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## COMPARISON OF DIFFERENT TREATMENTS FOR PATELLAR FRACTURES

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### Abstract

**Aim:** compare the types of surgical treatment for transverse patellar fractures.

**Materials and methods:** Study design: controlled clinical trial. The study was conducted in 2015-2018 on the clinical basis of the emergency hospital in Semey. The study included 48 patients with patellar fractures, including 33 men (73.3%) and 15 women (26.7%) over the age of 18 years (the oldest patient was 77 years old at the time of injury). The average age in the group was  $48.0 \pm 4.4$  years. Depending on the treatment, all patients were divided into 2 groups: the main group and the comparison group. The first group included 24 patients - 16 men and 8 women, the second - 17 men and 7 women. The average age for the selected groups also did not differ significantly -  $48.3 \pm 4.6$  and  $47.7 \pm 4.3$ , respectively. In the main group, treatment was carried out by using an improved method of transosseous osteosynthesis. In the comparison group, the method of open immersion osteosynthesis was used.

**Research results:** Complications associated with wound infection were observed only during the implementation of open surgical osteosynthesis and were observed in 3 patients, including one in whom delayed healing of a postoperative wound was associated with the development of a deep infection that required re-intervention.

Secondary divergence of fragments took place only in one case in the main group and in two cases in the comparison group. In both patients of the comparison group, repeated surgery was required.

The incidence of post-traumatic arthritis with severe clinical manifestations was minimal - one case in each group. However, contractures of the knee joint eventually developed in three patients in the comparison group and only in one in the main group. The overall complication rate in the main group was 12.5%, in the comparison group - 41.7% (differences by 3.33 times,  $\chi^2 = 5.38$ ,  $p = 0.040$ ). Moreover, these complications developed in two patients of the main group (8.3%) and in six patients in the comparison group (25.0%). The differences in this indicator were 3-fold ( $\chi^2 = 5.03$ ,  $p = 0.044$ ).

A more significant difference between the groups was revealed in relation to the duration of outpatient treatment (almost doubled due to the need for patient rehabilitation after removal of the metal device that provided osteosynthesis). Differences in the duration of inpatient treatment were 71.4% in favor of the main group. In both cases, these differences were statistically significant ( $p < 0.001$ ).

Statistical analysis was carried out using parametric methods (Student's t test). If the t-criterion is inapplicable due to the absence of the normal distribution of the variation series, the bootstrap technique was additionally used.

**Output:** The use of the technique of transosseous osteosynthesis for fractures of the patella in comparison with open methods of submerged osteosynthesis provides a decrease in the overall frequency of complications.

**Keywords:** fracture of the patella; transosseous osteosynthesis.

### Резюме

## СРАВНЕНИЕ РАЗЛИЧНЫХ МЕТОДОВ ЛЕЧЕНИЯ ПЕРЕЛОМОВ НАДКОЛЕННИКА

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**Цель исследования** – сравнить виды хирургического лечения поперечных переломов надколенника.

**Материалы и методы.** Дизайн исследования: контролируемое клиническое исследование. Исследование проводилось в 2015-2018 гг. На клинической базе Больницы Скорой Помощи города Семей. В исследование были

включены 48 пациентов с переломами надколенника, в том числе 33 мужчин (73,3%) и 15 женщин (26,7%) старше 18 лет (самому старому пациенту на момент получения травмы было 77 лет). Средний возраст этой группы  $48,0 \pm 4,4$  года. В соответствии с проведенным лечением все пациенты были разделены на две группы: основную группу и группу сравнения. В первую группу вошли 24 пациента - 16 мужчин и 8 женщин, во вторую - 17 мужчин и 7 женщин. Средний возраст выбранных групп также существенно не отличался -  $48,3 \pm 4,6$  и  $47,7 \pm 4,3$  соответственно. В основной группе для лечения применялся усовершенствованный метод чрескостного остеосинтеза. В группе сравнения применяли метод открытого погружного остеосинтеза.

Для статистической обработки применялся параметрический метод (критерий Стьюдента). Если t-критерий был неприменим из-за отсутствия нормального распределения, дополнительно использовался метод бутстрапа.

**Результаты исследования:** Осложнения, связанные с инфицированием раны, наблюдались только при открытом остеосинтезе. У 3 пациентов было замедленное заживление раны после операции, которое связано с развитием глубокой инфекции, что потребовало вторичного оперативного вмешательства.

Вторичное расхождение фрагментов произошло только в одном случае в основной группе и в двух случаях в группы сравнения. Общим пациентам контрольной группы потребовалось повторное хирургическое вмешательство.

Заболееваемость посттравматическим артритом с тяжелыми клиническими проявлениями крайне низка - 1 случай на группу. Однако в результате контрактуры коленного сустава возникли у трех пациентов в группе сравнения и только у одного пациента в основной группе. Общая частота осложнений в основной группе составила 12,5%, а в контрольной группе - 41,7% (разница в 3,33 раза,  $\chi^2 = 5,38$ ,  $p = 0,040$ ). Кроме того, эти осложнения возникли у двух пациентов (8,3%) в основной группе и у шести пациентов (25,0%) в группе сравнения. Разница этого показателя составляет 3 раза ( $\chi^2 = 5,03$ ,  $p = 0,044$ ).

Разница во времени амбулаторного лечения между двумя группами была значимой (почти вдвое из-за необходимости реабилитации пациента после удаления металлического устройства, обеспечивающего остеосинтез). Разница во времени госпитализации составляет 71,4%, показатели были лучше в основной группе. В обоих случаях эти различия были статистически значимыми ( $p < 0,001$ ).

**Заключение:** по сравнению с методом открытого погружного остеосинтеза надколенника, чрескостный остеосинтез может снизить общую частоту осложнений.

**Ключевые слова:** перелом надколенника; чрескостный остеосинтез.

Түйіндеме

## ТІЗЕ ҮСТІ СҮЙЕГІ СЫНЫҚТАРЫНЫҢ ӘР ТҮРЛІ ЕМДЕУ ӘДІСТЕРІН САЛЫСТЫРУ

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**Зерттеудің мақсаты:** тізе үсті сүйегінің көлденең сынықтарының оперативтік ем түрлерін салыстыру.

**Материалдар мен тәсілдер:** Зерттеудің дизайны: бақыланушы клиникалық зерттеу. Зерттеу жұмысы 2015-2018 жылдар аралығында Семей қаласының жедел медициналық көмек ауруханасының клиникалық базасында жүргізілді. Зерттеуге тізе үсті сүйегі сынған 48 науқас қатысты, оның ішінде 33 ер адам (73,3%) және 15 әйел (26,7%) 18 жастан асқан (ең үлкен науқас жарақат алған кезде 77 жаста болған). Топтағы орташа жас мөлшері  $48,0 \pm 4,4$  жасты құрады. Жүргізілген емге байланысты барлық науқастар 2 топқа бөлінді: негізгі топ және салыстыру тобы. Бірінші топқа 24 науқас кірді - 16 ер адам және 8 әйел, екіншісі - 17 ер адам және 7 әйел. Тандалған топтардың орташа жасы да айтарлықтай ерекшеленбеді - сәйкесінше  $48,3 \pm 4,6$  және  $47,7 \pm 4,3$ . Негізгі топта емдеу сүйек арқылы остеосинтездің жетілдірілген әдісімен жүргізілді.

Статистикалық талдау параметрлік әдістердің көмегімен жүргізілді (Student t-критерийі). Егер t-критерийі вариация қатарының қалыпты таралмауына байланысты қолданылмаса, бутстрап әдісі қосымша қолданылды.

**Зерттеу нәтижелері:** Жараның инфекциялауымен байланысты асқынулар тек ашық хирургиялық остеосинтез кезінде 3 науқаста байқалды, оның ішінде операциядан кейінгі жараның ұзақ жазылуы қайтадан оталық емді қажет ететін терең инфекцияның дамуымен байланысты болды.

Сынық бөлітерінің екінші реттік орнынан жылжуы негізгі топта тек бір жағдайда, ал салыстыру тобында екі жағдайда болды. Салыстыру тобындағы екі науқасқа да қайталама ота жасау қажет болды.

Жарақаттан кейінгі ауыр дәрежедегі артриттің клиникалық көріністерін аз кездесті - әр топта бір жағдай. Алайда, нәтижесінде тізе буынының контрактуралары салыстыру тобындағы үш науқаста және тек негізгі топтағы біреуінде дамыды. Жалпы топтағы асқынудың жалпы деңгейі 12,5%, салыстыру тобында 41,7% құрады (айырмашылық 3,33 есе,  $-2 = 5,38$ ,  $p = 0,040$ ). Бұл асқынулар негізгі топтағы екі науқаста (8,3%) және салыстыру тобындағы алты

науқаста (25,0%) дамыды. Бұл көрсеткіштің айырмашылықтары 3 есе болды ( $-2 = 5.03$ ,  $p = 0.044$ ). Салыстыру тобында ашық, батырмалы остеосинтез әдісі қолданылды.

Топтар арасындағы айтарлықтай айырмашылық амбулаториялық емдеу ұзақтығында анықталды (остеосинтезді қамтамасыз ететін металл құрылғыны алып тастағаннан кейін науқасты оңалту қажеттілігіне байланысты екі есеге жуық). Стационарлық емдеу ұзақтығының айырмашылығы негізгі топтың пайдасына 71,4% құрады. Екі жағдайда да бұл айырмашылықтар статистикалық тұрғыдан маңызды болды ( $p < 0.001$ ).

**Қорытынды:** Тізе үсті сүйегі сынықтарының сүйек арқылы остеосинтез әдісін остеосинтездің ашық әдістерімен салыстыра отырып, асқынулардың жалпы жиілігін төмендетуге болады.

**Түйінді сөздер:** Тізе үсті сүйегінің сынығы; сүйек арқылы остеосинтез.

#### Bibliographic citation:

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**Relevance.** Nowadays, surgical methods of immersion osteosynthesis prevail in the treatment of patellar fractures [1-3]. Because a very strong fixation of the patellar fragments is required to prevent them from diverging as a result of longitudinal traction of the quadriceps femoris muscle. At the same time, the implementation of immersion osteosynthesis is accompanied with significant inconveniences, primarily the need for subsequent removal of the device, which requires repeated surgical intervention. In this regard, it seems promising to develop and improve the approach to transosseous osteosynthesis by the method of Ilizarov [4,5].

In world and domestic trauma practice, there are developments of similar methods, but they are not widespread. A potential drawback of the available treatment option is the possibility of secondary divergence of fragments or their displacement in the sagittal plane with the formation of a "step" on the posterior surface of the patella. For the prevention of these complications, it is necessary to use devices that fix the patellar fragments at least in two planes.

**Purpose of the study** - improvement of the method of transosseous wire osteosynthesis in transverse fractures of the patella and its clinical testing.

**Materials and methods.** Study design: controlled clinical trial. The study was conducted in 2015-2018 on the clinical basis of the emergency hospital in Semey. The investigation is proactive. The author of this article perfected the method of cross-osteosynthesis and on this method of cross-osteosynthesis the knee joint was obtained Kazakhstan patent (Patent № 76234 Republic of Kazakhstan, 2012). Ethical issues were observed in accordance with the order of the Ministry of Health of the Republic of Kazakhstan No. 744 dated 19.11.09 "On approval of the Rules for conducting clinical trials and testing of pharmacological and medicinal products, medical devices and medical equipment". For each patient, informed consent was filled out for interventions and participation in the study. The choice of the method of treatment was made based on the date: on counting days, transosseous osteosynthesis was performed; on countless days, the traditional method of treatment was chosen.

The study included 48 patients with patellar fractures, including 33 men (73.3%) and 15 women (26.7%) over the age of 18 years (the oldest patient was 77 years old at the time of injury). The average age in the group was  $48.0 \pm 4.4$  years. Figure 1 shows the distribution of patients by age and sex.

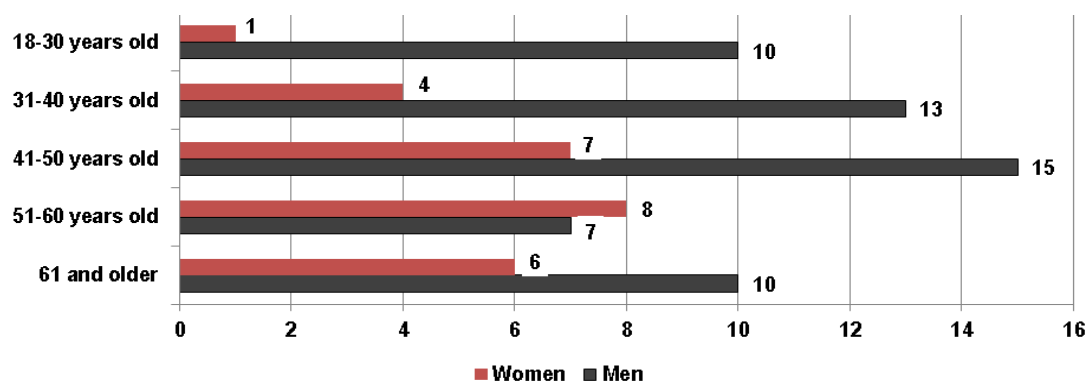
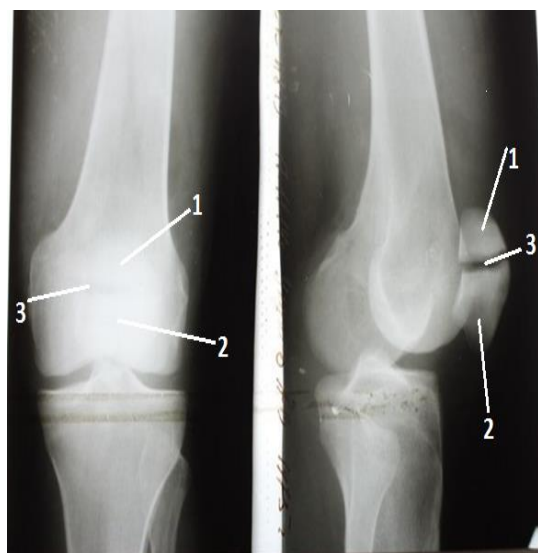


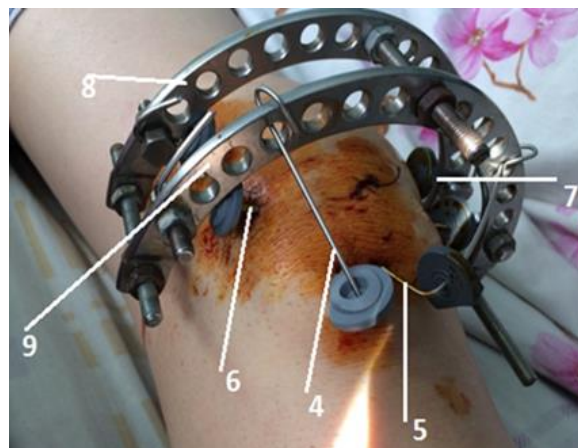
Figure 1. Age-sex distribution of patients in the general group.

There is a noticeable increase in the frequency of injuries in this category in men in relatively younger age groups.

Depending on the treatment, all patients were divided into 2 groups: the main group and the comparison group. The first group included 24 patients - 16 men and 8 women, the second - 17 men and 7 women. The average age for the selected groups also did not differ significantly -  $48.3 \pm 4.6$  and  $47.7 \pm 4.3$ , respectively.



a) radiograph



b) photo

1 - proximal fragment of the patella; 2 - distal fragment of the patella; 3 - break line; 4,5 - knitting needles held in the frontal plane; 6,7 - knitting needles held in horizontal density; 8,9 - half rings of G.A. Ilizarova.

Figure 2 (a,b). Method of transosseous osteosynthesis for patellar fractures.

The fragments are compared along the fracture line, bringing them together in the opposite direction to each other, tightly pressing against the articular surfaces of the intercondylar space of the femur. The latter method eliminates the displacement of the fragments in the sagittal plane, restoring the anatomical adherence of the articular surfaces of the patellar fragments to the cartilaginous covering of the intercondylar space of the femur.

To maintain the achieved reduction in the frontal plane, departing from the apex of the distal fragment on both sides by 0.7-1.0 cm, parallel to each other, perpendicular to the fracture line of the fragments, two spits are drawn. Spices pass through their thickness, until the sharp ends emerge to the subcutaneous layer of the apex of the proximal fragment. The condition of the patella fragments and the position of the spokes are monitored by performing X-rays.

With the correct implementation of the above methods of reposition and fixation of fragments, an adequate comparison of the fragments of the patella with each other is noted and secondary displacement of fragments is excluded when carrying out the compression pins.

Further, through the thickness of both fragments, one wire with a thrust pad is drawn in a mutually opposite direction along a horizontal plane perpendicular to the axis of the previous wires, holding the fragments in a repositioned position, until the stop of the thrust pads of the wires against the cortical layers of the fragments. The needles are fixed to the half rings of the apparatus of G.A. Ilizarov in a taut position and compress the fragments of the patella to each other along the plane of their fracture.

The degree of compression of the fragments is determined by performing control X-ray images in two

In the main group, treatment was carried out by using an improved method of transosseous osteosynthesis.

The operation was carried out as follows. Under spinal or epidural conduction anesthesia, the injured lower limb is maximally extended in the knee joint in order to remove the traction of the muscle tendon to the proximal patellar fragment and thereby facilitate relaxation of the quadriceps muscle and bring the fracture line of the patellar fragments closer to each other (Figure 2 a,b).

standard projections, until the gap between the fragments disappears. After that, the retaining fragments in the repositioned position of the 5,6 needles are removed, and if there is a danger, one of the fragments can be tilted in relation to the other, leading to their secondary displacement with the formation of a "ladder" on the articular surfaces of the patellar fragments, the distal end of these needles is shortened and left at 4-5 weeks before the formation of signs of fibrous adhesion of fragments with each other, excluding their secondary displacement.

The apparatus of two half-rings with the needles compressing fragments is left on the limb until complete fusion.

The patients of the comparison group underwent open surgical treatment (immersion osteosynthesis).

The frequency and structure of complications, the duration of inpatient and outpatient treatment, and clinical and functional outcomes were compared.

Statistical analysis was carried out using parametric methods (Student's t test). If the t-criterion is inapplicable due to the absence of a normal distribution of the variation series, the bootstrap technique was additionally used [6]. Comparison of relative values was carried out using Pearson's  $\chi^2$  test and Fisher's two-sided exact test (t).

$P < 0.05$  was taken as the boundary criterion of statistical significance for refuting the null hypothesis.

#### Research results.

Clinical results in the early and more distant period after the implementation of osteosynthesis are presented in the form of the frequency of complications (Fig. 3).

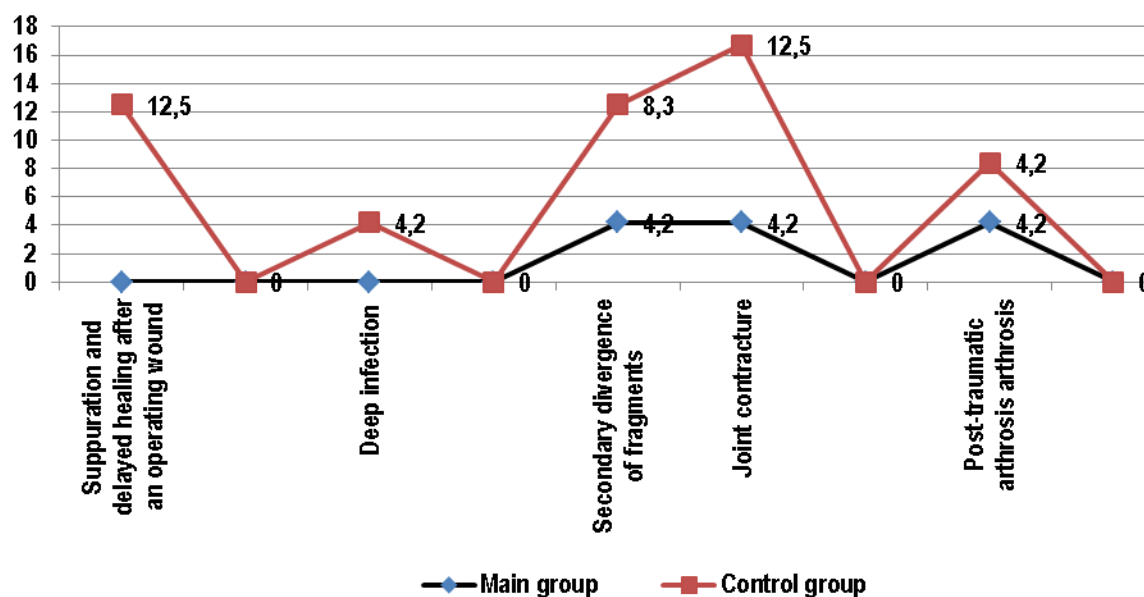


Figure 3. The frequency of complications that developed during the treatment of patellar fracture in the compared groups.

Complications associated with wound infection were observed only during the implementation of open surgical osteosynthesis and were observed in 3 patients, including one in whom delayed healing of a postoperative wound was associated with the development of a deep infection that required re-intervention.

Secondary divergence of fragments took place only in one case in the main group and in two cases in the comparison group. In both patients of the comparison group, repeated surgery was required.

The incidence of post-traumatic arthritis with severe clinical manifestations was minimal - one case in each

group. However, contractures of the knee joint eventually developed in three patients in the comparison group and only in one in the main group. The overall complication rate in the main group was 12.5%, in the comparison group - 41.7% (differences by 3.33 times,  $\chi^2 = 5.38$ ,  $p = 0.040$ ). Moreover, these complications developed in two patients of the main group (8.3%) and in six patients in the comparison group (25.0%). The differences in this indicator were 3-fold ( $\chi^2 = 5.03$ ,  $p = 0.044$ ).

Figure 4 shows the data on the duration of treatment for patients in the main group and the comparison group.

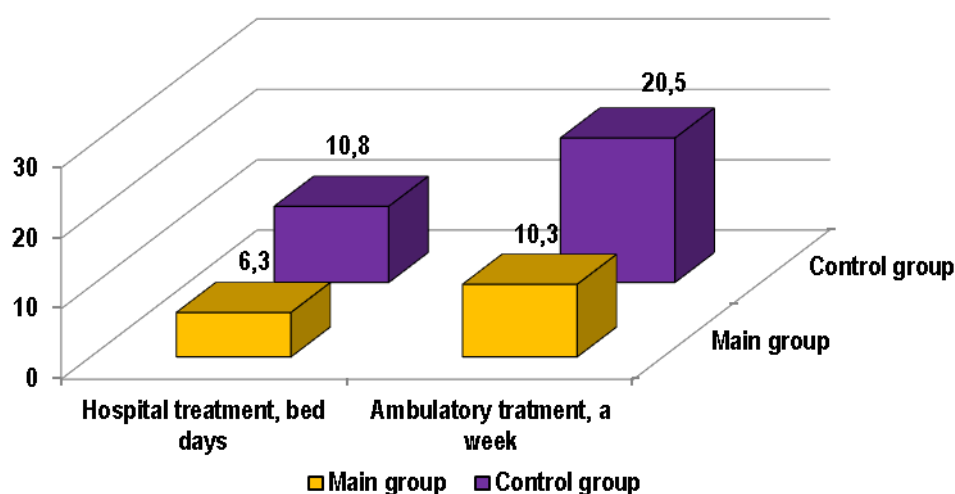


Figure 4. Duration of inpatient and outpatient treatment of patients in the compared groups.

A more significant difference between the groups was revealed in relation to the duration of outpatient treatment (almost doubled due to the need for patient rehabilitation after removal of the metal device that provided osteosynthesis). Differences in the duration of inpatient

treatment were 71.4% in favor of the main group. In both cases, these differences were statistically significant ( $p < 0.001$ ).

The structure of functional treatment outcomes is shown in Figure 5.

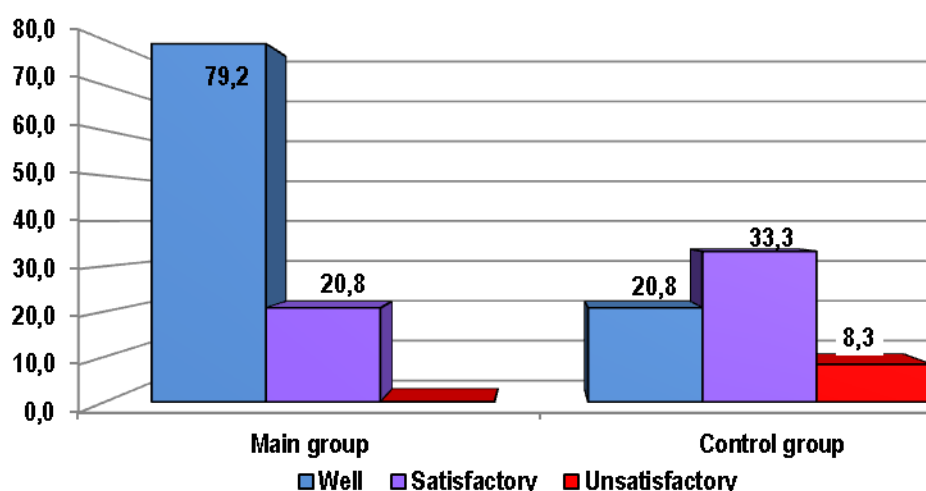


Figure 5. Functional results of treatment of patellar fractures.

It should be noted that in the main group we did not obtain unsatisfactory results, which were considered joint contractures with limited mobility of more than 50% of the required one. The structure of outcomes in this group included only good outcomes (complete recovery of mobility without pain) - 79.2% and satisfactory - 20.8%. However, there were no significant differences in outcome rates between groups.

In the comparison group, good results were observed in 58.3% of cases, satisfactory - 33.3% and unsatisfactory were obtained in two patients with complications (8.3%).

#### The discussion of the results

In the domestic trauma practice, the main place in the treatment of patellar fractures is occupied by open surgical interventions with bone osteosynthesis with various metal structures [7,8].

While there are clear advantages of this approach, including the possibility of direct reposition of fragments, in most cases of sufficient fixation efficiency, it is not without significant disadvantages. In particular, the implementation of the surgical intervention determines the presence of an operating wound, the risk of complications associated with it, and the need for additional treatment. Removal of constructions requires repeated intervention, hospitalization (albeit for a short period of time), wound treatment and prevention of wound infection [9,10].

In addition, as the literature data and our own clinical experience show, By no means in all cases the used constructions provide reliable fixation. There are cases of secondary displacement associated with the destruction of the structure or underlying bone tissue, which are among the most severe complications. In addition, the development of infection in the presence of predisposing factors or insufficiently effective prevention of it can also lead to negative results of fracture treatment in general [11,12].

In contrast to the above-described approach, the implementation of transosseous osteosynthesis is accompanied by minimal tissue trauma (it should be borne in mind that with a given localization of the fracture, no wire is passed through the articular surface).

In world and domestic clinical practice, there are examples of the use of this technique for the treatment of

patellar fractures [5,13]. In our work, we use a modified method that provides results that significantly exceed the indicators of an open operation.

#### Conclusion.

1. The use of the technique of transosseous osteosynthesis for fractures of the patella in comparison with open methods of submerged osteosynthesis provides a decrease in the overall frequency of complications by 3.33 times ( $p = 0.040$ ).

2. With the implementation of transosseous osteosynthesis, a significant reduction in the total duration of treatment of patients ( $p < 0.001$ ) is achieved both in the hospital and in the outpatient setting.

3. The functional results of treatment with transosseous osteosynthesis by the method we used are better than with open operations, although the differences were insignificant. When using transosseous osteosynthesis in our study, there were no unsatisfactory results.

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Almas Dyussupov: scientific Director

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Gulnar Gabdullina: analysis and selection of special retrospective sources;

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