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Single Institute Experience on 108 Consecutive Cases of Type II Odontoid Fractures: Surgery Versus Conservative Treatment

Tip II Odontoid Kırıklarında Ardışık 108 Olgu ile Tek Enstitü Deneyimi: Cerrahiye Karşın Konservatif Tedavi

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ABSTRACT

AIM: The incidence of cervical fractures in industrialized countries is about 11.000 cases per year. The objective of our study was to determine which of two treatments was more effective for the management of Type II odontoid fractures.

MATERIAL and METHODS: This study involved 108 cervical fractures treated at the "Department of Neurosurgery of Policlinico Umberto I" in Rome between 2002 and 2013. Sixty of the 108 axis fractures were treated conservatively with external immobilization, and the remaining 48 were treated surgically.

RESULTS: Patients undergoing surgery had a higher rate of fusion (91.67% vs. 46.67%) and shorter bone healing times (17 weeks compared to 21 weeks) than the patients who received conservative treatment.

CONCLUSION: All fractures of the odontoid process, without dislocation, should be treated with rigid external immobilization (preferably with a "Halo-vest"). All fractures of the odontoid process with dens dislocation > 5 mm should be considered as candidates for surgery. Type II odontoid fractures in patients over 50 years old should also be candidates for surgical treatment, while the outcome of such fractures, as regards conservative treatment, is better for patients under 50 years old.

KEYWORDS: Odontoid fracture, Anderson type II, Cervical trauma, Cervical instability

ÖZ

AMAÇ: Servikal kırıkların gelişmiş ülkelerdeki insidansı yılda yaklaşık 11.000 olgudur. Çalışmanın amacı Tip II odontoid kırıklarının tedavisinde iki tedaviden hangisinin daha etkili olduğunu belirlemekti.

YÖNTEM ve GEREÇLER: Çalışmaya 2002 ile 2013 yılları arasında Roma'da Policlinico Umberto I Beyin ve Sinir Cerrahisi Bölümü'nde tedavi edilen 108 servikal kırık olgusu alındı. 108 aksis kırığının altmışı eksternal immobilizasyonla konservatif olarak tedavi edilirken kalan 48 olgu cerrahi olarak tedavi edildi.

BULGULAR: Cerrahi yapılan hastalarda konservatif tedavi alanlara göre füzyon oranı daha yüksekken, (%91,67 ve %46,67) kemik iyileşmesi süresi daha kısaydı (17 hafta ve 21 hafta).

SONUÇ: Dislokasyonsuz tüm odontoid proses kırıkları rijid eksternal immobilizasyon ile (tercihen "Halo-vest" ile) tedavi edilmelidir. Odontoid prosesin dens dislokasyonu > 5 mm olan tüm kırıkları cerrahiye aday olarak değerlendirilmelidir. 50 yaş üzerindeki hastalarda da tip II odontoid kırıklarında cerrahi tedavi düşünülmelidir. Bu tür kırıklarda konservatif tedaviyle sonuç 50 yaş altındakilerde daha iyidir.

ANAHTAR SÖZCÜKLER: Odontoid kırığı, Anderson tip II, Servikal travma, Servikal instabilite

INTRODUCTION

The second cervical vertebra or axis, the first cervical vertebra or atlas, and the lower part of the occipital bone (occipital condyle) constitute the so-called craniovertebral junction (CVJ). The incidence of vertebral fractures in industrialized countries is more than 11.000 cases per year (13,27). Overall, 65% of vertebral fractures involve the cervical spine as the remaining sections require more force to be damaged. In fact, taking into account the entire spinal column, there are three main features that make the cervical column subject to these traumatic events: the increased mobility of this tract, the more minute structure of the cervical vertebrae, and finally the relatively less prominent muscle component (47). Vertebral fractures are divided into those without neurological deficits that make up the majority of the cases (about 80%) and those with neurological deficits that make up the remaining 20%. The male/female ratio is about 4:1 and the incidence has two peaks, one around 20 years old and the other around 60 years old. Road accidents account for the majority of the cases (over

40%), followed by accidents at home and work, and sports injuries. A traumatic brain injury should always be suspected in the case of neck trauma and the reverse is also true. The incidence of cervical fractures in polytrauma ranges from 1% to 6%. The most common location of cervical fractures is the axis (including the odontoid process), involved about in 25% of cases (29). A review of the literature reveals a variety of opinions regarding the treatment of odontoid fractures. Many authors believe that all fractures should be treated surgically to avoid the possible dangerous consequences of a dislocation (25, 3, 15). Hentzer and Schalimtzek (25) have found a non-union rate of 50% with conservative treatment, and therefore recommended early surgical treatment. Alexander and Davis (3) and Crutchfield and Schultz (15) have recommended operative treatment of all dislocations of atlas and the axis. Internal fixation usually involves the fusion of the first two or three cervical vertebrae (3,8). Some authors consider that external immobilization should be the initial treatment in all patients, and that surgical treatment is rarely necessary (4,11,12,35,44). Böhler (12) found union in 35 of 37 cases treated conservatively and said that "only in exceptional cases there is indication for surgery."

Given the wide disparity of opinion regarding the effectiveness of the treatments for axis fractures, the aim of this study was to compare conservative and surgical treatment using the "Chi Square Test" and "p values". We included a series of 108 consecutive cases of type II odontoid fractures according to the "Anderson, D'Alonzo" (5) classification and tried to determine which of the two treatments (conservative vs. surgical treatment) was the most valid.

PATIENTS and METHODS

108 consecutive cases of type II odontoid fractures presented at the Department of Neurosurgery of "Policlinico Umberto I" hospital in Rome from 2002 to 2013.

We excluded patients with type II odontoid fractures due to degenerative diseases such as rheumatoid arthritis, and patients with abnormalities of craniovertebral junction, first of all the "os odontoideum" from this study.

All patients were assessed with an accurate neurological examination at admission and underwent cervical x-ray in three projections as anterior-posterior, latero-lateral and open mouth projection together with a CT and MRI scan within 24 hours.

Surgery was performed within 72 hours after the injury. The presence of neurological symptoms due to spinal cord compression, and a dislocation of the dens greater than 5 mm were factors influencing the surgical choice.

There were three surgical treatment options: occipital-cervical fusion (33), posterior C1-C2 stabilization (24) and dens screw fixation (7). Dens screw fixation was performed in those fractures with intact transverse ligament and proper dens alignment. Dens dislocation greater than 5 mm was a contraindication for this surgical option (7), and therefore we opted for posterior C1-C2 stabilization in these cases (24), and in the case of combined C1-C2 fracture with atlanto-axial dislocation and displacement of the dens greater than 5 mm, for occipital-cervical fusion (33).

On the other hand, conservative treatment was performed with a "Philadelphia" type collar and SOMI brace or with a "Halo-Vest". Follow-up was performed about thirty days after hospital discharge with two-projection cervical radiography. A CT scan with coronal and sagittal reconstruction was performed from 2 to 6 months after treatment in order to demonstrate complete fusion of the dens. Follow-up was prolonged until complete recovery in patients where the first treatment option was unsuccessful. Patients were periodically contacted by telephone to check their condition.

RESULTS

The follow-up of the patients ranged from about one month to two years.

We assessed 108 type II odontoid fractures (5) (16 that also involved C1 and 4 the body of C2) in this study. The average age on admission was 62.6 years (range 28 to 84 years). There were 40 females (mean age 68 years, ranging from 47 to 80 years) and 68 males (mean age 57.3 years, range 28 to 84 years) with a M/F ratio of 1.7/1.

There were 88 type II C2 isolated fractures and 20 combined C1-C2 fractures (Table I). The causes of trauma are presented in Table II.

Neurological examination upon admission revealed that 14.8% of the patients presented with neurological deficits: There were 8 patients with tetraparesis (2 severe and 2 less severe), 4 patients with loss of strength in the upper limbs (right upper limb > left upper limb), and 4 patient with paresis of the left side of the body. The average inpatient duration was

Table I: The Number and the Type of C2 Fractures

N° of fractures	Cervical fracture type
88 Isolated C2 fractures	C2 type Anderson II
20 combined fractures	C1-C2

Table II: The Causes of Cervical Trauma

Causes of cervical trauma	N° of patients on 108
Automobile accidents	42 (39.9%)
Falls	66 (61.1%)
Falls at home	16
Falls as a result of ailments	4
Accidents at work	4
Falls by tram	4
Fallen down the stairs	12
Falls from a tree	14
Falls in the street	12

7.9 days, ranging from 2 days to 24 days. 36 patients (33.34%) had associated injuries (Figure 1) consisting of 16 rib fractures (4 with left pleural effusion and pneumothorax), 10 fractures of the lower limbs (2 lower part of the left patella, 8 tibia and fibula of the left leg), 4 fractures of the paranasal sinuses (2 maxillary sinus and right frontal sinus, 2 sphenoidal sinus), 4 fractures of the roof and floor of the right orbital cavity, and 2 left wrist fractures.

Conservative treatment was used for 60 patients (average age of 60.35 years): 40 (12 females and 28 males) with a "halo-vest" system, 20 (12 females and 8 males) with a "Philadelphia" type collar and bed rest plus a SOMI brace in the sitting or walking position.

Surgical treatment was used for 48 patients (average age 66.7 years): 20 (4 females and 16 males) with dens screw fixation (7), 12 (8 females and 4 males) with occipital-cervical fusion (33), and 16 (4 females and 12 males) with posterior C1-C2 stabilization (24) (Table III).

The dens was displaced anteriorly in 56 patients and posteriorly in 48 patients while 4 patients had no dislocation. The dislocation ranged from 1 mm to 11 mm (Figure 2).

Overall bony fusion was observed in 72 patients (66.6%) within a mean duration of approximately 19 weeks, ranging from 8 weeks to 28 weeks. Of the 60 patients conservatively treated, 28 (46.6%) showed radiographic fusion at the level of the odontoid fracture. The mean duration to bone healing was approximately 21 weeks, ranging from 13 weeks to 28 weeks.

Fusion of the fracture was found in 44 (91.67%) of the 48 patients undergoing surgery. The mean duration until bone healing was approximately 17 weeks, ranging from 6 weeks to 25 weeks. Patients undergoing surgery therefore had a higher rate of fusion (91.67% versus 46.67%, statistically significant: $p < 0.05$, as calculate with the "Chi Square Test") and, as mentioned above, shorter bone healing times (17 weeks compared to 21 weeks) than patients who received conservative treatment (Table IV). The first treatment was not successful in 36 (33.33%) of the total number of 108 patients. In fact, 32 patients did not show bone healing on follow-up CT and reported persistent neck pain after conservative treatment (20 females and 12 males, average age 70.6 years, with an average dens dislocation of 6.1 mm, 20 anteriorly and 12 posteriorly). In addition, 2 of these 32 patients had an infection of the "Halo-vest" pins. The remaining 4 patients, who were surgically treated, did not show any bone healing on radiographic follow-up and did not have complete recovery of their neurological symptoms (tetraparesis). Of these 36 patients with unfavorable outcome, 32 (initially treated conservatively) underwent surgery as follows: 20 dens screw fixation (7), 6 posterior C1-C2 stabilization (24), and 6 occipital-cervical fusion procedures (33). All these patients presented with bone healing after a mean value of 16 weeks (range 14-20 weeks). As regards the other 2 patients, who had initially undergone surgery, 1 died later when 79 years old (diabetes, hypertension, severe osteoporosis; fracture with 8 mm posterior dens dislocation), and 1 (84 years old, Anderson II type fracture with 5 mm posterior dens dislocation) received conservative therapy with a rigid collar for 3 months and experienced partial benefit as regards the neck pain but had little relief from the neurological symptoms.

DISCUSSION

The craniovertebral junction (CVJ) is a complex region that includes the occiput, in particular the occipital condyle (C0), and the first portion of the spine formed by the first and second cervical vertebrae: atlas (C1) and axis (C2). It is a transition between the skull and the cervical spine. This is the most mobile part of the cervical spine. The unique configuration of the bones and ligaments of the craniovertebral junction allows complex movements. The ligaments allow these movements, thus ensuring stability without compromising the delicate neural structures herein (2).

Odontoid process fractures, the focus of this work, are the most common fractures among those of the axis. They are responsible for approximately 25% of fractures of the cervical spine. According to the classification of "Anderson-D'Alonzo

Table III: The Conservative and Surgical Treatment Options for Type II Odontoid Fractures that were Performed

Nº of patients	Conservative treatment
60 (24 females and 36 males)	40 (12 females and 28 males) with "Halo-vest" 20 (12 females and 8 males) with collar type "Philadelphia"
Nº of patients	**Surgical treatment**
48 (16 females and 32 males)	20 (4 females and 16 males) dens screw fixation
	16 (4 females and 12 males) posterior C1-C2 stabilization
	12 (8 females and 4 males) occipital-cervical fusion

Table IV: The Features of Bone Healing for Surgery and Conservative Therapy

Nº of patients: 108	Surgical treatment: 48 patients	Conservative treatment: 60 patients	p value
Bone healing time (weeks)	Average; 17 weeks	Average; 21 weeks	0.021
Fusion rate (%)	91.67%	44.67%	0.0013

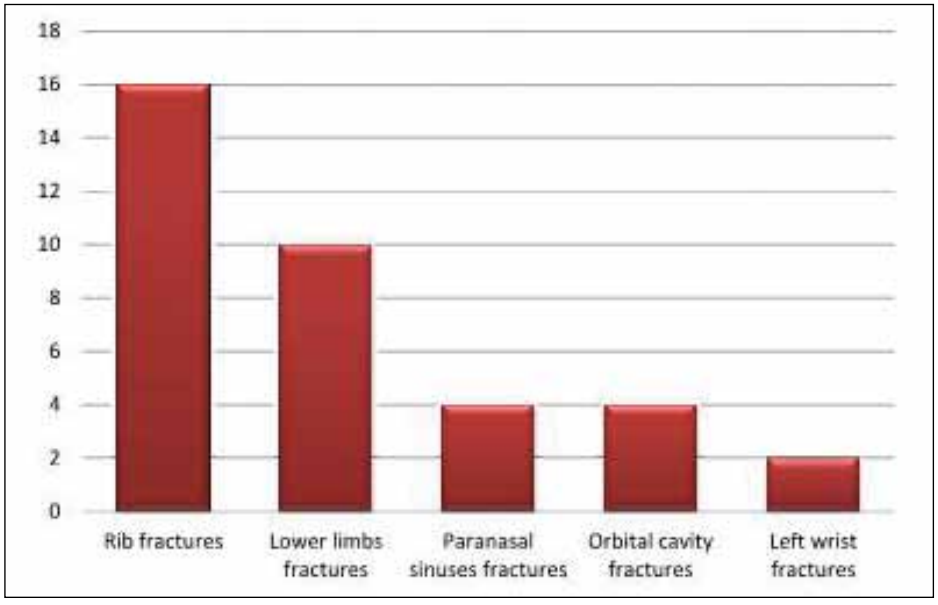

Figure 1: Associated trauma.

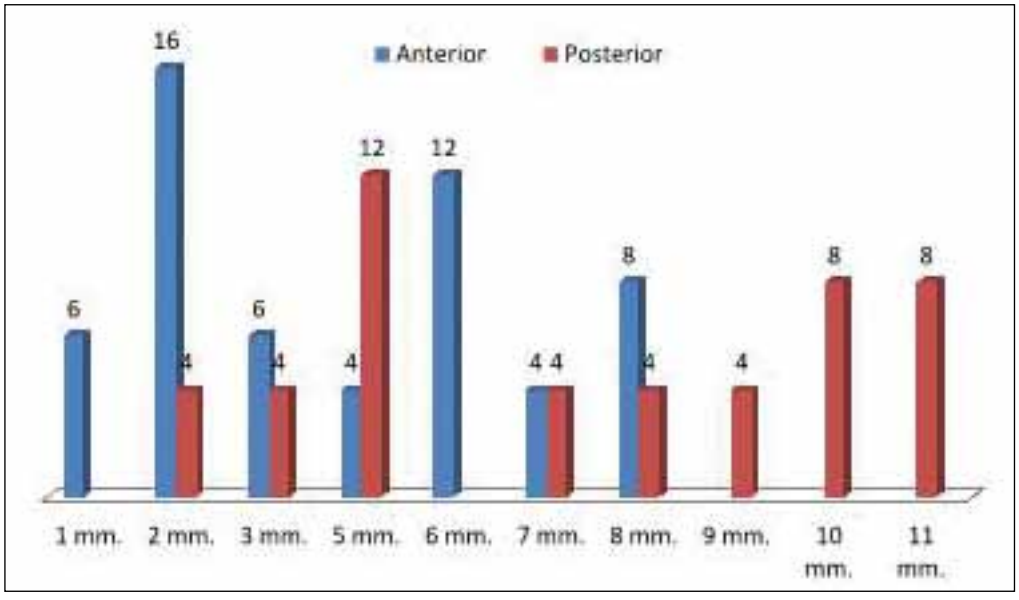

Figure 2: Dens dislocation.

(5)" we can distinguish three types. Type I fracture (about 5%) extends through the tip of the dens. This type is usually stable. Type II fracture (> 60%) extends through the base of the dens. It is the most commonly encountered fracture for this region of the axis. Type III fracture (> 30%) extends through the vertebral body of the axis (5).

Appropriate treatment for type II fractures has been the subject of much research but it is still a matter of discussion (26,28,34,45,46). In recent literature, there seems to be a growing trend to surgery as high rates of fusion and return to good function of the cervical spine have been highlighted (1,10,18,19,32). In contrast, there are several studies which report negative results for surgical treatment of fractures of the odontoid process, particularly in elderly patients with increased anesthetic risk and decreased bone quality (6,21,40,43). Conservative treatment by external immobilization ("Halo-Vest") or, alternatively, the use of rigid cervical collar, rather than an initial surgical approach was preferable in this category of patients (6,43,31). Many authors have turned their attention to certain factors such as the age, the degree of subluxation, the delay in the treatment, and the morphology of the fracture, which could be indicative of a possible surgical or conservative treatment (9,17,22). We observed a significant difference regarding the duration for bone healing between patients treated conservatively and patients undergoing surgery ($p < 0.05$, calculated through the "Chi Square Test"). Furthermore, patients undergoing surgery have a higher rate of fusion (91.6% versus 46.6%,

statistically significant: p <0.05, always calculated through the "Chi Square Test") and, as mentioned above, the bone healing times are shorter (17 weeks compared to 21 weeks) than in patients who received conservative treatment. In relation to the healing of the fracture, and then to its fusion, a series of studies have enumerated the potential risk factors for non-union of Anderson II fractures of the odontoid process (14,26,28,34,40,42,45,46). Factors such as the age of the patient, the degree of dens dislocation, the delay in the treatment and the presence of neurological deficits have been reported to influence the outcome of bone fusion. Several authors have considered advanced age as the most significant risk factor for non-union (28,37,40,42). Lennarson et al. (28) have analyzed a series of patients with Anderson II fractures and found that patients with more than 50 years old were 21 times more prone to failure as regards conservative treatment by "Halo-Vest" compared with patients younger than 50 years old. This finding is in agreement with our study because it is seen that the average age of the 32 patients whose conservative treatment failed was 70.1 years, whereas the 28 patients in whom conservative treatment was successful had an average age of 45.91 years. Further studies have highlighted the importance of the dislocation of the dens in relation to the rate of fusion (14,26,42). A dens dislocation > 5 mm, in particular towards the posterior, has been presented as a risk factor for the non-union of the fracture type Anderson II (14,21,23,26). Koivikko et al. (26) have stated that fusion probably does not occur in these cases due to insufficient contact of the bone fragments and therefore a poor blood supply, or because posterior displacement reflects more extensive ligament injuries (38). Our results also agree with these studies: 36 patients who did not show union of the fractures (32 treated conservatively and 4 addressed prior to surgery) had an average dislocation of 6.37 mm (20 anteriorly and 16 posteriorly).

CONCLUSION

Type I and type III fractures, according to the classification of "Anderson-D'Alonzo", tend to heal well after conservative treatment with external immobilization by halo-vest (fusion rate about 100% in type I and about 90% in type III) (30,41). Regarding fractures of type II, (5) associated with atlanto-axial instability, treatment options remain controversial (30,41). Some authors maintain the effectiveness of surgical treatment for these types of fractures (20, 36) but various options are possible as regards patients with fracture of the odontoid process (16, 39). The goals of treatment in these cases are radiographic bone fusion, the disappearance of pain and return to normal daily routine. Surgical treatment showed a higher fusion rate (91.67%) compared to conservative treatment by "Halo-vest" or by collar type "Philadelphia" (46.67%, p <0.05) in our study; bone healing time was also shorter (17 weeks versus 21 weeks, p <0.05). However, in certain situations such as in cases of dens dislocation less than 5 mm. and in younger patients (<50 years), conservative treatment ("Halo-vest" or collar type "Philadelphia") may be as effective as surgery. The surgical management of these fractures is recommended in older patients (> 50 years) and in those with dens dislocation is > 5 mm. In these situations, other factors such as the preference of the patient and the experience of the surgeon may be taken into consideration for a better treatment option. In conclusion, certain principles have been learned as regards the management of type II fractures according to the classification of "Anderson-D'Alonzo " on the basis of the cases analyzed in this Institute (Policlinico Umberto I in Rome, Department of Neurosurgery):

- All fractures of the odontoid process without dislocation, should be treated with rigid external immobilization (preferably by "Halo-vest").
- All fractures of the odontoid process with dens dislocation > 5 mm. should be considered as candidates for surgery.
- Type II fractures, according to the classification of "Anderson-D'Alonzo", in patients over 50 years old should also be candidates for surgical treatment, while the outcome of such fractures as regards conservative treatment is better in patients under 50 years old.

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