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AN ANATOMICAL MEASUREMENT AND EVALUATION OF SUPERIOR ARTICULAR FACET OF ATLAS VERTEBRAE IN EASTERN U.P.

Anatomy

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ABSTRACT

Introduction The superior articular facets of the atlas vertebra play a pivotal role in the biomechanics of the cervical spine, enabling crucial movements such as rotation and flexion of the head. Variations in their morphology can influence not only normal physiological function but also susceptibility to injury and the progression of cervical spine disorders. **Aims And Objectives** This study was conducted to deliver precise morphometric data and morphological variations of the superior articular facet of the atlas. **Material And Methods** 48 dried atlas vertebrae were taken from the department of anatomy, B.R.D. Medical College, Gorakhpur and measured using digital vernier calliper. **Results** In 48 atlas vertebrae, kidney-shaped SAFs were most common on each sides. Transverse lengths showed no significant difference between left and right sides. However, the anteroposterior length was significantly greater in the right side. **Conclusion** The width of the SAF of atlas was statistically significant on the left side. Morphologically predominance of kidney-shaped facets shape was seen in this study.

KEYWORDS

atlas, cervical, SAF, vertebrae

INTRODUCTION

The atlas (C1 vertebra) forms crucial link between skull and vertebral column at the craniovertebral junction (CVJ). Anatomically, it lacks traditional vertebral body, shaped like an irregular ring, comprises two lateral masses. These lateral masses are robust and features both superior and inferior articular facets. The superior articular facets (SAFs) are concave, elliptical or irregularly shaped depressions. They articulate with the occipital condyles to form the atlanto-occipital joint, which is responsible for flexion and extension of head.(1). Any variation in their shape or size could alter normal biomechanics, potentially contributing to instability or pathological changes in the CVJ(2). These anatomical structures are of profound clinical significance. Their variations can influence the outcomes of cervical spine surgeries, especially posterior fixation techniques involving lateral mass screws. Misidentification of SAF boundaries or dimensions may result in vertebral artery injury or inadequate stabilization(3). Furthermore, morphological anomalies, such as bilobed or dumbbell-shaped SAFs, may reflect altered developmental or functional adaptations and are associated with restricted movement or instability(4).

Understanding the occipito-atlanto region is important due to its anatomical variability and the presence of vital neurovascular structures. This study focuses on the morphometric analysis and shape variations of SAF in dry C1 vertebrae from the eastern U.P. population. The findings offer valuable insights for anatomists, assist clinicians in surgical planning, and contribute to accurate biomechanical modelling of the cervical spine.

MATERIAL AND METHODS

This observational study was conducted in the Department of Anatomy at B.R.D. Medical College, Gorakhpur. A total of 48 dry adult human atlas vertebrae of unspecified sex were included. Damaged or deformed vertebrae were excluded. A digital vernier caliper, accurate to 0.01 mm, was used for all measurements. Three measurements were recorded and average was taken for consideration. The parameters measured included anteroposterior length and transverse width of the SAFs. Shapes were classified into oval, kidney, dumbbell, and bilobed types based on visual inspection. Statistical analysis was performed using paired t-tests to compare the right and left SAFs. A p-value of less than 0.05 was considered statistically significant.

RESULT

Morphologically, four variations of SAFs were observed in 48 vertebrae: kidney, oval, dumbbell, and bilobed shapes (Table-1). The kidney-shaped facet was the most common, seen in 43.75% of cases in left and 50% in right side. Oval-shaped facets were observed in 37.5% on both sides, while dumbbell and bilobed shapes were the least common, each accounting for 6.25% of the total SAFs. The transverse length (Table-2) of the SAF ranged from 9.57 mm to 15.80 mm in right and 10.08 mm to 15.93 mm in left side, with the average 11.97 and 12.15 mm, respectively, showing no significant side difference ($p = 0.3619$). However, the anteroposterior length (Table-3) was significantly greater on the right (18.55 mm to 26.91 mm) than the left (16.52 mm to 27.68 mm), with average length of 23.03 and 21.74 mm, respectively. (p-value: 0.0074).

Table 1-Prevalence of different shape of SAF

No. of SAF	Side	Kidney	Oval	Dumbbell	Bilobed
96	Left	43.75%	37.5%	6.25%	0%
	Right	50%	37.5%	0%	6.25%

Table 2-Transverse width of SAF

No. of SAF	Side	Minimum	Maximum	Mean	SD	p-value
96	Left	10.08	15.93	12.15	1.63	0.3619
	Right	9.57	15.8	11.97	1.97	

Table 3- AP length of SAF

No. of SAF	Side	Min	Max	Mean	SD	p-value
96	Left	16.52	27.68	21.74	2.42	0.0074
	Right	18.55	26.91	23.03	2.53	

Table 4- Shape of SAF of present and previous studies

Shape	Cacciola et al. (2004)(3)	Sengul et al. (2006)(5)	Lalit et al. (2011)(6)	Tejaswi et al. (2022)(4)	Present Study (2025)
Kidney (%)	24%	28%	20%	18%	46.87%
Oval (%)	76%	72%	23.3%	62%	37.5%
Dumbbell (%)	0%	0%	56.7%	13.7%	3.13%
Bilobed (%)	0%	0%	0%	6.3%	3.13%

DISCUSSION

In the present study, kidney-shaped SAFs were the most prevalent

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(46.87%), differing from earlier studies like those by Cacciola et al. (2004)(3) and Sengul et al. (2006)(5), where oval shapes were more common. Dumbbell and bilobed shapes were less frequent, indicating possible regional or population-specific anatomical variations. These findings are important for surgical planning and anatomical understanding of the cervical spine.

Table 5- Mean transverse width of SAF (in mm) of present and previous studies

Studies	Mean transverse width	
	Right	Left
Kocabiyik et al. (2006)(5)	9.6	9.8
Gosavi et al. (2012)(7)	10.36	10.47
Konig et al. (2005)(8)	11.6	11.2
Kaur et al. (2014)(9)	11.21	11.32
Tejaswi et al. (2022)(4)	10.7897	11.2
Present Study	11.97	12.15

In the present study, average transverse width of the SAF in right and left are 11.97 mm &12.15 mm respectively, which is slightly higher than most previous Indian studies, including those by Gosavi and Vatsalaswamy (2012)(7) and Tejaswi et al. (2022)(4). The findings are comparable to Konig et al. (2005)(8), who reported similar widths in a German population. This suggests possible regional variation within India and highlights the importance of localized morphometric data for surgical planning at the craniovertebral junction.

Table 6- Mean anteroposterior length of SAF in present and previous studies

Studies	Mean AP length(mm)	
	Right	Left
Sengul et al. (2006)(10)	19.9	18.6
Gosavi et al. (2012)(7)	21.24	21.02
Konig et al. (2005)(8)	19.1	18.7
Kaur et al. (2014)(9)	21.52	21.51
Rocha et al. (2007)(11)	23.9	23.6
Tejaswi et al. (2022)(4)	21.9	22.1
Present Study	23.03	21.74

In the present study, average anteroposterior length of SAF on right and left was 23.03 mm & 21.74 mm respectively, which is higher than most previous Indian and international studies. Sengul and Kadioglu (2006)(10) and Konig et al. (2005)(8) reported smaller dimensions, while Rocha et al. (2007)(11) showed similar values in a U.S. population. Tejaswi et al. (2022)(4) and Kaur et al. (2014)(9) found slightly lower lengths in Indian populations. These findings suggest regional and population-based variations in SAF dimensions, which may have clinical relevance during cervical spine procedures.

CONCLUSION

The present study provides valuable insights into the morphological and morphometric variations of SAF of C1 vertebra. The predominance of kidney-shaped facets and the observed asymmetry in anteroposterior dimensions emphasize the need for further research to establish population-specific reference data. These findings have significant implications for clinical practice, particularly in diagnosing cervical spine disorders and planning surgical interventions. Future studies should explore the impact of genetic and environmental factors on SAF morphology to enhance personalized approaches in spine care.

Fig.1 Left dumbbell and right bilobed shaped SAF

Fig.2 Both left and right Kidney shaped SAF

Fig.4 Measurement of transverse width

Fig.3 Left and right oval shaped SAF

Fig.5 Measurement of Anteroposterior length

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