



# A retrospective evaluation of the treatment of viscerocranial fractures in Romania.

## A study of 1007 patients

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Țenț Paul Andrei\*, Juncar Raluca-Iulia\*\*, Ioan Anton Arghir\*\*\*, Oana Cristina Arghir\*\*\*, Juncar Mihai\*

\*Department of Oral and Maxillofacial Surgery, University of Oradea, Oradea, Romania

\*\*Faculty of Medicine and Pharmacy, University of Oradea, Romania

\*\*\*Pulmonology Department, Faculty of Medicine, Ovidius University of Constanta, Constanta, Romania

### A retrospective evaluation of the treatment of viscerocranial fractures in Romania. A study of 1007 patients

**AIM:** The treatment of viscerocranial fractures is complex and involves orthopedic, surgical methods, or combinations of both. The aim of this study is to evaluate the treatment methods applied and the type of materials used in the case of viscerocranial fractures in our geographical area, as well as to assess postoperative complications depending on each type of treatment, the location and the characteristics of the fracture lines.

**MATERIAL AND METHODS:** A 10-year retrospective statistical analysis of 1007 patients treated in a Romanian university hospital was performed, the data being collected from patients' medical records.

**RESULTS:** The most frequent maxillofacial fractures were located in the mandible (62.16%). The zygomatic bone was the most fractured bone of the midface (44.91%). In the majority of the fractures, displacement of the fractured fragments occurred (84.40%). Most of the patients had a favorable evolution (97.8%) Orthopedic/closed treatment was the most frequent treatment applied (78.15%). This was followed by the greatest number of postoperative complications, while ORIF surgical treatment registered the smallest number of complications ( $p=0.209$ ). The most frequent postoperative complication was osteitis (74.19%). The highest incidence of postoperative complications was found in the case of fractures in multiple locations and displacement of the fractured fragments ( $p=0.000$ ).

**CONCLUSIONS:** The most effective treatment method in the case of maxillofacial fractures is ORIF surgery. The rate of postoperative complications is directly proportional to the number of fracture lines and the degree of bone displacement.

**KEY WORDS:** Maxillofacial, Trauma, Treatment

### Introduction

With the global increase in road traffic accidents, sports injuries and interpersonal violence over the past years, the incidence of viscerocranial fractures has reached

alarming rates<sup>1</sup>. The clinical picture of maxillofacial fractures can vary from a simple undisplaced fracture with insignificant morphological implications to panfacial fractures associated with ocular, cerebral or cranial nerve injuries with major functional, morphological and aesthetic implications, which require complex multidisciplinary treatment<sup>2</sup>. The treatment of maxillofacial fractures regardless of the chosen therapeutic method is aimed at the following objectives: resizing the sagittal, transverse and vertical diameters of the viscerocranium, restoring habitual occlusion, repositioning the mandibular condyles in centric relation in the glenoid fossa of the temporomandibular joint, restoring orbital contour, paranasal sinus wall contour and, implicitly, facial contour<sup>3</sup>.

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Correspondence to: Juncar Raluca-Iulia, DMD, PhD, Faculty of Medicine, and Pharmacy, University of Oradea, Piata 1 December n. 10, 410073 Oradea, Romania (e-mail: ralucajuncar@yahoo.com)

Currently, in the majority of the cases, the treatment of choice for viscerocranial fractures is open reduction and internal fixation of the fractured bone fragments (ORIF)<sup>4</sup>. The advantages of this treatment are a better reduction and immobilization of the fracture focus with more rapid healing and a lower incidence of complications, an increase in quality of life and early social reintegration by avoiding maxillomandibular fixation (MMF)<sup>5,6</sup>. Nevertheless, there are situations in which orthopedic treatment by maxillomandibular fixation cannot be avoided because of the complexity of the type of fracture, in which case the association of ORIF and MMF is required<sup>7-9</sup>. Not taking into consideration the complexity of the trauma can lead to errors and, implicitly, to postoperative complications that are difficult to correct subsequently<sup>2</sup>. Given that in Romania, until recent years, there has been no national program allowing reimbursement of all materials necessary for surgical treatment (ORIF), the management of viscerocranial fractures was challenging for the surgeon, who frequently had to ignore the standard therapeutic indications<sup>10,11</sup>. So far, this aspect has not been assessed in a significant number of cases in our country.

The aim of this study is to evaluate the treatment methods applied and the type of materials used in the case of viscerocranial fractures in our geographical area, as well as to assess postoperative complications depending on each type of treatment, the location and the characteristics of the fracture lines.

## Materials and Methods

The study was conducted following the retrospective evaluation of patients admitted and treated in a Romanian university hospital over a 10-year period.

Data were collected from the medical records, and the following variables were monitored: the topographic location of the fracture lines in the viscerocranium, the degree of bone displacement, the type of treatment used (closed treatment, ORIF or combined treatment), the type of postoperative complications. It should be mentioned that the following therapeutic methods were included in the category of closed treatment: maxillo-mandibular fixation with Erich arch bars (MMF), Gillies reduction of the zygomatic bone, Adams suspension wires, and closed reduction of the nasal bones. The ORIF treatment category strictly included patients undergoing open reduction of the fracture foci with internal fixation by osteosynthesis with titanium plates and screws. Combined treatment consisted of closed treatment represented by MMF associated with ORIF of the fractures. We mention that according to the protocol of our clinic, all patients with midface fractures who also had concomitant mandibular fractures underwent maxillo-mandibular fixation with Erich arch bars (MMF).

The study inclusion criteria were the following: at least

one fracture line in the viscerocranium, imaging examinations confirming the presence and trajectory of the fracture line, treatment performed in the study host institution, signing of an informed consent by which the patient agreed to the use of his/her medical data for scientific research, follow-up of the cases for at least 6 weeks postoperatively.

The exclusion criteria were: patients without viscerocranial fractures, absence of imaging investigations, incomplete data of the medical record, initial treatment performed in another service than that of the host clinic, refusal to sign an informed consent for the use of medical data for scientific research purposes, absence of follow-up for at least 6 weeks.

This study was approved by the Territorial Ethics Commission (No. 34723/19.07.2017) and was therefore performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments<sup>12</sup>.

Data centralization in electronic format was carried out using Microsoft Excel software. Descriptive statistics of the evaluated cases was performed with a two decimal percentage accuracy. Statistical analysis was conducted with the MedCalc Statistical Software version 17.2 (MedCalc Software bvba, Ostend, Belgium; <https://www.medcalc.org>; 2017). Continuous data were expressed as mean and standard deviation, and nominal data were expressed as frequency and percentage. The frequencies of a nominal variable across the categories of another nominal variable were compared with the chi-square test. The comparison of a continuous nominal variable between two groups was performed with the T test for independent variables. A p value  $p < 0.05$  was considered statistically significant.

## Results

The study inclusion criteria were met by 1007 patients with viscerocranial fractures. Of these, 62.16% (n=626) had strictly mandibular fractures, 29.89% (n=301) had strictly midface fractures, and 7.94% (n=80) had concomitant mandibular and midface fractures.

In the mandible, a total number of 1099 fracture lines were present, the mandibular angle being the most frequently involved, 28.84% (n=317), followed by mandibular body fractures, 24.29% (n=267), subcondylar, 22.02% (n=242), paramedian, 17.38% (n=191), median, 3.18% (n=35), ramus, 2.00% (n=22), coronoid process, 1.18% (n=13), and alveolar process fractures, 1.09% (n=12). The majority of the patients had multiple mandibular fractures, 58.94% (n=369), those with single fractures representing a small percentage, 41.06% (n=257).

The incidence of midface fractures depending on topographic location was as follows: zygomatic bone, 44.91% (n=172), multiple, 27.15% (n=104), nasal bone, 14.88%

TABLE I - Distribution of postoperative complications depending on the treatment method.

Complications		Type of treatment			Total
		Closed	ORIF	Combined	
None Reported		766	110	100	976
		97.58%	93.22%	92.59%	97.1%
Osteitis		13	4	6	23
		1.66%	6.78%	5.56%	1.9%
Mal-union		6	0	2	8
		0.76%	0.0%	1.85%	0.3%
Total		787	114	106	1007
		100%	100%	100%	100%
P=					0,209

TABLE II - Distribution of postoperative complications depending on the degree of displacement of the fracture.

Fracture Displacement		Complications			Total
		None Reported	Osteitis	Mal-union	
Yes		823	19	8	850
		84.3%	82.61%	50,0%	84.4%
No		153	4	0	157
		15.7%	17,39%	50,0%	15.6%
Total P=0,004		976	23	8	1007
		100.0%	100.0%	100.0%	100.0%

TABLE III - Distribution of the type of treatment and postoperative complications depending on the topographic location of the fracture lines in the mandible.

Mandible Fracture Site		Type of treatment			Total	Complications			Total
		Closed	ORIF	Combined		None Reported	Osteitis	Mal-union	
Absent		247	27	27	301	297	4	0	301
		31.4%	21.7%	25.5%	29.9%	30.4%	10.5%	0.0%	30.0%
Median		7	0	1	8	8	0	0	8
		0.9%	0.0%	0.9%	0.8%	0.8%	0.0%	0.0%	0.8%
Paramedian		21	8	5	34	33	1	0	34
		2.7%	7.5%	4.7%	3.4%	3.4%	5.3%	0.0%	3.4%
Body		43	18	10	71	68	3	0	71
		5.5%	17.0%	9.4%	7.1%	7.0%	10.5%	0.0%	7.1%
Angle		107	22	7	136	131	5	0	136
		13.6%	18.9%	6.6%	13.5%	13.4%	26.3%	0.0%	13.5%
Ramus		5	1	0	6	6	0	0	6
		0.6%	0.9%	0.0%	0.6%	0.6%	0.0%	0.0%	0.6%
Subcondyle		60	4	5	69	69	0	0	69
		7.6%	2.8%	4.7%	6.9%	7.1%	0.0%	0.0%	6.9%
Cornoid Process		3	0	2	5	5	0	0	5
		0.4%	0.0%	1.9%	0.5%	0.5%	0.0%	0.0%	0.5%
Alveolar Process		5	2	1	8	8	0	0	8
		0.6%	1.9%	0.9%	0.8%	0.8%	0.0%	0.0%	0.8%
Multiple		289	32	48	369	351	13	5	369
		36.7%	29.2%	45.3%	36.6%	36.0%	47.4%	100.0%	36.5%
Total		787	114	106	976	26	5	1007	
		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	
P=					0.001			1.000	

(n=57), alveolar ridge, 7.05% (n=27), Le Fort II, 2.35% (n=9), Le Fort III, 1.31% (n=5), orbital, 1.31% (n=5), Le Fort I fractures, 1.04% (n=4).

Most of the patients had displaced fractures, 84.4% (n=850), those with non-displaced fractures representing a small proportion, 15.6% (n=157).

In this study, closed treatment methods were predominant, 78.15% (n=787), followed by ORIF surgery, 11.32% (n=114), and combined methods, 10.53% (n=106). In total, 2102 Erich arch bars were used for MMF and 762 monocortical miniplates with 3048 titanium screws were used for ORIF. Postoperative complications were reported only in 31 cases (2.2%). The

most frequent postoperative complication was osteitis, 74.19% (n=23), followed by malunion, 25.81% (n=8). In 10 cases of osteitis in the fracture focus, removal of the osteosynthesis material was sufficient for the favorable evolution of the case. In the other 13 cases initially treated using the closed method, surgery by curettage of the fracture site and ORIF was required, patients having a favorable evolution. In the case of patients with malunion, surgical reintervention was not necessary, given that none of these presented functional disorders. Patients treated by closed methods developed the greatest number of postoperative complications (Table I). Table II shows that patients with fractures accompanied

TABLE IV - Distribution of the type of treatment and postoperative complications depending on the topographic location of the fracture lines in the midface.

		Type of treatment			Total	Complications			Total
		Closed	ORIF	Combined		NoneReported	Osteitis	Mal-union	
Midface	Absent	488	81	57	626	605	19	2	626
Fracture Site		62.0%	72.6%	53.8%	62.2%	61.8%	78.9%	50,00%	62.1%
	La Fort I	2	2	0	4	4	0	0	4
		0.3%	1.9%	0.0%	0.4%	0.4%	0.0%	0.0%	0.4%
	Le Fort II	6	1	2	9	8	0	1	9
		0.8%	0.9%	1.9%	0.9%	0.8%	0.0%	12,50%	0.9%
	Le Fort III	1	1	3	5	5	0	0	5
		0.1%	0.0%	2.8%	0.5%	0.5%	0.0%	0.0%	0.5%
	Zygomatic	150	14	8	172	170	2	0	172
		19.1%	13.2%	7.5%	17.1%	17.4%	10.5%	0.0%	17.1%
	NasalBones	53	3	1	57	56	0	1	57
		6.7%	0.9%	0.9%	5.7%	5.7%	0.0%	12,50%	5.7%
	AlveolarProcess	26	1	0	27	27	0	0	27
		3.3%	0.9%	0.0%	2.7%	2.8%	0.0%	0.0%	2.7%
	Orbit	2	3	0	5	5	0	0	5
		0.3%	2.8%	0.0%	0.5%	0.5%	0.0%	0.0%	0.5%
	Multiple	59	8	35	104	98	2	4	104
		7.5%	6.6%	33.0%	10.1%	10.0%	10.5%	50,00%	10.1%
Total	787	114	106	1007	976	23	8	1007	
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	
P=				0,000				0,000	

by displacement of the fractured bones developed postoperative complications more frequently.

Multiple mandibular fractures were most frequently associated with osteitis in the fracture focus, as can be seen in Table III, while in the midface, multiple fractures were most frequently correlated with malunion (Table IV). Although the majority of the fractures were treated by closed methods, a predominance of ORIF treatment and combined treatment in the case of fractures in multiple locations and those located in the mandibular body and the zygomatic bone could be observed ( $p=0.001$ ). Patients with multiple viscerocranial fractures developed postoperative complications more frequently. This result was statistically significant in the case of fractures located in the midface ( $p=0.000$ ) and statistically insignificant in the case of fractures located in the mandible ( $p=1.000$ ). Osteitis occurred more often postoperatively in the case of multiple fractures, mandibular angle fractures and zygomatic bone fractures, while malunion was predominant in the case of multiple fractures ( $p=0.000$ ).

## Discussions

The high incidence of mandibular fractures evidenced in this study is confirmed and explained by other authors<sup>1-4</sup>. Anatomically, the mandible is more exposed to injuries due to its prominence in the midface<sup>2-4</sup>. From an etiological point of view, the mandible is mainly fractured following trauma secondary to aggres-

sion by hitting with the fist, while midface bone fractures are more often caused by firearms or road traffic accidents<sup>1-7, 13-15</sup>. In the geographical area where the study was performed, interpersonal violence through hitting with the fist was predominant, which explains this result<sup>16</sup>. The current study indicates the mandibular angle to be the most frequently fractured area, which is explained by other authors by the fact that the mandibular angle is a thinner bone area, especially if impacted teeth are present<sup>17-19</sup>. Contrary to our results, other authors confirm a higher rate of mandibular body fractures<sup>6</sup>, paramedian<sup>19,20</sup> or subcondylar fractures<sup>21,22</sup>. The location of the fracture line in the mandible differs depending on the action of the etiological agent, its consistency, surface and kinetic energy, as well as on the position of the head and mandible at the time of the impact<sup>17-22</sup>. In this context, the absence of a literature consensus regarding this aspect can be explained.<sup>16-22</sup>

In the midface, the highest incidence of fractures was in the zygomatic bone, a result confirmed by other authors<sup>2,4,23,24,26</sup>. In contrast to our results, some authors indicate the highest frequency of midface fractures in the orbit<sup>6,26</sup> or the nasal bones<sup>15</sup>, while in military conflict areas, panfacial fractures are predominant<sup>13,14</sup>. Biomechanically, the zygomatic bone is the lateral weight-bearing pillar of the midface, being an important absorber of post-traumatic shocks at this level<sup>1-6</sup>. However, when the kinetic energy of the wounding agent is too high, this bone fractures<sup>1-6</sup>. Also, due to its prominence in the facial skeleton, it is more exposed to injuries compared to other bone structures<sup>8-15</sup>.

Other authors also report the closed method as the main treatment method, similarly to the result of this study<sup>7,27-29</sup>. In contrast, some studies indicate ORIF surgery<sup>1-3,5,6,9,13,14,30,31</sup> or combined treatment<sup>32,33</sup> as the main therapeutic method. In the past, MMF was widely used in the treatment of mandibular fractures<sup>20-24,32,33</sup>. Thus, the retrospective nature of the current study can explain why MMF is therein the main treatment method. Nevertheless, it should not be forgotten that this involves many disadvantages, including inadequate fracture reduction and late complications such as malunion. For this reason, at present, MMF has been largely replaced by ORIF surgical techniques<sup>1-3,5,6,9,13,14,30-33</sup>. A well conducted surgical treatment ensures rapid and far better healing of the fracture focus by Haversian remodeling, allows maintaining adequate oral hygiene and early social reintegration, while there is practically no injury to the marginal periodontium<sup>1-3,5,6,9,13,14,30-33</sup>. However, there are clinical situations in which MMF treatment cannot be avoided<sup>19-25</sup>. Such situations are those of patients with major general comorbidities in whom the general anesthetic risk and the operative risk are higher than the benefit of the intervention<sup>25-30</sup>. Patients who refuse surgical treatment also fit in this category<sup>26</sup>. Not least, the possible unavailability of the materials required for ORIF in the service concerned should also be taken into consideration<sup>25-30</sup>. This difficulty also existed in Romania, being overcome only in the last 5 years<sup>11</sup>. This fact can further explain the great number of maxillofacial fractures treated orthopedically in this study. Also, undisplaced subcondylar fractures and intracapsular condylar fractures are treated conservatively, non-surgically, a treatment that was included in the category of closed treatments in this study<sup>32-34</sup>. In the case of subcondylar fractures with displacement or dislocation of the condyle from the glenoid fossa, ORIF is required<sup>17-26</sup>. However, the potential risk of injury to the facial nerve in this case can lead to patient's refusal of surgery or to surgeon's choice of a treatment method involving lower risks<sup>35</sup>. Currently, in some centers, endoscopic reduction of subcondylar fractures is performed, which minimizes the risk of injury to the facial nerve<sup>36</sup>. In this study, ORIF surgical treatment was more frequently used in the case of mandibular body, mandibular angle or multiple fractures, a result similar to that of other authors<sup>31-33</sup>. In these cases, the traction of muscles unequally inserted into the bone fragments makes their anatomical reduction difficult by orthopedic methods alone, osteosynthesis being often necessary<sup>31-33</sup>. In the midface, closed treatment was predominant in the case of zygomatic bone and nasal bone fractures. This result was statistically significant, being found in other specialty publications<sup>7,34,36,38</sup>. Zygomatic bone fractures without displacement or with minor displacement (1-2 mm), in the absence of functional disorders, can be treated conservatively, the patient being followed up for the

next 6 weeks<sup>30,34,38</sup>. In the protocol of our clinic, displaced, non-comminuted zygomatic fractures are initially reduced using the Gillies technique, the intervention being converted to ORIF only in the absence of bone fragment stability. These indications are also found in the literature<sup>2-7,30,34</sup>. In contrast, other authors indicate ORIF in all zygomatic fracture cases due to the possibility of bone redisplacement under the traction of the masseter muscle during functional acts<sup>2,39,40</sup>. Nasal bone fractures unassociated with other midface fractures are generally treated by closed reduction methods<sup>1-10</sup>. In the case of displaced orbital fractures, surgical reconstruction of the orbital walls is required<sup>6,7,9,10</sup>. This approach is also found in our results. However, the number of purely orbital fractures was significantly reduced in this study, insufficient data being available to draw statistically significant conclusions in this regard.

In the case of multiple maxillomandibular fractures of the face with severe occlusal disorders, the association of MMF and ORIF is often necessary in order to obtain stable occlusion during the bone healing period<sup>1-7,30-34</sup>. These results are also found in our study, with statistical significance, where a large part of the multiple fractures were treated using the combined orthopedic-surgical method.

The number of postoperative complications found in this study was reduced, most of the patients having a favorable evolution. The literature reports similar rates of complications<sup>1-7,33-38</sup>. Osteitis in the fracture focus was the most frequent complication in this study, a result similar to those of a number of publications<sup>5,6,9,41,42</sup>.

Osteitis occurred more frequently in the mandible. The low incidence of infectious complications in the midface is due to the rich vascularization of this territory, which has been observed by other authors<sup>44</sup>. In contrast, some authors indicate the most frequent occurrence of malunion<sup>2,30</sup>. In our study, malunion developed more frequently following closed treatment methods, similarly to the findings of other authors<sup>2,30</sup>. This result is statistically significant and is not surprising given that the reduction of the fractured bone fragments is evaluated based on palpation criteria in this case, and not by direct visualization of the fracture focus like in the case of ORIF<sup>2,30</sup>. Postoperative complications had a statistically significantly higher incidence among patients with multiple fractures accompanied by displacement of the fractured bone fragments. This result is confirmed by other studies<sup>5,42,43</sup>. Multiple and displaced fractures are more difficult to reduce and immobilize adequately by strictly orthopedic/closed methods<sup>5,9,13,14,42,43</sup>.

Inappropriate reduction of these fractures predisposes to the development of complications<sup>5,9,13,14,42,43</sup>. This is also shown by our study, the highest incidence of complications being found among patients treated orthopedically. Similarly to the literature data, this study also found the smallest number of complications in the case of patients treated by ORIF<sup>1-3,5,6,9,13,14,30-33</sup>. Open reduc-

tion under direct visual control and rigid fixation in this case decrease the risk of complications, ORIF being currently the indication of choice for the treatment of viscerocranial fractures<sup>1-3,5,6,9,13,14,30-33</sup>. However, in this study, the rate of postoperative complications in the case of fractures treated by closed methods was also minimal, most of the patients having a favorable evolution. This emphasizes the fact that in the absence of the necessary means to perform osteosynthesis at large, a well-designed orthopedic closed treatment with the anatomical reduction of the fractured fragments ensures optimal healing and satisfactory results, without significant functional disorders or postoperative complications.

The limitations of this study are primarily derived from its retrospective nature, the data collected from the medical records being dependent on the accuracy with which they were registered at the time of treatment, as well as during postoperative follow-up. However, we believe that the data obtained are representative of our geographical area and that they have a considerable scientific and clinical impact.

## Conclusions

The most frequent methods used for the treatment of viscerocranial fractures in the geographical area analyzed in this study were the closed methods. The most effective treatment method was open reduction and internal fixation, ORIF, which registered the lowest rate of postoperative complications. The most frequent postoperative complication was osteitis in the fracture focus. Patients with multiple fractures accompanied by displacement of the fractured bone fragments had an increased risk of developing postoperative complications.

## Riassunto

Il trattamento delle fratture cranio-encefaliche è complesso e coinvolge tecniche ortopediche, chirurgiche o entrambe tra loro combinate. Lo scopo di questo studio è quello di valutare le modalità di trattamento applicate e il tipo di materiali utilizzati in caso di fratture di tale tipo nella nostra area geografica, nonché di valutare le complicanze postoperatorie a seconda di ogni tipo di trattamento, la sede topografica e le caratteristiche del linee di frattura.

Per questo è stata eseguita un'analisi statistica retrospettiva di 10 anni su 1007 pazienti trattati in un ospedale universitario rumeno, traendo i dati dalle cartelle cliniche dei pazienti.

**RISULTATI:** Le fratture maxillo-facciali più frequenti erano localizzate nella mandibola (62,16%) e l'osso zigomatico era l'osso più fratturato della faccia (44,91%). Nella maggior parte delle fratture si è verificato lo spostamento dei frammenti (84,40%). La maggior parte dei

pazienti ha avuto un'evoluzione favorevole (97,8%). Il trattamento ortopedico/chiuso è stato il trattamento applicato più frequentemente (78,15%), ma è stato seguito dal maggior numero di complicanze postoperatorie, mentre il trattamento chirurgico ORIF ha registrato il minor numero di complicanze ( $p = 0,209$ ).

La complicanza postoperatoria più frequente è stata l'osteite (74,19%). La più alta incidenza di complicanze postoperatorie è stata riscontrata nel caso di fratture multiple e con spostamento dei frammenti fratturati ( $p = 0,000$ ).

Si conclude che il metodo di trattamento più efficace in caso di fratture maxillo-facciali è la chirurgia ORIF. Il tasso di complicanze postoperatorie è direttamente proporzionale al numero di linee di frattura e al grado di spostamento osseo.

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