

Received: 29 April 2023 / Accepted: 13 August 2023 / Published online: 31 August 2023

DOI 10.34689/SH.2023.25.4.018

UDC 616-001:611.137.9

TREATMENT OUTCOMES OF INTRA-ARTICULAR PILON FRACTURES. RETROSPECTIVE CROSS SECTIONAL STUDY

Sabina K. Aubakirova¹, <https://orcid.org/0000-0003-1730-4230>

Marat A. Zhanaspayev¹, <https://orcid.org/0000-0002-0610-0112>

Ayan O. Myssayev², <http://orcid.org/0000-0001-7332-4856>

Alexandr A. Prokazyuk¹, <https://orcid.org/0000-0002-6030-4749>

Arman C. Mussabekov¹, <https://orcid.org/0000-0001-8618-0345>

Aidos S. Tlemisov¹, <https://orcid.org/0000-0002-4239-6627>

Meirkhan Zh. Atudinov¹, <http://orcid.org/0000-0001-9995-8814>

¹ NJSC "Semey Medical University", Department of Traumatology and Pediatric Surgery, Semey c., Republic of Kazakhstan;

² Department of Science and Human Resources of the Ministry of Health of the Republic of Kazakhstan, Astana c., Republic of Kazakhstan.

Abstract

Background. Intra-articular tibia pilon fractures are quite seldom but they present a challenging issue for orthopedic and trauma surgeons as their management is difficult and comminuted pilon fractures are associated with high rate of complications. This research is aimed at elucidation of epidemiology of intra-articular pilon fractures and treatment outcomes in our practice.

Methods. Our study was based in all hospitals of East Kazakhstan region providing care to the patients with intra-articular tibia pilon fractures. We included all adult patients who were hospitalized within the period of 2014-2019. Overall, we enrolled 151 patients and three of them had injuries of both limbs (154 legs).

Results. Intra-articular tibia pilon fractures were more common among men (64.9%) and the prevailed mechanism of injury was the effect of rotational forces (53.2%). Ilizarov external fixation was the most common treatment used (22.1%), followed by the locking plate fixation (18.9%). However, almost half of the patients were undergone delayed surgical treatment in preoperative period. Approximately 20% of fractures in our study were treated conservatively with the use of cast. Such complication as postoperative wound infection was observed with locking plate fixation, while secondary displacement was more common in Ilizarov external fixation.

Conclusion. There is a room for improvement of management of intra-articular tibia pilon fractures at the hospital level of Kazakhstan.

Keywords: *pilon fracture, epidemiology, Intra-articular fracture, complications of pilon fracture, treatment of pilon fracture.*

Аннотация

ИСХОДЫ ЛЕЧЕНИЯ ВНУТРИСУСТАВНЫХ ПЕРЕЛОМОВ ПИЛОНА. РЕТРОСПЕКТИВНОЕ ПОПЕРЕЧНОЕ ИССЛЕДОВАНИЕ.

Сабина К. Аубакирова¹, <https://orcid.org/0000-0003-1730-4230>

Марат А. Жанаспаев¹, <https://orcid.org/0000-0002-0610-0112>

Аян О. Мысаев², <http://orcid.org/0000-0001-7332-4856>

Александр А. Проказюк¹, <https://orcid.org/0000-0002-6030-4749>

Арман С. Мусабеков¹, <https://orcid.org/0000-0001-8618-0345>

Айдос С. Тлемисов¹, <https://orcid.org/0000-0002-4239-6627>

Мейрхан Ж. Атудинов¹, <http://orcid.org/0000-0001-9995-8814>

¹ НАО «Медицинский университет Семей», г. Семей, Республика Казахстан;

² Департамент науки и человеческих ресурсов Министерства здравоохранения Республики Казахстан, г. Астана, Республика Казахстан.

Введение. Внутрисуставные переломы пилон (дистального метаэпифиза большеберцовой кости) голени встречаются достаточно редко, но представляют серьезную проблему для травматологов, так как их лечение затруднено, а многофрагментарные переломы пилон связаны с высокой частотой осложнений. Настоящее исследование направлено на выяснение эпидемиологии внутрисуставных переломов пилон и результатов лечения в нашей практике.

Методы. Наше исследование проводилось в 3 больницах Восточно-Казахстанской области, оказывающих помощь больным с внутрисуставными переломами пилон большеберцовой кости. Включены все взрослые

пациенты, находившиеся на стационарном лечении в период с 2014-2019 гг. Всего было госпитализировано 151 пациент, из них трое с травмами обеих конечностей (154 конечности).

Результаты. Внутрисуставные переломы пилон большеберцовой кости чаще встречались у мужчин (64,9%), преобладающим механизмом повреждения был подвывих в голеностопном суставе (53,2%). Аппарат Илизарова был наиболее распространенным методом лечения (22,1%), на втором месте накостный остеосинтез пластиной (18,9%). Однако почти половине пациентов производилось отсроченное оперативное лечение. Примерно 20 % переломов в нашем исследовании лечили консервативно с иммобилизацией гипсовой повязки. Такие осложнения, как нагноение послеоперационной раны, наблюдалось при открытом вправлении и накостном остеосинтезе пластиной, а вторичное смещение отломков чаще наблюдалось при лечении на аппарате по Илизарову.

Выводы. На основании результатов исследования пролеченных больных есть необходимость модернизация методов лечения внутрисуставных переломов пилон большеберцовой кости на госпитальном уровне Казахстана.

Ключевые слова: переломы пилон, эпителиология, внутрисуставные переломы, осложнения переломов, лечение перелом пилон.

Түйіндеме

БУЫНІШІЛІК ПИЛОН СЫНЫҚТАРЫ ЕМІНІҢ НӘТИЖЕЛЕРІ. РЕТРОСПЕКТИВТІ КӨЛДЕНЕІ ЗЕРТТЕУ.

Сабина К. Аубакирова¹, <https://orcid.org/0000-0003-1730-4230>

Марат А. Жанаспаев¹, <https://orcid.org/0000-0002-0610-0112>

Аян О. Мысаев², <http://orcid.org/0000-0001-7332-4856>

Александр А. Проказюк¹, <https://orcid.org/0000-0002-6030-4749>

Арман С. Мусабеков¹, <https://orcid.org/0000-0001-8618-0345>

Айдос С. Тлемисов¹, <https://orcid.org/0000-0002-4239-6627>

Мейрхан Ж. Атудинов¹, <http://orcid.org/0000-0001-9995-8814>

¹ «Семей медицина университеті» КеАҚ, Семей қ., Қазақстан Республикасы;

² Қазақстан Республикасы Денсаулық сақтау министрлігінің Ғылым және адам ресурстары департаменті, Астана қ., Қазақстан Республикасы.

Өзектілігі. Сирақтың буынішілік пилон сынықтары (үлкен жіліктің дистальды метаэпифизінің) өте сирек кездеседі, сонда да травматологтар үшін үлкен қиындық туғызады, себебі олардың емі оңай емес және көпфрагментарлы сынық түрлерінің асқынуларының жиілігі жоғары болып келеді. Бұл зерттеу буынішілік пилон сынықтарының эпидемиологиясы мен біздің тәжірибеміздегі емдеу нәтижелерін анықтауға арналған.

Әдістері. Біздің зерттеу үлкен жілік сүйегінің буынішілік сынықтары бар науқастарға көмек көрсетілетін Шығыс Қазақстан облысының 3 ауруханасында жүргізілді. 2013-2019 жж. аралығында стационарлық ем алған барлық ересек науқастар зерттеуге кірістірілді. Барлығы 151 науқас ауруханаға жатқызылған, олардың ішінде үшеуі екі аяқтың жарақатымен болды (154 аяқ).

Нәтижелері. Үлкен жілік сүйегінің буынішілік пилон сынықтары жиі ер адамдарда кездескен (64,9%), жарақаттын басым механизмы тобық буынындағы жартылай шығу болды (53,2%). Ең көп таралған емдеу әдісі Илизаров аппараты болды (22,1%), екінші орында пластинамен сүйекүстілік остеосинтез болды (18,9%). Бірақ науқастардың жартысына ота кешіктіріліп жасалған. Біздің зерттеудегі сынықтардың 20%-ы гипстық таңғышпен консервативті емделген. Операциядан кейінгі жараның іріңдеуі сияқты асқынулар ашық орнына келтіру мен пластинамен сүйекүстілік остеосинтезінде байқалды, ал Илизаров аппаратымен емдеу кезінде сынық бөліктерінің екіншілік ығысуы жиі байқалды.

Тұжырым. Емделіп шыққан науқастарды зерттеу нәтижелері негізінде Қазақстанда үлкен жілік сүйегінің буынішілік пилон сынықтары емінің госпитальдық деңгейде жаңғыртылуы қажет екені анықталды.

Түйінді сөздер: пилон сынықтары, эпителиология, буын ішілік сынықтар, сынықтың асқынуы, пилон сынықтарын емдеу.

Bibliographic citation:

Aubakirova S.K., Zhanaspaev M.A., Myssaev A.O., Prokazyuk A.A., Mussabekov A.S., Tlemisov A.S., Atudinov M.Zh. Treatment outcomes of intra-articular pilon fractures. Retrospective cross-sectional study // *Nauka i Zdravookhranenie [Science & Healthcare]*. 2023, (Vol.25) 4, pp. 146-152. doi 10.34689/SH.2023.25.4.018

Аубакирова С.К., Жанаспаев М.А., Мысаев А.О., Проказюк А.А., Мусабеков А.С., Тлемисов А.С., Атудинов М.Ж. Исходы лечения внутрисуставных переломов пилон. Ретроспективное поперечное исследование // *Наука и Здравоохранение*. 2023. 4(Т.25). С. 146-152. doi 10.34689/SH.2023.25.4.018

Аубакирова С.К., Жанаспаев М.А., Мысаев А.О., Проказюк А.А., Мусабеков А.С., Тлемисов А.С., Атудинов М.Ж. Буынішілік пилон сынықтары емінің нәтижелері. Ретроспективті көлденеі зерттеу // *Ғылым және Денсаулық сақтау*. 2023. 4 (Т.25). Б.146-152. doi 10.34689/SH.2023.25.4.018

Introduction

Management of pilon fractures remains one of the unresolved issues for orthopedic and trauma surgeons. Distal tibial fractures involving extra-articular fractures of metaphysis and intra-articular tibial fractures tend to be more severe in nature. All these fractures are termed as plafond or pilon fractures. Most often these fractures happen as a result of high-velocity injuries, such as a fall from height or crush injury and depend on foot position at the time of event. These injuries often require complex reconstruction with advanced soft tissue management to achieve wound and fracture healing. [4] Comminuted intra-articular pilon fractures are associated with high rate of infectious complications and non-union rates, and may result in limb loss in an otherwise fit and healthy adult. [3]

There are several classification systems used for pilon fractures. Ruedi-Allgower and AO classification systems rely on X-rays, while Leonetti and Tigani classification system is based on CT scan. In particular, Ruedi-Allgower classification considers only intrarticular fractures and distinguishes three types of them: type 1 – non displaced fracture, type 2 – fracture with large articular fragments, type 3 – fracture with comminution + impaction. [12] At the same time, AO classification system is designed to deal with distal tibial fractures (Müller AO Classification of Fractures-Long Bones) and is divided on 43-A extra-articular, 43-B partial articular, 43-C complete articular fractures, and each category is further subdivided based on amount and degree of comminution. New classification scheme developed by Leonetti and Tigani suggests 4 fracture groups: type I are all non-displaced fractures (type Ia), and all extra-articular fractures (type Ib). Type II presents in two subtypes: IIS – the fracture's line lies on the

sagittal plane and separates the pilon in a medial and a lateral fragment, and IIF – the fracture's line lies on the frontal plane and separates the pilon in an anterior and a posterior fragment. In type III fractures the bone's fragments are displaced in three parts. This group is further divided in two subtypes: IIIS – the main fracture line lies on the sagittal plane, IIIF – the main fracture line lies on the frontal plane. Type IV fractures are presented by highly comminuted articular fractures or displaced 4 parts. [7]

According to the epidemiological studies, the rate of distal metaepiphysis fractures ranges from 3 % to 10 % of all tibia fractures and composes less than 1 % of lower extremity fractures. [16] Although the epidemiology of distal metaepiphysis fractures is relatively well-studied, there is a lack of publications related to the management of these complicated injuries in world setting. Thus, the aim of this study was to evaluate treatment outcomes of intra-articular pilon fractures, as well as early and late complications in three hospital units of East Kazakhstan region over the period of six years (2014 – 2019).

Materials and methods

Study setting

Our study was based in East Kazakhstan region (EKR) of the Republic of Kazakhstan. The total population of Kazakhstan as of November 1, 2019 is 18,592,730 people. It occupies 74th place in the global list of countries in terms of population with the average density just over 6.82 people per km². The population of East Kazakhstan region is 1 369 597 people, and the population of Ust-Kamenogorsk –region's administrative center – is 331,597 people, while that of Semey – the second biggest city of the region – is 323,199 people [17] (Figure 1).

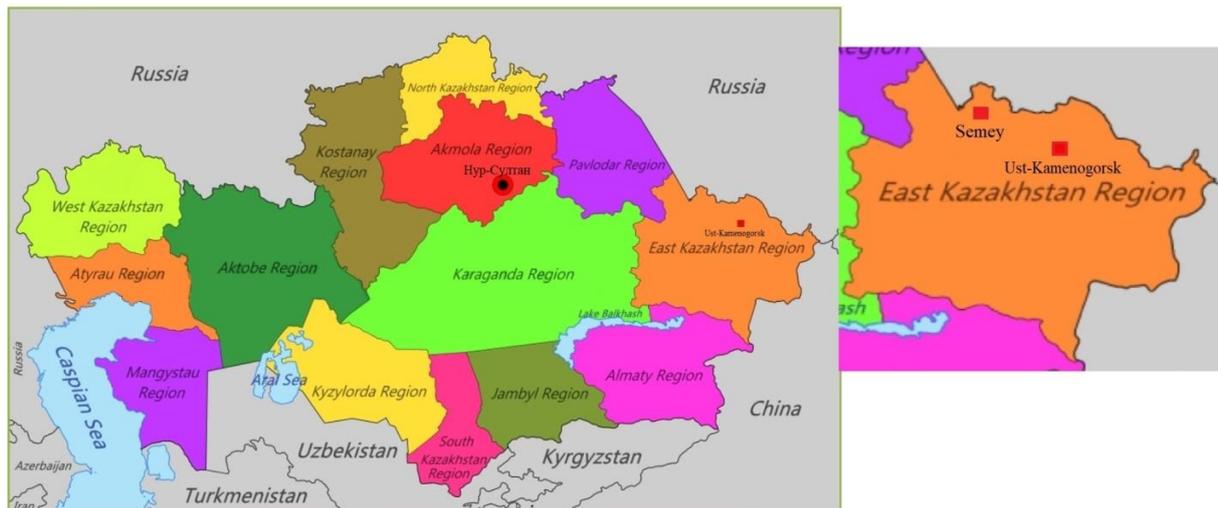


Figure 1. Map of Kazakhstan showing East Kazakhstan region and location of two largest cities (Ust-Kamenogorsk and Semey)

Study design and procedures

Three hospitals of EKR located in two largest cities provide specialized in-patient orthopedic and trauma care. Of these, Emergency hospital (Hospital 1 in our study) is located in Semey city, while two hospitals – City hospital No. 1 (Hospital 2 in our study) and Regional hospital (Hospital 3 in our study) are located in Ust-Kamenogorsk. By its design, this was a retrospective study based on the

data obtained from the electronic database of these hospitals.

After receiving written permission from the hospitals' administration, we obtained the personal files of all patients who were hospitalized with distal tibial metaepiphysis fractures within the period of six consecutive years (2014 – 2019). Out of all distal tibial metaepiphysis injuries, we manually extracted all patient files on pilon 43C multiple

comminuted fractures. From these, we retrieved information related to patient age, personal history, circumstances of the injury, X-ray descriptions, details of treatment applied, including surgical intervention, as well as treatment outcomes and complications. Due to the lack of a single Picture Archiving and Communication System (PACS), radiograms of patients were unavailable. For this reason, we used the Ruedi and Allgower classification system, and grounded our judgment on the basis of clinical diagnosis, description of surgical intervention and description of radiograms presented in the patients' files.

At the beginning of the study we obtained approval from the local Ethical Committee (Semey Medical University, protocol 2 dated 18 October, 2019). Since only anonymous patient data were used, no informed consent was needed.

Table 1 presents the basic demographics of the study population. In total, we identified 151 patients with intra-articular pilon 43C fractures. As three patients had injuries of both limbs, this study included 154 legs. The median age of all patients constituted 43 years, there were more men (64.9%) than women (35.1%). The proportion of urban population was 57.8% and rural population accounted 42.2%. Overall, 55.2 % patients were enrolled from Hospital 1, 19.5 % patients were enrolled from Hospital 2, and 25.3% patients were enrolled from Hospital 3. The most common type of fracture was type III (64.3%), following by type II (32.5%) and non-displacement type I fractures (3.2%).

Table 1.

Demographic data of study participants (n = 154 legs).

Demographic characteristics		No.	%
Gender	Male	100	64.9
	Female	54	35.1
Age	18-27	14	9.1
	28-37	25	16.2
	38-47	44	28.6
	48-57	38	24.7
	58-67	20	13
	68 and older	13	8.4
Locality	Town	89	57.8
	Village	65	42.2
Facilities	Hospital 1	85	55.2
	Hospital 2	30	19.5
	Hospital 3	39	25.3
Year of hospitalization	2014	30	19.5
	2015	20	13
	2016	29	18.8
	2017	34	22.1
	2018	17	11
	2019	24	15.6
Type of the fractures (Ruedi and Allgower classification)	Type 1	5	3.2
	Type 2	50	32.5
	Type 3	99	64.3
Type of injury	Multiple injury	23	14.9
	Isolated trauma	131	85.1
Type of fracture	Closed	132	85.7
	Open	22	14.3

Complex fractures with multiple injuries constituted 14.9%, while isolated trauma of the tibia composed 85.1%. A closed fracture without skin penetration was predominant (85.7%) as compared with open fractures (14.3%).

Inclusion criteria: All patients aged 18 years and older with traumatic intra-articular pilon fractures.

Exclusion criteria: we excluded patients with acute compartment syndrome, those who were younger than 18 years, patients who present with pathological fracture due to generalized bone or joint disease.

Definitions

We evaluated treatment outcomes on the basis of primary patient files and grounded our judgment on the fracture reduction, postoperative wound infection, and early treatment complications that were defined as the presence of hardware failure, secondary displacement of fragments, and soft tissue infection. Late complications were presented by osteomyelitis, bone defects, soft tissue defects, deformity requiring correction, and problems resulted in arthrodesis.

We studied the validity of the Foot and Ankle Outcome Score (FAOS) when used to evaluate the outcome of 51 patients (34%) out of total 151 patients (mean age 46 years), who agreed and were able to pass the questionnaire, treated from 2013 to 2019 with pilon fracture. The FAOS is a 42-item questionnaire assessing patient relevant outcomes in five separate subscales (Pain, other Symptoms, Activities of daily living, Sport and recreation function, foot and ankle-related Quality of life). The FAOS met set criteria of validity and reliability. Each question is scored on a 5-point Likert scale from 0–4 (none, mild, moderate, severe, and extreme problems). Scores are calculated for each subscale by summing the total score of each subscale and dividing it by the possible maximum score of the subscale. The normalized score is transformed to a scale of 0–100 (100 = no problems, 0 = extreme problems). [11,18] Of the 151 patients, 78 patients (52%) died or are in places inaccessible for communication with them. The rest refused to take the questionnaire.

Statistical analysis

At the first stage of statistical analyses we checked for the normality of data distribution with the help of Shapiro-Wilk test. As the data distribution has proven to be normal, the means with standard deviation (standard error) were computed. To enable comparisons between the study groups, Fisher's exact test was used. We preset the significance level of statistical tests at $p < 0.05$. All statistical tests were performed with the help of SPSS (Statistical Package for the Social Sciences) software, version 23.0 for Windows.

Results

In this study the prevailed mechanism of injury was the impact of rotational forces on leg (53.2%). This included twisting/pivoting on foot, and a fall from the stairs. The second most common mechanism of injury was fall from a height of more than 1 meter (30.5%), which included a fall from a horse (9 cases). Road traffic accidents occupy the third position (9.1%). Direct trauma implied to a drop of something heavy on a foot and was seen in 4.5% cases. Workplace accident was observed in a single case (0.6%) and in 3 cases (1.9%) the patients did not remember the circumstances of their injury (Table 2).

Table 2.

Mechanisms of injury (n = 154 legs).

Mechanism of injury	No.	%
Road traffic accident	14	9.1
Workplace accidents	1	0.6
Fall from a height (1m.)	47	30.5
Rotational forces (of the foot)	82	53.2
Direct trauma	7	4.5
Others	3	1.9

Table 3 gives an overview of treatment methods utilized for pilon fractures in three study hospitals. The most common treatment used was Ilizarov external fixation (22.1%) that was mostly applied in patients with type III fractures, which followed by locking plate fixation (18.9%). Plate fixation (7.8%) was the most frequent in type II pilon fractures. However, in preoperative period almost half of the patients underwent to skeletal traction (48.1% in type III fractures and 17.5% in type II fractures). Also, closed fracture reduction with casting was used in 100% of type I fractures, in 24% of type II fractures, and in 22.2% of type III fractures.

Table 3.

Type of treatment used (n=154 legs).

Method of treatment		Type I		Type II		Type III	
		No.	%	No.	%	No.	%
Surgical	Locking Plate fixation	0	0	11	7.1	29	18.8
	External fixation	0	0	6	4.6	33	22.1
	Pin fixation	0	0	3	2.2	2	1.4
	Screw fixation	0	0	7	4.5	4	2.6
	Plate fixation	0	0	12	7.8	10	6.5
	Intramedullary Nailing	0	0	1	0.7	2	1.3
	Primary arthrodesis	0	0	0	0	1	1.7
Conservative	Skeletal traction	0	0	27	17.5	74	48.1
	Closed reduction + Cast	5	100	12	24	22	22.2
	pinning + Cast	1	0.6	3	1.9	12	7.8
	Temporary external fixation	0		0		3	2

Table 4 presents data on treatment outcomes at the time of hospital discharge. We did not specify such treatment outcome as fracture reduction because it was observed in nearly all patients, except for those patients who had non-displaced fractures. Also we did not identify

even a single case of hardware migration in early postoperative period. Postoperative wound healing was seen almost in all cases. However, the patients didn't stay long at the hospital, so we might not trace all cases of wound infection.

Table 4.

Treatment complications at discharge (n=138 legs).

	Cast with trans articular fixation	Locking Plate fixation	External fixation	Plate fixation	p-value
Surgery wound infection	2 (5.4%)	4 (10%)	2 (5.1%)	1 (4.5%)	0.823
Secondary displacement	3(8.1%)	3(7.5%)	4(10.3%)	1(4.5%)	0.841
Skin and soft tissue infection	1(2.7%)	2(5%)	3(7.7%)	0	0.701

Table 5 presents late treatment complications requiring re-hospitalization. The need in repeated surgery means that the method of treatment was changed. Some patients were underwent skin grafting, and the correction of deformation as a secondary procedure. When patients had deep infection after pilon fractures, surgical debridement of infected bone tissue was done. Arthrodesis of ankle joint was performed only in a single case when the patient had multi-fragmented fracture with joint destruction. Such complications as arthritis and joint stiffness were excluded from the analysis as we could not trace these patients.

Table 5.

Late treatment complications (n = 31 legs).

Complications	No.	%
Osteomyelitis	3	1.9
Repeated surgery	9	5.8
Bone defect	4	2.6
Soft tissue defect (skin graft)	4	2.6
Deformation correction	7	4.5
Surgical removal of infected bone tissue	3	1.9
Arthrodesis	1	0.6

Table 6 presents the results of a questionnaire survey of patients after treatment of pilon fractures. The survey showed that the average value of the indicators of all subscales is 70.32. Whereas the largest value is 98% and, accordingly, the smallest value is 21%, also calculated the average value for each subscale of the questionnaire. Lowest scores were reported in the FAOS-QoL subscale.

Table 6.

Results of questioning on a FAOS scale.

	mean
FAOS - Sympt	67,19
FAOS - Pain	73,75
FAOS - Function	76,07
FAOS - Sport	60,38
FAOS - QoL	56

Discussion

The main purpose of the present research was to study the epidemiology of intra-articular pilon fractures and treatment outcomes in a real world practice. In overall, the frequency of occurrence of pilon fractures per 100,000 population for 2014 is 2.19, for 2015 - 1.46, for 2016 - 2.11, for 2017 - 2.48, for 2018 - 1.24, for 2019 - 1.75. The

average incidence over 6 years was 1.87 per 100,000 populations in year. It was more common for men to have pilon fractures than for women. The commonest surgical intervention was Ilizarov external fixation. Still, a significant number (around 20 %) of fractures in our study were treated conservatively since hospitals were not equipped with the necessary equipment and the doctors were not qualified enough to carry out such surgical interventions as locked plate fixation. Another common problem for Kazakhstan in medical practice is disintegration of in-patient and out-patient care and those doctors who perform surgeries do not monitor their patients after hospital discharge. A common complication of locking plate fixation was postoperative wound infection, while secondary displacement of bone fragments was frequently associated with external fixation. Such late complication as repeated surgery was the most predominant. Nevertheless, none of these differences reached the level of statistical significance as this is a seldom type of fracture. A small amount of complication was observed in our study because it was impossible to follow all the patients as they had a chance to seek for medical help at any hospital of the country.

The population in this region is mainly rural, and prevails over the urban. The mechanism of low-energy torsional injuries results in lesser articular comminution and larger fracture fragments that remain in continuity with subchondral bone structures. This type of injuries was the most common in our study (53.2 %). It has to be noted that East Kazakhstan region has long winters and icy pavements are seen almost for 6 months of the year, which predisposes to falls. The second commonest type of injury was axial compression that drives the articular surface proximally into the metaphysis, with associated metaphyseal comminution. This mechanism occurs in high-energy trauma that might be present in falls from a height and was seen in 25.3 % cases in our study. Alternatively, the same mechanism is present in road traffic accidents, which were identified in 9.1 % cases.

Globally, low-velocity traumas are less predominant among tibialpilon fractures and are typically seen in sports injuries secondary to rotational forces. In contrast with our findings, high-stress trauma is more common and produces axial transmission of the load when talus is pushed onto distal tibia that leads to multifragmentary implosion of bones and associated injury of cartilaginous structures. Such traumas are seen in road transport accidents, falls from a height, workplace accidents. [14,1,8] Also, it is important to consider the position of foot at the time of trauma. [12,1,8] [6] With the foot dorsiflexed, compressive forces are placed on the anterior part of the plafond, whereas with the foot plantar flexed the forces are directed posteriorly. If the foot is in neutral position, the axial force can also compromise the integrity of articular surface. [12,1,15] Osteoporotic changes of the bones may influence the fracture type. The soft tissue envelope in these cases may be affected by the presence of concomitant pathology due to such comorbidities as diabetes mellitus, vascular disorders, chronic intake of corticosteroids, etc. [12,2,5,13]

The search of clinical guidelines on management of intra-articular pilon fractures in open data sources helped us to identify the only guideline from the National Institute for Health and Care Excellence (UK) dated February, 2016. This

publication emphasizes the need for early intervention within the first 24 hours from a moment of trauma. Otherwise, the surgery has to be postponed until a later time due to the risk of infectious complications. According to this guideline, external fixation could be used as a method of an early intervention, while plate fixation is used at the later stages and both methods provide comparable outcomes in terms of a complication rate. If a definitive management and initial surgery cannot be performed at the receiving hospital within the first 24 hours after injury, skeletally mature adults with displaced pilon fractures need to be transferred to an orthoplastic centre. Ideally, this transfer should be performed between the emergency departments of two hospitals to avoid delay. Another indication for a transfer to orthoplastic centre is the presence of displaced pilon fractures or/and wound complications. However, it has to be noted that this guideline mostly refers to very low quality of evidence in the majority of included studies. [9]

In this study the date of hospitalization and the date of injury are different because almost half of the patients (42.2 %) came from rural settings and need to make a long trip to get specialized medical care. Some of the patients feared medical interventions and refused a surgery for this reason.

Management of intra-articular pilon fractures in East-Kazakhstan region is a complex task. Due to the lack of plates and plate-related consumables, the doctors have to make their choice in limited conditions. Still, globally external fixation and locking plates are two methods of choice used for this category of trauma. However, in three study hospitals the locking plates were introduced only in 2015 and before this most cases were treated with casting and/or external fixation and plate. Thus, there were certain problems of pilon fractures' management associated with inertia of trauma professionals and learning curve needed to master new surgical technique. Besides, the region faced periodic shortage in consumables even during the recent years. An interesting finding of this study is that temporary measures like skeletal traction were applied in 17.5% of patients with type II fractures and in 48.1% of patients with type III fractures. A definitive treatment was used after skeletal traction or casting in the majority of cases. Quite seldom, definitive fixation was used within the first 24 hours after injury (7.9%).

We were unable to track all patients with late complications as it is a common practice for Kazakhstan to enable a patient choice of healthcare establishment and some patients being dissatisfied with treatment outcomes select other hospital for complication management. Thus, the real rate of late surgical complications is likely to be even higher. Also, some patients presented with complications too late due to the fear of re-operation or treatment disappointment. Still, due to the Government's efforts, there was a significant improvement in terms of overall supply and many opportunities for qualification upgrade of medical professionals were created over recent years.

When repeated surgical intervention is needed for complication management, the method of treatment needs to be revised. The sample of such complications could be made of bone defects that resulted from multi-fragmented fracture, fractures with soft tissue injury, which required skin grafting, and correction of deformation caused by the failure of previous surgery. Also, in those patients who have osteomyelitis secondary to pilon fractures, surgical debridement of infected bone tissue is mandatory. [10, 19]

As a result of the survey and questioning, many patients are dissatisfied with the results of their treatment. Many people experience pain symptoms during physical activity, some even at rest. And it greatly influenced the quality of life of patients and their ability to work.

This study has certain strengths and limitations. First, we covered the period of six consecutive years and traced all patients with intra-articular tibia pilon fractures hospitalized to specialized medical facilities of East Kazakhstan region. However, the study limitations originate from its retrospective design and unavailability of patients' radiograms, which made us rely on Ruedi and Allgower classification system. Also, we could not accurately evaluate the late treatment complications as not all patients presented for their management at the same hospitals. Finally, the sample size was relatively small as this is a seldom type of trauma, that is why the level of significance of all statistical tests exceeded 5%.

Acknowledgments. The authors would like to express their gratitude to the administration of all study hospitals for their assistance and provision of information.

Conflict of interests. The authors declare that they have no conflicts.

Funding: The study was carried out within the framework of the grant funding project of the Ministry of Education and Science of the Republic of Kazakhstan: Individual registration number AP13067824 "Development and optimization of diagnostic methods and surgical traumatology using artificial intelligence and robotics".

References:

1. Bocchi L., Maniscalco P., Bertone C., Rivera F., Crainz E. Fractures of the tibial plafond: a comparison of treatment methods // *J Orthop Traumatol.* 2000.1:51–6. <https://doi.org/10.1007/s101950070029>
2. Calori G.M., Tagliabue L., Mazza E., de Bellis U., Pierannunzi L., Marelli B.M. et al. Tibialpilon fractures: which method of treatment? // *Int. J. Care Injured.* 2010. 41. 1183–1190. <https://doi.org/10.1016/j.injury.2010.08.041>
3. Duckworth A.D., Jefferies J.G., Clement N.D., White T.O. Type C tibial pilon fractures: short- and long-term outcome following operative intervention // *The bone & joint journal* 2016), 98-B(8) 1106–11. <https://doi.org/10.1302/0301-620X.98B8.36400>
4. Dujardin F., Abdulmutalib H., Tobenas A.C. Total fractures of the tibialpilon // *Orthopaedics & Traumatology: Surgery & Research.* 2014. 100. S65–S74. <https://doi.org/10.1016/j.otsr.2013.06.016>
5. Heim U., Näser M. Operative treatment of distal tibial fractures. Technique of osteosynthesis and results in 128 patients (author's transl) // *Archiv für Orthopädie, Mechanotherapie und Unfallchirurgie.* 1976. 86:341–56. <https://doi.org/10.1007/BF00418910>
6. Helfet D.L., Koval K., Pappas J., Sanders R.W., DiPasquale T. Intraarticularpilon fracture of the tibia // *Clinical Orthopaedics and Related Research.* 1994. 298:221–8. <https://doi.org/10.1097/00003086-199401000-00029>
7. Leonetti D, Tigani D. Pilon fractures: A new classification system based on CT scan // *Injury*, 2017, 48(10). <https://doi.org/10.1016/j.injury.2017.07.026>
8. Lovisetti G., Agus M.A., Pace F., Capitani D., Sala F. Management of distal tibial intra-articular fractures with circular external fixation // *Strategies in Trauma and Limb Reconstruction.* 2009. 4:1–6. <https://doi.org/10.1007/s11751-009-0050-7>
9. National Institute for Health and Care Excellence (UK); 2016 Feb. National Institute for Health and Care Excellence: Clinical Guidelines. (accessed 15 February 2020).
10. Quinnan S. Definitive management of distal tibia and simple plafond fractures with circular external fixation // *Journal of Orthopaedic Trauma*, 2016, 30(11). <https://doi.org/10.1097/BOT.0000000000000694>
11. Roos E.M., Brandsson S., Karlsson J. Validation of the Foot and Ankle Outcome Score for Ankle Ligament Reconstruction // *Foot and Ankle International*, 2001, 22(10). <https://doi.org/10.1177/107110070102201004>
12. Rüedi T.P., Allgöwer M. The operative treatment of intra-articular fractures of the lower end of the tibia // *Clinical Orthopaedics and Related Research*, (1979), NO. 138, 105–110. Scopus 2-s2.0-0018776466
13. Rüedi T.P. Fractures of the lower end of the tibia into the ankle joint: results 9 years after open reduction and internal fixation // *Injury*, 1973, 5(2):30–4. [https://doi.org/10.1016/S0020-1383\(73\)80089-0](https://doi.org/10.1016/S0020-1383(73)80089-0)
14. Saad B., Yingling J., Liporace F., Yoon R. Pilon fractures: Challenges and solutions // *Orthopedic Research and Reviews*, 2019, 11. <https://doi.org/10.2147/ORR.S170956>
15. Scoolaro J., Ahn J. Pilon fractures // *Clinical Orthopaedics and Related Research*, 2011, 469:621–3. <https://doi.org/10.1007/s11999-010-1509-z>
16. Sharma Jeevan K., Chaudhary P., Rijal R., Pokharel B. Randomized controlled trial comparing outcome of hybrid ilizarov versus distal tibialmetaphyseallocking plate for treatment of distal tibial fractures in adults // *Orthopaedic world congress.* 2018.
17. Statistics Department of East Kazakhstan Region Government (2013-2019). Available from: <http://www.shygys.stat.kz/>. (accessed 15 February 2020).
18. Viscarra MoUinedo H., Assessment of Quality of Life and Functional Status in Patients with Ankle Fracture Using Self-reported Outcome Instruments. Dissertation, Moscow 2011. 240 c.
19. Wyrsh B., McFerran M.A., McAndrew M., Limbird T.J., Harper M.C., Johnson K.D. et al. Operative treatment of fractures of the tibial plafond: A randomized, prospective study // *Journal of Bone and Joint Surgery - Series A*, 1996. 78(11). <https://doi.org/10.2106/00004623-199611000-00003>

Corresponding author:

Аубакирова Сабина Кайратовна – Ассистент кафедры травматологии и детской хирургии, НАО «Медицинский университет Семей», г. Семей, Республика Казахстан.

Postal address: Республика Казахстан, 071400, г. Семей, ул. Мичурина 140А.

E-mail: sabina_ak@mail.ru

Phone: 8 702 8529560