

Variation In Superior Articular Facets of Atlas Vertebrae In Terms of Its Morphology

Dr. Kintu Vyas *, Dr. Hemang Joshi**, Dr. Mitesh Dave***, Dr. Jigna Parmar****,
Dr. Hina Rajput*, Dr. Bhavesh Shroff*****.

*Asst. Professor, Dept. of Anatomy, Medical College Vadodara, ** Asst. Professor, Dept. of Anatomy, Government Medical College Rajkot, ***Asst. Professor, Dept of Anatomy, GMERS, Medical College Valsad, **** Tutor, Dept of Anatomy, SBKSMI&RC, pipariya, Vadodara, *****Asst. Professor, Dept of PSM, Medical College Vadodara,.

Abstract: Background: Hypermobility of Atlanto-Occipital joints give rise to symptoms related to vascular compromise viz syncope, vertigo, transient impairment of visual field, altered consciousness. Surgical management of congenital anomalies of craniovertebral junction requires a precise identification of underlying pathophysiological condition. For this reason variation in superior articular facets of atlas vertebrae in terms of its morphology should be known. Method: The morphology of 100 atlas vertebrae had been studied and observations of total 200 facets were noted. Measurements were taken with a vernier callipers and a compass. Result : In the present study, typical oval, elongated or kidney shaped outline was found in 74.5% facets. Constrictions or notches were present on 48% facets. Complete separation (4.5%) is suggestive of tendency towards possible restriction of movement at atlanto-occipital joint as part of evolutionary changes. Roughly circular pressure facets had been observed in 78% of vertebrae indicating possibly greater pressure at this site during movement at atlanto-occipital joint. Conclusion: Knowledge of this variation in craniovertebral junction is of significant importance for Neurosurgeons and Orthopaedic surgeons doing various surgeries in this region. [Vyas K et al NJIRM 2013; 4(1) : 12-15]

Key Words: superior articular facets of atlas vertebra, constriction or notches, degree of separation, pressure facets.

Author for correspondence: Dr. Kintu Kumar Vyas 109, Vishwamitri Township, Near Vishwamitri Railway Station, Manjalpur-390011. e- mail: drkintu_vyas@yahoo.co.in

Introduction: The craniovertebral junction is the area bounded by three bones: Occiput, Atlas and Axis. The Atlas is the first cervical vertebra which supports the “globe” of the head¹. Malformations of this junctional region are of great significance for Neurosurgeons, Neurophysicians & Orthopaedic surgeons. Injuries of upper cervical spine which cause severe disabilities following trauma². The unique structure and the anatomical location of Atlas forms a safety mechanism³. Superior articular facet (SAF)s, which are present on atlas vertebra face superomedially and are admirably accepted for nodding movements and also for the weight bearing of the head⁴. Cervical spine malformations & craniovertebral junction abnormalities which lead to hypermobility of Atlanto-Occipital joints give rise to neurological and vascular symptoms. Surgical management of these congenital anomalies of craniovertebral junction requires a precise identification of pathophysiological conditions. Unfortunately well illustrated and clinical oriented classification of malformation of craniovertebral junction and cervical spine has not yet been carried out. With this information in mind the present study was taken up to find out variation in superior articular

facets of atlas vertebrae in terms of its morphology.

Material and Methods: Total 100 human atlas vertebrae of unknown age & sex were examined from collection of Anatomy Department of various medical colleges of Gujarat. Observations of 200 superior articular facets were noted. Following features were systemically observed with naked eyes and vernier callipers.

1. **The presence of a notch/constriction:** The presence of notch/constriction in lateral and medial borders of facet was noted.⁵.
2. **The presence of pressure facet:** the presence of pressure facets at anterior & posterior ends of main articular facets was sought and noted⁵.
3. **The presence of a separating groove:** a separating groove of variable breadth & depth was found to be present in the facets throughout the whole or part of breadth of the facets between the anterior and posterior pressure facets i.e. in central region or on the medial or lateral boundary⁵. Sometimes this groove is well defined and divides the facet into two⁵.
4. **The tendency of separation:** the presence of constriction or groove or both is suggestive of

division of facet into two or a tendency towards it. The degree of separation was categorised as follows:

3*- complete separation

2*- greater than or equal to 50% separation; here the maximum articular breadth & central articular facet breadth were compared with naked eye & with vernier callipers.

1*- less than 50% separation⁵.

5. The shape of superior articular facet (SAF):

According to presence of constriction or a groove & a tendency of separation, different shapes of SAF are defined as follows:

- Oval shaped without any constriction,
- Kidney shaped- constriction on either medial or lateral side,
- Elongated - with or without constriction; with relatively non-bevelled borders.
- Dumb-bell shaped - prominent constriction on both sides. Completely separated facets are also put in this category.

Result: Total 200 superior articular facets from 100 Atlas vertebrae were studied for the presence of a constriction or a groove & tendency for separation; complete or incomplete one. Based on these findings, the percentage was calculated for different parameters. The shapes of SAF were also studied & analysed statistically by applying the Chi-Square test. According to statistics, multiple responses are allowed which are found in this study.

Table 1 shows the presence of constriction on one or both side of a facet was mostly located near the central region of facets. Constrictions were present on medial border in 32 (16%) facets, on lateral border in 13 (6.5%) & on both the borders in 51 (25.5%) out of total 200 SAF.

Roughly circular pressure facets were present in most of the cases in the anterior and posterior parts of SAF. The presence of such pressure facets was found only on left side in 6(6%) SAF, only on right side in 4(4%) SAF and on both sides in 68 (68%) SAF.

Table: 1 Presence of constriction on SAF of atlas vertebrae

SAF	CONSTRICTION				TOTAL
	ABSENT	Medial side of facet	Lateral side of facet	Both side of facet	
Right	51	17	9	23	100
Left	53	15	4	28	100

The number and percentage of the presence of groove which was formed by the rough area present between pressure facets have been shown in table no. 4.

Table: 2 Tendency of separation of SAF of atlas vertebrae

SAF	Tendency of separation		
	Complete	Incomplete	Absent
Only on right facet	1	10	7
Only on left facet	2	7	9
On Both the facets	3	35	44

Table 2 shows division of one facet into two or tendency towards it in either complete or incomplete form. 56 atlas vertebrae (56%) show tendency of separation on one or both the facets.

Table 3 shows that division of one facet into two or tendency towards it was seen in 96(48%) superior articular facets out of 200 facets. Total 16 SAF had shown separation only on right side & 14 had shown only on left side which was almost equal on both sides. Complete separation was present in 9(4.5%) facets out of 200.

Table: 3 Degree of separation of SAF of atlas vertebrae

SAF	Degree of separation		
	1*	2*	3*
Only of right facet	10	5	1
Only of left facet	5	7	2

Of Both the facets	22	8	3
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Table: 4 Comparative study of presence of groove on SAF of Atlas vertebrae.

Groove	Shamer singh ⁵		Lalit M, et al		Present study	
	N	%	N	%	N	%
Only on Right facet	16	8	3	10	7	7
Only on Left facet	23	11.5	3	10	18	18
On Both the facets	109	54.5	11	36.6	40	40
Absent	52	26	13	43.3	35	35

Table: 5 Comparative study of incidence & types of shape of superior articular facets of Atlas vertebrae.

Author	Total Atlas studied	Shape of SAF	Rt SAF	Lt SAF	Total
Lalit M, et al	30	Oval	10	7	17
		Reniform	6	6	12
		Dumb-bell	11	10	21
		F8	3	7	10
Present study	100	Oval	37	39	76
		Reniform	26	19	45
		elongated	14	14	28
		Dumb-bell	23	28	51

The superior articular facet of atlas varies greatly in its shape and size as shown in Table 5. According to this 74.5% superior articular facets of atlas were typical oval, elongated or kidney shaped.

Discussion: In the present study a large number of variations were seen in the shape, size and depth of superior articular facets of total 100 adult atlas vertebrae.

Constrictions were present on medial border in 32(16%), on lateral border in 13(6.5%) & on both borders in 51(25.5%) out of 200 SAF. These proportions are quite variable compared to the work of Shamer Singh & Lalit M, et al (Table 6). This may be because of higher incidence of oval shaped (38%) facets which were without constriction or notches compared to other facets which were with or without constriction or notches.

Table: 6 Comparative study of presence of constriction on SAF of atlas vertebrae.

Author	SAF	CONSTRICTION			
		ABSENT %	Medial side of facet %	Lateral side of facet %	Both side of facet %
Shamer singh	Rt	26.5	4	2.5	67
	Lt	21	3	7	69
Lalit M, et al	Rt	33.3	13.3	6.66	46.6
	Lt	23.3	10	10	56.6
Present study	Rt	51	17	9	23
	Lt	53	15	4	28

Roughly circular pressure facets were present in most of the cases in anterior and posterior parts of superior facets indicating possibly greater pressure at these sites during the movement at Atlanto-Occipital joints. Such pressure facets are described only by Shamer Singh in most of the cases but details of which were unavailable. These were quite evident in some of those vertebrae which showed no signs of division of SAF by grooves or notches.

Rough area between pressure facets tends to form a groove, which may divide the facet into two. The proportions of presence of such grooves matches with work of Shamer Singh & Lalit M, et al (Table 4). Paraskevas G, et al studied 86 dried vertebrae and found that notch was absent in 37.2% of superior articular facets. No transverse groove was found in 24.4% and the presence is increased with the age and assumed that the increase of incidence of the separation, the rough surfaces,

the grooves and the decrease of notches could be possibly the result of a restriction of the Atlanto-Occipital motion in the old age⁷.

Division of one facet into two or tendency towards it was seen in 96(48%) facets out of 200 SAF. The tendency to separate is almost equal on both left & right side SAF (Table 2). Complete division of one SAF into two was present in 9(4.5%) out of 200 facets (Table 3), which matches with findings of Shamer Singh who found it in 22(5.5%) out of 400 facets⁵. Billman F, et al (2007) studied 500 human atlas and 256 atlases of non-human primates. Bipartition of one of both of the superior articular facets was observed in 104 individuals out of the 500 (20.8%). No case of bipartition of the superior articular facets of the atlas was found in any of the 256 atlases of non-human primates studied. The appearance of the bipartition of the superior articular facet of the atlas during human evolution could be the result of functional modifications due to the acquisition of constant erect posture and bipedalism⁸.

According to present study typical oval, elongated or reniform shaped facets were found in 74.5% with majority of them being oval shaped (38%), followed by dumb-bell or Figure 8 shaped which is found in 51(25.5%) which is comparable to findings of Lalit M, et al (50.5%)(Table no. 5) & Shamer Singh who found it in majority of cases. The P value is 0.652 for the difference between percentage of types of shapes on the right and left sides of SAF.

Conclusion: Variation in the shape of superior articular facets of atlas vertebrae varied from oval, reniform to dumb-bell shaped. Pressure facets were present on majority of superior articular facets of atlas vertebrae. Area between them tends to form a groove. The tendency of separation from incomplete to complete was also found on superior articular facets of atlas vertebrae. The present study provides precise data about these variations to clinicians and surgeons for better understanding and management of pathophysiology of atlanto-occipital region and to anthropologists to study evolution.

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