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Recent Trend in Management of Odontoid Fracture

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Abstract

Background and aim: Odontoid fractures are among the most common spinal injuries of the elderly. Moreover, in patients older than 79 years, odontoid fractures occur even more frequently than all other spinal injuries together. Odontoid fractures account for 5–15 % of all cervical spine injuries in skeletally mature individuals. Methods: This study aimed to review and describe lines of treatment of odontoid process fracture with special reference to the recent treatment modalities. This is a review article, The search was performed in MEDLINE, Embase, Pubmed and CINAHL Plus in the same date range with the following mediacl terms: "Odontoid; Fracture; spinal injuries including articles from 2000 to 2021, Excluded articles from review are those of language other than English. Results and conclusion: Traumatic atlantoaxial dislocation with isolated odontoid fracture often encountered in clinical practice. Most of them reduce on extension, barring posterior dislocation. Skeletal traction helps, if they fail to reduce on extension. However, few patients, especially those presenting late, fail to reduce, despite traction. Previously, such patients with irreducible Traumatic atlantoaxial dislocation were managed with transoral odontoidectomy and posterior fusion. In the recent past, direct posterior reduction and fusion by intraoperative manipulation of the joints has been attempted successfully in a few cases of irreducible Traumatic atlantoaxial dislocation. Such a procedure is of advantage as it circumvents the transoral surgery**.** Non operative treatment include. Hard cervical orthosis for 6-12 weeks. halo vest immobilization for 6-12 weeks. Operative options include posterior C1-C2 fusion, Anterior odontoid osteosynthesis and transoral odontoidectomy.

Keywords: Odontoid, Fracture, spinal injuries.

1. Introduction

Odontoid process fracture also known as peg or dens fracture, occur where there is a fracture through the odontoid process of c2. Axis has odontoid process (dens) and body. It develops from five ossification centers. Subdental (basilar) synchondrosis is an initial cartilagenous junction between the dens and vertebral body that does not fuse until ~6 years of age. The secondary ossification center appears at ~ age 3 and fuses to the dens at ~ age 12 [1]**.**

The axis is supplied through a vascular watershed that lies between the apex and the base of the odontoid. The apex is supplied by branches of internal carotid artery. The base is supplied from branches of vertebral artery. The limited blood supply in the watershed area is thought to affect healing of type II odontoid fractures [1]**.**

Odontoid fractures are among the most common spinal injuries of the elderly. Moreover, in patients older than 79 years, odontoid fractures occur even more frequently than all other spinal injuries together. Odontoid fractures account for 5–15 % of all cervical spine injuries in skeletally mature individuals. While it is generally well accepted that non-operative treatment should be recommended for type I and type III fractures in Anderson-D'Alonzo system, the optimal treatment for type II odontoid fractures is still controversial.Unfortunately, the type II odontoid fractures take up the majority of dens injuries (65–74 %) [2].

Upper cervical spine lesions frequently occur in patients with rheumatoid arthritis. Synovitis at C1– 2 results in erosion of the odontoid process as well as rupture of the transverse ligament, leading to spontaneous atlantoaxial instability and subluxation. Bone atrophy and erosion of the base of the odontoid process as well as instability at C1 – 2 may cause a fragility fracture of the odontoid process. Hyperextension and hyperflexion in combination with axial compression are considered to be the most relevant mechanisms for odontoid fracture development [3]**.**

Traumatic atlantoaxial dislocation with isolated odontoid fracture often encountered in clinical practice. Most of them reduce on extension, barring posterior dislocation. Skeletal traction helps, if they fail to reduce on extension. However, few patients, especially those presenting late, fail to reduce, despite traction. Previously, such patients with irreducible Traumatic atlantoaxial dislocation were managed with transoral odontoidectomy and posterior fusion. In the recent past, direct posterior reduction and fusion by intraoperative manipulation of the joints has been attempted successfully in a few cases of irreducible Traumatic atlantoaxial dislocation. Such a procedure is of advantage as it circumvents the transoral surgery [3].

Non operative treatment include. Hard cervical orthosis for 6-12 weeks. halo vest immobilization for 6-12 weeks. Operative options include posterior C1-C2 fusion, Anterior odontoid osteosynthesis and transoral odontoidectomy [1]**.**

This study aimed to review and describe lines of treatment of odontoid process fracture with special reference to the recent treatment modalities.

2. Materials and methods

This is a review article, The search was performed in MEDLINE, Embase, Pubmed and CINAHL Plus in the same date range with the following mediacl terms: "Odontoid; Fracture; spinal injuries including articles

from 2000 to 2021, Excluded articles from review are those of language other than English

3. Results

A. Non operative:

- Conservative: assuming no neurologic symptoms or instability.
- Hard cervical orthosis for 6-12 weeks

Indications:

Type I Andreson and D'Alonzo

Type II Andreson and D'Alonzo in elderly who are not surgical candidates: union is unlikely; however a fibrous union should provide sufficient stability except in the case of major trauma.

Type III Andreson and D'Alonzo fractures: no evidence to support Halo over hard collar.

Halo vest immobilization for 6-12 weeks

Indications:

Type II young patient with no risk factors for nonunion

Contraindications:

Elderly patients: do not tolerate halo (may lead to aspiration, pneumonia, and death).

B. Operative:

Posterior C1-C2 fusion

Indications: **Type II fractures with risk factors for nonunion. Type II/III fracture nonunions.** Os odontoideum with neurologic deficits or instability.

2-Anterior odontoid osteosynthesis

Indications: **Type II fractures with risk factors for nonunion AND.** Acceptable alignment and minimal displacement. Oblique fracture pattern perpendicular to screw trajectory. Patient body habitus must allow proper screw trajectory.

Outcomes: associated with higher failure rates than posterior C1-2 fusion **3-transoral odontoidectomy**

Indications: severe posterior displacement of dens with spinal cord compression and neurologic deficits [1]**.**

<u>Surgical Techniques:</u>

C1-C2 posterior fusion techniques

Approach: Posterior midline cervical approach

Stabilization technique: Sub laminar wiring techniques (Gallie or Brooks) require postoperative halo immobilization and rarely used.

Posterior C1-C2 transarticular screws construct contraindicated in patients with an aberrant vertebral artery.

Posterior C1 lateral mass screw and C2 pedicle screw construct modern screw constructs do not require postoperative halo immobilization.

Posterior fusion and instrumentation of the C1-2 are common way for C1-2 arthrodesis. The C1-2 transarticular screw fixation (TASF) combined with posterior bone and wire construct is generally considered to be the *gold standard *, which can provide superior biomechanical properties**.** However, the TASF has several drawbacks, such as the procedure requires preliminary reduction of the C1-2 joint before screw placement and up to 23% of patients have anatomy unsuitable for this screw trajectory [4]**.**

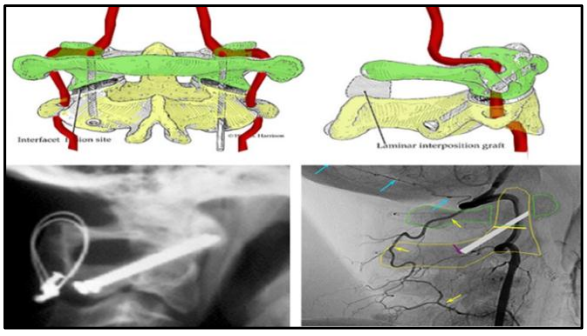

Fig. (1) Posterior fusion

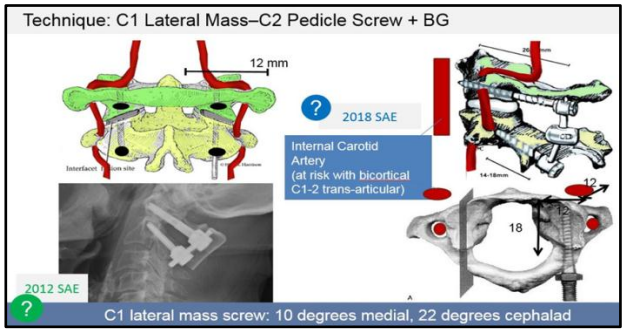

Fig. (2) C1 Lateral Mass- C2 Pedicle Screw + BG

Outcomes*:* C1-C2 fusion will lead to 50% loss of neck motion. Higher fusion rate in elderly compared to anterior fusion.

Anterior odontoid screw osteosynthesis

Approach: anterior approach to cervical spine. Technique*:* single screw adequate. Pros & cons: associated with higher failure rate than posterior C1-2 fusion. Advantage is preservation of atlantoaxial motion [1].

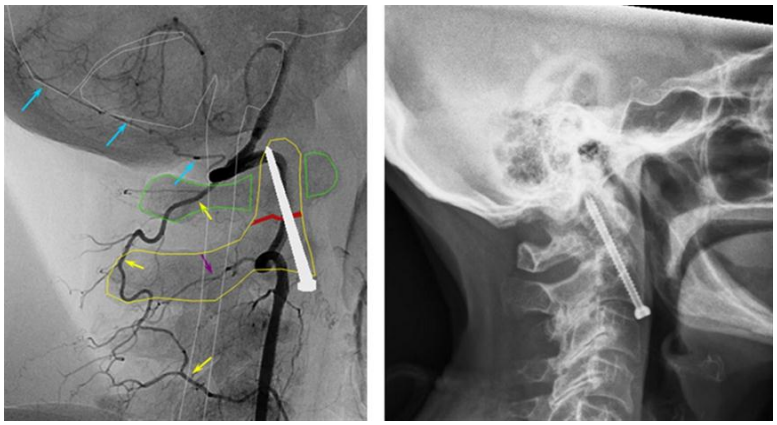

Fig. (3) Anterior odontoid screw osteosynthesis

Transoral odontoidectomy

Technique: usually combined with posterior stabilization procedure [1]**.**

Complications of treatment of odontoid fracture surgery:

Nonunion: increased risk in Type II fractures due to poor blood supply**.** Average nonunion rate 33% (up to as high as 88%)**.** Risk factors for nonunion include:

- ≥ 6 mm displacement (>50% nonunion rate).strongest reason to opt for surgery.
- age > 50 years
- fx comminution
- fracture gap > 1 mm
- angulations > 10°
- delay in treatment (> 4 days)
- posterior re-displacement (> 2 mm)
- smoker

Regarding the treatment of odontoid fracture type 1 most authors recommend nonsurgical treatment **(Kandziora et al., 2010).**

4. Discussion

Treatment trends for odontoid fractures type 1 are impossible to evaluate in our study, as there were only two patients with odontoid type 1 fracture. In the absence of high-level evidence, the treatment rationale of odontoid fractures type II of the elderly has been a matter of debate. In the US there is a trend towards surgical management of these fractures [5]**.**

In this study a trend towards surgical management was found, as well. This trend was seen both for the younger population and for the elderly [5]**.**

These results cannot be generalized for the rest of Sweden, as the no availability of cervical spinal expertise in rural areas combined with a resilience of patients and doctors to a long-distance referral, a common anaesthesiologist-driven fear of complications in elderly patients, and the seemingly obvious economic advantage of cervical orthoses over costly surgical procedures motivate surgeons to use nonsurgical treatment [6]**.**

With regard to the treatment of odontoid type 3 fractures there is a consensus on nonsurgical treatment, such as a collar or halo-vest.The treatment rationale of odontoid fractures type 3 in our study followed these recommendations. Regarding treatment of Hangman's fracture type 1, nonsurgical treatment with a rigid collar was dominating. Hangman's fractures type 1 are a domain of nonsurgical treatment, while for types 2 and 3 fractures there is a consensus on surgical treatment depending on the degree of displacement. In this study all 12 Hangman's fractures type 2 underwent surgery [7]**.**

There are no recommendations on the treatment of the atypical C2 fracture, since it summarises multiple unclassifiable fracture types. In this study, most of the atypical C2-fractures were treated non surgically with an external brace, and two patients were treated with a halo-vest.

Odontoid fractures are not uncommon injury, accounting for 9–18% of cervical spine fractures especially in elderly patients. Although the conservative methods were well described in treatment of odontoid fractures, type II fractures and shallow type III odontoid fractures. (according to the classification of Anderson and D'Alonzo) were recognized mechanically unstable with a high risk of nonunion or mortality, and surgical stabilization was recommended [8]**.**

Many posterior surgical techniques were reported in previous literatures, including Gallie's C1/2 wiring and Magerl's posterior C1/2 transarticular screw fixation and posterior C1 lateral mass + C2 pedicle screw fixation, however, these posterior techniques were performed via an open surgical approach, with disadvantages of considerable tissue trauma, blood loss, higher risk of vertebral arteries injury, and some other risks of pneumonia, acute respiratory distress syndrome, and decubitus ulcer [9]**.**

Anterior odontoid screw fixation was first described by Bohler in 1980s, proved anatomic feasibility and could preserve the C1/2 rotation and provide adequate stability.Furthermore, anterior odontoid screw fixation could be introduced percutaneously,with only about 10 mm skin wound, and have the advantages of being minimally invasive,

having less blood loss, having shorter skin scar, and having quicker post-operative recovery [10].

However, anterior odontoid screw fixation is not suitable for all patients. In Grauer type IIC fracture, which is extending from anterior-inferior to posterior-superior or with significant comminution, the bone of C2 body for screw anchor is too small to introduce the odontoid screw.Sometimes, the trajectory of odontoid screw cannot be determined satisfactorily, such as the case reported by Salem et al. that the fracture position was unacceptable, and other surgical techniques need to be considered [11].

Anderson and D'Alonzo classified odontoid fractures as type I, II, or III.Type II fractures have a watershed blood supply and have a high nonunion rate with risk for subsequent chronic pain, atlanto-axial instability, and neurological deterioration along with high mortality rates [12].

These classifications were later expanded upon by Grauer, who included three different subtypes of type II fractures based on displacement, comminution, and fracture line obliquity to help guide treatment.A type IIA fracture describes a minimally or non-displaced fracture without comminution which may be treated with external immobilization. A type IIB fracture line extends craniocaudal anterior-superior to posterior-inferior and is amenable to anterior screw osteosynthesis. Type IIC fracture extends caudocranially from anterior-inferior to posterior-superior with or without comminution. This fracture type is more amenable to posterior C1-2 fusion. However, identifying the optimal treatment for a type II fracture has been difficult. There are many factors that should be considered to choose the optimal treatment of type II fractures, such as patient age, type of fracture, extent and direction of fracture displacement, associated other injuries, and potential possibility of fracture fusion. Because the instability of these fractures places patients at significant risk for further disastrous spinal cord injury, the fracture stabilization should be acquired as early as possible. However, the treatment of odontoid fracture can be challenging because of the complex anatomy of C1 and C2. The type II fracture occurs through the base of the odontoid process and the blood supply to the odontoid process may be compromised [13].

Currently, ACSF has been a popular surgical treatment. This technique was first reported in 1980 by Nakanishi.Numerous studies have reported the high fusion rate of anterior screw fixation to stabilize type II odontoid fractures. [14]

5. Conclusion

Odontoid fractures are among the most common spinal injuries of the elderly. direct posterior reduction and fusion by intraoperative manipulation of the joints has been attempted successfully in a few cases of irreducible Traumatic atlantoaxial dislocation. Such a procedure is of advantage as it circumvents the transoral surgery. Non operative treatment include. Hard cervical orthosis for 6-12 weeks. halo vest immobilization for 6-12 weeks. Operative options include posterior C1-C2 fusion, Anterior odontoid osteosynthesis and transoral odontoidectomy.

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