

## Sexing Adult Human Atlas Vertebrae in South India

Ganesh T. Waghmode<sup>1</sup>, Vishal M. Salve<sup>2</sup>, Pavankumar B. Shinde<sup>3</sup>, Uma T. Waghmode<sup>4</sup>

### Abstract

*Background:* Bone is often the only material remaining after decaying process of the human body. Therefore identification of age, sex is aim of anatomist, forensic expert as well as anthropologist. Present study will be helpful in medico legal cases in identification of sex with atlas vertebrae 150 atlas vertebrae with known sex 98 male and 52 female were obtained. Measurements of atlas vertebrae were taken by using Vernier callipers. Mean, range, standard deviation calculated. Z test was used to find out statistical significance. *Results:* Demarking point regarding Distance between both tips of transverse process of atlas vertebrae in male was >86.34 and in female it was <62.98. Demarking point regarding transverse diameter of vertebral canal of atlas vertebrae in male was >32.6 and in female it was <22.07 Demarking point regarding anteroposterior diameter of vertebral canal of atlas vertebrae in male was >33.12 and in female it was <25.23 Demarking point regarding area of vertebral canal of atlas vertebrae in male was > 632.5 and in female it was < 455.8 Demarking point regarding circumference of vertebral canal of atlas vertebrae in male was > 100.45 and in female it was < 80.4. *Conclusions:* Parameters of atlas vertebrae more than Demarking point will be definitely of male atlas vertebrae and less than Demarking point will be of female atlas vertebrae. Present study will help in identification of sex of unknown atlas vertebra.

**Keywords:** Atlas Vertebra; Demarking Point; Sex Determination.

### Introduction

If total skeleton is available, then it is easy to identify the sex of given skeleton but many time few or single bone is available, then it becomes difficult to identify sex of given unknown skeleton. A study on sex determination of skull was done by Stewart. He gave correct sex determination of skull in above 77% of crania [1].

**Author's Affiliation:** <sup>1</sup>Associate Professor <sup>2</sup>Professor, Dept. of Anatomy, Navodaya Medical College, Mantralayaam Road Raichur, Dist Raichur, Karnataka-584101, India. <sup>3</sup>Medical Officer, Primary health centre, Sangeli, Tal Sawantwadi Dist Sindhudurg, Maharashtra-416510, India. <sup>4</sup>Medical Officer, Rural health centre, Mohol, Dr. Waghmode Hospital Kurul Road, At Post Mohol Dist Solapur, Maharashtra-413213, India.

**Corresponding Author:** Ganesh Trimbak Waghmode, Associate Professor, Dept. of Anatomy, Navodaya Medical College, Mantralayaam Road Raichur, Dist Raichur, Karnataka-584101, India.

E-mail [gw1726@gmail.com](mailto:gw1726@gmail.com)

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Jit and sigh evolved demarking point (DP) based on statically calculated ranges of various measurable characters of clavicle which are useful to identify sex with 100% accuracy [2].

Stini have argued that body size is different in male and female because of requirement of reproduction and lactation [3].

According to Stinson sexual dimorphism is influenced by genetic, environmental and nutritional as well as functional characters [4].

Holland has studied sex determination of fragmentary crania by analysis of cranial base [5].

Krogman had carried out study on individual bones; according to them all the bones of the skeleton do not have the same importance in sexing skeleton. In more than 90% of cases skull, femur sacrum and pelvis help in sexing accurately [6].

Shamersingh and K C Gangrade have done study on sexing of adult clavicles and demarking points. Demarking points were found out from calculated range which was equal to mean +/- 3 S.D (standard

deviation). Sex can be identified with 100% accuracy by using demarking points [7].

In study by Venkatesh G et al the anteroposterior diameter, transverse diameter and area of the foramen magnum can be employed as better tools for sexing the skulls, when only fragments of skull such as foramen magnum is available for identification of sex [8].

According to Ramamoorthy B et al the most dimorphic variable to determine sex of the skull, was biauricular breadth followed by weight of the skull [9].

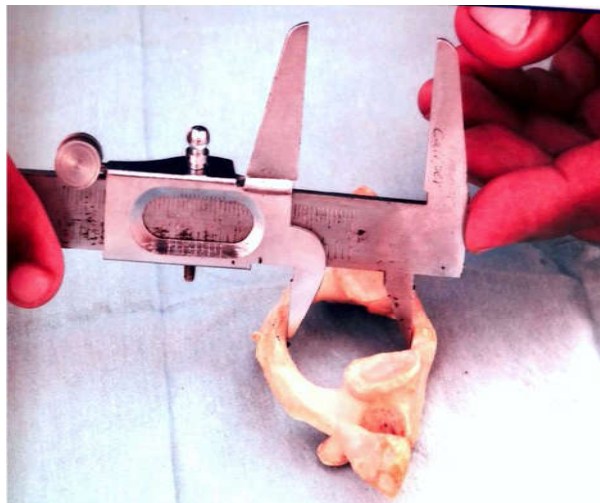
In a review study by Krishnan K Geometric morphometry, Diagnose Sexuelle Probabiliste method, the newer 3D methods and molecular techniques are available but morphometric study of dry skeleton is still very important in identification of sex [10]. In present study morphometric and stastical analysis of atlas vertebra is considered for sex determination. It will be helpful to anatomists, anthropologists and forensic experts.

## Result

**Table 1:** Anatomical Parameters of the Atlas vertebrae (in mm)

Sr. No.	Parameter	sex	Mean	S.D	D.P	Statistical Significance
1	Distance between both tips of transverse process	M	78.49	+/-5.17	> 86.34	P<0.001
		F	70.17	+/-5.39	< 62.98	P<0.001
2	Transverse diameter of vertebral canal	M	27.2	+/-1.71	>32.6	P<0.001
		F	25.58	+/-2.34	<22.07	P<0.001
3	Anteriposterior diameter of vertebral canal,	M	29.61	+/-1.46	>33.12	P<0.001
		F	27.0	+/-2.04	<25.23	P<0.001
4	Area of vertebral canal,	M	632.5	+/-58.9	>775	P<0.001
		F	538.87	+/-78.9	<455.8	P<0.001
5	Circumference of vertebral canal,	M	98.5	+/-3.7	>100.45	P<0.001
		F	82.06	+/-6.13	<80.40	P<0.001

SD= standard deviation, DP=demarking point, M=Male, F=Female, > = greater than and < = less than



**Fig. 1:** Measurement of atlas vertebra by venires calliper

## Material and Method

Hundred and fifty human first cervical vertebrae with known sex 98 male and 52 female were obtained from medical college in Maharashtra.

Following measurements were recorded with Vernier calliper accurate to 0.1 mm for linear measurements

1. Distance between both tips of transverse process
2. Transverse diameter of vertebral canal
3. Anteriposterior diameter of vertebral canal,
4. Area of vertebral canal superior articular facet length, right
5. Circumference of vertebral canal

Mean, range and Standard deviation were calculated from all measurements of 152 atlas vertebrae . Demarking points were calculated from formula mean +/-3 S.D (standard deviation)

'Z' test was used to find out statistical significance.

## Discussion

Similar study was done by G.P. Pal et al [11] and E.A. Marino [12].

In a study by G.P. Pal et al mean distance between both tips of transverse process in male was 74.2mm and standard deviation was +/-14.4. Demarking points for distance between both tips of transverse process in male was >75.4mm, so atlas vertebrae having distance between both tips of transverse process >75.4mm will be male atlas vertebrae. Mean distance between both tips of transverse process in female was 66.7mm and standard deviation was +/-3.0 and demarking points for Distance between both tips of transverse process in female was <81mm, so atlas vertebrae having distance between both tips

of transverse process <81mm will be female atlas vertebrae. In present study mean distance between both tips of transverse process in male was 78.49mm and standard deviation was +/- 5.17 and demarking points in male was >86mm Mean distance between both tips of transverse process in female was <70.17mm and standard deviation was +/- 5.39 demarking points in female was 62.98mm

Mean Transverse diameter of vertebral canal in male in study by G.P. Pal et al was 28.71mm and in female it was 24.8mm and standard deviation was +/- 3.4 in male and +/- 1.8 in female and mean in present study was 27.2mm in male and 25.58mm in female and standard deviation was +/- 1.71 in male and +/- 2.34 in female

Demarking points for transverse diameter of vertebral canal in male in study by G.P. Pal et al was >30.2mm in male and in female it was <18.51mm and in present study it was >32.6 mm in male and <22.07mm in female

Mean anteroposterior diameter of vertebral canal in male in study by G.P. Pal et al was 33.30mm and in female it was 28.8mm and standard deviation was +/- 3.8 in male and +/- 2.2 in female and mean in present study was 29.61mm in male and 27.0mm in female and standard deviation was +/- 1.46 in male and +/- 2.04 in female

Demarking points for anteroposterior diameter of vertebral canal in male in study by G.P. Pal et al was >35.4mm in male and in female it was <21.9mm and in present study it was >33.12 mm in male and <25.23mm in female

Mean area of vertebral canal in male in study by G.P. Pal et al was 710.0mm<sup>2</sup> and in female it was 563.0mm<sup>2</sup> and standard deviation was +/- 175 in male and +/- 93.0 in female and mean in present study was 632.5mm<sup>2</sup> in male and 538.87mm<sup>2</sup> in female and standard deviation was +/- 58.90 in male and +/- 78.95 in female

Demarking points for area of vertebral canal in male in study by G.P. Pal et al was >842mm<sup>2</sup> in male and in female it was <185mm<sup>2</sup> and in present study it was >775 mm<sup>2</sup> in male and < 455mm<sup>2</sup> in female

Mean circumference of vertebral canal in male in study by G.P. Pal et al was 103.02mm and in female it was 91.4mm and standard deviation was +/- 8.6 in male and +/- 4.7 in female and mean in present study was 98.5mm in male and 82.6mm in female and standard deviation was +/- 3.7 in male and +/- 6.13 in female

Demarking points for circumference of vertebral canal in male in study by G.P. Pal et al was >105.5mm

in male and in female it was <74.4mm and in present study it was >100.45 mm in male and <80.4mm in female

Difference is seen in present study and study by GP Pal as variation is present due to, as racial variation is present between north Indian and south Indian population [18].

E A Marino studied sex estimation using the first cervical vertebrae regarding eight parameters from the articular region of superior articular facet of both sides and inferior articular facets of both sides seven regression and seven discriminate function equations were created that predict sex with 77% to 85 % and 75% to 85% accuracy respectively In present study we have used demarking points with the help of these, sex of unknown atlas vertebra can be identified with 100% accuracy [12].

## Conclusion

In present study we have calculated demarking points of distance between both tips of transverse process, anteroposterior diameter of vertebral canal, transverse diameter of vertebral canal, area of vertebral canal and circumference of vertebral canal for both male and female atlas vertebrae. If Parameters of atlas vertebra with unknown sex are more than Demarking points then that atlas vertebra will be definitely of male and if less than Demarking point then it will be of female. Present study will help in identification of sex of atlas vertebra with unknown sex which is frequently required in medico legal cases.

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