

Annotation

of the dissertation work of Kasymov Kuanysh T. on the topic:
"Clinical and biomechanical substantiation of stable and functional minimally invasive fixation of sacroiliac joint injuries", submitted for the degree of Doctor of Philosophy (PhD) in the specialty 8D10102 "Medicine".

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Introduction. Various authors in their works confirm that pelvic ring injuries are relatively rare, comprising 0.3% to 8% of all fractures, occurring approximately in 20 to 37 per 100.000 population. The increase in unstable pelvic bone injuries is proportional to the rise in transportation, industrial, and domestic trauma. The treatment of pelvic bone fractures is one of the most difficult tasks in orthopedic surgery. Unsatisfactory treatment outcomes in the long-term period can range from 30 to 60%.

Relevance: Injuries to the posterior regions, including the sacrum, sacroiliac joints, and posterior portions of the iliac bones, occur in 20% to 51.0% of pelvic trauma cases. They are classified as Type C (vertically unstable, severe) and are more prevalent among younger patients (15-30 years). Most pelvic ring injuries result from high-energy traumas such as road accidents, falls from height, crush injuries, or direct impacts.

According to one study, fractures of the pelvic bones in 30% of cases are accompanied by fractures of the bones of the lower extremities, damage to the genitourinary system was found in 60% of cases, damage to the sacroiliac joints in 22.7%, sacral fractures in 23.7%, rupture of the sacroiliac joint in 51.9% of cases. A combination of a transforaminal fracture of the sacrum was also found - 21.4%.

One challenging task in orthopedic surgery is the treatment of pelvic ring injuries, with surgical methods gaining recognition. Numerous open and closed surgical stabilization methods for the pelvic ring are described in works by authors from different countries. However, the current unsatisfactory results persist, ranging from 30% to 60% according to various researchers.

The purpose of the study: Improving treatment outcomes for injuries of the sacroiliac joint.

Objectives

1. To develop an original device for minimally invasive fixation of sacroiliac joint injuries.
2. To study the biomechanical features of the developed device.
3. To develop a method of surgical treatment of sacroiliac joint injuries using a new device.
4. To conduct a comparative assessment of the results of surgical treatment using the developed device.

Scientific novelty:

For the first time:

- a new device has been developed for minimally invasive fixation of sacroiliac joint injuries with an element of compression and decompression;
- the biomechanical features of the developed device have been studied;
- the results of the clinical use of the developed device in patients with sacroiliac joint injury were studied;
- a surgical method of surgical treatment using a new device has been developed.
- based on a comparative assessment, the advantages of using a new device in comparison with the traditional method have been proven.

Main points to be defended

The use of a new device makes it possible to fix the sacroiliac joint in case of sacral dysmorphic disorder, in which it is very difficult to insert an iliosacral screw (the traditional method). The use of the original device for transforaminal fractures of the sacrum with compression of nerve roots and neurological symptoms makes it possible to perform minimally invasive decompression.

Implementation of the research results:

- Eurasian Patent for invention No. 037735. Device for minimally invasive blocking osteosynthesis of sacroiliac joint injuries.
- Patent of the Republic of Kazakhstan No. 34591. Device for minimally invasive blocking osteosynthesis of sacroiliac joint injuries.
- Methodological recommendation "Minimally invasive blocking osteosynthesis of sacroiliac joint injury", Semey, 2020. ISBN 978-601-7990-23-7.
- Monograph " Diagnosis and complex treatment of pelvic and acetabulum fractures", Semey, 2020. ISBN 978-601-7278-06-9.
- The main results of the dissertation are used in the educational process at the Department of Traumatology and Orthopedics of NAO "Medical University Semey" in the training of residents, orthopedic traumatologists at advanced training courses, as well as in the examination and treatment of patients with damage to the sacroiliac joint at the Trauma Center and Orthopedics Department of the State Public Healthcare Institution "Emergency Hospital" in Abai Region, the Trauma and Endoprosthetics Department of the State Public Healthcare Institution "Multispecialty City Hospital No. 1" in the city of Astana, and the State Public Healthcare Institution "Shymkent City Multispecialty Hospital".

Publications

7 works have been published on the subject of the dissertation. Of them, 3 - in the materials of international and republican scientific-practical conferences. One article - in the journal "Georgian Medical News", which has a percentile of 26 in the Scopus database. Three articles were published in scientific editions recommended by the Committee for Control in the Sphere of Education and Science.

General characterization of materials and methods of research.

The research work was performed under the grant funding project of the Ministry of Education and Science of the Republic of Kazakhstan (IRN AP05135531) "Development of a system of orthosurgical rehabilitation of pelvic bone injuries in

road traffic accidents in the Republic of Kazakhstan" (2018-2020). Approval of the Ethical Committee of the NAO "Semey Medical University" was obtained (Minutes No. 2 of October 18, 2019).

At the first stage, the current ideas about the epidemiology of pelvic ring injuries, the applied anatomy of the pelvic ring, the classification of pelvic ring injuries, the clinical and instrumental diagnosis of pelvic ring injuries, and the tactics and methods of treatment of pelvic ring injuries were studied. The literature review included an in-depth review of 286 literature sources. The literature review utilized medical information databases such as: Pubmed, Cophrane Library, TripDatabase, Asademu Global, normative-legal acts of the Republic of Kazakhstan, domestic and foreign dissertations were studied.

At the second stage, a device for minimally invasive compression-distraction block osteosynthesis of sacroiliac joint injuries was developed.

The original device is manufactured in one of the major manufacturers of implants for osteosynthesis ChM z.o.o., Republic of Poland, made of titanium and its alloys in accordance with the requirements of ISO 5832 standard.

In the third stage, the biomechanical features of the developed original device were studied. Biomechanical tests were performed and logged in the Research and Development Department of ChM z.o.o., Republic of Poland in compliance with international standards.

At the fourth stage of the study, we developed a technique of surgical treatment of sacroiliac joint injuries, for the performance of which we created a special set of instruments

At the fifth stage, we performed a comparative evaluation of the treatment results in patients with sacroiliac joint injury using the developed original device.

We have developed an excerpt map based on the analysis of literature data, taking into account the main factors necessary for comparative analysis.

The observation period is from June 2019 through August 2022.

Base of the study - the Trauma Center and Orthopedics Department of the State Public Healthcare Institution "Emergency Hospital" in Abai Region, the Trauma and Endoprosthetics Department of the State Public Healthcare Institution "Multispecialty City Hospital No. 1" in the city of Astana, and the State Public Healthcare Institution "Shymkent City Multispecialty Hospital".

Study design: a randomized controlled trial.

Sixty patients with sacroiliac joint injury were included in the study and divided into control and experimental groups. Since sacroiliac joint injury is rare, we performed a continuous sampling.

The evaluation of treatment efficacy included pain assessment at discharge, pain assessment at 3, 6 and 12 months after surgery, and disability time. In addition to clinical criteria, the assessment of treatment results involves the study of patient's quality of life in the long-term period using the Majeed Pelvic Score.

CONCLUSION

Patients with high-energy trauma to the pelvic bones experience a decrease in quality of life in the first 6 months, followed by rapid recovery by 12 months after injury, but do not reach the same level at five-year follow-up. Quality of life and physical activity at a mean follow-up of 4.4 years in patients with pelvic bone fractures are lower than the population average in the corresponding age group. Treatment of pelvic bone fractures is one of the most difficult tasks in orthopedic surgery and unsatisfactory long-term results can range from 30 to 60% according to different sources.

Thus, improving the diagnosis and increasing the effectiveness of treatment of sacroiliac joint injuries remains one of the most urgent problems of traumatology today. The aim of our study was to improve the results of treatment of sacroiliac joint injuries.

Within the framework of the conducted research we have developed a new device for minimally invasive blocking osteosynthesis of KPS injuries with elements of compression and distraction, studied biomechanical features of the developed device, developed a method of operation using the new device, studied the results of clinical use of the device in patients with KPS injuries and proved the advantages of using the device in comparison with traditional methods on the basis of comparative evaluation.

The findings of the study led to the following conclusions:

1. An original device for minimally invasive locking osteosynthesis of sacroiliac joint injuries was developed. 2 patents for invention were obtained:

- Eurasian patent for invention No. 037735. Device for minimally invasive locking osteosynthesis of injuries of the sacroiliac articulation / Appl. 2019.07.29. Publ. 2021.02.26. Bulletin No. 2.

- Patent of the Republic of Kazakhstan № 34591. Device for minimally invasive blocking osteosynthesis of injuries of the sacroiliac joint / Published 13.11.2020. Bulletin No. 45.

The advantages of the device are the following: it allows not only compression, but also distraction of bone fragments due to the oblong hole and built-in sleeve in the proximal part of the cannulated rod, and stable fixation in the same position. The possibility of distraction of bone fragments allows to widen the sacral foramen in transforaminal fractures of the lateral mass of the sacrum with compression of nerve structures. The device is applicable in sacral dysmorphism, where traditional iliosacral screws are very difficult to insert. The minimally invasive technique of the surgery allows early rehabilitation of the patient. Placement of the device on the dorsal surface of the sacrum reduces the risk of damage to roots and vessels.

2. Biomechanical testing of the device with three static and two dynamic loads was performed. The results of the biomechanical tests showed the following characteristics:

- at a torsion speed of 360°/min, moment of force 28.8 Nm damage to the screw threads occurred only at an angle of 52°, and failure at the connection point between the rod sleeve and the screw occurred only at a torsion speed of 60° and a moment of force 31.3Nm;

- In static compression tests, the device was damaged at a load level of 13121N (1327.9kg) and 13664N (1393.3kg) in tensile tests;
- In dynamic compression tests, the design carried a maximum load of 1750N for 117,000 cycles and a minimum load of 750N for 1 million cycles;
- in dynamic tensile tests, the strength of the structure reached a maximum of up to 6500N for 600 cycles and a minimum of 1750N for 1 million cycles;

Based on the biomechanical studies, it is safe to state that the developed original device has sufficient biomechanical strength.

3. A surgical technic for fixation of sacroiliac joint with a new device was developed, which is conditionally divided into three main stages:

I. Drilling of the posterior iliac spines for correct placement of the guide spoke.

II. Installing the device and blocking the vitamins.

III. Creating compression or distraction by rotating the integrated sleeve in the proximal part of the rod with a screwdriver.

A special set of tools has been created for this mode of operation.

4. The comparative evaluation of the treatment results using the developed original device showed that the use of the original device allowed to reduce the duration of the treatment period (on average 11 days earlier patients were discharged). It was 1.5 times higher than in the control group. Absence of pain in patients on the third day in comparison after 12 months increased from 13,3% (n=4) to 86,7% (n=26) in the experimental group and from 10% (n=3) to 66,6% (n=20) in the control group. According to the Majid scale in the remote period (3,6 and 12 months) the frequency of excellent results increased from 13,3% to 90,0% in the experimental group, and in the control group from 10% to 73,4%.

Thus, according to the obtained conclusions, we can say that the purpose of the study has been achieved. The results of treatment of sacroiliac joint injuries have been improved.