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Case Report

Experience in surgical treatment of type II odontoid fractures: A report of two cases and review of the literature

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ABSTRACT

Two cases of type II odontoid fractures were reported to share our experience in surgery treatment of such cases. A 33-year-old woman with comminuted type II odontoid fracture and a 42-year-old man with fracture end hardened type II odontoid fracture received surgical treatment in our hospital. Though imaging examination suggested that these two patients were suitable for anterior screw fixation, we encountered difficulties during the operation. The two patients eventually underwent posterior C_1–C_2 fusion surgery and recovered well. According to the experience of these two cases, we found that the fracture line angle and the degree of comminution are two important factors affecting surgical decision-making. Although anterior screw fixation is the ideal choice for type II odontoid fractures with anterior superior to posterior inferior fracture line, it may not be the best choice for comminuted or fracture end hardened type II odontoid fractures.

Introduction

With the increase of traffic injury and height falling injury, the incidence of odontoid fractures has increased in recent years, which accounts for 9%–19% of adult spine fractures.[1] Odontoid fractures undermine the stability and function of the atlantoaxial joint. The main function of the atlantoaxial joint is axial rotation, and 50% of the rotation of the head and neck is mainly achieved through the axial rotation of the atlantoaxial joint. Since Anderson and D'Alonzo classified odontoid fractures into three types (type I involving the tip, type II involving the neck, type III involving the body) in 1974, this standard has been adopted worldwide.[2]

While type I and III odontoid fractures are generally treated conservatively, the treatment of type II odontoid fractures is still controversial.[3] In simple type II odontoid fracture, the nonunion rate of conservative treatment is as high as 50%–80%, which means surgical treatment is necessary.[4] At present, the surgical methods of odontoid fractures are mainly divided into two types: anterior approach and posterior approach. The anterior screw fixation now is the most widely used technique for type II odontoid fracture with anterior superior to posterior inferior fracture line. Though it is a physiological reconstruction surgery, which means the rotation activity of the cervical spine can be preserved, it does not apply to all types of type II odontoid fracture even with anterior superior to posterior inferior fracture line. In this article, we describe a patient with comminuted type II odontoid fracture and one with hardened fracture end type II odontoid fracture. Both of them failed to receive anterior screw fixation and finally were treated with posterior C_1–C_2 fixation and fusion. This article aims to share our surgical experience and to provide related literature review.

Case report

Case 1

A 33-year-old woman suffered from neck pain with limited activity following car accident for 5 days. Physical examination showed no abnormality in muscle strength of limbs. Physiological reflex could be derived and there was no pathological sign. Local hospital's imaging examination including X-ray and CT scans suggested type II odontoid fracture and anterior screw fixation was performed according to her medical history and examination (Fig. 1). During the surgery, the position of the guide wire did not seem to be abnormal in the positive and lateral positions at first (Fig. 2A and 2B). The position is still acceptable when the guide wire has just passed through the fracture end (Fig. 2C). But as the guide wire entered further, its orientation began to change, the odontoid

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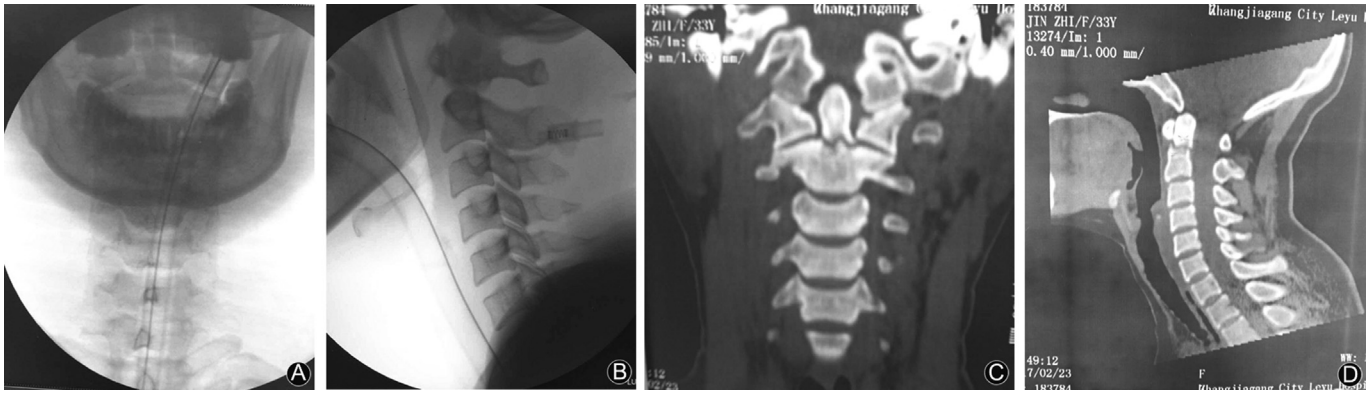

Fig. 1. The pre-operative anteroposterior (A) and lateral (B) radiographs and computed tomography scan (C, D) showed type II odontoid fracture.

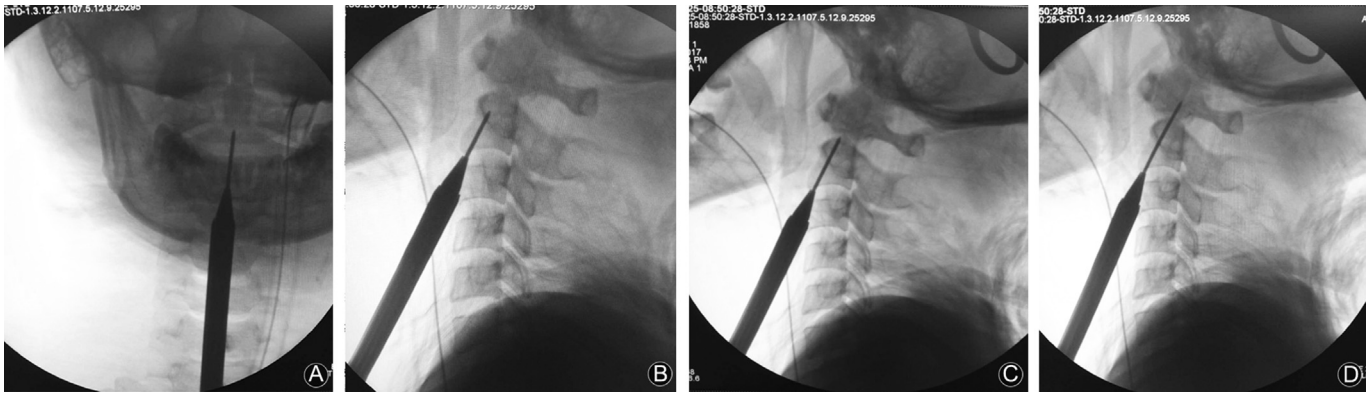

Fig. 2. The intraoperative anteroposterior (A) and lateral (B, C) radiographs showed the guide wire was in good position. The intraoperative lateral (D) radiograph showed the odontoid process was displaced to the front of the wire.

process was displaced to the front of the wire (Fig. 2D). We temporarily fixed the C_2 vertebral body with another guide wire and tried to continue drilling the guide wire, but the same situation happened again (Fig. 3). We encountered difficulty in putting the guide wire in position during surgery and finally we decided to perform the second surgery of posterior C_1–C_2 fixation and fusion. Postoperative CT sagittal reconstruction showed odontoid comminuted fracture (Fig. 4). Postoperative X-ray and three-month postoperative CT examination showed that the fracture end was well aligned and bony union achieved (Fig. 5).

Case 2

A 42-year-old man with a one-week-history of car accident came to our hospital because of limited neck rotation activity. A week ago, he hit the head in a car accident and received debridement and suturing at a local hospital. The patient felt the neck rotation was limited after the accident and the X-ray of the local hospital suggested type II odontoid fracture (Fig. 6). There were no obvious abnormalities in the physical examination of the extremities. We tried to perform anterior odontoid screw fixation in the

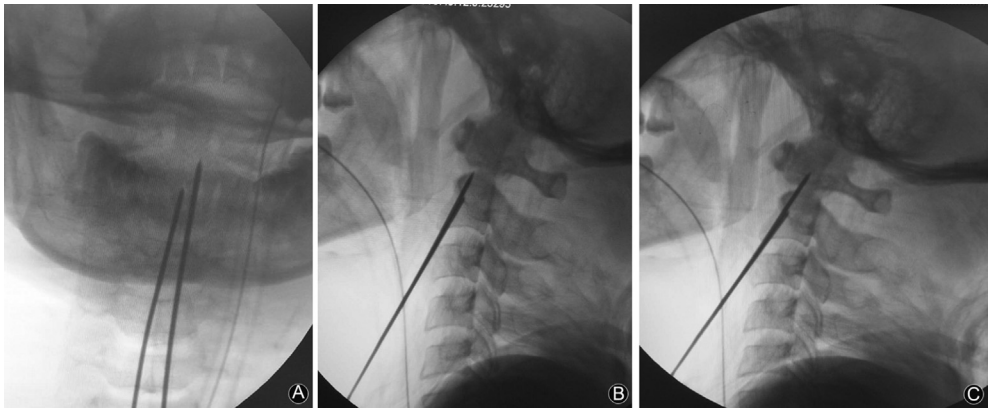

Fig. 3. The intraoperative anteroposterior (A) and lateral (B) radiographs showed that we used two guide wires to fix the C_2 vertebral. The intraoperative lateral (C) radiograph showed the odontoid process was still displaced to the front of the wire.

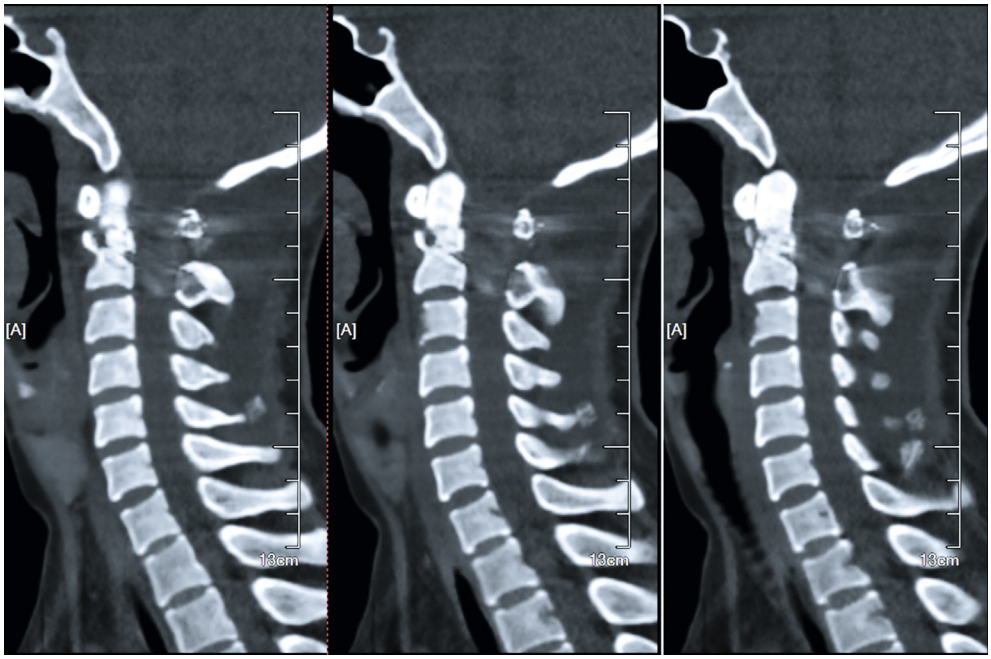

Fig. 4. The postoperative computed tomography scan showed odontoid comminuted fracture.

beginning. In the course of surgery, the odontoid process was located by the C-arm and the position and direction of Kirschner wire insertion were also determined (Fig. 7). After putting the guide wire in the right position and direction under the navigation of O-arm, we put the guide wire into the hollow screw under the condition of maintaining the position of the wire (Fig. 8). However, the screw cannot enter the fracture end of the odontoid process in any case and the gap between the fracture ends was also increasing (Fig. 9). We finally decided to change the surgical approach and performed posterior C_1–C_2 fixation and fusion with O-arm-based navigation (Fig. 10).

Discussion

The purpose of surgical treatment of type II odontoid fractures is to obtain postoperative stability immediately and to avoid prolonged external fixation and eventually to obtain bony union. It can also avoid delayed neurological impairment or neck pain.

The Anderson classification does not discuss the pathological fractures of type II odontoid fractures, such as fracture displacement, fracture line direction, fracture end hardening and fracture fragmentation, which are the factors affecting fracture healing. The fracture line of case 1 is transverse and case 2 is anterior superior to posterior inferior. Grauer et al.[5] modified the Anderson classification's type II odontoid fractures into three subtypes, A, B and C, depending on the direction of the fracture line. Subtype A has a transverse line, subtype B has an anterior superior to posterior inferior line, and subtype C has an anterior inferior to posterior superior line. This recommendation has been accepted by many scholars.[6–9] Subtype A and B odontoid fractures are amenable to anterior screw fixation. Conversely, subtype C odontoid fractures are difficult to stabilize with lag screw because the screw trajectory

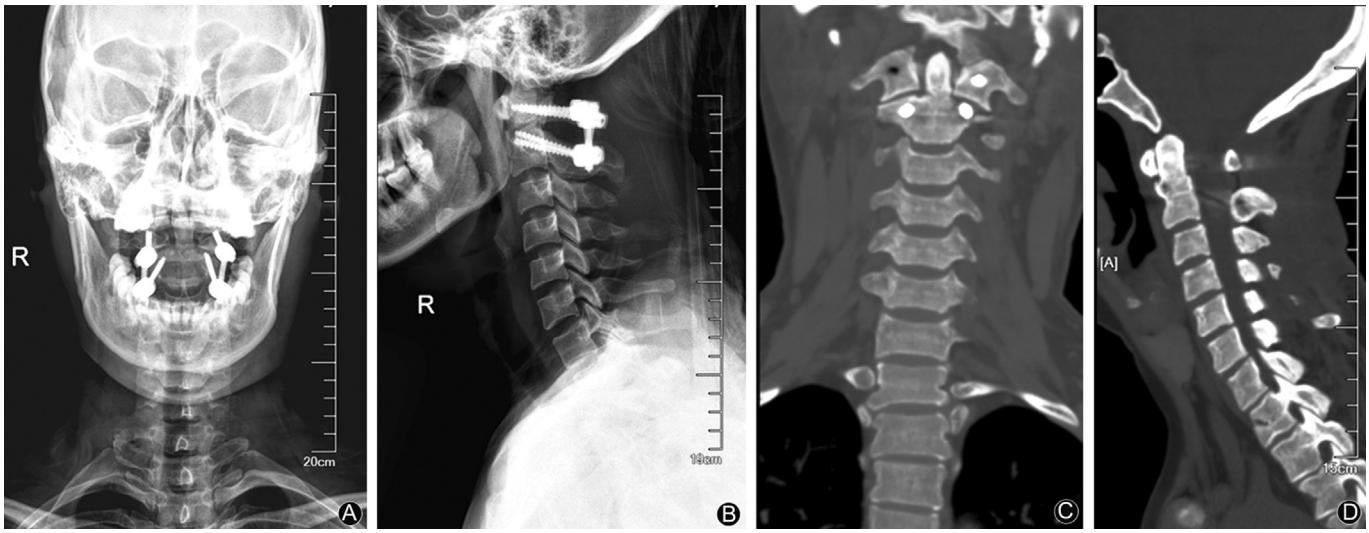

Fig. 5. The postoperative anteroposterior (A) and lateral (B) radiographs showed a satisfactory position of instrumentation. The computed tomography scan reconstructions of 3-month follow-up showed good bony healing.

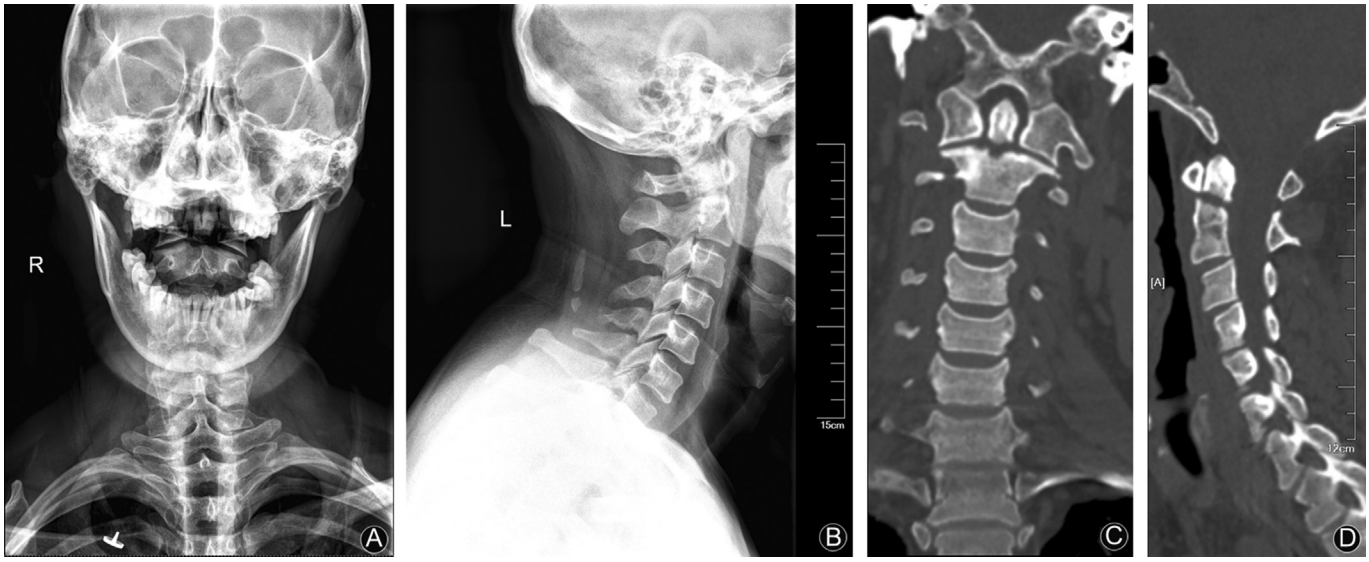

Fig. 6. The pre-operative anteroposterior (A) and lateral (B) radiographs and computed tomography scan (C, D) showed type II odontoid fracture. The fracture line was from anterior superior to posterior inferior.

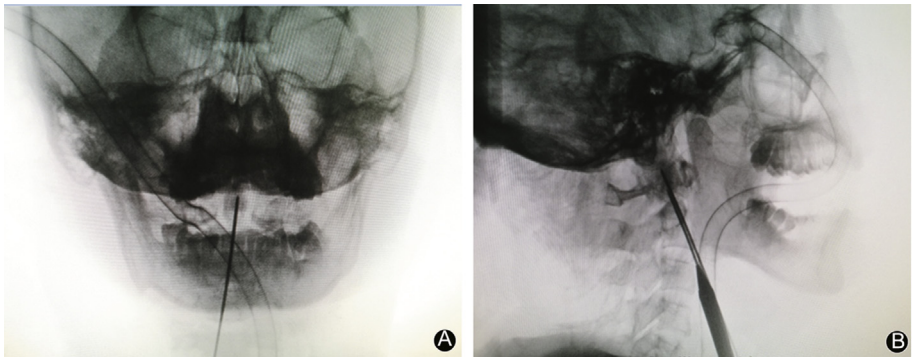

Fig. 7. The Intraoperative anteroposterior (A) and lateral (B) radiographs showed the guide wire was in satisfactory position.

and the fracture line are in the same direction.[10] The lag screw needs to be perpendicular to the fracture line to avoid the shear force, which may cause the displacement of the fracture end.[11]

The advantage of the anterior odontoid screw fixation is that the fracture end will be directly connected and fixed, theoretically reconstructing the continuity of the odontoid process, and the motor function of the atlantoaxial joint can be restored after the fracture is healed. Anterior screw fixation has been reported having averaging 94.5% high clinical successful rate.[12,13] Therefore we tried to treat the patients with anterior screw fixation at the beginning.

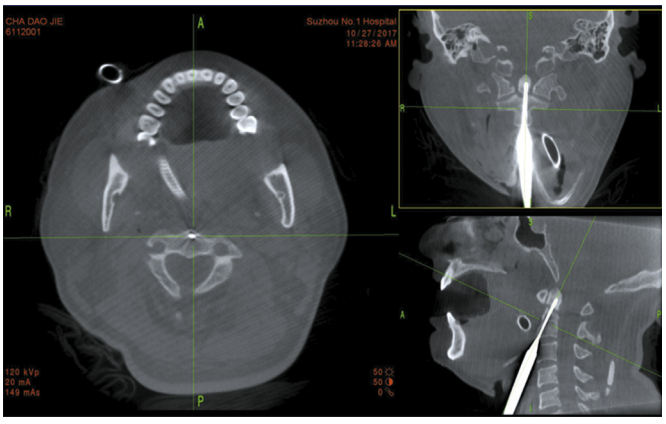

Fig. 8. The computed tomography scan reconstructions with O-arm showed the guide wire was in a satisfactory position.

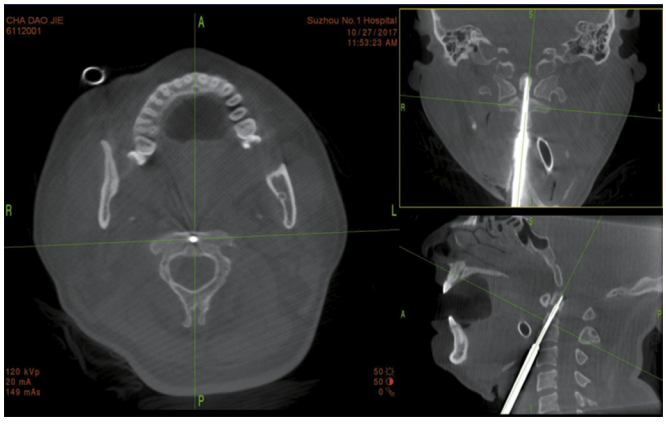

Fig. 9. The computed tomography scan reconstructions with O-arm showed distal odontoid process being displaced.

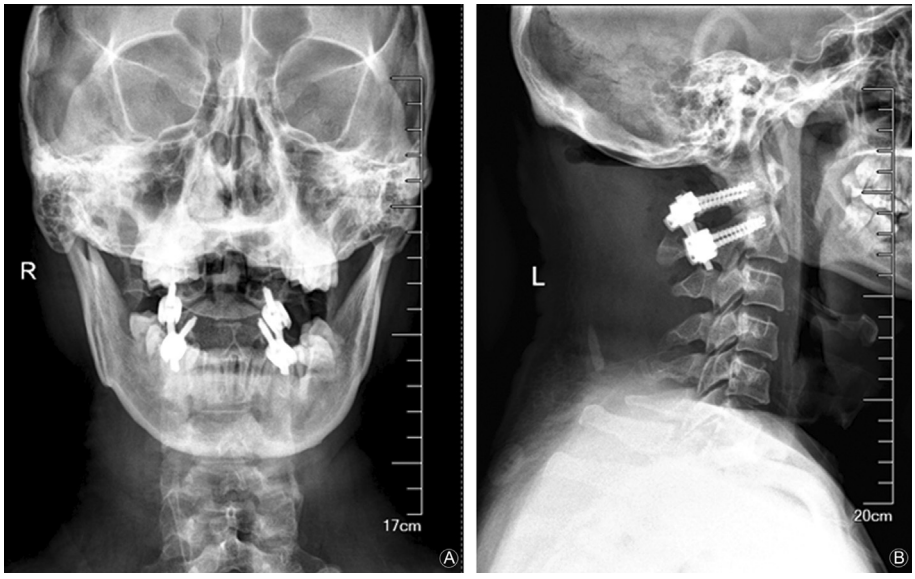

Fig. 10. The postoperative anteroposterior (A) and lateral (B) radiographs showed a satisfactory position of instrumentation.

We believe that the cause of failure is the comminuted fracture of the odontoid process and the hardening of the odontoid process. The CT images of the first patient were done at a local hospital, but multi-slice spiral CT (MSCT) was not done. We believe that limited CT images were the reason why we did not find the occult comminuted odontoid fracture. The patient underwent a 64-slice spiral CT scan after surgery, and the insertion of the guide wire during the anterior procedure caused a certain degree of displacement of the fracture, so the comminuted odontoid fracture was found after the surgery. Hadley et al.[14] identified a fracture subtype IIA based on comminution of the odontoid base. Greene et al.[15] reported 199 patients with odontoid fractures. Four of five patients with type IIA comminuted fractures required early surgical treatment. The prognosis of comminution at the base of the odontoid fractures would be worse.[16]

Although in case 2, the hardening of the odontoid fracture end does not necessarily occur after the fracture, hardened fracture ends and fracture gaps filled with soft tissue scars still may be one of the reasons that type II odontoid fracture has the high risk of nonunion with anterior screw fixation. If the effective restoration and fixation cannot be obtained, the fracture healing rate is very low. The healing time may be longer due to bone absorption or hardening at the fracture end and the screw occupying the contact surface at the fracture end.[17] An ideal treatment method should be to promote fracture healing and restore the stability of atlantoaxial joints. Studies have confirmed the high healing rate of posterior C_1–C_2 fixation and fusion.[18–20] Although it may affect 50% function of cervical axial rotation and 10% flexion and extension movements, the posterior fusion surgery is more commonly used in old rather than acute odontoid fractures with hardened fracture ends.[21] With his subtype classification of type II odontoid fracture, Grauer[5] pointed out that patients with significant kyphotic deformities, osteoporosis, anterior inferior to posterior superior fracture line and significant comminution may need a C_1–C_2 fixation and fusion.

For type II odontoid fracture patients who were originally treated surgically through an anterior approach, 4.5% received a posterior approach surgery again.[22] Apfelbaum[13] reported 10% hardware complication rate of anterior screw fixation. The most common two complications were screw pullout related to comminution fracture and backout related to failure to cross the apical cortex with the screw threads.

Based on the experience with the two cases, we suppose that the reasons for the failure of anterior approach surgery are as follows: (1) The comminuted odontoid fracture can cause great difficulty in the placement of the guide wire, and the displacement of the fracture block may occur during the process, resulting in a surgical failure. (2) The degree of hardening of the odontoid fracture end may not be exactly the same as the fracture time. Therefore, when preoperative imaging indicates that the fracture end may harden, anterior surgery should be cautiously considered. (3) The direction of the fracture line is an important consideration when evaluating the feasibility of anterior screw fixation as treating type II odontoid fractures. When the fracture line is transverse or anterior superior to posterior inferior, the fracture end may not be in close contact after screwing, which may lead to delayed healing or nonunion of the fracture. Compared with anterior approach, the range of indications for posterior approach fixation is wider. Posterior surgical fixation provides good stability and reduces the fracture gap through compression between the atlantoaxial screws, reducing the likelihood of fracture nonunion. Therefore, posterior approach fixation can be considered for comminuted and old typeIIodontoid fractures.

With the experience in treating two cases of type II odontoid fracture, we find that many factors can affect surgical decision-making such as fracture line, degree of fracture end hardening and fracture type. It requires careful preoperative planning and skillful manoeuvre to get successful outcomes. In the case of comminuted type II odontoid fractures or fracture ends hardened, there is a certain risk of failure of anterior screw fixation even if it has anterior superior to posterior inferior fracture line.

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Ethical statement

The study protocol was approved by the local Medical Ethics Committee. Informed consent was obtained from all individual participants in the study.

Declaration of competing interest

No benefits have been received from a commercial party related directly or indirectly to the subject of this manuscript.

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