

# Patient-reported outcome following nonsurgical management of type II odontoid process fractures in adults

## ABSTRACT

**Background:** Transverse (type II) odontoid process fracture is among the most commonly encountered cervical spine fractures. Nonsurgical management through external immobilization is occasionally preferred to surgical management but is criticized for its higher rates of failure and lower patient satisfaction. Our aim is to analyze patient-reported outcomes in patients who underwent nonsurgical treatment for type II odontoid fractures.

**Methods:** We identified patients >18-year-old who underwent external immobilization as a treatment for isolated type II odontoid fracture between 2007 and 2012. We collected demographic parameters, clinical presentation, mode of injury, imaging studies and modality and duration of treatment (soft collar, halo-vest, or both). Patients were contacted by telephone to participate in a 15-min survey addressing their recovery including their subjective rate of return to preinjury level of functioning.

**Results:** Fifteen patients met the inclusion/exclusion criteria and participated in our survey. Patients were followed up for an average of 19 months after injury. Overall mean age was 61 years. Injury followed a mechanical fall or a road traffic accident in 11 and 4 cases, respectively. External immobilization was achieved by halo vest only in nine patients, soft collar only in two patients (13%), and through a sequential combination in the remaining 4 (27%). This was deployed for a mean of 7.8 months. Radiological studies at the last follow-up showed bony healing (27%), fibrous nonunion (60%), and persistent instability (13%). Patients reported gradual recovery of function throughout the 1<sup>st</sup> year after injury with levels above 70% of preinjury functioning achieved by 13% of patients at 6 months, 33% at 9 months, and 47% at 12 months. Overall satisfaction with nonsurgical management was 68%.

**Conclusion:** In selected patients with type II odontoid fractures, external immobilization represents a good option with acceptable course of recovery.

**Key words:** Cervical spine; external immobilization; odontoid fracture; patient-reported outcome.

## Introduction

Type II (transverse) fracture of the odontoid process represents a management challenge commonly encountered in neurosurgery spine practices.<sup>[1]</sup> The fracture is neither uncommon nor exclusive to the elderly population. Odontoid fractures have been reported to account for 9%–15% of all adult cervical fractures with a bi-modal distribution involving early adulthood in addition to the elderly age group.<sup>[2-4]</sup> Fractures in the elderly group are more likely to be low-energy falls, unlike those of younger patients that usually sustain it after motor vehicle accidents.<sup>[5]</sup> In-hospital

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and early mortality are also significantly high and survivors are at risk of suffering delayed myelopathy even years after injury.<sup>[5-7]</sup>

The underpinning pathophysiology and biomechanics are not well understood to explain the relatively higher rates of nonunion.<sup>[8,9]</sup> In addition, there remains no global consensus on the best management paradigm for this fracture pattern.<sup>[10-13]</sup> Multiple surgical approaches and techniques were advocated over time, but none has proven conclusive benefit.<sup>[14,15]</sup> Conservative (nonsurgical) management, on the other side, has also been practiced but still as well with no definite evidence.<sup>[9,16,17]</sup> Nonsurgical management is achieved through external immobilization, either through a halo vest or soft collar. Although deemed as the least invasive treatment option, external immobilization has been criticized for the longer duration, low success rate, inconvenience, and associated morbidity in the fragile elderly population.<sup>[11]</sup> With the new calls for practicing patient-centered care (PCC), it was necessary to assess the impact of nonsurgical management from the patient's point of view.<sup>[18]</sup> The aim of this study is to gather patient-reported outcomes (PROs) and patients' satisfaction in those undergoing nonsurgical treatment of type II odontoid process fracture.

## Methods

### Patient enrollment and clinical parameters

This is a retrospective survey analysis of PROs in nonsurgically treated type II (transverse) odontoid process fracture. The study took place at Aberdeen Royal Infirmary Teaching Hospital. On exemption of the local Institutional Review Board, medical records were searched for patients aged 16–80 years of age who were diagnosed for the first time with cervical spine fractures of all causes in the 5-year period May 2007–April 2012. Medical records search utilized the inclusive International Classification of Diseases 10 code S12 for fracture of cervical vertebra and other parts of neck. For all patients, we collected demographic parameters (age, gender), medical history of malignancy or arthritis (osteoarthritis, rheumatoid arthritis, or other), clinical presentation, mode of injury, mechanism of injury, follow-up imaging studies, and concomitant radiology reports (cervical spine magnetic resonance imaging, computed tomography [CT], or X-ray). We also collected timing and modality of treatment rendered (soft collar, Halo-vest, or surgical fixation) through the 1<sup>st</sup> year after diagnosis. We then excluded patients with follow-up <12 months from diagnosis and cases of pathological fractures. We also excluded patients who received surgical intervention (primary or salvage) within the 1<sup>st</sup> year after injury.

### Imaging, fracture classification, and follow-up

For all patients, radiology reports were then reviewed to exclude patients with cervical spine fractures other than type II odontoid process fracture. Patients with multiple cervical spine fractures including a type II odontoid fracture were also excluded. Diagnostic CT imaging for patients with radiologically reported type II fractures was adjudicated by the senior authors (MHK and PB) to confirm the diagnosis and absence of other concomitant cervical spine injuries. Type II odontoid process fracture was defined as per Anderson and D'Alonzo classification as that involving the base of the odontoid process below the level of the transverse band of cruciform ligament. As per local institutional guidelines, all patients with odontoid process fractures are routinely followed up with both plain neck CT and dynamic flexion/extension X-ray of the cervical spine to assess radiological healing. Radiological recovery was determined based on imaging studies at the last follow-up and classified as bony healing, fibrous nonunion, or persistent instability. Persistent instability was diagnosed by the end of the follow-up when movement of the odontoid process stump is seen on dynamic (flexion/extension) lateral cervical spine X-rays. In the absence of instability, the patient was deemed to have achieved bony healing if bone trabeculations are visualized bridging the fracture site on high-resolution CT imaging. Fibrous nonunion was diagnosed when there is no mechanical instability but without evidence of bony healing at the fracture site.

### Survey

Patients were then contacted through telephone to explain the purpose of the study, confirm information drawn from medical records, and run the survey (or arrange a later convenient appointment). A maximum of three attempts, 10 days apart, were made to contact the patient. A 15-min telephone-based survey was conducted with patients to collect patients' subjective assessment of the healing process. Patients were asked to confirm data extracted from clinical records and report any symptom persisting after the last follow-up. Patients were also asked to express any nuisance or complication encountered due to external immobilization. In addition, we asked patients to quantify their subjective rate of return to preinjury level of functioning/activity throughout the 1<sup>st</sup> year of treatment. Patients were also asked to rate their satisfaction among five graded strata (very dissatisfied, moderately dissatisfied, neutral, moderately satisfied, and very satisfied) and again on a scale from 1 to 10, with ten being the most satisfied. Finally, participants were asked if they would have preferred surgical fixation after the procedure was explained to them [Figure 1].

**Non-surgical treatment of fracture odontoid process (Type II)**  
**Telephone-based patient survey**

- Patient initials: .....
- Confirmation of clinical data
  - Date of injury: .....
  - Mechanism of injury: .....
  - Modality and duration of treatments received:
    - ..... Duration: .....
    - ..... Duration: .....
    - ..... Duration: .....
  - Residual symptoms:
    - Pain
    - Restriction of movement
    - Grittiness / Discomfort
    - Tingling / Paresthesia
- Any direct or indirect consequences of neck immobilization from the patient point of view:.....  
.....  
.....
- Subjective assessment of healing process – Return to pre-injury level of functioning / activity (%)
  - Three months after injury: .....
  - Six months after injury: .....
  - Nine months after injury: .....
  - Twelve months after injury: .....
- Overall satisfaction with treatment (1-10): .....  
[Very dissatisfied / Mod. Dissatisfied / Neutral / Mod. Dissatisfied / Very dissatisfied]
- Hypothetical question, if surgical fixation was an option given:
  - If uncomplicated, surgery offers a quicker return to daily activities without need for prolonged neck immobilization.
  - Better bony healing rates compared to external immobilization alone.
  - Risks are minimal, involving general risks of surgery (anesthesia, bleeding, wound infection, etc). Minor risks of cervico-cranial junction surgery (weakness of neck muscles, swallowing problems, hoarseness of voice and stroke).
  - Preference over surgery (Yes/No): .....

Figure 1: Telephone-based survey sheet. Contacted subjects were asked to participate in a 15-min survey over the phone to confirm data on the injury, treatment received, and also to report their subjective rate of recovery

## Results

### Patient characteristics

A total of 19 patients with isolated traumatic type II odontoid process fractures met our inclusion and exclusion criteria. Two patients passed within the 1<sup>st</sup> year of injury and another two patients could not be reached after three attempts. All contacted patients agreed to participate and answered all items in the telephone-based survey. Participating patients were followed up for a mean of 19 months, ranging

16–27 months. Six (40%) of the patients were males and nine (60%) females, with an overall mean age at time of diagnosis of 61 years (32–80). Past medical history was significant for osteoarthritis in four patients (27%), but none of the patients had history of rheumatoid arthritis or malignancy. In 11 (73%) patients, the injury followed a mechanical fall and the other four (27%) had suffered a road traffic accident. Of those who had a mechanical fall, the mechanism of injury was hyperflexion in seven patients (64%), hyperextension (fall onto forehead) in two

patients (18%), and two (18%) patients could not accurately specify/recall the incident. External immobilization was achieved only by halo vest in nine patients (60%), only by soft collar in two patients (13%), and through a sequential combination in the remaining four patients (27%). External immobilization was deployed for a mean duration of 7.8 months (ranging 6–11) [Table 1].

### Clinical and radiological assessment at the last follow-up visit

Radiological assessment of imaging studies at the last follow-up visit involved formal radiology reports adjudicated by the senior authors (MHK and PB). Patients were classified into three categories based on the presence or absence of bony trabeculations bridging the fracture site on CT scans and visualization of movement/angulation of the distal stump on flexion/extension films [Figure 2]. Six (40%) out of the fifteen patients were completely asymptomatic at the last follow-up assessment. In the remaining patients, persistent clinical symptoms reported at the last follow-up visit were pain (40%), restriction of neck movement (20%), tingling/discomfort sensation (20%), and grittiness/clicking (7%). Complications of external immobilization were seen in seven cases (47%) and were in the form of mild pressure-related skin changes in four patients and pin-site superficial infection in three patients at the end of follow-up.

### Patient reported outcomes

Patients reported gradual recovery of function throughout the 1<sup>st</sup> year after injury with levels above 70% of preinjury functioning achieved by 2 (13%) patients at 6 months, 5 (33%) patients at 9 months, and 8 (54%) patients at 12 months [Figure 3]. Overall satisfaction with nonsurgical management was 68% ranging 4–10 out of 10. None of the patients reported being very dissatisfied with treatment. Reported grades were moderately dissatisfied in 13% ( $n = 2$ ), neutral in 33% ( $n = 5$ ), moderately satisfied 26% ( $n = 4$ ), and very satisfied 26% ( $n = 4$ ). When asked about surgical fixation, only two patients (13%) expressed preference to surgical fixation, had it been an option.

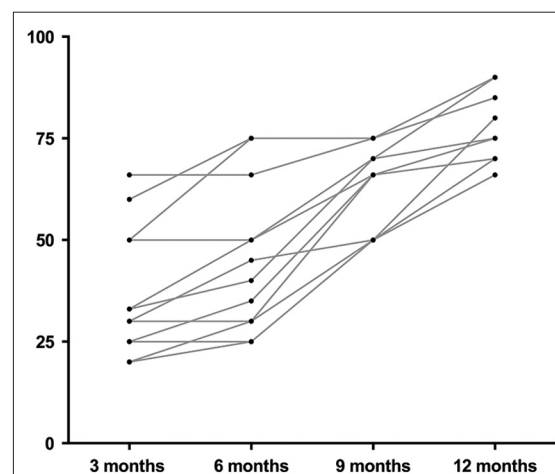
### Discussion

PCC has been gaining considerable momentum owing to the highly positive outcomes associated with such practice.<sup>[19]</sup> Among the various components of PCC, PRO reflects one of the more important aspects.<sup>[20]</sup> Fortunately, PRO has been applied to the field of spine surgery, and various studies conducted started to pinpoint the parameters influencing patient satisfaction.<sup>[21-27]</sup> For instance, in a number of studies, patient satisfaction correlated with whether or not patient expectations were met.<sup>[28,29]</sup> In turn, another study has found

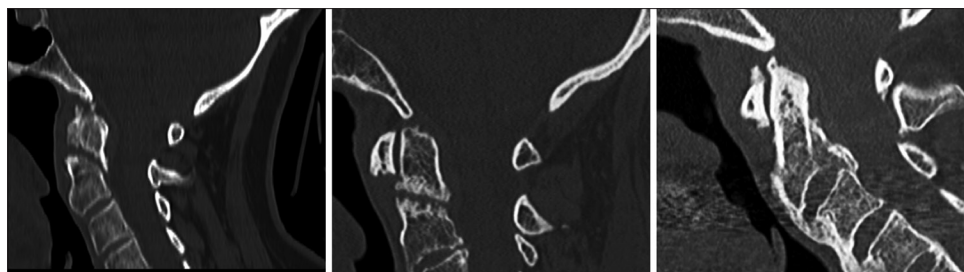
that patient expectations are highly affected by demographics, functional statuses, and prior treatments.<sup>[30]</sup> However, many of the assessments present at hand to determine outcome measures are patient-independent and not reflective of what the patient deems important to his or her satisfaction. Such outcome measures in odontoid fractures are reflective in measuring bone fusion, morbidity, mortality, degree of disability, and hospitalization.<sup>[12]</sup> Yet, in this era of PCC and PRO, it is integral to assess patient satisfaction of their quality of life through self-reported measures.<sup>[23]</sup>

**Table 1: Baseline characteristics and treatment rendered in the surveyed patients**

Parameter	
Sample size	15
Age: mean (range)	61 (32-80)
Male (%)	6 (40)
Follow-up (month) mean (range)	19 (16-27)
Medical history (%)	
Osteoarthritis	4 (27)
Rheumatoid arthritis	-
Malignancy	-
Mode of injury (%)	
Fall	11 (73)
RTA	4 (27)
Mechanism of injury	
Hyperflexion	7 (64)
Hyperextension	2 (18)
External immobilization (%)	
Halo vest only	9 (60)
Soft collar only	2 (13)
Combination	4 (27)
Duration of immobilization: mean (range)	7.8 (6-11)
Complications	7 (47)
Pressure-related	4
Pin-site infection	3



**Figure 2: Patient-reported outcome. Fifteen patient surveyed in our analysis quantified the rate of return to preinjury level of activity at 3, 6, 9, and 12 months after starting treatment. Lines are < 15 due to overlap in numbers**



**Figure 3: Computed tomography scan of odontoid fractures showing nonunion (left), fibrous nonunion (middle), and bony healing (right)**

Odontoid fractures represent a significant portion of spine fractures that is known to be more prevalent among the elderly population with a considerable risk of morbidity and mortality.<sup>[9,11,31]</sup> D'Alonzo and Anderson classified odontoid fractures into three categories.<sup>[11]</sup> Type I is a relatively stable fracture that is oblique through the upper portion. Type II involves the base of the peg at the junction with the C2 body, while type III extends into the body of C2. Among the three types, type II is considered to be the most unstable, and unfortunately, the most common among the three with studies showing an increasing in its incidence.<sup>[9]</sup> The management of type II fractures remains controversial, with not enough evidence to justify an intervention over conservative treatment or vice versa.<sup>[32,33]</sup> While many of the studies utilized objective parameters to evaluate both strategies (i.e., rate of radiological bony fusion, rates of neurological injury from spinal instability, complications, pain, functions and activity of daily living, and death), this study aimed to directly assess patient satisfaction after conservative treatment in addition to the more commonly utilized measure of outcomes.<sup>[33]</sup>

External immobilization for type II odontoid fractures is perhaps one of the oldest treatment modalities is spinal surgery.<sup>[34,35]</sup> Its continued use in modern neurosurgery in spite of the perceivably protracted duration and higher failure rates denotes a substantial therapeutic value.<sup>[36]</sup> This study aimed primarily to describe patients' reported experience and satisfaction. While our findings could serve to guide decision making for patients and practitioners, generalizability of these findings is however limited due to the small sample size and the retrospective nature. The study design is also inherently limited by the lack of comparative surgical cohort and lack of randomization whereby included patients were selected for external immobilization and/or were not suitable candidates for surgical treatment. Another limitation of our analysis was the exclusion of patients undergoing delayed or salvage surgical fixation after external immobilization within the 1<sup>st</sup> year from injury. Those patients were excluded as the indication of surgery could not be accurately elucidated in all cases, and hence, the reported failure rate could be underestimated.

Radiological bony fusion, which is usually quoted as a marker of success, was 25% in our sample. This was relatively lower than the previously reported numbers in other studies.<sup>[37]</sup> However, the majority of patients were satisfied with their outcome. This highlights the importance of PRO and assessing patient-reported satisfaction in addition to the currently acceptable markers of therapy. Conservative management of type II odontoid fracture, when feasible, has the potential for significant patient satisfaction independent of radiological or clinical findings. As patient satisfaction is a main end-point in PCC, future studies should integrate this as a main end-point for future studies in type II fractures.

## Conclusion

In carefully selected patients, external immobilization represents a good option for treatment of type II odontoid process fracture with acceptable course of recovery.

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## Conflicts of interest

There are no conflicts of interest.

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