

## RESULTS OF TREATMENT OF PATIENTS WITH MIDFACIAL FRACTURES

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### Abstract

**Background.** Fractures of the bones of the facial skeleton, in particular the midface area, are one of the most frequent reasons for patients to apply to maxillofacial inpatient care, not only in Ukraine but also abroad. Along with more modern treatment technologies (osteosynthesis using titanium miniplates and minigrad for fixation bone fragments), methods of repositioning of fragments with subsequent tamponade of the maxillary sinus with iodoform tampon and without tamponade and fixation of fragments are used. A certain group of patients is treated conservatively, which is associated with their reluctance to undergo surgery, minimal displacement of fragments or minimal cosmetic and functional impairments. **The purpose of the study.** Comparative evaluation of the results of treatment of patients with fractures of the midface area by repositioning the fragments of the zygomatic-orbital complex without fixating the fragments and their subsequent fixation by tamponade of the maxillary sinus with iodoform tampon. **Object and methods of research.** The comparison was made of the results of treatment of 70 patients with fractures of the midface area, among which 13 patients were treated by the method of repositioning fragments of the zygomatic-orbital complex (ZOC) without fixation and without maxillary sinus tamponade, 29 patients underwent repositioning of ZOC fragments with subsequent fixation of fragments with iodoform tampon – the tamponade of the maxillary sinus was performed on the affected side. For comparison, the results of conservative treatment of 28 patients with fractures of the midface area were used. **Results.** It was found that the reliable ( $\chi^2=11.43$ ;  $p<0.05$ ) majority of patients (64 %) sought treatment within 0–3 days after injury. 83–89 % of patients who underwent repositioning of the fragments had fresh small-fragment fractures. The reliable ( $\chi^2=11.43$ ;  $p<0.05$ ) majority of them simultaneously had 3–4 sites of bone fractures of the midface area, hemisinus of varying degrees and paresthesia in the infraorbital area. In the majority of patients who underwent repositioning of bone fragments with and without tamponade (85 % and 93 %, respectively), the final displacements ranged from 3.1 to 6 mm. In patients treated conservatively, in most cases (93 %) the displacements were greater than 3.1 mm, which remained after treatment. **Conclusion.** In the majority of patients treated with the studied methods, in the long term, the displacement of bone fragments remained, which had functional and cosmetic consequences. In all studied groups, a certain cosmetic effect was achieved over time, as evidenced by a reliable ( $\chi^2=160.9$ ;  $p=0.00000$ ) decrease in the indicator by the VAS.

**Keywords:** *fractures of the midface area, reposition of fragments without fixation, reposition of fragments with fixation, tamponade of the maxillary sinus, computed tomography, visual analogue scale.*

### Introduction

Traumatic fractures of the maxillofacial area account for 14 to 17 % of all facial injuries [1]. The frequency of severe or complex maxillofacial

injuries, according to a number of authors, has been declining over the past 10 years [2].

Traumatic fractures of the bones of the facial skeleton, in particular the midface area, are one of the most frequent reasons for patients to apply to maxillofacial inpatient care, not only in Ukraine but also in foreign countries [3–9].

It is known that fractures of the midface area cause severe deformities, which affects the appearance of patients' faces [10].

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Quite often these fractures cause various other concomitant pathological conditions that can cause impaired nasal breathing, occlusion, vision, etc. [11].

The most common injuries of the skull and maxillofacial area occur as a result of road traffic accidents, street and household injuries, injuries in the area of military conflicts [12, 13].

In order to achieve the maximum cosmetic and functional result in patients with midface fractures, treatment should be started as soon as possible [14].

Surgical methods of treatment are most often used in Ukraine and in near and not-so-near abroad for the treatment of midface fractures with displacement of fragments [15–17]: reposition of fragments without fixation and reposition of fragments with fixation, which is performed by tamponade of the maxillary sinus with iodoform

of 28 patients with fractures of the mid face area (third group), who were treated conservatively or refused surgery were used for comparison.

All patients in the first group were male. The average age of patients was  $(29.6 \pm 10.8)$  years old with a range of 20 to 57 years, i.e. all patients were of working age. The second group consisted of 28 ( $97 \pm 3.2$ ) % of men and one woman. The mean age of patients was  $(29.4 \pm 9.6)$  years old with a range of 18 to 62 years. Of all patients in this group, only one patient was of retirement age. The group of patients receiving conservative treatment of fractures of the midface area consisted of 28 people, among whom there were 25 ( $89 \pm 5.9$ )% of men and 3 ( $11 \pm 5.9$ )% of women. Of all patients in this group, only one patient was of retirement age.

*Table 1* shows the distribution of patients in the study groups by the mechanism of injury.

**Table 1**

*Distribution of patients with fractures of the midface area by the mechanism of injury, (%)*

Mechanism of injury	Group			Total (n=70)
	1 (n=13)	2 (n=29)	3 (n=28)	
Falling	4 (31±12.8)	14 (48±9.3)	10 (36±9.1)	28 (40±5.9)
Household	0	0	3 (10±5.7)	3 (4.0±2.3)
Criminal	8 (62±13.5)	15 (52±9.3)	11 (37.7±5.7)	34 (49±6.0)
Due to road traffic accident	1(7.0±5.9)	0	3(10±5.7)	4 (6.0±2.3)
Industrial	0	0	1(3.6±2.8)	1(1.0±0.9)

tampon, external fixation, using a Kirschner wire, balloon tamponade of the maxillary sinus, Foley catheter, etc. [18–23].

Thus, it is of practical interest to compare common methods of treating midface fractures of different etiology and localization in order to further improve them.

## 2. Purposes, subjects and methods:

**2.1. Purpose** of the study was the comparative evaluation of the results of treatment of patients with fractures of the midface area by repositioning the fragments of the zygomatic-orbital complex without tamponade of the maxillary sinus and repositioning the fragments of the zygomatic-orbital complex with subsequent tamponade of the maxillary sinus.

## 2.2. Subjects & Methods

We compared the results of treatment of 70 patients with fractures of the midface area, among whom 13 patients were treated by the method of repositioning the maxillary sinus fragments without fixation and without maxillary sinus tamponade (first group), 29 – by the method of repositioning fragments with maxillary sinus tamponade (second group). The results of treatment

According to the data of *Table 1* it can be noted that the largest number of injuries was criminal (49 %) and as a result of falling (40 %), other types of injuries were rare.

The examination of patients at hospitalization included: general clinical blood and urine tests, biochemical blood tests, electrocardiography, X-ray or fluorography of thoracic organs, cone-beam computed tomography (CBCT) of the skull/midface area.

Evaluation of the severity of clinical manifestations of traumatic injuries before treatment, as well as the course and outcomes of treatment, was performed using a visual analogue scale (VAS) [24]. The VAS, used in our study, was modified by us and allowed to objectively evaluate the initial condition and outcomes of treatment of patients with fractures of the midface area. According to the VAS, the following symptoms were evaluated in points: intensity of pain, presence of nasal breathing and nosebleeds on the side of the injury, sensitivity impairments, presence of edema, subcutaneous emphysema, soft tissue hematoma, hemosinus of the maxillary sinus, restriction of mouth opening, "stairs"

symptom (including malocclusion), visual impairment on the side of the injury, and the magnitude of the displacement of the fragments was also taken into account (according to the data of CBCT).

An objective evaluation of the effectiveness of treatment was performed by comparing the magnitude of displacement of bone fragments before and after treatment. For the convenience of presenting information, a scoring scale was introduced, according to which: 0 points – no displacement, 1 point – displacement from 1 to 3 mm; 2 points – 3.1–6 mm; 3 points – 6.1–9 mm; 4 points – 9.1–12 mm; 5 points – 12.1–15 mm; 6 points – more than 15 mm.

The results of the study were processed using the STATISTICA – 13.3 software package (license AXA9051924220FAACD-N). Descriptive statistics methods and nonparametric  $\chi^2$  Pearson and Mann-Whitney criteria were used. In cases of significant variance of indicators, the medians (Me) and quartiles (25 %; 75 %) were calculated.

### 3. Results & Discussion

The results of the study of the health encounter terms after injury are shown in *Table 2*. It can be noted that reliable differences in the frequency of encounters within a certain period of time from the moment of injury were detected only between the second and third groups.

matic-orbital complex). The patients of this group were divided by the fracture side in the following way: 12 (41 ± 9.1) % of patients had fractures on the right side, 17 (59 ± 9.1) % – on the left side. In the third group 3 (11.0 ± 5.9) % of patients had linear fractures of the midface area – zygomatic-orbital complex, 23 (82 ± 7.3) % – small-fragment fractures of zygomatic-orbital complex, 2 (7.0 ± 4.8) % – large-fragment fractures of zygomatic-orbital complex.

The patients of the third group were divided by the fracture side in the following way: 7 (25 ± 8.2) % of patients had fractures on the right side, 17 (61 ± 9.2) % of patients – on the left side, 4 (14 ± 6.6) % of patients had Le-Fort fractures (on both sides).

The distribution of patients in the study groups by the localization of fractures is shown in *Table 3*. According to the data of *Table 3* it can be noted that in the reliable majority of patients of all groups, fractures are localized in zygomatic-orbital complex (40 %), and are accompanied by fractures of the zygomatic arch and bone (50 %).

Usually with injuries of the midface area there are bone fractures in several places (*Table 4*).

According to the data of *Table 4* it can be noted that in the reliable ( $\chi^2 = 11.43$ ;  $p < 0.05$ ) majority of cases (64 %) 3–4 sites of fractures of the midface area, known in the literature as

**Table 2**

*Distribution of patients by the terms of health encounter, (%)*

Group	Term of health encounter, day			
	0	1–3	4–7	More than 7
1 (n=13)	2 (15±9.9)	6 (46±13.8)	4 (31±12.8)	1 (8.0±7.5)
2 (n=29)	4 (14±6.4)	10 (34±8.8)	7 (24±7.9)	8 (28.0±8.3)
3 (n=28)	12 (43±9.4)* $\chi^2 = 5.52$	11 (39±9.2)	2 (7.0±4.8)	3 (11.0±5.9)
Total	18	27	13	12

*Note:* \* – differences in the frequency of encounter of patients within a certain period after injury between the second and third groups are reliable ( $p < 0.05$ ).

According to the data of *Table 2* it can be noted that the reliable ( $\chi^2 = 11.43$ ;  $p < 0.05$ ) majority of patients (64 %) sought treatment within 0–3 days after injury.

All patients of the first group, 24 (83 ± 7.0) % of patients of the second and 25 (89 ± 5.9) % of patients of the third group had fresh fractures, which constituted the reliable majority in each group.

All patients of the first group had closed small-fragment fractures of the midface area, in 92 % of cases – with localization on the left side. The patients of the second group had closed small-fragment fractures of the midface area (zygo-

"tripod fracture" and "tetrapod fracture", were observed simultaneously.

Some patients of the first group, in addition to fractures of the midface area had: fractures of the mandible – 2 (15 ± 9.9) % and fractures of the nasal bones – 6 (46 ± 13.8) %. In the second group the following were observed: fractures of the mandible – 1 (3.6 ± 2.8) % and fractures of the nasal bones – 10 (34 ± 8.8) %. 18 (62.4 ± 9.0) % of patients in this group had no concomitant fractures. In the third group there were fractures of the mandible in 3 (11.0 ± 5.9) % of cases, fractures of the nasal bones – in 11 (46 ± 13.8) %, mandible and nose – 12 (43 ± 9.4) % of cases.

Table 3

Distribution of patients of the studied groups by the fracture localization

Groups	Localization of the fracture				
	ZOC	ZOC and ZAC	ZA or ZB	ZOC, ZA and ZB	Le-Fort
1 (n=13)	4 (31±12.8)	0	0	9 (69±12.8)	0
2 (n=29)	12 (41±9.1)	1 (3.0±2.8) $\chi^2=12.42$	0	16 (55±9.2)	0
3 (n=28)	12 (43±9.4)	1 (3.6±2.8)	1(3.6±2.8)	10 (36±9.1)	4(14±6.6)
Total	28 (40±5.9)	2 (3.0±2.0) <sup>1,2</sup> $\chi^2=28.68$ $\chi^2=40.01$	1 (1.4±1.0) <sup>1,2</sup> $\chi^2=31.71$ $\chi^2=43.23$	35 (50±6.0)	4 (5.6±2.8) <sup>1,2</sup> $\chi^2=23.33$ $\chi^2=34.16$

Notes: ZOC – zygomatic-orbital complex; ZAK – zygomatic-alveolar complex; ZA – zygomatic arch; ZB – zygomatic bone; <sup>1</sup> – differences in the incidence of ZOC fractures and other fractures are reliable ( $p<0.05$ ); <sup>2</sup> – differences in the incidence of ZOC fractures in combination with ZA and ZB and other fractures are reliable ( $p<0.05$ ).

Table 4

Distribution of patients by the number and localization of fracture sites, (%)

Group	SFZA	Walls of MS	Number of fracture sites			
			1	2	3	4
1 (n=13)	0	3 (23±11.7)	1 (8.0±7.5)	0	3 (23±11.7)	6 (46±13.8)
2 (n=29)	0	4 (14±6.4)	3 (10.0±5.6)	2 (7.0±4.7)	7 (24±7.9)	13 (45±9.2)
3 (n=28)	1 (3.6±2.8)	3 (11.0±5.9)	1 (3.6±2.8)	7 (25±8.2)	4 (14±6.6)	12 (43±9.4)
Total	1 (1.4±1.0)	10 (14±4.1)	5 (7.0±3.0) <sup>1</sup> $\chi^2=25.28$	9 (13±4.0) <sup>1</sup> $\chi^2=16.64$	14 (20±4.8) <sup>1</sup> $\chi^2=9.46$	31 (44±5.9)

Notes: SFZA – solitary fracture of zygomatic arch; MS – maxillary sinus; <sup>1</sup> – differences in the incidence of four and other number of fractures are reliable ( $p<0.05$ ).

Paresthesia in the infraorbital area was observed in all patients of the first and second groups, in the third group it was in 27 (96 ± 3.7) % of patients. One of the indications for surgical treatment is the presence of hemosinus. Table 5 shows the distribution of patients according to the degree of hemosinus.

According to the data of Table 5 it can be noted that the reliable majority of patients (90 %) of all groups have hemosinus of varying degrees, which occurred against the background of damage to the walls of the maxillary sinus.

An important indicator that determines the further tactics of treatment of patients is the magnitude of displacement of bone fragments (Table 6).

The analysis of the distribution of patients according to the magnitude of displacement (Table 6) showed that in the first group before the treatment 54 % of patients had a displacement of 9 mm or more, in the second group there were 37 % of such patients, and after the treatment there were no such patients in the groups. Most patients of these groups (85 % and 93 %, respectively).

Table 5

Distribution of patients with fractures of the midface area by the degree of hemosinus, (%)

Group	Degree of hemosinus			Total
	1/3 of sinus	2/3 of sinus	Total	
1 (n=13)	2 (15±9.9)	6 (46±13.8)	3 (23±11.7)	11 (85±9.9)* $\chi^2=12.46$
2 (n=29)	4 (14±6.4)	14 (48±9.3)	9 (31±8.6)	27 (93±4.7)* $\chi^2=43.1$
3 (n=28)	4 (14±6.6)	10 (36±9.1)	11 (46±13.8)	25 (89±5.9)* $\chi^2=34.57$

Note: \* – differences in the incidence of hemosinus in the corresponding group and its absence are reliable ( $p<0.05$ ).

Table 6

Distribution of patients of the studied groups by the magnitude of displacement of bone fragments before and after treatment, (%)

Conditions of registering	Group	Displacement, points				
		1	2	3	4	5
Before	1 (n=13)	0	3 (23±11.7)	3 (23±11.7)	6 (46±13.8)	1 (8.0±7.5)
	2 (n=29)	0	4 (14±6.4)* $\chi^2=25.02$	14 (48±9.3)	10 (34±8.8)	1 (3.6±2.8)
	3 (n=28)	2 (7.0±4.8)	15 (54±9.4)	6 (21±7.7)	4 (14±6.6)	4 (14±6.6)
After	1 (n=13)	2 (15±9.9)	7 (54±13.8)	4 (31±12.8)	0* $\chi^2=7.8$	0
	2 (n=29)	2 (7.0±4.7)	23 (79±7.6)	4 (14±6.4)	0* $\chi^2=12.08$	0
	3 (n=28)	2 (7.0±4.8)	15 (54±9.4)	6(21±7.7)	4(14±6.6)	4(14±6.6)

Notes: \* – differences in the frequency of the corresponding points in the group before and after treatment are reliable ( $p < 0.05$ ).

respectively) had the final displacements in the range of 3.1–6 mm. In the third group of patients treated conservatively, in most cases (93 %) the displacements were greater than 3.1 mm, which remained after conservative treatment.

Thus, in all studied groups, the displacement of bone fragments, which had not only cosmetic but also functional consequences, remained in the majority of patients.

In order to evaluate the cosmetic effect before and at different periods of treatment, the points according to the VAS were calculated.

For clarity of the presentation, scale diagrams were constructed (Figure). Friedman criterion, which is used to analyze repeated measurements associated with the same object, was used to evaluate the results obtained by the VAS.

In all studied groups, a certain cosmetic effect was achieved over time, as evidenced by a reliable ( $\chi^2=160.9$ ;  $p=0.00000$ ) decrease of the indicator. In the first and second groups according to Figure there is an increase in the indicator after surgery, due to postoperative edema.

Further, the indicator by the VAS decreases. In the third group, where the patients were not operated, the indicator was decreasing throughout

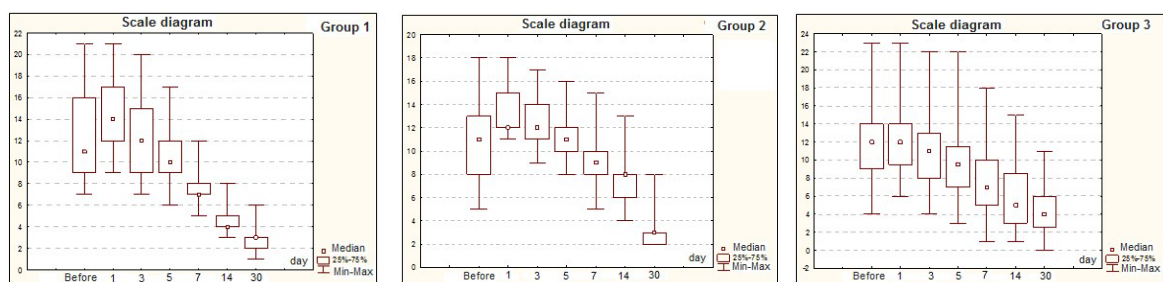
the observation period. No reliable differences were found between the groups by the VAS before surgery and 30 days after it.

In modern clinical practice, visualization and clinical methods are used to evaluate the results of treatment of facial area fractures [25, 26].

There are data in the literature on the use of the VAS points as clinical indicators. The authors use the VAS to evaluate the condition of patients by fractures of the nasal bones [27], fractures of the mandible [28], but in the available literature we have not found information on the use of the VAS to evaluate the quality of treatment of fractures of the midface area.

Therefore, in this study we used the VAS developed by us, which made it possible to objectively evaluate the results of treatment of patients with fractures of the midface area. To evaluate the anatomical features of fractures and the quality of their correction in different ways, CBCT was used.

We have found that both methods of repositioning the fragments allow, to a certain extent, to obtain a positive result in the treatment of fractures of the midface area, but in most cases the displacement of bone fragments remains. If



Scale diagrams of the indicator by the VAS in the studied groups

patients are treated conservatively, the displacement of bone fragments remains forever. This indicates the imperfection of the analyzed methods.

Thus, a comparative analysis of the results of treatment of patients with fractures of the midface area showed that in most of them there were final cosmetic and functional deficiencies, which remained in the long-term observation. Displacement of bone fragments can remain when using any of the analyzed treatment methods.

### Conclusions

1. Evaluation of the period of seeking medical care showed that the reliable ( $\chi^2=11.43$ ;  $p<0.05$ ) majority of patients (64%) sought treatment within 0–3 days after injury.

2. 83–89 % of patients, who underwent repositioning of fragments, had fresh small-fragment fractures. The reliable ( $\chi^2=11.43$ ;  $p<0.05$ ) majority of them simultaneously had 3–4 sites of bone fractures of the midface area, hemosinus of varying degrees and paresthesia in the infra-orbital area.

3. In the majority of patients, who underwent repositioning of bone fragments with and without tamponade (85 % and 93 %, respectively), the final displacements were in the range of 3.1–6 mm. In patients treated conservatively, in most cases (93 %) the displacements were greater than 3.1 mm,

which remained after treatment. In the majority of patients treated with the studied methods, in the long term, the displacements of bone fragments remained, which had functional consequences.

4. In all studied groups, a certain cosmetic effect was achieved over time, as evidenced by a reliable ( $\chi^2=160.9$ ;  $p=0.00000$ ) decrease in the indicator by the VAS.

The prospect for further research is a comparative evaluation of the results of treatment of fractures of the midface area using the methods of bone osteosynthesis methods to fixate the fragments using standard titanium mini-plates and individual 3-D simulated titanium mini-grids.

### Declarations:

#### Statement of Ethics

The authors have no ethical conflicts to disclosure.

#### Consent for publication

All authors give their consent to publication.

#### Disclosure Statement

The authors have no potential conflicts of interest to disclosure.

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#### Data Transparency

The data can be requested from the authors.

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