

MORPHOLOGICAL STUDY

C-2 anterior plate-screw fixation: a quantitative anatomical and morphometric evaluation

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Abstract: Objectives: Discectomy and inter-vertebral body fusion combined with the anterior plate-screw fixation is the common procedure in cervical spine surgery. But the anterior plate-screw fixation of the C2 spine has been the uncommon surgical procedure. In this study, we analyze the anatomy of the C2 body relevant to C2 anterior plate-screw fixation.

Material and methods: Eighty-six dried C2 spines were evaluated directly for this study. Measurements were made on the C2 body width and midsagittal anteroposterior (AP) depth and the anteroposterior parasagittal depth 5 mm lateral to midline on the inferior endplates, in addition to on the middle body. Measurements also were made of anteroposterior parasagittal vertebral depth with both medial and lateral inclination of 10 degrees, with respect to the parasagittal plane of the vertebral body.

Results: The ideal maximum screw length and trajectory was found to be AP medial parasagittal depth of inferior surface of the C2 body [Right: 13.7 ± 1.4 mm (11.0–17.9), Left: 13.6 ± 1.5 mm (10.7–17.8)].

Conclusions: We report the measurements of the vertebral body of the C2. We think these measurements provide guidelines for operating on the anterior C2 spine, and enhance the confidence interval for the surgeon (Tab. 3, Fig. 1, Ref. 24). Full Text in free PDF www.bmj.sk.

Key words: anterior plate, screw, corpus, C2, axis.

The anterior spinal fusion of the C2–C3 segment is indicated in rare situations such as Hangman's fracture and tumor lesions (1, 2). Anterior approach is an alternative for surgical treatment of Hangman's fractures, and sometimes the only choice when there is a disc herniation of C2–C3 and medullar compression, C2 body fracture, or a failed posterior arthrodesis (2, 3, 4, 5, 6). Type II Hangman's fractures are often treated surgically with a C2–C3 anterior cervical discectomy, fusion, and plating (2, 7). Other attempt was made to obtain a safer exposure for anterior operation on C2–C3. Wilson et al described a case of transoral approach with C2–C3 plating (8, 9). A detailed knowledge of the osseous anatomy of the C2 spine is essential for the anterior column reconstruction and the insertion of internal fixation (10). The quantitative anatomy of the C2 vertebral body relevant to anterior plate-screw fixation has not been well documented and has been addressed infrequently in anatomic stud-

ies. The aim of this study was to measure important anatomical parameters of the C2 body in terms of the C2 anterior plate-screw fixation.

Materials and methods

Eighty-six complete and undamaged adult Caucasian, dry, C2 spines obtained from two medical schools (Ankara, and Sutcuimam) were used. Specimens having gross evidence of congeni-

Tab. 1. Lengths and depths measured on dried specimens.

1. The height of the C2 body from anterior
2. The height of the C2 body from posterior
3. AP midline sagittal depth of inferior surface of the C2 body.
4. AP medial parasagittal depth of inferior surface of the C2 body (right).
5. AP parasagittal depth of inferior surface of the C2 body (right).
6. AP lateral parasagittal depth of inferior surface of the C2 body (right).
7. AP medial parasagittal depth of inferior surface of the C2 body (left).
8. AP parasagittal depth of inferior surface of the C2 body (left).
9. AP lateral parasagittal depth of inferior surface of the C2 body (left).
10. Transverse diameters of inferior surface of the C2 body (Anterior).
11. Transverse diameters of inferior surface of the C2 body (Midline).
12. Transverse diameters of inferior surface of the C2 body (Posterior).
13. Distance between the most inferior point of the C2 body and the middle point of right C2 facet
14. Distance between the most inferior point of the C2 body and the middle point of left C2 facet
15. Distance between the middle point of right C2 facet and middle point of left C2 facet

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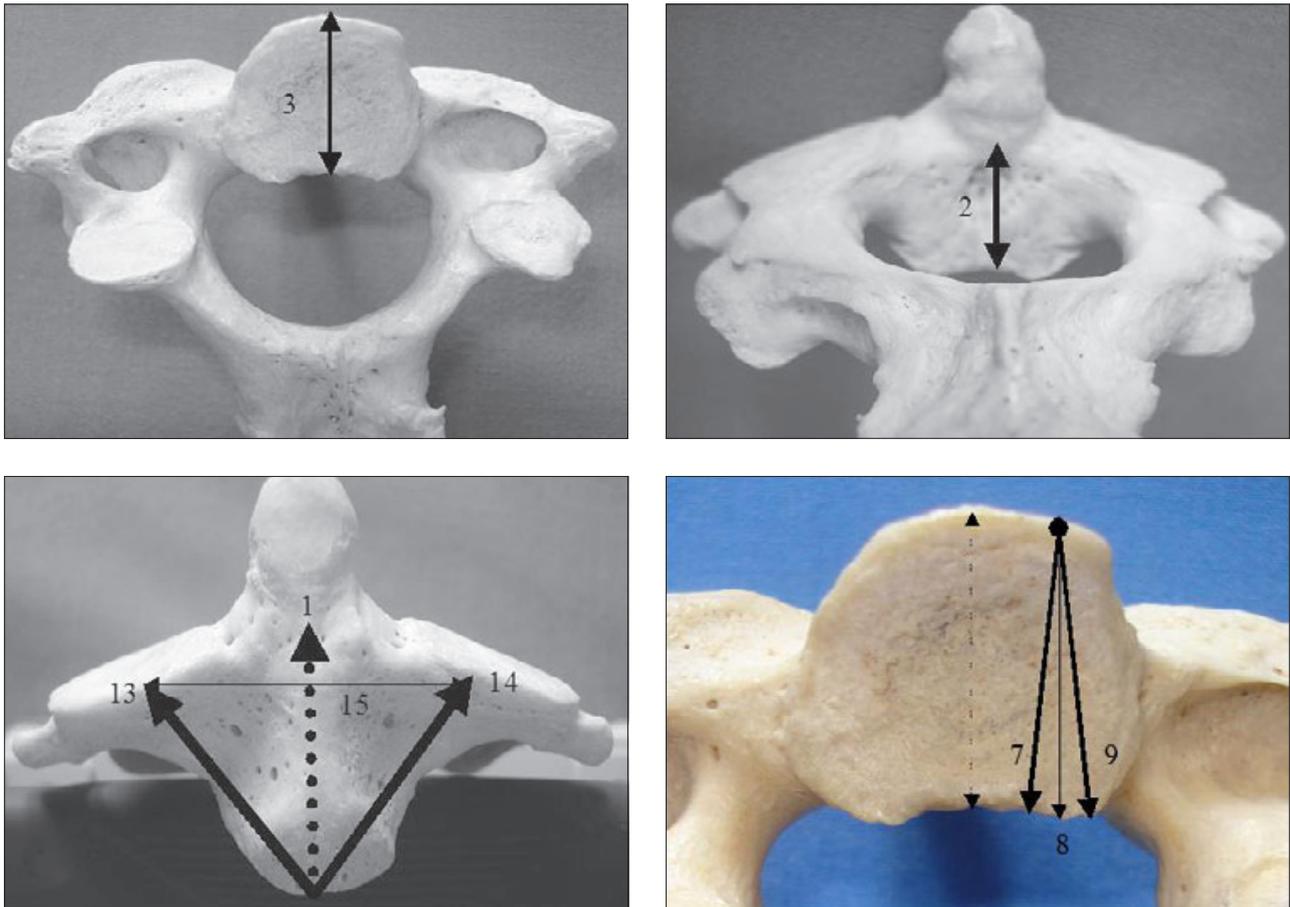


Fig. 1. A. Inferior view of the C2 spine, showing the measurements of the AP midline sagittal depth. (distance between the anterior and posterior cortices). B. Posterior view of the C2 spine, showing the measurements of the height of the C2 body. C. Anterior view of the C2 spine, showing the measurements of the height of the C2 body, distance between the most inferior point of the C2 body and the middle point of right and left C2 facets, and distance between the middle point of right C2 facet and middle point of left C2 facet. D. Inferior view of the C2 spine, showing the measurements of the AP medial parasagittal depth (left), AP parasagittal depth (left), AP lateral parasagittal depth (left).

Tab. 2. Measurements (lengths in millimeters) on dry anatomic specimens from C2 cadavers (n:86).

Screw Length	Mean±SD	Minimum	Maximum
1. The height of the C2 body from anterior	21.2±1.7	17.3	26.0
2. The height of the C2 body from posterior	16.8±1.9	12.4	21.7
3. AP midline sagittal depth of inferior surface of the C2 body.	13.9±1.5	10.4	18.4
4. AP medial parasagittal depth of inferior surface of the C2 body (right).	13.7±1.4	11.0	17.9
5. AP parasagittal depth of inferior surface of the C2 body (right).	13.1±1.5	10.5	18.3
6. AP lateral parasagittal depth of inferior surface of the C2 body (right).	13.3±1.4	10.2	17.7
7. AP medial parasagittal depth of inferior surface of the C2 body (left).	13.6±1.5	10.7	17.8
8. AP parasagittal depth of inferior surface of the C2 body (left).	13.2±1.6	10.2	18.9
9. AP lateral parasagittal depth of inferior surface of the C2 body (left).	13.2±1.4	10.2	17.7
10. Transverse diameters of inferior surface of the C2 body (Anterior).	11.5±1.1	9.2	16.0
11. Transverse diameters of inferior surface of the C2 body (Midline).	16.2±1.6	12.9	20.6
12. Transverse diameters of inferior surface of the C2 body (Posterior).	14.3±1.9	10.5	20.2
13. Distance between the most inferior point of the C2 body and the middle point of right C2 facet	23.2±1.9	17.5	27.4
14. Distance between the most inferior point of the C2 body and the middle point of left C2 facet	23.2±1.9	17.5	27.0
15. Distance between the middle point of right C2 facet and middle point of left C2 facet	28.8±2.5	22.1	35.7

†Lengths in millimeters.

Tab. 3. The results in our series and the series reported in the literature.

	Naderi et al ^[21]	Xu et al ^[22]	Schaffer et al ^[23]	Kandziora et al ^[24]	Senoglu et al
The anterior height of the C2 body	23.2±2.4 (17.8–34.5)	Female 19.5±1.7 (17–23) Male 21.1±1.7 (18–24)	23.4±2.2 (18.1–30.1)	21.9±1.67 (17.0–28.4)	21.2±1.7 (17.3–26.0)
The posterior height of the C2 body	17.9±2.2 (13.6–27.5)	Female 15.3±1.1 (14–18) Male 16.5±1.6 (14–20)	19.7±2.1 (15.0–25.5)	17.8±1.45 (11.4–22.1)	16.8±1.9 (12.4–21.7)
The AP diameters of the inferior surface of the C2 body	15.8±1.7 (12.5–20.2)	Female 15.0±1.7 (12–18) Male 16.1±1.5 (14–20)	-	16.7±1.30 (13.6–20.0)	13.9±1.5 (10.4–18.4)
The transverse diameters of the inferior surface of the C2 body	18.1±1.8 (14.7–24.7)	Female 18.7±2.5 (15–25) Male 19.0±2.0 (14–23)	-	15.9±1.45 (12.2–20.1)	16.2±1.6 (12.9–20.6)

†Lengths in millimeters

tal or acquired pathology were excluded from this study. The material was of undetermined gender and age. Fifteen parameters were measured on these specimens by a neurosurgeon using a Vernier caliper accurate to 0.05 mm (Tab. 1, Fig. 1A–D). Direct measurements of the cervical spine were made of the inferior endplate of the C2 vertebral body.

Parameters measured included the anteroposterior midline sagittal depth and the anteroposterior parasagittal depth 5 mm lateral to the midline. Measurements of the anteroposterior parasagittal vertebral depth with both medial and lateral inclination of 10 degrees, with respect to the parasagittal plane of the vertebral body (Fig. 1D) were also made. Finally, the sagittal and bilateral parasagittal depths at the middle vertebral body were measured (Fig. 1A, D). Also, the measured parameters included parameters regarding the height, transverse diameter, and depth of the C2 body from anterior as well as posterior, and inferior views (Tab. 1, Fig. 1).

Statistical analysis

Data were expressed as the mean (SD), median and range. Analyses were performed using the SPSS software, version 9.0 for Windows (SPSS, Chicago, IL, USA).

Results

Eighty-six C2 spines were evaluated, and the mean and standard deviation were calculated for each parameter. Data were recorded and evaluated for C2 spine measurements. There was no variation in any of the measured parameters. The measurements of all parts of the C2 body showed uniformity.

The anatomical measurements are given in Table 2.

Discussion

The anterior plate-and-screw fixation with bone fusions was developed in the mid-1970s (11, 12, 13, 14). The indication of anterior fixation of the C2–C3 segment is much less frequent compared to more distal levels of the subaxial spine and is more related to posttraumatic instability, with emphasis on Hangman's fracture or tumor lesions (2, 6, 15). This is an excellent treatment option, sometimes the only viable option, for patients with C2–C3 disruption and instability. The anterior cervical plating procedures are well established as a surgical treatment in the lower cervical spine and have offered excellent fusion rates, a low complication rate, and opportunity for early mobilization (12, 13, 14, 16, 17, 18).

Intraoperative complications of anterior cervical spine surgery after the anterior soft tissue has been dissected injury to the nerve root, the vertebral artery (VA), and the spinal cord (14, 17, 19). Injury to the spinal cord during drill or screw placement is the most feared complication of this procedure. Therefore, proper screw length is the most important issue for safety of vertebral body screw placement (20).

The AP and the transverse diameters of the inferior surface of the C2 body were reported to be 15.8±1.7 mm (12.5–20.2) and 18.1±1.8 mm (14.7–24.7), respectively, by Naderi et al (Tab. 3) (21). In our study, The AP and the transverse diameters of the inferior surface of the C2 body were found to be 13.9±1.5 mm (10.4–18.4) and 16.2±1.6 mm (12.9–20.6), respectively (Tabs 2 and 3). These two measurements are useful for determining the size of the interbody graft and for placing vertebral body screws in anterior plate fixation.

The anterior and posterior height of the C2 body were reported to be 23.2±2.4 mm (17.8–34.5) and 17.9±2.2 mm (13.6–

27.5), respectively, by Naderi et al (Tab. 3) [21]. In our study, the anterior and posterior height of the C2 body was found to be 21.2 ± 1.7 mm (17.3–26.0) and 16.8 ± 1.9 mm (12.4–21.7), respectively (Tabs 2 and 3). Only slight variations existed between the anterior and posterior heights of the vertebral bodies.

The results of this study provided us information useful for the interbody graft and for placing vertebral body screws in anterior plate fixation.

In order to find out the ideal screw trajectory, the trajectories at 5mm lateral to the midline with an inclination of 10 degrees medially and laterally as well as vertical midline trajectory were measured. The ideal maximum screw length and trajectory was found to be AP medial parasagittal depth of inferior surface of the C2 body [Right: 13.7 ± 1.4 mm (11.0–17.9), Left: 13.6 ± 1.5 mm (10.7–17.8)] (Tab. 2). The longest distance was obtained in this direction as seen in our measurements.

Conclusions

Application of the data reported in this study may reduce possible operative complications and improve the margin of safety for the surgeon. All these original data from cadavers may be helpful during the anterior approach for discectomy and the anterior screw-plate placement.

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