KLINIKINIAI TYRIMAI

The treatment of odontoid fractures with a significant displacement

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Key words: *cervical spine injury, fracture, odontoid, halo-vest device, posterior atlantoaxial fusion.*

Summary. *Objective. The purpose of this study was to determine the treatment features of odontoid fractures with a significant displacement.*

Material and methods. Thirty-seven patients with acute odontoid fractures were treated in Kaunas University of Medicine Hospital between 1998 and 2003. Seventeen persons with displacement of fragments less than 5 mm or 5 mm (according to E. A. Seybold and J. C. Bayley method) were in the first group. Twenty patients with displacement of fragments more than 5 mm were in the second group. The attempt of closed reduction of the cervical spine axis was performed for all patients. If successful closed reduction was achieved, patients were placed in halo-vest device for 8 weeks. If closed reduction failed, patient was operated according to W. E. Gallie. Postoperatively, all patients wore a halo-vest device during the first 8 weeks.

Results. Demographics including age, sex, neurological condition, and associated spinal fractures were similar in patients from these groups ($p>0.05$). Successful closed reduction of the cervical spine axis was achieved in 11 (64.7%) patients from the first group and in 13 (65%) patients from the second group ($p>0.05$). Six (35.3%) patients from the first group and seven (35%) from the second group were treated with immediate C1–C2 posterior fusion ($p>0.05$). Two (16.7%) from twelve patients from the second group were treated by external immobilization by halo-vest device and had nonunion of fracture 8 weeks after the treatment. All operated patients had a solid fusion.

Conclusions. If closed reduction of the odontoid fracture with a significant displacement was achieved then external immobilization by halo-vest device can be used. Posterior fusion is the treatment of choice for irreducible odontoid fractures.

Introduction

The most common traumatic axis injury is fracture through the odontoid process, either through the tip of the dens (type I), or through its base (type II) or involving the odontoid but extending into the vertebra body (type III) (1–3). The odontoid fractures represent 7–15% of all cervical spine fractures. Most of the patients are injured during a fall or a motor vehicle accident; with exception of elderly, osteoporotic patients and patients with long-standing rheumatoid arthritis (1, 4, 5). The treatment of type II and type III odontoid fractures remains controversial; no single treatment algorithm has gained universal acceptance. There are strong advocates of a primary surgical and nonsurgical management (6–8). Several factors have been identified as predisposing to nonunion or malunion of type II and type III fractures. One of these factors is an initial fracture displacement, either anterior or posterior, greater than 5 mm (4). The purpose of this study was to determine the treatment features of odontoid fractures with a significant displacement.

Material and methods

A prospective review of a consecutive series of patients admitted to Kaunas University of Medicine Hospital between January 1998 and December 2003 was performed. Forty-four patients out of 104 patients with atlantoaxial fractures had the odontoid fractures. There were 34 men and 10 women with a median of age 51 years (range 20–76 years). Patients with delay-

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ed diagnosis of odontoid fracture more than four weeks and with the diagnosis of rheumatoid arthritis or who did not agree with our treatment protocol were excluded from the study. Seven patients were excluded from the study. Another 37 patients were divided into two groups according to the fractures displacement. Seventeen persons with displacement of fragments less than 5 mm or 5 mm (according to E. A. Seybold and J. C. Bayley method) were in the first group (9). Twenty patients with displacement of fragments more than 5 mm were in the second group.

The initial status of the patient was assessed and neurologic examination was performed according to the American Spinal Cord Injury Association guidelines after admission to the hospital (10). On admission, anteroposterior and lateral cervical radiographs as well as an open mouth odontoid view were obtained on all patients. Axial computerized tomography scanning with a sagittal and coronal reformatting was performed to delineate further the type of upper cervical spine injury. The odontoid fracture displacement and angulation were measured from admission radiographs by E. A. Seybold and J. C. Bayley method (9). The closed reduction of the axis of the cervical spine was performed to all patients within 1–2 hours after the admission to the hospital. The displaced odontoid fractures were reduced by the halo-vest device (PMT Halo System) or by halo traction. The ring for the halo-vest device and halo traction was placed at a level below the area of the greatest diameter of the skull, about at the level of the eyebrows and approximately 1 cm above the tips of the ears. The ring was fixed to the skull bones by four pins (11). The weight required for the skeletal traction and a closed reduction of the cervical spine injuries was accounted by the general guideline – 1 kilogram per superior injury level. The weight for a patient with odontoid fractures was 2 kilograms. The alignment of the cervical spine was checked after the application of weights for a skeletal traction or performed attempts by halo-vest device for a cervical spine reduction by X-ray examination. Once a successful closed reduction was achieved by the halo traction the patients were placed in halo-vest device and were allowed to ambulate. If successful closed reduction failed, then the patient was placed in the halo-vest device and the restoration of the alignment of the cervical axis was performed again. If a successful closed reduction failed at all events then the patient was operated (was performed posterior cervical fusion according to W. E. Gallie) within 48 hours after the admission to the hospital. Postoperatively all patients wore the halo-vest device during the first 8 weeks. The clinical and radiographic evaluation was conducted at 4 and 8 weeks after the performed treatment. Cervical radiographs were reviewed by an independent radiologist. After 8 weeks, the halo-vest device was removed and flexion extension radiographs were obtained. If no movement of the dens in the relation to the body of the axis was seen, the fracture was regarded as stable with the patient placed in a rigid cervical collar for the next month. If the movement of the dens in the relation to the body of the axis was seen on the flexion extension radiographs, then a posterior fusion according to W. E. Gallie was performed. The patient's level of satisfaction was determined by Cervical Oswestry Scale 8 weeks after the performed treatment (12).

Statistical analysis of the data was performed using t-test, Fisher's exact test (F) or chi – square (χ^2) analysis. Statistical significance was set at the 0.05 level.

Results

Demographics including age, sex, neurological condition, and associated spinal fractures were similar in patients from these groups ($p>0.05$). Most fractures were due to low velocity injuries such as a fall (Table 1–3).

Successful closed reduction of the cervical spine axis was achieved in 11 (64.7%) patients from the first group and in 13 (65%) patients from the second group ($p(\chi^2)>0.05$) (Fig. 1). Six (35.3%) patients from the first group were treated with immediate C1-C2 posterior fusion because closed reduction was failed. Seven (35%) patients from the second group were also operated for the same reasons. We did not notice any difference between two groups ($p(\chi^2)>0.05$).

One patient from the second group died from the development of the acute respiratory distress 76 hours after the admission to the hospital and successful closed reduction of the cervical spine axis by halo-vest device.

Table 1. **Distribution of injury mechanisms in patients with odontoid fracture**

Mechanism of injury	The first group (n=17)	The second group (n=20)	Probability value
Motor vehicle accident	5 (29.4%)	7 (35%)	$p(\chi^2)>0.05$
Fall	11 (64.7%)	12 (60%)	$p(\chi^2)>0.05$
Other	1 (5.9%)	1 (5%)	$p(F)>0.05$

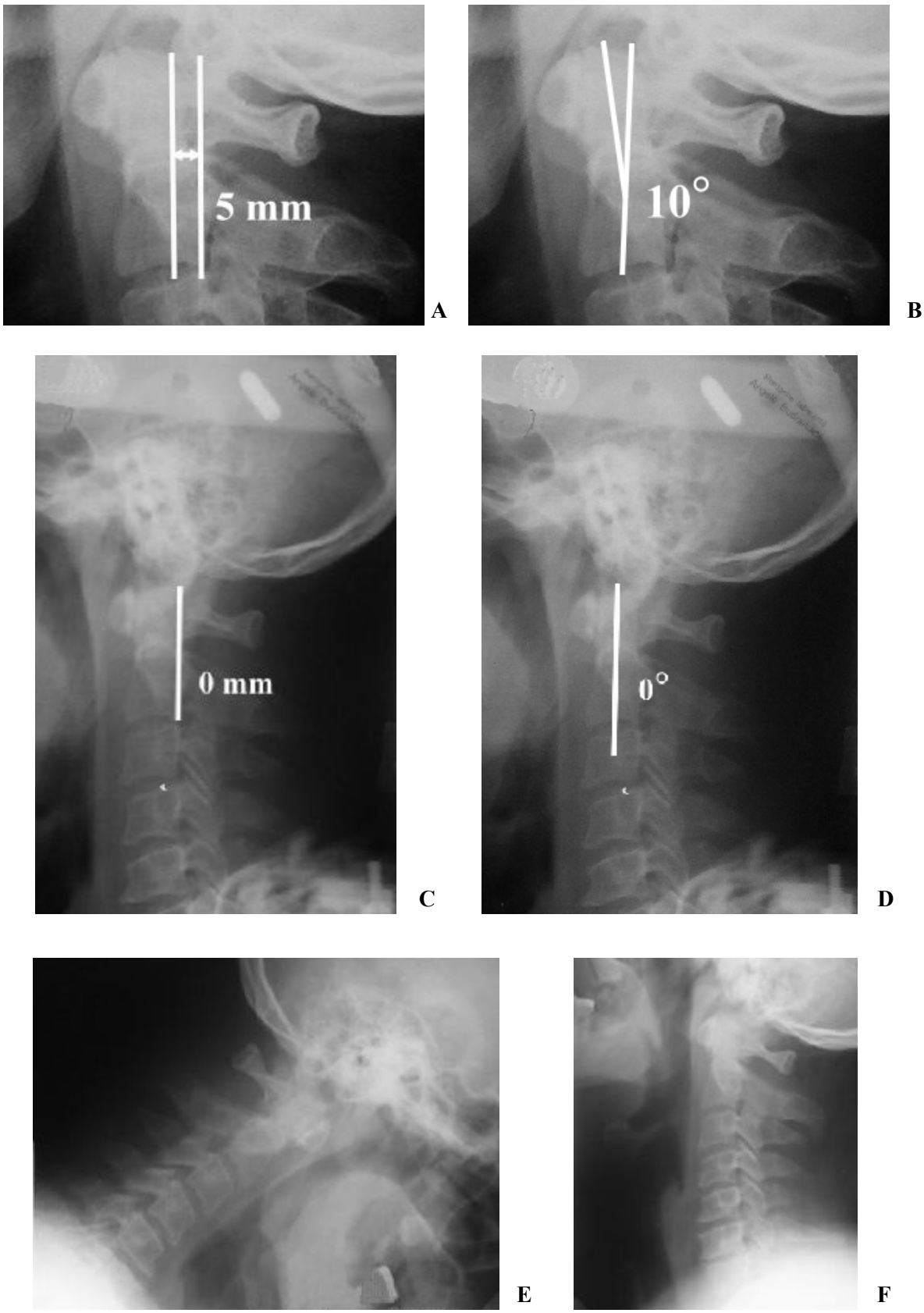

Fig. 1. **Radiographs of a 50-year-old man with II type odontoid fracture (displacement and angulation of the fragments were 5 mm and 10°, respectively) (A, B). Patient was treated by reposition and immobilization with "halo-vest" device (C, D). Flexion extension radiographs 8 weeks after treatment show complete union with anatomical alignment (E, F).**

Table 2. **Associated spinal fractures in patients with odontoid fracture**

Fracture location	The first group (n=17)	The second group (n=20)	Probability value
C1 (atlas)	2 (11.8%)	2 (10%)	p(F)>0.05
C3–C7 (the lower cervical spine)	2 (11.8%)	0	p(F)>0.05
Lumbar spine	1 (5.9%)	0	p(F)>0.05

Table 3. **The features of odontoid fractures**

Features of the odontoid fractures	The first group (n=17)	The second group (n=20)	Probability value
Type II	11 (64.7%)	12 (60%)	$p(\chi^2)>0.05$
Type III	6 (35.3%)	8 (40%)	$p(\chi^2)>0.05$
Displacement	3.6±1.1 mm	10.5±3.6 mm	p(t)<0.05
Angulation	15.6±7.5°	28.8±18.1°	p(t)<0.05

Seventeen patients from the first group and 19 from the second group were investigated 8 weeks after the treatment (Table 4).

Two (16.7%) out of twelve patients from the second group were treated by external immobilization by halo-vest device and had nonunion of fracture 8 weeks after the treatment. These patients had type II of the odontoid fracture (Table 5, 6, 7).

Discussion

The odontoid fractures are the most common injury pattern of the axis and are most often caused by motor vehicle accidents (13). In our study we found, that the falls were the main reasons of these injuries. Type II fracture occurs at the junction of the odontoid process with the body of the axis. This is the most common type accounting for approximately 60% of odon-

Table 4. **Complications associated with halo-vest device immobilization**

Complications	The first group (n=17)	The second group (n=19)	Probability value
Screw loosening	1 (5.9%)	2 (10.5%)	p(F)>0.05
Scalp infections	0	1 (5.3 %)	p(F)>0.05

Table 5. **Results of individual treatments**

Treatment	The first group (n=17)		The second group (n=19)		Probability value
	union	nonunion	union	nonunion	
Non-operative treatment	11 (100%)	0	10 (83.3%)	2 (16.7%)	p(F)>0.05
Surgical treatment	6 (100%)	0	7 (100%)	0	p(F)>0.05

Table 6. **Clinical outcomes according to Cervical Oswestry Scale 8 weeks after external immobilization by halo-vest device**

Outcome	The first group (n=11*)	The second group (n=10*)	Probability value
No disability	6 (54.5%)	9 (90%)	p(F)>0.05
Mild disability	5 (45.5%)	1 (10%)	p(F)>0.05

* There were included patients with solid fusion.

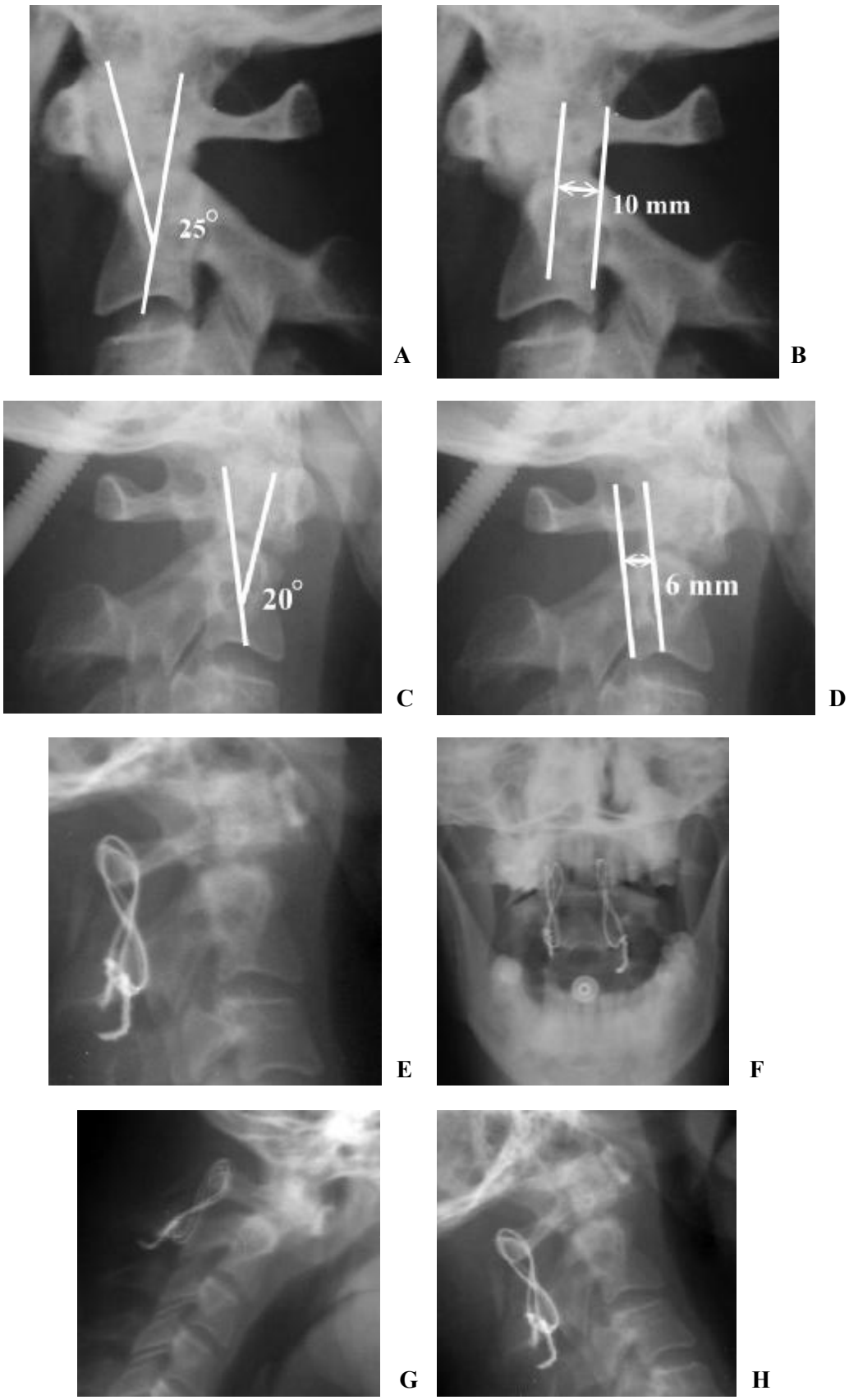

Fig. 2. **Radiographs of a 36-year-old man with II type odontoid fracture (displacement and angulation of the fragments were 10 mm and 25°, respectively) (A, B). Patient was treated by reposition and immobilization with "halo-vest" device unsuccessfully (C, D). C1–C2 fusion was performed (E, F). Flexion extension radiographs 8 weeks after treatment show osseous union (G, H).**

Table 7. **Clinical outcomes according to Cervical Oswestry Scale 8 weeks after surgical treatment**

Outcome	The first group (n=6*)	The second group (n=7*)	Probability value
No disability	3 (50%)	3 (42.9%)	p(F)>0.05
Mild disability	3 (50%)	4 (57.1%)	p(F)>0.05

* There were included patients with solid fusion.

toid fractures. Type III fracture extends downward into the cancellous portion of the body, representing a fracture through the body of the axis. This type accounts for 30% of odontoid fractures (1, 4). After the performed investigation we determined the same data. Current management of the odontoid fractures is based on three principles: timely diagnosis, reduction of the fracture, and sufficient immobilization to a permit healing (14). We agree with many authors that a rigid external immobilization appears to be the most successful for the patients with type III and nondisplaced type II odontoid fractures (4, 6, 16). The factors associated with a bone nonunion after the rigid immobilization includes patients older than 40 years, displacements greater than 5 mm, posteriorly displaced fractures and patients with neurologic deficits (16). Two (16.7%) patients from our study had displacement of fracture greater than 5 mm and were treated by a closed reduction and external immobilization by halo-vest device and had a nonunion of fracture 8 weeks after the treatment. Treatment of the cervical spine injury by the immobilization by halo-vest device is associated with some complications. The most common complications are scalp infection, decubitus, screw loosening and osteomyelitis (9, 16). In our study we found, that the most common complication was the loss of the pin fixation. We agree with several authors that the posterior fusion (according to W. E. Gallie) yielded the highest union rates (100%) and it is the treatment of choice for irreducible odontoid fractures (6, 17) (Fig. 2).

Conclusions

If closed reduction of the odontoid fracture with a significant displacement was achieved, external immobilization by halo-vest device can be used. Posterior fusion is the treatment of choice for irreducible odontoid fractures.

Gerokai pasislinkusių kaklo antrojo slankstelio danties lūžių gydymo ypatybės

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Raktažodžiai: stuburo kaklo dalies trauma, lūžis, kaklo antrojo slankstelio dantis, „žiedo-liemenės“ įtvaras, užpakalinė atlantoaksialinė fiksacija.

Santrauka. *Darbo tikslas.* Ištirti gerokai pasislinkusių kaklo antrojo slankstelio danties lūžių gydymo ypatybes.

Tyrimo medžiaga ir metodai. Iširti 37 pacientai, kurie 1998–2003 metais gydyti Kauno medicinos universiteto klinikose dėl kaklo antrojo slankstelio danties lūžio. Matuojant Seybold EA ir Bayley JC metodu, 17 pacientų (pirma grupė) nustatytas fragmentų poslinkis mažesnis kaip 5 mm arba 5 mm. 20 pacientų (antra grupė) fragmentų poslinkis buvo didesnis kaip 5 mm. Visiems pacientams bandyta ištaisyti kampinę stuburo ašies deformaciją uždaru būdu. Ištaisius stuburo kaklo dalies ašies deformaciją, kaklas imobilizuotas „žiedo-liemenės“ įtvaru. Neištaisius kampinės stuburo kaklo dalies ašies deformacijos, pacientai operuoti ir atlikta fiksacija Gallie metodika. Po operacijos kaklas imobilizuotas „žiedo-liemenės“ įtvaru aštuonioms savaitėms.

Rezultatai. Palyginus pirmos ir antros grupės pacientus, statistiškai reikšmingo skirtumo tarp pacientų amžiaus, lyties, nervinių struktūrų pažeidimo, gretimų stuburo sužalojimų dažnio nenustatyta. Uždaru būdu stuburo kaklo dalies ašies deformacija ištaisyta 11 (64,7 proc.) pirmos grupės pacientų ir 13 (65 proc.) antros grupės (p>0,05). 6 (35,3 proc.) pirmos grupės ir 7 (35%) antros grupės pacientai buvo operuoti (p>0,05). Dviem (16,7%) iš 12 antros grupės pacientų, kuriems buvo ištaisyta stuburo kaklo dalies ašies deformacija ir aštuonias savaites tęsta imobilizacija „žiedo-liemenės“ įtvaru, diagnozuoti nesugiję lūžiai. Visiems operuotiems pacientams nustatyta susiformavusi kaulinė spondilodezė.

Išvados. Esant gerokai pasislinkusiam kaklo antrojo slankstelio danties lūžiui, ištaisius kampinę stuburo ašies deformaciją, galima taikyti imobilizaciją „žiedo-liemenės“ įtvaru, o kitais atvejais būtina operuoti.

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