The Corona Dentis: Description of an Anatomic Variant with Technical Implications for Anterior Odontoid Screw Placement

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BACKGROUND: **Type 2 odontoid fractures are the most common cervical fractures among the elderly. Neurologic deficit is usually caused by myelopathy as a result of posterior dens migration. Direct anterior screw placement provides stabilization and can preserve C1-C2 movement. The presence of a bony excrescence on the anterior superior tip of the dens may lead to placement of a screw of incorrect length.**

METHODS: **Twenty C2 dry specimens were examined for the presence of a corona dentis, which is a bony excrescence in the coronal plane near the apex of the dens. When identified, measurements of the corona dentis were performed using calipers and a ruler. In addition, anteroposterior (AP) and lateral fluoroscopy was performed on all specimens found to have a corona dentis.**

RESULTS: **A corona dentis was found on 20% of our C2 specimens and had an average width of 9 mm and an average height of 4.5 mm. The average width of the dens did not vary as the normal tip of the dens transitioned into the coronae. In no specimen did the corona dentis seem to be composed of trabecular bone and it was seen as a superior projection of cortical bone on fluoroscopy. On fluoroscopy, the corona dentis could be identified on a true AP projection. In angulated AP views, fluoroscopic images overestimated the length of the corona dentis.**

CONCLUSIONS: **We describe a new entity termed the corona dentis because of its crownlike feature. It is a superior cortical bone protrusion and should be noted as a variant of the dens during anterior odontoid screw placement. Its propensity to increase the height of the dens markedly can lead to higher rates of neurologic deficits during type 2 odontoid fractures if not appreciated. A true AP view is critical for correct screw size placement.**

INTRODUCTION

Type 2 dens fractures as described by Anderson and D'Alonzo[1] are the most common cervical fractures among the elderly.[2] The fracture occurs at the junction of the odontoid and vertebral body of the axis.[1] It is most often caused by a fall from standing height in elderly patients, whereas in younger patients, it often presents during high-velocity injuries. In octogenarians, it is associated with up to 41% 1-year mortality regardless of whether the patient undergoes conservative or surgical treatment.[3] It is associated with a 9.6%–13% risk of neurologic deficit, usually as a result of myelopathy caused by posterior dens migration, presenting in an acute or chronic fashion.[4-6]

Conservative treatment can result in fibrous nonunion. Advocates for surgery have suggested that the risk of developing myelopathy after a fracture is higher than the immediate perioperative surgical risk. Surgical treatments can be divided between posterior surgical approaches, most commonly involving a C1-C2 fusion, and an anterior approach by placement of an odontoid screw. Direct anterior screw placement provides stabilization and can preserve C1-C2 movement. Nonunion rates vary in reports from the literature, young patients being more likely than elderly ones to have successful union. One such study found a nonunion rate after anterior odontoid screw placement of 4% in patients younger than 65 years compared with a 12% nonunion rate for

Key words
- Anatomy
- Axis
- C2
- Complications
- Neurosurgery
- Odontoid process
- Spine
- Surgery

Abbreviations and Acronyms
AP: Anteroposterior

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older patients.[7] A meta-analysis found a pooled nonunion rate of 10% after anterior odontoid screw placement.[8]

METHODS

Twenty C2 dry specimens were examined for the presence of a corona dentis, a bony excrescence in the coronal plane near the apex of the dens. These C2 specimens were derived from 5 adolescent and 15 adult specimens with no signs of previous surgery, trauma, or congenital malformation. When identified, measurements of the corona dentis were performed using calipers and a ruler. In addition, anteroposterior (AP) and lateral fluoroscopy was performed on all specimens found to have a corona dentis.

RESULTS

A corona dentis (Figure 1) was found on 4 of our C2 specimens (20%) and had an average width of 9 mm (range, 7–11 mm) and an average height of 4.5 mm (range, 3–6 mm). The average width of the dens did not vary as the normal tip of the dens transitioned into the corona and could not be easily be visualized as an area of lower density during AP imaging because of its thick cortex. Furthermore, an angulated AP view overestimated the length of the dens. However, the average height of the normal dens in our specimens with coronae was 16.5 mm (range, 15–18 mm), resulting in a combined total height of 21 mm. This finding implied an increase in height of the apex of the dens of approximately 27%–30%. In no specimen did the corona dentis seem to be composed of trabecular bone and it was seen as superior projection of cortical bone on fluoroscopy (Figure 2). The smooth superior apical border was preserved in all specimens with a corona dentis without sclerotic bone in the superior-posterior apical margin. None of the 4 specimens found to have a corona dentis had laterality of this structure (i.e., the left and right sides of the coronal ridge were symmetric). During the current study period of the corona dentis, another study in our laboratory of the alar ligaments identified a corona dentis in a cadaveric specimen of an adult male. This specimen and subsequent computed tomography of the area are included as an illustration of the anatomy of this structure and relationships at the craniocervical junction, including the nearby alar ligaments (Figure 3).

DISCUSSION

We identified a corona dentis in 20% of our specimens. This finding might lead to confusion during intraoperative imaging of patients with type 2 odontoid fractures and result in incorrect screw placement. To our knowledge, this variant configuration of the dens has not been reported previously and knowledge of its existence and effect on dens height is important to spine surgeons operating on C2 regarding odontoid fractures.

The strength of an odontoid screw is achieved by bicortical purchase, through the body of C2 and penetrating the apical cortex.[9] The fusion rate is higher for patients with horizontal and posterior oblique fractures, with an increased fusion failure rate when screw placement is delayed for more than 1 week after fracture.[10] Anatomic biomechanical models have shown that 1-screw and 2-screw constructs are equally stable.[11] Trabecular bone is weaker, and although important for fusion, it provides less stability during initial screw placement. The cortical bone in the anterior aspect of the dens and body of the axis is thicker than the lateral and posterior cortical bone.[12] Experts recommend a shallow screw trajectory that fixes the apical cortex and the anterior inferior cortex of the axis.[9]

The corona dentis should not be confused with a persistent os terminale (the Bergman ossicle) because in the latter, the terminal ossicle is separate from the dens as a result of a failure of fusion.[13] The smooth superior apical border was preserved in our specimens with a corona dentis without sclerotic bone in the superior-posterior apical margin, making it unlikely that it results from a fracture that spontaneously fused with the apical segment of the dens.

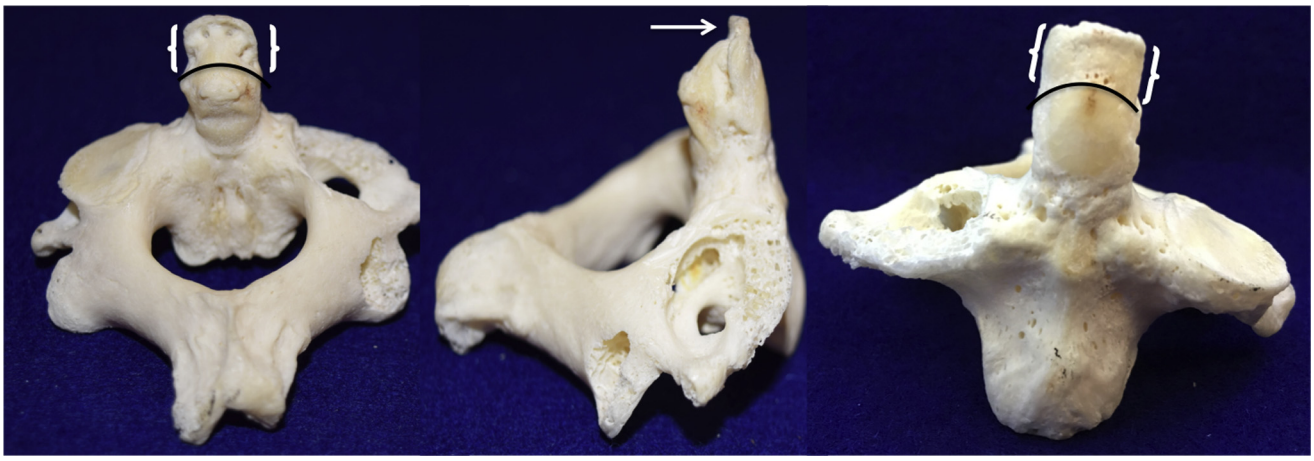

Figure 1. Example of the corona dentis (*brackets* and *arrow*) from an adult specimen posterior, lateral, and anterior views. On the posterior and anterior views, an arched black line is added to show the apex of the normal dens.