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Epidemiological assessment of maxillofacial fractures in inhibitants of Lower Silesia, Poland, in 2002–2006 – Treatment of maxillofacial fracture

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Abstract

Introduction and objective. Epidemiological assessment of maxillofacial fractures carried out by a given specialized centre may constitute valuable material for comparison with other regions of Poland and the European Union. This material could help standardize the present methods of treating craniofacial skeleton dislocations, and plan appropriate financial resources both for specialized treatment of such fractures and fractures that require multidisciplinary care. Moreover, the frequency of complicated maxillofacial fractures leading to residual disability and circumstances in which fracture occurred may be useful for the Social Security authorities.

Materials and methods. This study is a continuation of research on maxillofacial traumatology carried by the Maxillofacial Department of the Medical University in Wrocław, Lower Silesia. Since 1956, a statistical review of maxillofacial fractures has been kept in 5 or 10-year periods. Statistical analysis of this kind is useful in indentifying the frequency of the phenomenon, taking suitable treatment precautions, verifying treatment methods, and analyzing costs and losses incurred as a result of absence at work. Sociological aspect of such studies includes indicating sources of socially adverse phenomena, i.e. violence or alcohol abuse. The studies were based on clinical documentation of 937 patients, where dependencies between chosen parameters were identified. As a basic statistical analysis of variable interdependence the $\chi 2$ test of independence was applied.

Conclusions. Lately, there have been more maxillofacial fractures resulting from civilization changes. Simultaneously, there are new treatment methods and significant progress has been made regarding materials that are used in these treatments.

Key words

maxillofacial fractures, epidemiology, Low Silesian Polish population

INTRODUCTION

Methods of treating maxillofacial fractures. The aim of maxillofacial fracture treatment is to restore appropriate morphology and functioning. The main methods in treating this type of fractures are reposition (*reposition*) and fixation (*fixatio)* of dislocated fragments in an anatomical position so that bone union and appropriate bone functioning can be restored as quickly as possible. There are many commonly applied methods of treating fractures, i.e. preservative-orthopedic, surgical or mixed.

There are numerous preservative-orthopedic methods of treating the craniofacial skeleton which use different types of ligations, splints and retainers. The disadvantages of preservative-orthopedic methods of treating maxillofacial fractures, such as discomfort connected with long-term stabilization of jaw fracture in occlusion, difficulties with eating, problems with keeping appropriate oral hygiene, and frequent inflammations of paradontal tissue, led specialists to seek other ways to stabilize craniofacial dislocations [1, 2]. Dynamic developments in medical science, especially surgery, anesthetics, biomedical engineering and biomaterials, and antibiotic therapy, allowed for the introduction of surgical methods of treating craniofacial fractures to restore the anatomical and functional activity of the patient.

In order to obtain stable plate osteosynthesis, certain surgical procedures have to be followed. These procedures include immediate fracture treatment, very precise reposition of bone fragments and fitting a plate to the stabilized surface, choosing an appropriate location for plate fixation while taking into consideration affecting forces, uniaxial screw insertion, stabilizing the plate with at least two screws and not allowing for bone overheating [3, 4, 5, 6]. These procedures allow specialists to obtain physiological balance of forces affecting bone fragments, restore appropriate anatomical bone continuity, reduce the risk of complications, and acquire optimal bone union time. An important aspect of improving plate osteosynthesis methods was development in the area of biomaterials. Apart from strictly medical benefits of using state-of-art surgical techniques, the economical benefits are also significant, i.e. shorter stay in hospital and smaller number of control, post-treatment visits [7].

As Korzon has observed [8], late admission to hospital of patients with maxillofacial fractures has an important

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influence on further treatment. Korzon highlights the lack in the literature of appropriate and complete data on the time of admission of such patients. Moreover, Barańczak emphasizes that it is crucial to treat such fracture immediately, especially in children, as there tend to be connective tissue adhesions which make it impossible to reposition fragments appropriately.

MATERIALS AND METHODS

The analyzed group was selected from among 6,012 patients hospitalized in the Maxillofacial Surgery Department of Wrocław Medical University in 2002–2006. Before conducting the studies, the authors obtained appropriate permission to use the medical documentation of patients from the Bioethics Committee at Wrocław Medical University (KB – 235/2008).

Medical documentation of 937 patients treated due to maxillofacial fractures was used. The time interval from time of fracture to admission, the time of treatment and length of stay were evaluated. Consultations, specialist examinations and treatment methods were also taken into account.

To fulfill the above-mentioned tasks, the total of data acquired from the case history cards were entered onto a spreadsheet. The data was analyzed statistically in accordance with standard methodology used in medical science (STATISTICA 9.0). As a basic method of analyzing variable interdependencies in this work, the χ2 test of independencies was used.

Table 1. Dependency between time intervals from fracture incidence to hospital admission, and analyzed period and craniofacial fracture location

			Time interval from fracture incidence to hospital admission			Total	
			3 days	4–10 days	> 10 days		
Year	2002	No.	83	68	24	175	$\chi^2(8) = 11.960$; C = 0.113; p = 0.153
		%	16.7%	21.7%	20.7%	18.9%	
	2003	No.	104	41	20	165	
		%	20.9%	13.1%	17.2%	17.8%	
	2004	No.	118	86	29	233	
		%	23.7%	27.5%	25.0%	25.2%	
	2005	No.	106	68	28	202	
		%	21.3%	21.7%	24.1%	21.8%	
	2006	No.	86	50	15	151	
		%	17.3%	16.0%	12.9%	16.3%	
Craniofacial bone fracture location	Lower face fractures	No.	306	162	47	515	$\chi^2(4) = 39.022$; C = 0.204; p < 0.01
		%	59.4%	31.5%	9.1%	100.0%	
	Upper face fractures	No.	139	134	62	335	
		%	41.5%	40.0%	18.5%	100.0%	
	Lower and upper face fractures	No.	34	8	4	46	
		%	73.9%	17.4%	8.7%	100.0%	

RESULTS

In the statistical part of the research, to evaluate dependencies between dependent variable and independent variable the authors applied the χ2 test. To measure the strength of dependencies for nominal features, contingency coefficient C was used. All χ2 tests were carried out where the level of statistical significance was $\alpha = 0.05$. There were instances where empirical data was incomplete, which influenced the Tables where deviations in samples from 937 people may be found. This did not result from a mistake, but – as mentioned before – from incomplete data. Because analyzed sample of people was large, such a lack of data influenced the second or third decimal digit in the counted χ^2 statistics. The analysis may be assumed to be reliable. To relate the results with general population, interpretations were performed on the basis of percentage indicators [%].

Time interval from fracture incidence to hospital admission. Dependencies between time intervals from fracture incidence to hospital admission and the analyzed period was not statistically significant (Tab. 1). At any time between 2002–2006, the time from fracture incidence to hospital admission was statistically comparable. Statistically significant, however, was the time between injury and hospital admission and fracture location. Patients with lower face massive fractures were usually admitted within 3 days from the injury (41.5%); a similar number of patients were admitted within 4–10 days after the fracture (40.0%). Patients with fractures to both the lower and upper face massive bones were usually admitted within 3 days from the day of fracture (73.9%). There was no statistical significance of dependencies between time interval from the time of fracture to admission and the place of residence (Tab. 2).

Table 2. Dependency between time interval, from time of fracture to admission, and place of residence

			Place of residence		Total
			Urban areas	Rural areas	
Time interval from fracture incidence to hospital admission	3 days	No.	365	132	497
		%	53.3%	54.8%	53.7%
	4–10 days	No.	229	84	313
		%	33.4%	34.9%	33.8%
	> 10 days	No.	91	25	116
		%	13.3%	10.4%	12.5%
Total		No.	685	241	926
		%	100.0%	100.0%	100.0%

$\chi^2(2) = 1.387$; C = 0.029; p = 0.500

First aid. In over 78% of incidents, patients received immediate medical help in the form of fracture immobilization or initial reposition. These procedures were applied at the site of the incident by paramedics or medical personnel on the arrival at the out-patient clinic. Included here are also short-term hospitalization cases in the Trauma Surgery Department in the region where the above procedures were conducted. The dependency between help received by rural residents and urban residents before being admitted to the clinic was not statistically significant (Tab. 3).

Specialist consultations. The frequency of specific types of consultations in the consecutive years of 2002–2006 did not

Table 3. Dependency between help received by rural residents and urban residents before admission to the clinic.

			Place of residence		Total
			Urban areas	Rural areas	
First aid	Not received	No.	157	44	201
		%	22.6%	18.1%	21.5%
	Received	No.	537	199	736
		%	77.4%	81.9%	78.5%
Total		No.	694	243	937
		%	100.0%	100.0%	100.0%

$\chi^2(1) = 1.918$; C = 0.048; p = 0.166

differ and is therefore statistically insignificant. Patients with lower face fractures most frequently required neurological consultations (49.3%), patients with upper face dislocations required ophthalmological consultations (50.7%), while those with both lower and upper face fractures required neurological consultations in 45.0% of the cases, and ophthalmological consultations in 30.0%. This dependency is statistically significant (Tab. 4).

CT scan. The greatest number of CT scans in the analyzed group of people was performed in 2005 (18.1%); in 2006 – 15.7%, in 2004 – 11.9%, in 2003 – 10.7% and 2002 – only 3.4%. This dependency was statistically significant. There was no statistically significant dependency between lower face fracture and CT scan as this examination was performed only in 2.3% of the cases. In patients with upper face fractures, CT scans were performed in 24.9% of incidents. In patients with both lower and upper face dislocations, 34.0% had CT scans performed. Analyses showed that CT scans were performed in patients with lower and upper face fractures, or those with upper face fractures only (Tab. 5).

Type of treatment and surgical treatment methods. The frequency of treatment in consecutive years of 2002–2006 did not differ, and is therefore statistically insignificant. The most popular surgical treatment method in 2002–2006 was miniplate osteosynthesis (42.8%). Close reposition with a single-toothed hook was another frequently used technique (20.1%). In 14.7% of the cases, open reposition was used and in 12.3% – suture (Fig. 1).

Table 5. Dependency between CT scans and analyzed period and craniofacial fracture location

			CT scans		Total	
			No	Yes		
Year	2002	No.	169	6	175	$\chi^2(4) = 21.620$; C = 0.150; p < 0.001
		%	96.6%	3.4%	100.0%	
	2003	No.	151	18	169	
		%	89.3%	10.7%	100.0%	
	2004	No.	208	28	236	
		%	88.1%	11.9%	100.0%	
	2005	No.	167	37	204	
		%	81.9%	18.1%	100.0%	
	2006	No.	129	24	153	
		%	84.3%	15.7%	100.0%	
Craniofacial bone fracture location	Lower face fractures	No.	508	12	520	$\chi^2(2) = 117.471$; C = 0.339; p < 0.001
		%	97.7%	2.3%	100.0%	
	Upper face fractures	No.	254	84	338	
		%	75.1%	24.9%	100.0%	
	Lower and upper face fractures	No.	31	16	47	
		%	66.0%	34.0%	100.0%	

Time interval from hospital admission to ultimate trauma management. From 2002 (76.1%) – 2006 (86.3%), there was annual increase in patients who received ultimate trauma treatment within 7 days from admission. Similarly, from 2002 (23.9%) – 2006 (13.7%) there were fewer cases of ultimate treatment administered more than 7 days from admission. This correlation is statistically significant. Patients with lower face fractures in 83.2% were ultimately treated within 7 days from admission. Also, patients with lower face fractures in 70.2% underwent the same procedure within 7 days from admission. Patients with both lower and upper

Table 4. Dependency between frequency of specific types of consultations and analyzed period and craniofacial fracture location

			Year					Craniofacial bone fracture location		
			2002	2003	2004	2005	2006	Lower face fractures	Upper face fractures	Lower and upper face fractures
Specialist consultations	Neurological consultations	No.	38	37	42	42	33	68	93	27
		%	48.7%	44.6%	34.4%	36.8%	36.3%	49.3%	33.2%	45.0%
	Internal medicine consultation	No.	3	3	10	8	8	19	10	3
		%	3.8%	3.6%	8.2%	7.0%	8.8%	13.8%	3.6%	5.0%
	Laryngological consultation	No.	8	8	11	4	7	12	19	6
		%	10.3%	9.6%	9.0%	3.5%	7.7%	8.7%	6.8%	10.0%
	Ophthalmological consultations	No.	23	28	45	47	35	14	142	18
		%	29.5%	33.7%	36.9%	41.2%	38.5%	10.1%	50.7%	30.0%
	Other	No.	6	7	14	13	8	25	16	6
		%	7.7%	8.4%	11.5%	11.4%	8.8%	18.1%	5.7%	10.0%
Total		No.	78	83	122	114	91	138	280	60
		%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
			$\chi^2(16) = 13.839$; C = 0.166; p = 0.611					$\chi^2(8) = 79.193$; C = 0.337; p < 0.001		

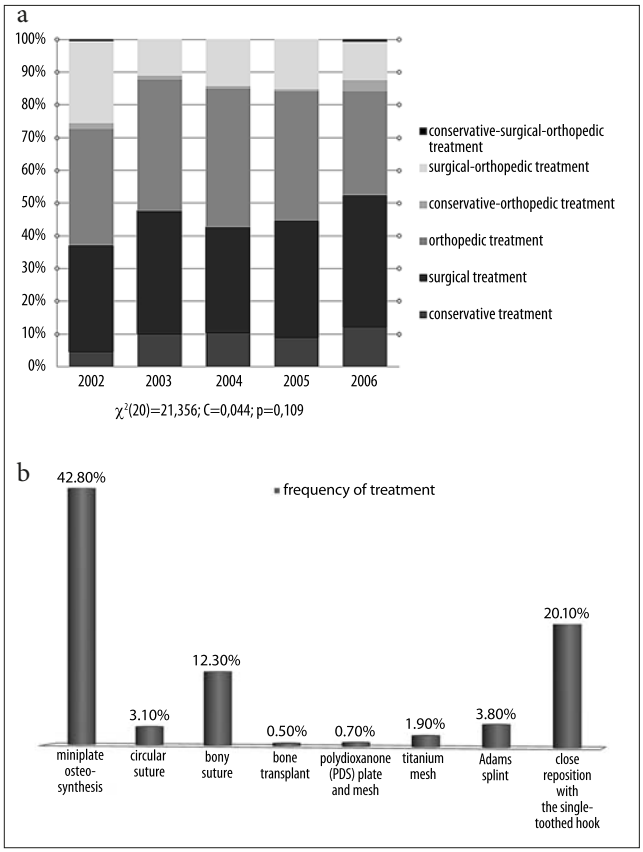

Figure 1. Type of treatment and surgical treatment methods:
a. type of treatment and methods of surgical treatment in 2002–2006;
b. type of surgical treatment methods.

face dislocations were treated ultimately within 7 days from admission in 77.3%. Interestingly, ultimate trauma treatment within 7 days from admission was administered mostly in cases of lower face fractures (83.2%). This correlation was statistically significant (Tab. 6).

Length of stay. There was a statistically significant correlation between length of stay and particular year. The greatest number of stays that lasted up to 7 days was in 2004 (28.6%). Length of stay from 8–14 days was most frequent in 2003–2005. Length of stay from 15–21 days was most frequent in 2002–2004. There was a statistically significant correlation between length of stay and fracture location. Patients with lower face fractures usually stayed for up to 7 days (61.0%). Patients with upper face fractures also stayed for up to 7 days (43.5%) and from 8–14 days in 41.4%. Patients with both upper and lower face fractures stayed between 8–14 days (47.8%) and for up to 7 days in 45.7%. This means that patients with lower face fractures spent the shortest time in hospital (up to 7 days). Patients with upper face fractures or mixed fractures stayed in hospital longer than patients with lower face fractures (Tab. 7).

Table 6. Dependency between time interval from hospital admission to ultimate trauma management and analyzed period and craniofacial fracture location

			Time interval from hospital admission to ultimate trauma management		Total	
			< 7 days	> 7 days		
Year	2002	No.	124	39	163	$\chi^2(4) = 17.093$; C = 0.141; p = 0.002
		%	76.1%	23.9%	100.0%	
	2003	No.	101	47	148	
		%	68.2%	31.8%	100.0%	
	2004	No.	168	40	208	
		%	80.8%	19.2%	100.0%	
	2005	No.	156	34	190	
		%	82.1%	17.9%	100.0%	
	2006	No.	120	19	139	
		%	86.3%	13.7%	100.0%	
Craniofacial bone fracture location	Lower face fractures	No.	416	84	500	$\chi^2(2) = 17.864$; C = 0.146; p < 0.001
		%	83.2%	16.8%	100.0%	
	Upper face fractures	No.	193	82	275	
		%	70.2%	29.8%	100.0%	
	Lower and upper face fractures	No.	34	10	44	
		%	77.3%	22.7%	100.0%	

Table 7. Dependency between length of stay and analyzed period and craniofacial fracture location

			Length of stay				Total	
			< 7 days	8–14 days	15–21 days	> 21 days		
Year	2002	No.	85	64	19	4	172	$\chi^2(12) = 28.276$; C = 0.173; p = 0.005
		%	17.0%	19.1%	26.4%	28.6%	18.7%	
	2003	No.	70	71	19	4	164	
		%	14.0%	21.2%	26.4%	28.6%	17.8%	
	2004	No.	143	70	19	3	235	
		%	28.6%	20.9%	26.4%	21.4%	25.5%	
	2005	No.	117	69	9	3	198	
		%	23.4%	20.6%	12.5%	21.4%	21.5%	
	2006	No.	85	61	6	0	152	
		%	17.0%	18.2%	8.3%	0%	16.5%	
Craniofacial bone fracture location	Lower face fractures	No.	313	167	29	4	513	$\chi^2(6) = 35.056$; C = 0.195; p < 0.001
		%	61.0%	32.6%	5.7%	0.8%	100.0%	
	Upper face fractures	No.	144	137	41	9	331	
		%	43.5%	41.4%	12.4%	2.7%	100.0%	
	Lower and upper face fractures	No.	21	22	2	1	46	
		%	45.7%	47.8%	4.3%	2.2%	100.0%	

DISCUSSION

By analyzing the time interval from the time of fracture to hospital admission in the Maxillofacial Surgery Department in Wrocław, 3 time ranges were described: up to 3 days, 4–10 days and more than 10 days. More than a half of the patients stayed up to the 3rd day from the time of fracture (53.67%), 33.8% were admitted between 4th – 10th day after the incident and 12.53% later than 10th day. In Pawela's studies [10], the average admission time from the moment of fracture

was 4.7 days, whereas in Korzon's study [8], 44.80% of patients with maxillofacial fractures were admitted after 3 or more days. According to Oleszkiewicz, the greatest number of patients were admitted between the 2nd – 4th day – 35.4%. In these studies, the correlation between admission time and treatment results was assessed, obtaining the greatest percentage of good results among patients admitted between the 2nd – 4th day from the time of fracture, whereas the greatest percentage of unsatisfactory results occurred in patients admitted between the 15th – 25th day, or later, from the time of fracture [11].

In the presented study, the correlation between fracture location and hospital admission shows that patients with all possible locations of craniofacial fractures were admitted within 3 days of the moment of injury. In the case of fractures located in both upper and lower face massives, the percentage of early admission was 73.9%. This is not surprising, as the intensity of morpohological-functional disorders accompanying lower and upper face fractures is so great that the patient has to seek specialist help really quickly.

There were no significant differences in relation to the place of residence and time of admission. A little more than a half of urban and rural residents were admitted within 3 days of the moment of fracture. This means that there is constant improvement in access to basic dental care in rural areas because a great number of patients are referred to the clinic in Wrocław by first contact dentists.

In 78.5% of cases, hospitalized patients were provided with immediate aid in a form of fracture immobilization or initial reposition. Such actions were usually taken immediately at the site of accident by paramedics, or within a short time after the accident in the outpatient clinic by the surgeon or GP. Since patients with maxillofacial fractures usually first contact general practitioners, especially in the Lower Silesian region, the idea that these doctors should obtain skills necessary to help patients with maxillofacial fractures [12] is justified. As there are more dentists and GPs working in the rural areas of Lower Silesia, the authors of the presented study observed no statistically important differences in relation to first aid for residents of rural and urban areas who suffered from maxillofacial fractures (81.9%:77.4%, respectively).

In 488 out of 937 patients' consultations with other specialists were necessary. The most frequently consulted were neurologists – 39.3%, opthalmologists – 36.5% and otolaryngologists – 7.8%). In cases of upper face fractures, a half of all consultations were with opthalmologists – 50.7%), whereas patients with lower face fractures required neurological consultations – 49.3%). Such procedures were necessary as maxillofacial fractures are usually complicated and may affect neighbouring organs, i.e. brain and sense organs. Maxillofacial dislocations are frequently accompanied by eyeball and eye nerve damage, nasal pyramid fractures or paranasal sinuses opening, nose bleeding and concussion or brain contusion, intracranial haematomas or cranial base fractures [13, 14].

In maxillofacial traumatology, it is very important, and often necessary, to perform a CT scan. This examination helps to precisely identify the type of fracture, its line, presence of indirect fragments and internal damage. Moreover, 3D reconstructions in CT allow for early preparation of tissue transplants shaped to fit bone defects [15]. In this study, in 12.1% of patients, CT scans were performed, in which almost one-third were for patients with both lower and upper face fractures. In the light of worldwide standards, CT imaging, especially multiorgan, is one of the most basic examinations especially in cases of upper face fractures affecting eye socket [16]. The number of CT scans performed in the Maxillofacial Surgery Department of Wrocław Medical University rose systematically in the consecutive years of the analyzed period, which is in accordance with trends in Western-European maxillofacial traumatology.

The great majority of patients (78.9%) received ultimate treatment within 7days from the admission. Treatment time was strictly related to fracture location. After admission, the most frequently complicated fractures of the upper face were treated, and most rarely jaw fractures, were treated later than the seventh day. Kheirallah, by identifying the treatment time of lower face fractures in 656 patients of the I Maxillofacial Clinic IS AM in Warsaw, concluded that fractures of this type were usually treated within 7 days from admission (73.9%) [17]. The ultimate treatment of complicated upper face fractures, especially those accompanied by CUN injuries, was usually longer [18].

The most frequently used treatment methods were: preservative, surgical, orthopedic and surgical-orthopedic. In 84 cases of maxillofacial fractures, after clinical examination and CT imaging that excluded dislocation of fragments, preservative treatment was administered that consisted of observation and periodic controls. Orthopedic treatment, as the only treatment method, especially in uncomplicated fractures of the body and ramus of the mandible [19] was used in 38.4% of cases. Surgical treatment accounted for only 35.3% of cases. Mush less frequent incidents of using sutures (12.3%) were observed and plate osteosynthesis became more common (42.8%) [20, 21, 22]. According to Kryst [18], in the 1990s, the frequency of using titanium plates in surgical reposition amounted for 18.7%, whereas sutures were used in 26.2%.

Close reposition of zygomatic bone with the single-toothed hook (20.1%) was a frequent technique used in the Clinic in Wrocław, together with open reposition (14.7%). In cases of multifragment fractures of the eye socket wall, reconstruction with bone graft, usually taken from the wing of the illium, was administered or stabilization of fragments using titanium mesh or PDS foil, obtained very good results. In cases of eye socket wall reconstructions with titanium mesh, it is worth noting that titanium not only has osseointegrative features, but it is also biocompatible with soft peribulbar tissues. Reposition with plate osteosynthesis allows for better stabilization of bone fragments, prevents unpleasant feelings connected with immobilization of both jaws, as well as difficulties with eating and keeping appropriate dental hygiene, and in the case of toothless patients, excludes the necessity to use uncomfortable preservative-orthopedic methods [23]. Even though plate osteosynthesis is more expensive than the orthopedic method, it has economical benefits, such as shorter hospitalization time and patient's comfort [18, 24].

The length of stay of patients in the Maxillofacial Surgery Department of Wrocław Medical University, assessed in 4 periods, indicated the predominance of short stays of up to 1 week (54.3%). According to Prof. Pawela [10], who studied 5,218 cases of maxillofacial fractures treated in a 10-year period, the average length of stay was 11.3 days. Although this value is average, it included a large number of cases; therefore, it may also be assumed that short stays dominated

in the Wrocław Clinic. Nevertheless, when certain location of fracture is taken into consideration, the length of stay was different. Patients with lower face fractures were usually discharged within 7 days (61%), and between 8 – 14 day – 32.6%. Patients with upper face fractures were also usually discharged within 7 days, or between the 8th – 14th day of stay (43.5% and 41.4%, respectively). Patients with both face massives fractured stayed much longer – 8–15 days (47.8%).

Kryst's observations [18], made on the basis of 2,234 cases of fractures treated in 1985–1995, proved that the average length of stay of patients with different fractures of the upper face was up to 15 days in the case of isolated orbital floorfractures and up to 26.5 days in the case of cranio-orbital fractures. Complicated upper and middle face skull fractures with accompanying morphological-aesthetic complications and compromised visual system, required advanced reconstructive treatment and prolonged postoperative control [18]. Coexistent injuries also influenced a patient's length of stay. It was observed that patients with brain, chest and abdominal cavity injuries could be ultimately treated after 7 days of hospitalization.

CONCLUSIONS

The general tendency (53.6%) of quick hospital admission (up to the 3rd day since the moment of injury) allows for reduction of complications and obtaining better treatment results. In 78.5% of cases, the fractures were treated immediately and more than half of the patients were admitted within 3 days since the moment of fracture. The great majority of patients (78.9%) were ultimately treated within 7 days from admission, and in the analyzed period, the most frequently used surgical method of treating different types of maxillofacial fractures was plate osteosynthesis (42.8%). The length of stay at the Maxillofacial Surgery Department of Wrocław Medical University in 54.3% of cases did not exceed 7 days.

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