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ANALYSIS OF THE PREVALENCE AND CLINICAL COURSE OF FRACTURES OF THE PARANASAL SINUSES

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Summary. The relevance of the problem under study is conditioned upon insufficient information on the prevalence and clinical course of fractures of the paranasal sinuses in Astana. The purpose of the study is to conduct a retrospective analysis of these injuries and to identify the prevalence and epidemiological features of fractures of the paranasal sinuses in the city of Astana. Initially, the study included the medical histories of patients for 2018-2023 of both sexes aged 8 to 84 years (a total of 314 people) who were diagnosed with a fracture of the paranasal sinuses. Out of the 314 cases, 293 met the inclusion and exclusion criteria. The medical records of these 293 cases (including medical histories and records of clinical examinations, medical images such as X-ray pictures, computerized tomography scans, and their reports) were thoroughly examined. Men aged 13-35 were the most frequently affected, and traffic accidents and motorcycle accidents were the most common causes of fractures. Nearly half of the patients (n = 160, 54.6%) received surgical treatment. Open reposition and internal fixation were performed in 87 patients (29.7%). 11% of patients had no treatment. The most frequent complication was an infection of a postoperative wound or tissue near a metal structure. The presented data have potential significance for the development of new strategies for injury prevention and the identification of patients at risk of postoperative complications.

Key words: sinus diseases; epidemiology of fractures; public health; maxillofacial surgery; Kazakhstan.

АНАЛИЗ РАСПРОСТРАНЕННОСТИ И КЛИНИЧЕСКОГО ТЕЧЕНИЯ ПЕРЕЛОМОВ ОКОЛОНОСОВЫХ ПАЗУХ

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Резюме. Актуальность исследуемой проблемы обусловлена недостаточностью информации о распространенности и клинического течения переломов придаточных пазух носа в г. Астана. Задачей текущего исследования является выявление распространенности и эпидемиологических особенностей переломов придаточных пазух носа в городе Астана. Цель исследования: провести ретроспективный анализ указанных травм в городе Астана. Изначально исследование вошли истории болезней пациентов за период с 2018 года по 2023 год обоих полов в возрасте от 8 до 84 лет (всего 314 человек), у которых был диагностирован перелом придаточных пазух. Из 314 случаев 293 соответствовали критериям включения и исключения. Медицинские записи этих 293 случаев (включая истории болезни и записи

клинических осмотров, медицинские изображения, такие как рентгеновские снимки и компьютерная томография, а также их отчеты) были тщательно изучены. Мужчины в возрасте 13-35 лет были наиболее часто поражаемыми, а дорожно-транспортное происшествие и мотоциклетная авария были наиболее распространенной причиной переломов. Приблизительно половина пациентов (n = 160, 54,6%) получило хирургическое лечение. Открытая репозиция и внутренняя фиксация были выполнены 87 пациентам (29,7%). У 11% пациентов лечение отсутствовало. Наиболее частым осложнением было инфицирование послеоперационной раны или ткани около металлической конструкции. Представленные данные имеют потенциальное значение для разработки новых стратегий профилактики травм и выявления пациентов с риском развития послеоперационных осложнений.

Ключевые слова: заболевания пазух носа; эпидемиология переломов; здоровье населения; челюстно-лицевая хирургия; Казахстан**.**

Introduction. Traumatic injuries are a serious public health problem, as a result of which about five million people die worldwide. The World Health Organisation (WHO) defines road traffic accidents as the most common cause of head injuries [1]. The accelerating pace of modern life, high-speed travel, the increasing frequency of violence, overpopulation, the scale of road accidents, sports injuries, combat and work injuries have turned maxillofacial fractures into a special form of social disease that does not give immunity to anyone [2]. Global health has evolved to focus on reducing health inequalities and ensuring the highest attainable standard of health for all people. To this end, numerous actors are currently conducting activities and policies regarding global goals, paying special attention to improving health systems. In global health, surgery has sought to determine the burden of surgical diseases and propose policies to improve access to surgical interventions. Dental and maxillofacial surgery is underrepresented in this system but it plays a vital role in reducing global health inequalities associated with exposure to dental and craniofacial diseases [3]. The causes and frequency of maxillofacial fractures vary significantly from one country to another, depending on cultural characteristics, as well as social and environmental factors [4].

Maxillofacial injuries often occur in the practice of emergency medical care. It is estimated that more than 50% of patients with such injuries have multiple injuries requiring coordinated management of emergency physicians and specialist surgeons in the field of otolaryngology, traumatology, plastic surgery, ophthalmology, and maxillofacial surgery. Maxillofacial injuries can occur as an isolated injury or combined with multiple injuries to the head, chest, abdomen, spine, and limbs [5]. Facial trauma can be considered as a serious public health burden due to considerable morbidity, deformity, and loss of function, which can increase socio-economic consequences with high treatment costs and disability [6]. Maxillofacial injuries, especially fractures, require special attention in diagnostics due to the close anatomical proximity to the brain and frequent association with serious concomitant injuries, such as traumatic brain injury. Thus, if damage to the maxillofacial region is suspected, it is necessary to evaluate vital structures in the head and neck [7]. Therewith, isolated fractures of the bones of the facial part of the skull rarely pose a threat to life. However, when inhaling blood during oral bleeding is combined with a state of depression of consciousness, death can occur from aspiration and asphyxia [4].

In the United States of America (USA) and the United Kingdom (UK), road accidents remain a frequent and significant cause of maxillofacial injuries. However, their number has reportedly decreased due to the application of such legislative measures as mandatory use of seat belts, speed limits, and fines for drunk driving [4,8]. Thus, reports on various aspects of the epidemiology of injuries of the facial part of the skull continue to accumulate but there is a limited amount of information concerning this pathology in the city of Astana and in Kazakhstan in general. The vast majority of maxillofacial injuries are preventable; therefore, preventive strategies aimed at the aetiology of these injuries are important to reduce their occurrence. A clear knowledge of injury characteristics and treatment outcomes is vital to achieving acceptable functional and cosmetic results [5]. In addition, the assessment of the cause, frequency, and severity of maxillofacial fractures plays an important role in determining effective therapeutic and preventive measures.

The purpose of the study is to conduct a retrospective analysis of these injuries and to identify the prevalence and epidemiological features of fractures of the paranasal sinuses in the city of Astana.

Materials and Methods. In the course of the research, theoretical methods (literature analysis, generalisation); empirical methods (study of the experience of medical organisations, regulatory documentation, medical records of patients); methods of mathematical statistics and graphical

representation of the results were used. Initially, the study included the medical histories of patients for 2018-2023 of both sexes aged 8 to 84 years (a total of 314 people) who were diagnosed with a fracture of the paranasal sinuses. Out of the 314 cases, 293 met the inclusion and exclusion criteria. The medical records of these 293 cases (including medical histories and records of clinical examinations, medical images such as X-ray pictures, computerized tomography (CT) scans, and their reports) were thoroughly examined. The analysis of the prevalence and clinical course of fractures of the paranasal sinuses was carried out based on several medical institutions in the city of Astana of the Republic of Kazakhstan. The criteria for inclusion and exclusion from the study are shown in Table 1.

Table 1 – Criteria for inclusion and exclusion of patients

Exclusion criteria	Inclusion criteria
Patients with a history of paranasal sinus fractures (re-hospitalisation)	All cases of fractures of the paranasal sinuses, regardless of age
Patients with concomitant pathology of the facial area of the head, such as cyst, tumour, osteomyelitis, and fibrous dysplasia, which can cause fractures of the face.	Consent of the patient or their legal representatives to conduct the examination
Patients with a genetic disease or congenital facial abnormality	
Missing or incomplete records.	

All patients were divided into 5 groups: from 5 to 12 years, from 13 to 18 years, from 19 to 35 years, from 36 to 50 years, and from 51 to 80 years. The age characteristics of the groups are shown in Table 2.

Table 2 – Age characteristics of the groups

Group number	Age of patients (full years)
Group 1	8-12
Group 2	13-18
Group 3	19-35
Group 4	36-50
Group 5	51-84

During the study, the privacy of an individual patient was protected. All personal information, such as medical card numbers, was not included in the dataset and the patients described by the data remain anonymous. A structured standardised form was developed, which included the demographic characteristics of patients (age at the time of injury, sex, and ethnicity), the aetiology of the injury, the type of fracture, and the method of treatment. According to the aetiology of the injury, it was classified as a traffic accident, motorcycle accident, hitting a pedestrian, attack, fall, work injury, sports injury, etc. The type of fractures of the paranasal sinuses in the examined medical documents was classified according to the following anatomical location: fractures of the bones of the maxillary sinus, frontal sinus, lattice labyrinth and sphenoid sinus. There were the following treatment methods: conservative treatment (closed reduction), surgical treatment (open reduction with internal fixation), and lack of treatment (the patient died, refused treatment, or was transferred to another hospital). The data was entered into a computer and then structured and systematised using standard Microsoft Office Excel programmes.

Results. The number of patients with male paranasal sinus fractures prevailed over the female. The smallest difference was observed in Group 1. The largest percentage of patients were persons of working age. The sex and age characteristics of patients whose medical documents were included in the study are shown in Table 3.

Table 3 – Sex and age characteristics of groups

Group number	Age of patients (full years)	Total number of patients	Number and percentage of female persons	Number and percentage of male persons
Group 1	8-12	47	22 (47%)	25 (53%)
Group 2	13-18	61	20 (33%)	41 (67%)
Group 3	19-35	98	20 (20%)	78 (80%)
Group 4	36-50	50	12 (24%)	38 (76%)
Group 5	51-84	37	14 (37%)	20 (63%)

The distribution of injuries by sex and age is shown in Table 4. The results of this study confirm previously published data that young men under the age of 24 are the most frequently affected group of patients 50. About half of the patients had multiple fractures. Among the fractures of the frontal sinus, 27% were isolated fractures of the face plate, in other cases, there were combined fractures.

Frontal fractures usually occurred as a result of motorcycle accidents, road accidents, and attacks. 80% of patients with such fractures had serious concomitant injuries. The aetiology of injuries in the examined medical documents is indicated in Table 4.

Table 4 – Aetiology of injuries in the examined medical documents

Aetiology of injury	Frequency of occurrence (in percent)
Traffic accident	20
Motorcycle accident	57
Pedestrian collision	5
Attack	6
Fall	7
Work injury	1
Sports injury	2
Others	2

The data above are consistent with other publications. Thus, the purpose of the previous study [4] was to assess the frequency and aetiology of maxillofacial fractures in the Greek population over 5 years. A retrospective clinical and epidemiological study included 727 patients treated for a total of 1,142 facial bone fractures between 2005 and 2009. The cause, type, place of injury, sex, age, and nationality of the patient were evaluated. Road accidents remained the most common cause of injuries (50.8%), followed by attacks (26.3%), falls (13.8%), work injuries (3.2%), and sports injuries (3%). The researchers concluded that traffic accidents remain the most common cause of maxillofacial fractures. Fractures of the facial skeleton caused by the attack increased considerably during the estimated period. Combined injuries were most often associated with road accidents. A prospective inpatient study of patients with maxillofacial trauma was conducted at the Bugando Medical Centre from November 2008 to October 2009.

The data were collected using a structured questionnaire and analysed using the SPSS (Statistical Package for the Social Sciences) version 11.5 computer programme. A total of 154 patients were examined. There are more males than females, in a ratio of 2.7:1. Their average age was 28.32 ± 16.48 years, and the modal age group was 21-30 years. The majority of injuries were caused by road accidents (57.1%), followed by attacks and falls in 16.2% and 14.3% of cases, respectively. The most frequent injuries were soft tissue injuries and fractures of the lower jaw. The most common combined injuries were head/neck injuries (53.1%) and limb injuries (28.1%). Surgical rehabilitation (95.1%) was the most common surgical procedure. Closed reduction of maxillofacial fractures was used in 81.5% of patients. Open reposition and internal fixation were performed in 6.8% of cases. Complications occurred in 24% of patients, mainly due to infection and malocclusion. The average length of hospital stay was 18.12 ± 12.24 days. The mortality rate was 11.7%. The researchers concluded that road traffic accidents remain the main etiological factor of maxillofacial injuries in the current conditions. They also noted that special attention should be paid to measures to prevent road accidents to reduce the number of such injuries.

A traffic accident is the main cause of maxillofacial trauma, which is characterised by an increasing prevalence in young people and refers to a combined injury of the upper and lower extremities, craniocerebral and eye injuries [9]. Injuries due to road accidents are the main cause of morbidity and

mortality worldwide. According to forecasts, by 2030, road accidents will become the fifth leading cause of death [10,11]. It has been reported that fractures of the frontal sinus account for 5% to 15% of all fractures of the facial part of the skull and usually occur as a result of road accidents, attacks, and sports injuries. A considerable effort is required to fracture the thick cortical bone of the face plate. This explains the high percentage of patients who had comorbidities. Such damages develop due to high-energy mechanisms [12]. High-energy trauma is more often associated with sphenoid bone fractures compared to medium- and low-energy trauma. There is a correlation between fractures of other bones of the facial skull and fractures of the sphenoid sinus and the sphenoid bone [13].

Fractures of the frontal sinus and naso-orbital-ethmoidal fractures are one of the most difficult injuries in craniofacial trauma. A multidisciplinary approach is necessary for the treatment of intracranial and orbital injuries, which are often observed in connection with these fractures. Advances in sophisticated imaging and the evolution of minimally invasive surgical techniques are introducing more conservative options that can provide better outcomes for patients while minimising the risks and complications associated with more conventional treatment approaches [12]. During the initial examination and diagnostics of a patient with a maxillofacial injury, special attention should be paid to this area due to its proximity to vital anatomical structures near the head and neck area. These structures must be carefully examined whenever an injury occurs in this area [4]. The sphenoid bone is most often broken as a result of severe cranial blunt force injuries. Fractures of the pneumatised parts of the sphenoid bone can lead to damage to the structures surrounding the walls of the sphenoid sinus. As a result, patients with sphenoid sinus fractures may suffer from such complications as damage to the internal carotid artery and leakage of cerebrospinal fluid. Previous studies noted that traumatic nasal liquorrhea was the most frequent consequence of sphenoid sinus fractures. Only fractures of the sphenoid sinus tectum were significantly associated with leakage of cerebrospinal fluid, while other areas did not show a considerable connection. Non-contrast CT is an effective screening test for assessing traumatic nasal leakage of cerebrospinal fluid in fractures of the sphenoid sinus. Clinicians still need to integrate clinical and radiographic information to determine the need for additional assessment and intervention [14].

Approximately half of the patients (n = 160, 54.6%) received surgical treatment. Open reposition and internal fixation were performed in 87 patients (29.7%). 11% of patients had no treatment. The most frequent complication was an infection of a postoperative wound or tissue near a metal structure. Similar results were obtained in previous studies. For example, in a retrospective review of the case histories of 980 patients treated for maxillofacial fractures from January 2009 to December 2011 [15], which used descriptive statistics and evaluated independent demographic and injury-related factors for their relationship to outcome using multidimensional logistic regression. A total of 1949 fractures were treated in 980 patients during the study period. The most common aetiology was an attack (n = 293, 29.90%). The majority had fractures of the eye socket (n = 359, 36.33%). In total, 803 fractures were treated promptly in 500 patients. Fractures of the lower jaw bone were more often treated surgically (79.82%). Postoperative complications occurred in 69 out of 500 operated patients (13.8%), most often due to infection of metal structures (n = 16, 3.20%). Multiple fractures were associated with a higher probability of surgical intervention ($p<0.001$) and the development of postoperative complications ($p<0.001$) compared with isolated fractures. The authors concluded that maxillofacial fractures most often affect young men, more often as a result of attacks. Among the bone injuries, fractures of the lower jaw accounted for the largest share of surgical interventions. High-energy injuries were associated with an increased risk of multiple fractures and the development of postoperative complications.

Discussion. The question of which materials for osteosynthesis are the safest in maxillofacial surgery also remains open. The use of titanium in maxillofacial fixation is limited due to its palpability, mutagenic effects, and interference with visualisation, which leads to the need for subsequent removal. The use of a biologically absorbable fixing material potentially eliminates these limitations. In a recent meta-analysis, researchers analysed the complications of absorbable fixation in maxillofacial surgery. The authors conducted a systematic search in PubMed, Embase, the Cochrane Central Register of Systematic Reviews, and the Cochrane Central Register of Controlled Trials published before December 2012. The information was obtained from 20 papers that contained data from 1,673 patients. Available data indicated that patients in the group of absorbable drugs had significantly more complications than in the titanium group (relative risk (RR) = 1.20; 95% confidence interval (CI): 1.02-1.42; P=0.03). There were no large discrepancies in the other subgroup (RR=1.89; 95% CI: 0.85-4.22; P=0.12). There was also no significant difference between the groups of absorbable and titanium materials receiving bilateral sagittal osteotomy (BSSRO) (RR = 1.45; 95% CI: 0.84-2.48; P=0.18) and Le Fort I osteotomy (RR=0.65; 95% CI: 0.34-1.23; p=0.18). After combining the results of five studies, it became clear that in the group of absorbable prostheses, the incidence

of complications during fracture fixation was significantly lower than in the titanium group (RR=0.71; 95% CI: 0.52-0.97; P=0.03). Thus, this meta-analysis shows that the absorbable fixation systems used for fixation in maxillofacial surgery do not have adequate safety profiles. The safety of absorbable fixation systems was higher when fixing fractures. Absorbable fixation systems, as a rule, have the same favourable safety profile as titanium fixation during Le Fort I, double-jaw surgery, and BSSRO [16].

In addition, the problems of anaesthesia in maxillofacial surgery were raised in scientific publications. Postoperative anaesthetic complications are very common and the duration of surgery is often called the main risk factor for postoperative complications. The identification and treatment of these complications are important to ensure quality care. The purpose of a recent study [17] was to evaluate postoperative complications of mild, moderate, and severe in patients who underwent maxillofacial surgery under general anaesthesia and to determine the safety of general anaesthesia in healthy patients and those with concomitant diseases. A prospective study was conducted in the department of maxillofacial surgery. Two hundred and twenty patients operated under anaesthesia were taken into the study. All previous corresponding medical and dental records were noted and confirmed by a pre-formulated questionnaire, which was filled out before and after surgery for up to 12 weeks. Mild, moderate, and severe complications were noted. Women had more complications than men. The most frequent complications in patients without chronic diseases were sore throat, dysphagia, nausea, vomiting, pain, oedema, and patients with concomitant diseases also experienced delayed wound healing, hypertension, and infection. The researchers concluded that the use of general anaesthesia is considered safe but is associated with risk. Before surgery, the state of health in the past should be assessed.

Factors that affect the long-term hospitalisation of cyclists and motorcyclists with injuries to the oral cavity and maxillofacial region have also been the subject of study by scientists. It was identified that the number of fracture lines and the use of jaw fixation were independent factors affecting the long-term hospitalisation of both cyclists and motorcyclists with maxillofacial injuries. Since such patients need long-term treatment, reducing the severity of such injuries is an important task to improve these people's quality of life [18]. Maxillofacial injuries occur in contact and non-contact sports. Despite advances in protective equipment and rule changes, an unacceptably high level of maxillofacial injuries persists. These injuries are clinically complex. Significant morbidity, deformity, and disability associated with these injuries can be avoided by rapid diagnosis and corresponding treatment [19]. According to the World Health Organisation, occupational injuries are one of the most considerable problems in most countries. About 125 million cases of occupational injuries are registered annually in the world. On average, there are about 220 thousand fatal accidents. To date, the mortality from injuries received at work ranks third. However, more often deaths occur only from heart and cancer diseases. In the period from 2008 to 2018, there was a positive trend in occupational injuries in Kazakhstan [20]. Head injuries can be the result of other diseases. Thus, although a close relationship was found between traumatic brain injury of <1 year and the risk of amyotrophic lateral sclerosis, this result suggests the possibility of an inverse causal relationship [21,22].

In addition, the current study did not consider bad habits and alcoholism in patients. It is known that excessive alcohol consumption is associated with a considerable proportion of violent and nonviolent deaths from injuries [23]. In the current study, treatment was divided into surgical and conservative. However, there was no emphasis on individual methods, including the use of robots. Using robotic surgical systems, maxillofacial surgery is performed with less blood loss, fewer complications, shorter hospitalisation, and better cosmetic results than standard open surgeries. Nevertheless, the use of robotic surgery methods for the treatment of head and neck diseases remains at an experimental stage and their long-term impact on surgical morbidity, cancer control, and quality of life has yet to be established. More well-planned studies are required before this approach can be recommended as a standard treatment paradigm. Nevertheless, robotic surgical systems will inevitably be extended to maxillofacial surgery [21,22]. As noted earlier, in the current study, 11% of patients had no treatment and some of them had a fatal outcome. It may also give rise to research on improving medical care. Thus, it is estimated that 45% of injury deaths can be avoided through the introduction of emergency care systems [21]. Thus, information is accumulating on various aspects of the epidemiology of injuries and fractures of the maxillofacial region.

Conclusions. In this study, the authors investigated the prevalence and clinical course of fractures of the paranasal sinuses in Astana of the Republic of Kazakhstan based on data from medical records of patients. Men aged 13-35 were the most frequently affected, and traffic accidents and motorcycle accidents were the most common causes of fractures. Nearly half of the patients (n = 160, 54.6%) received surgical treatment. Open reposition and internal fixation were performed in 87 patients (29.7%). 11% of patients had no treatment. The most

frequent complication was an infection of a postoperative wound or tissue near a metal structure. Maxillofacial injuries are a therapeutic problem for traumatologists, maxillofacial and plastic surgeons. They can also cause socio-economic consequences and have high costs for treatment and rehabilitation. Patients after such injuries may have a temporary or permanent disability. The presented data have potential significance for the development of new strategies for injury prevention and the identification of patients at risk of postoperative complications.

This study can be used in further work to identify the frequency of the pathology of diseases under consideration and also provides a basis for the development of guidelines for the treatment of injuries of the paranasal sinuses and the planning of preventive strategies. An important aspect remains focusing on further work with an increased data set size to include more parameters, such as the presence of alcohol dependence, chronic diseases, type of intervention, material of structures used, adherence to treatment, etc. In the course of the study, new questions and problems arose that need to be solved. The study was carried out only in one city, so it should be noted that a more accurate assessment of the prevalence and clinical course of fractures of the paranasal sinuses in the population of Kazakhstan can help politicians and doctors to take more effective public health measures for the prevention and treatment of this pathology.

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