

A Cross Sectional Study on Sex Difference in sagittal Length of Second Cervical Vertebrae

Masuma Akhtar Banu¹, Shamim Ara², Borhan Uddin Ahamed³, Sharmin Rahman⁴, Yesmin Nahar⁵, Rahanur Akhter⁶

Abstract:

Context: Examination of bone is important for identification of sex of an individual. The present study was planned to collect data regarding sagittal length of human dry ossified second cervical vertebrae and to find out possible variations in male and female.

Materials & Methods: A cross-sectional analytical type of study was conducted in the department of Anatomy, Dhaka Medical College, Dhaka, from January 2012 to December 2012. The study materials consist of 156 human dry ossified second cervical vertebrae of unknown sex. The study samples were distributed in male and female sex groups by discriminant function analysis technique.

Results: Among 156 vertebrae 55.77% was male and 44.23% was female. The mean (\pm SD) sagittal length of second cervical vertebrae was greater in male than that of female ($P < 0.001$).

Conclusion: Sagittal length of second cervical vertebra was greater in male compared to female. The differences in length can be useful in sex differentiation.

Key words: Sagittal length, second cervical vertebra, sex, discriminant analysis technique.

Introduction

Axis is the second cervical vertebra and is characterized by the dens or odontoid process, body, weight bearing superior articular facets and a large spinous process¹. The second cervical vertebra is unique in shape and allows rotation of head. The axis permits the "No" gesture type of rotation. The body of the second cervical vertebra is composite and consists of the partly fused centra of the atlas and axis and a rudimentary disc between them². In severe injuries due to motor vehicle collisions, assaults and falls, the body of the second cervical vertebra is displaced anteriorly with respect to the

body of the third cervical vertebra. At second cervical vertebra, most individuals (91%) present bifid spinous process³. Lower surface of spinous process of second cervical vertebra is grooved and ends in a wide bifurcation. The tip of spinous process resembles an inverted U¹. The sagittal length of second cervical vertebra is the difference between the most anterior point of the body and the most posterior point of the most projecting part of bifid spinous process⁴⁻⁶.

It has widely been recognized that skeletal characteristics vary among populations. So each population should have specific standards to optimize the accuracy of identification. Though use of the entire skeleton is optimal for estimating sex of an individual, complete skeletal remains are often not available. Some skeletal elements such as skull, foramen magnum, vertebrae, pelvis, sacrum, humerus provide better estimation of sex than other skeletal elements. Determination of sex is estimated by second cervical vertebrae in forensic or archaeological situation⁷. The sagittal length is by far the best single variable for estimation of sex⁴⁻⁶.

1. Assistant Professor, Department of Anatomy, Uttara Adhunik Medical College
2. Professor and Head, Department of Anatomy, Dhaka Medical College
3. Associate Professor, Department of Forensic Medicine, Monno Medical College
4. Assistant Professor, Department of Anatomy, Ad-din Women's Medical College
5. Assistant Professor, Department of Anatomy, City Medical College
6. Lecturer, Department of Anatomy, Shaheed Suhrawardy Medical College

Correspondence : Dr. Masuma Akhtar Banu

So far it is known the morphometric measurement of second cervical vertebrae have not yet been studied in Bangladesh. This study was undertaken to measure the sagittal length of second cervical vertebrae and to evaluate the difference in length of the same between male and female. The study is expected to be helpful for the forensic experts and anthropologists for determination of sex from the second cervical vertebrae collected from Bangladesh. It may also be beneficial for spine surgeons and radiologists for diagnosis of traumatic, congenital disorder and treatment of cervical instability, spinal trauma and extensive laminectomies.

Materials and Methods

A total of 156 human dry ossified second cervical vertebrae of unknown sex were collected purposively from the Department of Anatomy of Dhaka Medical College and other government and non-government Medical Colleges in Dhaka. Then the sexes of collected vertebrae were determined by a multivariate linear discriminant function analysis technique. This multivariate linear discriminant analysis technique was applied to the collected data is as follows-

$$Z = b_0 + x_1 b_1 + x_2 b_2 + \dots + x_n b_n$$

Here b_0 to b_n are the coefficients and x_1 to x_n are the variables which is mentioned below-

X_1 = height of anterior surface of dens (independent variable).

X_2 = height of anterior surface of the body of second cervical vertebra (independent variable).

In this study the value of Z for each specimen was calculated by substituting the values of the variables in the linear function. A sectioning point (SP) was created by using the mean discriminant scores. To assign the case to either male or female sex, the product Z was compared to the sectioning point derived by the discriminant function. A value higher than the sectioning point was considered to be male and a value below it was considered to be female. By discriminant analysis technique the sex was determined and the grouping was done.

Afterwards for the measurement of sagittal length of second cervical vertebrae, the most anterior point of the body and the most posterior point of the most projecting part of bifid spinous process of second cervical vertebrae were determined. A red dot was given on the most anterior point of the body of second cervical vertebra. Another blue dot was given on the most posterior point of spinous process. Then sagittal length of second cervical vertebra was measured as the distance between the two determined points with the help of digital slide calipers and the reading was recorded (Fig.-1).



Fig.-1: Photograph showing the measurement of sagittal length of second cervical vertebra by using digital slide calipers. The dot in the body indicates most anterior point of it and the dot in spinous process indicates most posterior point of it.

After collection of data, the findings of this study was analyzed by SPSS version 17 and revealed important information regarding morphometric variation. Comparison of the values of different variables between male and female was done by unpaired Student's 't' test.

Ethical clearance

This study was approved by Ethical Review committee of Dhaka Medical College.

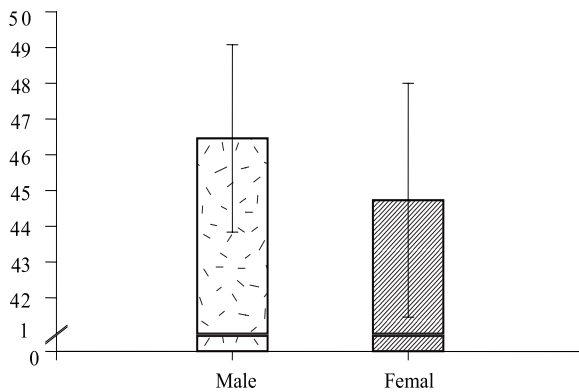
Results

The dry ossified second cervical vertebrae were grouped into male and female by discriminant function analysis technique (Table-I).

Table-I
Distribution of study subjects into different sex according to discriminant function analysis technique

Sex	Number of second cervical vertebra (n)	Total (%)
Male	87	55.77
Female	69	44.23

The range of sagittal length was 38.28-53.49 mm in male and 35.20-53.02 mm in female. The mean (\pm SD) sagittal length of the second cervical vertebrae in male and female were 46.46 ± 2.62 mm and 44.73 ± 3.27 mm respectively. The mean sagittal length of the second cervical vertebrae was significantly higher in male than that of female ($P < 0.001$) (Fig.-2).



Discussion

In the present study the mean sagittal length of second cervical vertebrae was significantly ($P < 0.001$) greater in male than that of female ($p < 0.001$) which was similar to the study represented by Wescott⁴, Marlow⁵ and Bethard⁶. The lowest sagittal length of second cervical vertebrae in male was greater than that of female. However upper limits in both sexes were closely related.

Wescott⁴ examined 400 second cervical vertebrae from Hamann-Todd and Terry anatomical collection. Among them 100 was Black and 100 was White people of each sex. The race of the Black is Negroid and the White is Caucasoid⁸. In Black, he reported that the mean sagittal length was 51.06 ± 2.85 mm in male and 47.14 ± 2.39 mm in female. In White, the mean sagittal length was 52.36 ± 2.42 mm in

male and 47.68 ± 2.41 mm in female. Allbright⁷ taken vertebrae from 119 individuals of an immigrant population of European ancestry collected from the University of Tennessee William M. Bass Skeletal Collection. According to the study of Allbright mean sagittal length of second cervical vertebrae was 50.15 ± 2.12 mm in male and 47.54 ± 2.54 mm in female. Marlow and pastor⁵ studied 153 second cervical vertebrae of European ancestry collected from Natural History Museum, London. The race of the European ancestry is Caucasoid⁹. They found 50.22 ± 2.45 mm and 46.50 ± 2.72 mm the mean sagittal length in male and female respectively.

In the present study the mean value in both sexes was lower than that of other researchers. The reason for this might be due to racial and geographical variation. The present study was carried out in second cervical vertebrae collected from Bangladesh. Skeletons that are available in Bangladesh also come from neighboring countries. Bangladeshis are mixed race of Negroid, Caucasoid and Mongoloid¹⁰. However the highest sagittal length in present study was nearly similar to the mean values of others researchers.

Measurement directly taken from autopsy cases is more accurate and reliable than that of dry ossified samples. We cannot claim that these second cervical vertebrae belong to Bangladeshi people. So in further studies along with larger sample size we require second cervical vertebrae from Bangladeshi cadaver to get more precise picture of Bangladeshi people which will help to establish a baseline data from which we can compare different morphometric parameters of second cervical vertebrae with the findings of other researches.

Conclusion

The study revealed that the male second cervical vertebra was larger than the female second cervical vertebra. Further radiographic study of living second cervical vertebrae and comparison of the radiographic findings of human dry ossified second cervical vertebrae might be beneficial in this regard.

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