100	17.54±1.50	t=20.42 P=0.0001
	Kayalvizhi et al ¹¹ (2017)	50	16.95±1.18	t=13.65 P=0.0001

Table-8 Comparison of width of inferior articular facet of left side

Present Study in(mm)	Other Studies	Number of Vertebra	Measurement in mm (Mean±SD)	Unpaired T test
13.5±0.91 (250atlas)	Sengul et al ³ (2006)	40	8.5 ± 1.5	t=29.06 P=0.0001
	Gosavi et al ⁴ (2012)	100	14.42 ± 1.67	t=6.60 P=0.0001
	Rekha P. et al ⁵ (2014)	75	10.66±1.48	t=20.20 P=0.0001
	Jasveen K. et al ⁶ (2014)	50	14.94±1.51	t=8.99 P=0.0001
	Salahuddin et ⁷ al. (2015)	30	16.39±1.93	t=14.06 P=0.0001
	Sutha(2016) ⁸	50	14.51±1.17	t=6.80 P=0.0001
	Rekha BS. et al ⁹ (2016)	100	14.48±1.80	t=9.47 P=0.0001
	Nitixa P et al ¹⁰ (2016)	100	15.0±2.03	t=9.54 P=0.0001
	Kayalvizhi et al ¹¹ (2017)	50	14.73±3.83	t=4.50 P=0.0001

Table-9 Comparison of width of inferior articular facet of right side

Present Study in(mm)	Other Studies	Number of Vertebra	Measurement in mm (Mean±SD)	Unpaired T test
12.8±0.75 (250 atlas)	Sengul et al ³ (2006)	40	8.8 ± 1.5	t=26.41 P=0.0001
	Gosavi et al ⁴ (2012)	100	14.01 ± 1.93	t=8.45 P=0.0001
	Rekha P. et al ⁵ (2014)	75	10.42±1.42	t=19.10 P=0.0001
	Jasveen K. et al ⁶ (2014)	50	14.99±1.65	t=14.75 P=0.0001
	Salahuddin et ⁷ al. (2015)	30	15.84± 1.83	t=17.03 P=0.0001
	Sutha(2016) ⁸	50	14.92±1.28	t=15.91 P=0.0001
	Rekha BS. et al ⁹ (2016)	100	14.84±1.31	t=18.26 P=0.0001
	Nitixa P et al ¹⁰ (2016)	100	14.97±1.89	t=15.39 P=0.0001
	Kayalvizhi et al ¹¹ (2017)	50	13.64±3.33	t=3.58 P=0.0001

On comparison of measurement of inferior articular facet length and width, with the findings of Sengul et al (2006)³, Gosavi et al (2012)⁴, Jasveen k. et al (2014)⁶, Rekha P. et al (2014)⁵, Salahuddin et al (2015)⁷, Nitixa P et al (2016)¹⁰, Sutha (2016)⁸, Rekha BS. et al (2016)⁹, and Kayalvizhi et al (2017)¹¹ it was noticed that all the above parameter showed differences from their study, which were found to be statistically significant (p <0.05).

CONCLUSION:

The observations made in the present study may be helpful to neurosurgeons who routinely operate close to important structures such as nerve roots and vertebral artery in the atlanto-occipital area. This data will also be helpful to decide the proper screw size for spine surgeons during c1-c2 posterior fixation also.

REFERENCES:

1. Standring, S. and Gray, H. (2008). Gray's anatomy. 41st ed. [Edinburgh]: Churchill Livingstone/Elsevier. pp.720-748.
2. Snell, R. (2007). Clinical anatomy by systems. 7th ed. Philadelphia: Lippincott Williams & Wilkins. pp386
3. Sengul G, Kodiglu HH, Morphometric anatomy of atlas and axis vertebrae. Turkish Neurosurgery, 2006; 16(2):69-76
4. Gosavi, N Shilpa Morphometric study of the atlas vertebrae using manual method. Malaysian orthopaedic journal; 2012 6 (3):18-20
5. Rekha P, Chauhan S, Saxena D, Meena SL. A morphometric study of atlas & axis vertebrae in rajasthan population. J Evolution of Med Dent Sci. 2014;3(74):15497-506
6. Jasveen K, Mamta S, Poonam S, Ajay K. Morphometry of the vertebral canal of atlas and axis. Int J Anat Res 2017;5(4.3):4711-4715
7. Ansari MS, Mukesh S, Kumar S, Ravi, PG, Raj K. Morphometric Analysis of Atlas and Its Clinical Significance: An Anatomical Study of Indian Human Atlas Vertebrae Indian J Neurosurg 2015;4:92-97
8. Sutha S Morphometric analysis of Atlas in western Tamilnadu population dissertation submitted for MD degree Dr MGR Medical University 2017 :53-54
9. Rekha B.S , Dhanalaxmi D N, Variations in foramen transversarium of atlas vertebra: An osteological study in South Indians 2014; 2(1): 224-228
10. Nitixa P, Gupta DS. A morphometric study of adult human atlas vertebrae in South Gujarat population, India. Int J Res Med Sci 2016;4:4380-6.
11. Kayalvizhi I, Bansal S, Dhidharia K, Narayan RK, Kumar P. Morphometric study of the articular facets of atlas vertebra in north indian population. Int J Anat Res 2017;5(2.2):3829-3832.