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ORIGINAL ARTICLE

Use of cone beam computed tomography (CBCT) to examine the diameter of the odontoid process in the Indian population

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ABSTRACT:
Introduction: There are ethnic variations in the morphometry of odontoid4-6 and it has to be properly known prior to accomplish the success of the surgery either with 1 or 2 screws fixation.**Materials and Methods:**A specially prepared form for the study was employed to gather the accessible information. Several sites and measurements were established in the axial, sagittal, and coronal plane in CT scan. Measurements were taken for screw length, screw insertion angle, and distance of screw exit from apex in the sagittal plane.**Results:**The average age of the participants in the study was 43.30 ± 17.11 years (ranging from 17 to 76). There were 114 males and 116 females. AP diameter of the odontoid is bigger than the transverse diameter at the base and waist of the odontoid. **Conclusion:**In addition, if the size of the odontoid is not sufficient for using a single screw for fixation, then another approach for fixation should be considered.
Keywords: Morphometric, Odontoid, CT- scan.

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INTRODUCTION

Anderson D Alonzo,[1] The odontoid fracture has been divided into three kinds, with type 2 being the most prevalent (65-74%). Type 2 refers to a fracture at the waist of the odontoid, which is the thinnest section. In recent times, anterior screw fixation has become the favoured method for treating odontoid fractures,[2,3] However, there is no agreement in the literature about the use of one screw or two screws in anterior odontoid fixation. There are ethnic differences in the size and shape of odontoid4-6, and it is important to be aware of these variances in order to ensure the effectiveness of the surgery, whether using 1 or 2 screws for stabilisation. Given this context, we examined the size and shape of odontoids in the Delhiese population and found that it is possible to use either 1 or 2 screws.

The indications for screw placement vary depending on the type of fracture and the specific odontoid process. Additionally, the limited room for insertion may pose challenges when using two 3.5 mm screws.[7] The proper diameter of the odontoid process is crucial as it varies from person to person,[8,9] Cervical spinal fractures are more frequent in those who have been involved in car accidents within the Indian population.[10] Multiple imaging techniques can be utilised to visualise the odontoid process, such as X-ray, which provides a two-dimensional view of the odontoid process and the surrounding bones. MDCT and CBCT scans also display the odontoid process and nearby bones in three dimensions. This imaging technique can identify bone fractures.[11] Magnetic resonance imaging (MRI): This imaging method identifies ligament and soft tissue damage. In this study, our goal is to utilise cone beam computed tomography (CBCT) to examine the diameter of the odontoid process in the Indian population. We will also analyse the possibility of treating odontoid fractures with either one or two cortical screws.

MATERIALS AND METHODS

A total of 230 individuals who underwent CT scans of the head or cervical spine, and showed no signs of cervical vertebrae damage or fracture, were included in the study. We utilised a 64 slice MDCT scanner (Somatom Perspective, Siemens, Erlanger, Germany) and the CT-scan slices were obtained at 1.2 mm intervals. The Horosprogramme (v3.3.6) was utilised to obtain precise morphometric measures at a certain angle in the axial, coronal, and sagittal planes. This initiative was initiated following approval by the institutional review committee.

A specially created form for the study was used to gather the accessible information. Different locations and measurements were established in the axial, sagittal, and coronal plane in CT scan. Measurements were taken for screw length, screw insertion angle, and distance of screw exit from apex in the sagittal plane. The AP and transverse dimensions of the odontoid were measured in the axial plane at its base. The anteroposterior (AP) and transverse width of the odontoid were measured in the axial plane at the middle of the odontoid. The breadth of the odontoid was measured in the horizontal plane at the middle of the odontoid.

Inclusion criteria

It is important to include only good-quality photos in the research to provide precise measurements of the odontoid process. It is also vital to have an equal

number of men and women of similar ages in the sample to ensure age-appropriate gender balance.

Exclusion criteria

Fractures, tumours, or infections of the dens, as well as individuals whose radiological scans did not reach the established measurement standards or whose dynamic CBCT scans generated unsatisfactory images, were all causes to remove participants from the research.

Statistical analysis

After confirming the normal distribution of the variables, the independent sample The t-test was used to compare the variables across genders, while the ANOVA test was used to analyse the differences among different age groups. The Pearson correlation coefficient was used to evaluate the connections between the factors being studied. A P value below 0.05 was considered significant.

RESULTS

The mean age of the study population was 43.30 ± 17.11 years (range 17-76). There were 114 males and 116 females. AP diameter of the odontoid is larger than the transverse diameter at the base and waist of the odontoid. The mean distance between the apex of the odontoid and the screw exit point was 2.54 ± 0.94 mm (range, 0-3.8mm). (Table 1)

Table 1: Measurement of different parameters

Age (yrs)		Sagital screw length (mm)	Screw Angle	Axial Base AP (mm)	Axial Base TR (mm)	Coronal Waist TR (mm)	Axial Waist AP (mm)	Axial Waist TR (mm)	Screw tip apex distance (mm)
Mean	43.30	37.51	56.63	11.60	10.90	9.08	11.22	9.63	2.54
SD	17.11	4.12	5.72	0.96	2.00	0.99	0.82	0.94	0.94
Range	17-76	30.5-43	49-67	9.1-13.7	9.1-14.3	7.2-11.4	9.3-13.2	7.6-11.4	0-4.6

The difference in the AP diameter and transverse diameter of odontoid at base and waist of odontoid on axial view were statistically significant p-value <0.001. (Table 2)

Table 2: Comparision of Anteroposterior Diameter with a transverse diameter of odontoid at base and waist of the odontoid

	Anteroposterior Diameter	Transverse Diameter	p-value
Base of Odontoid	11.63±0.96	10.90±2.00	<0.001
Waist of Odontoid	11.25±0.82	9.62±0.94	<0.001

In our study 108 (47.3%) of the Delhiese population had their transverse waist diameter in the axial section between 8.5-8 mm and 41 (15.71%) had their dimension below 8.5 mm. (Table 3)

Table 3: Distribution of population according to the transverse waist diameter on axial section

Transverse waist diameter on axial section (mm)	Male	Female
<7.4	12 (10.5)	27 (23.2)
7.4-9	52 (45.6)	51 (43.9)
>9	50 (43.8)	38 (32.7)
	114	116

There was a statistically significant difference in all the measurements of the odontoid between the male and female population except in the transverse diameter of the base of odontoid in axial section (P-value 0.398) (Table 4)

Table 4: Comparision of different measurement parameters between male and female population

	Age (yrs)	Sagital screw length (mm)	Screw Angle	Axial Base AP (mm)	Axial Base TR (mm)	Coronal Waist TR (mm)	Axial Waist AP (mm)	Axial Waist TR (mm)	Screw tip apex distance (mm)
Male (n = 114)									
Mean	41.10	38.73	56.21	11.80	10.84	9.33	11.53	9.80	2.44
SD	17.05	3.64	5.30	0.84	0.94	0.98	0.94	0.87	0.89
Range	17-73	32-42	48-66	10.4-13.8	9.1-13	8.3-12.6	9.3-13.2	7.8-11.4	0-4.7
Female (n = 116)									
Mean	45.41	36.23	57.08	11.43	8.97	8.79	11.04	9.58	2.73
SD	17.07	4.09	6.09	0.98	2.09	0.86	0.56	0.99	0.98
Range	17-76	30.8-41.2	48-66	9.1-13.3	9.2-11.3	7.2-8.9	9.9-12.3	7.4-11.1	0-4.6
P-value		<0.001	0.094	<0.001	0.396	<0.001	<0.001	0.020	0.036

DISCUSSION

There was no significant difference in the union rate of odontoid fracture when utilising two 3.5 mm screws compared to one 3.5 mm screw.[12-15] The smallest width of the odontoid for positioning two 3.5 mm screws is 9mm.[16] Morphological research on the different ethnic groups have indicated that in many cases, it can be challenging to fit two 3.5 mm screws in the odontoid process. For instance, this is true for approximately 5% of the population in North America,[17] 30% in Europe[18], 35% in Brazil[19], 33% in Malaysia[20], 55% in India, 61% in Kuwait[21] and 54% of individuals in Egypt had an odontoid size less than 9 mm. In this context, a few surgeons proposed the use of either two 2.7mm screws or a single 4.5mm herbert screw.[22] Given that there needs to be a minimum of 0.5 mm of cortical bone surrounding the screw for a secure grip, two screws with a diameter of 2.7 mm each require a minimum odontoid diameter of 7.4 mm, while one 4.5 mm herbert screw requires a minimum diameter of 5.5 mm. The odontoid has its smallest diameter where the transverse ligament of the atlas is attached. The anteroposterior diameter of the odontoid is considerably bigger than the transverse diameter in several sources, and our investigation also found a similar result.

We have seen that around 46.1% and 14.76% of the population in Delhi had an odontoid dimension ranging from 7.4 to 9 mm and below 7.4 mm, respectively. What percentage of the whole population has an odontoid dimension below 9mm? Therefore, the surgeon should exercise caution before to performing the odontoid fixation utilising either a 2 screw approach (with screws of either 3.5 mm or 2.7 mm) or a single 4.5 mm screw. 21.7% of women in Delhi had an odontoid diameter below 7.4 mm, whereas only 7.7% of men had a population with an odontoid diameter below 7.4 mm. Therefore, it is necessary to perform more accurate morphometric calculations and preoperative planning in the situation of a woman patient who is scheduled to undergo anterior odontoid fixation. The screw came out from a point 1.5±0.9 mm behind the highest point of the odontoid. This discovery becomes even more important when employing the 2 screws in AP position, as the posterior screw will exit much further back from the posterior wall of the odontoid. This increases the likelihood of thecal sac injury caused by the tip of the screw.

We need to remember that the axial cut waist diameter is not the sole determinant in determining fracture treatment. The surgeon needs to consider the fracture configuration, osteoporosis, condition of the transverse ligament, type of fracture (traumatic, pathological, or nonunion), length of the neck, cervical kyphosis, and presence of barrel chest before choosing the surgical approach. This will significantly impact the surgical management and the overall outcome. There may be observer bias when conducting measurements with the Horosprogramme, which could be a limitation of this study.

CONCLUSION

The surgeon should always examine the structure of the fracture and the size of the odontoid from a CT scan before choosing the surgical methods. In this research, we found that nearly two-thirds of females from Delhi had a diameter of the odontoid that is not sufficient for two 3.5 mm screws. Therefore, it is necessary to consider using either a 2.7 mm screw or a single screw fixation approach in most situations. In addition, if the diameter of the odontoid is not sufficient for a single screw fixation, then another approach for fixation should be taken into account.

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