

A clinical case

Osteosynthesis of a Periprosthetic Fracture of the Proximal Femur Type B2 Using a Developed Anatomical Locking Plate. A Case Report

[Amanzhol Balgazarov](#)¹, [Serik Balgazarov](#)², [Ruslan Abilov](#)³, [Ruslan Botaev](#)⁴,
[Alexandr Krikliyvy](#)⁵, [Yersultan Alzhanov](#)^{6*}

Received: 24 December 2026

Revised: 02 February 2026

Accepted: 17 February 2026

Published: 28 February 2026

Citation: Amanzhol Balgazarov, Serik Balgazarov, Ruslan Abilov, Ruslan Botaev, Alexandr Krikliyvy, Yersultan Alzhanov. Osteosynthesis of a Periprosthetic Fracture of the Proximal Femur Type B2 Using a Developed Anatomical Locking Plate. A Case Report. *Trauma & Ortho Kaz*, 2026, 77 (1), jto041.

<https://doi.org/10.52889/1684-9280-2026-77-1-jto041>

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¹ Trauma Surgeon, Department of Traumatology Number 4, National Scientific Center of Traumatology and Orthopedics named after academician N.D. Batpenov, Astana, Kazakhstan.

E-mail: amanzhol.balgazarov@gmail.com

² Deputy Director for Clinical Affairs, National Scientific Center of Traumatology and Orthopedics named after Academician N.D. Batpenov, Astana, Kazakhstan. E-mail: serik.bal@mail.ru

³ Head of the Department of Traumatology Number 4, National Scientific Center of Traumatology and Orthopedics named after Academician N.D. Batpenov, Astana, Kazakhstan.

E-mail: abilovruslan79@gmail.com

⁴ Head of the Department of Polytrauma, Arthroplasty, and Combustiology, Multidisciplinary City Hospital Number 1, Astana, Kazakhstan. E-mail: Botaev_76.kz@mail.ru

⁵ Trauma Surgeon, Department of Traumatology Number 4, National Scientific Center of Traumatology and Orthopedics named after academician N.D. Batpenov, Astana, Kazakhstan.

E-mail: krikliyvialexandr@gmail.com

⁶ PhD student, Karaganda Medical University, Karaganda, Kazakhstan. E-mail: ersyultan@gmail.com

*Corresponding author: ersyultan@gmail.com

Abstract

The rising global volume of joint replacement procedures has led to a significant increase in the incidence of periprosthetic femoral fractures, highlighting an urgent need for less invasive surgical alternatives for medically frail patients and those at high surgical risk. This report presents the experience of successful osteosynthesis of a type B2 fracture according to the Vancouver classification using a new anatomical blocking plate as an alternative to technically complex revision arthroplasty. Internal fixation with an anatomic locking plate in a fracture type B2 according to the Vancouver scale provided stable consolidation, as evidenced by a Harris hip score of 91 and an Oxford hip score of 42. Restoration of range of motion up to 90 degrees of flexion without implant migration demonstrates that this method can be an effective, less traumatic alternative to revision surgery. Such an approach can allow to stabilize the bone-implant structure and start the early mobilization of patients with a high surgical risk.

Keywords: periprosthetic femoral fractures, Vancouver classification, open reduction and internal fixation, anatomical locking plate, revision arthroplasty.

1. Introduction

The global incidence of primary and revision total hip arthroplasty (THA) is steadily rising, driven by an aging population and the expansion of surgical

indications to younger, more active cohorts [1,2]. Consequently, there has been a parallel increase in the frequency of postoperative periprosthetic femoral

fractures (PPFs), which represent one of the most challenging complications in contemporary orthopedic surgery [1-3]. These fractures impose a substantial healthcare burden, characterized by significant patient morbidity, high perioperative mortality rates, and profound socio-economic costs [2,4,5].

To effectively standardize surgical management, the Vancouver classification system is universally recognized and widely adopted [1,6,7]. Type B fractures, which occur around or just distal to the prosthetic stem, account for approximately 80% of all PPFs [1]. Specifically, Vancouver type B2 fractures are defined by a loose femoral stem in the presence of adequate surrounding bone stock [1,3,6]. According to the traditional Vancouver algorithm, the established «gold standard» for B2 fractures is revision arthroplasty (RA), utilizing a long-stem prosthesis that bypasses the fracture site to achieve stable diaphyseal fixation [1,7].

Despite its status as the standard of care, RA is a technically demanding, invasive, and expensive procedure [6,7]. Patients presenting with PPFs often exhibit significant somatic frailty and multiple

comorbidities, which may limit their tolerance for extensive revision surgeries regardless of chronological age [7]. As a result, less invasive therapeutic alternatives have gained significant clinical traction [8]. Recent literature increasingly supports open reduction and internal fixation (ORIF) alone, utilizing locking compression plates (LCP) – such as specifically developed anatomical locking plates or reversed contralateral distal femoral LISS® plates – as a viable alternative to RA for Vancouver B2 fractures [5,6,9]. Internal fixation offers distinct advantages, including reduced operative time, cost-effectiveness, and the preservation of bone stock [10].

The aim of this article is to present a clinical case of successful osteosynthesis for a Vancouver type B2 periprosthetic femoral fracture using a novel anatomical locking plate designed to achieve stable fixation and preserve bone stock as an alternative to revision arthroplasty. This case report conforms to the CARE guidelines and the EQUATOR network.

2. Clinical Case Description

Patient Information and Clinical History

A 53-year-old male patient presented to the emergency department with acute pain in the right hip and a complete inability to bear weight on the limb after a fall from standing height. Ten months prior, he had undergone a total hip arthroplasty (THA) using a

Stryker implant due to a femoral neck fracture. Upon admission, the patient's general condition was of moderate severity. Informed consent was obtained from the patient for the inclusion of his clinical data and imaging in this report.



Figure 1 - Preoperative anteroposterior radiograph of the right hip

Physical Examination

Clinical evaluation of the right lower extremity revealed: external rotation of the foot and a 1.0 cm shortening of the limb; presence of a well-healed, 13.0 cm linear surgical scar on the lateral aspect of the

proximal thigh from the previous THA; significant tenderness upon palpation of the proximal third of the femur, with pain exacerbated by axial loading; a positive «stuck heel» sign; no distal neurovascular

deficits were observed; peripheral pulses were palpable and warm.

Diagnostic Assessment

Anteroposterior radiography of the right hip revealed a spiral comminuted periprosthetic fracture of the proximal femur. Observations included significant fragment displacement around the stem and signs of prosthesis instability, consistent with a Vancouver type B2 classification (Figure 1).

Although the fracture was radiographically classified as Vancouver type B2 due to the fracture pattern and fragment displacement around the femoral component, detailed CT analysis and intraoperative assessment demonstrated that the prosthesis retained sufficient functional stability (Figure 2).



Figure 2 - Preoperative multi-slice computed tomography (CT) scans. Detailed visualization (a–g) of the fracture geometry and the involvement of the greater trochanter, used for precise surgical planning

This clinical finding, combined with the patient's high surgical risk, justified the use of a custom-designed anatomical locking plate. The application of this plate facilitated stable osteosynthesis at the fracture site, eliminating the need for femoral component revision.

Preoperative 3D modeling was utilized to analyze the fracture geometry and plan the fixation strategy (Figure 3).

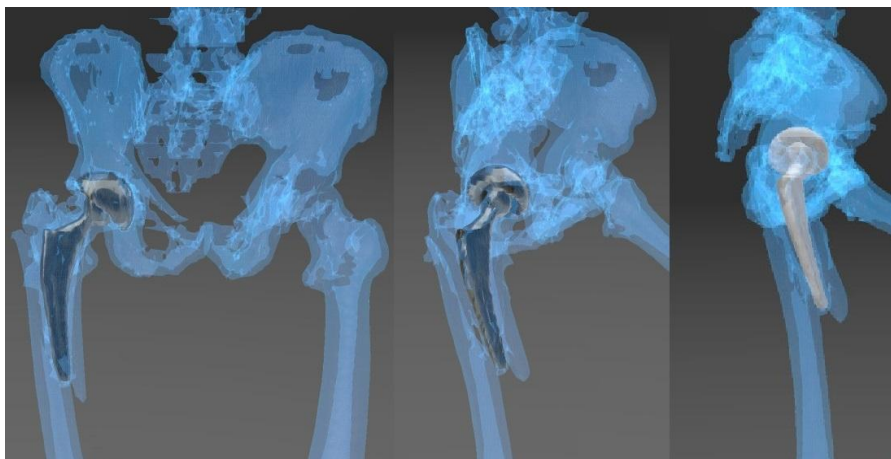


Figure 3 - Preoperative 3D digital reconstruction and modeling of the right proximal femur. The three-dimensional visualization allows for a comprehensive assessment of the Vancouver type B2 periprosthetic fracture geometry, demonstrating the spatial orientation of the comminuted fragments in relation to the stable prosthesis stem for precise surgical planning.

Therapeutic Intervention

Considering the high surgical risk and the confirmed stability of the stem, a decision was made to perform internal fixation using a developed anatomical locking plate as a less invasive alternative to revision arthroplasty (Figure 4a, 4b). The procedure

was performed under general anesthesia. Initially, a closed reduction of the femoral fragments was achieved on an orthopedic traction table and verified via fluoroscopy. The fracture was provisionally stabilized with three K-wires, followed by the application of three cerclage wires.



Figure 4 - The developed anatomical locking plate designed for periprosthetic fracture fixation: (a) Anterior view: Illustrates the unique configuration of locking screw holes in the proximal segment, specifically engineered to allow for bicortical screw placement around the prosthesis stem. (b) Lateral view: Demonstrates the pre-contoured anatomical curvature and integrated cerclage-positioning holes that prevent wire migration along the plate

The innovative locking plate was then inserted submuscularly. The specific design of this plate offered two critical advantages: bicortical fixation – specially oriented screw holes in the proximal segment allowed for 65mm screws to achieve stable bicortical placement

without interfering with the existing prosthesis stem; stable cerclage – dedicated holes along the plate prevented the cerclage wires from shifting, ensuring long-term construct rigidity.



Figure 5 - Postoperative anteroposterior radiograph of the right femur. The image demonstrates stable internal fixation of the Vancouver type B2 periprosthetic fracture using the developed anatomical locking plate

The final construct was secured distally with one cortical and two locking screws, while the proximal part was fixed with six specialized screws. Total operation time was 125 minutes with an estimated blood loss of 800 ml.

Post-operative findings

Postoperative radiographic control confirmed satisfactory alignment and anatomical reduction of the bone fragments (Figure 5).

Control Radiography: Confirmed satisfactory alignment of the fragments and stable positioning of the internal hardware.

Duplex Ultrasound (Venous): Performed on the first post-operative day; no evidence of deep vein

thrombosis (DVT) was detected in the lower extremities.

Follow-up and Outcomes

The patient received a standard post-operative regimen including Ceftriaxone and Ciprofloxacin for infection prophylaxis, and Enoxaparin/Rivaroxaban for thromboprophylaxis. He was discharged on the 7th post-operative day.

The clinical and functional outcomes demonstrated consistent and significant improvement throughout the 28-week follow-up period.

Range of Motion (ROM): A marked increase in hip mobility was observed. Flexion improved from 50° at 6 weeks to 90° by the 15th week, and extension reached 15° by the 28-week mark (Figure 6a, 6b).

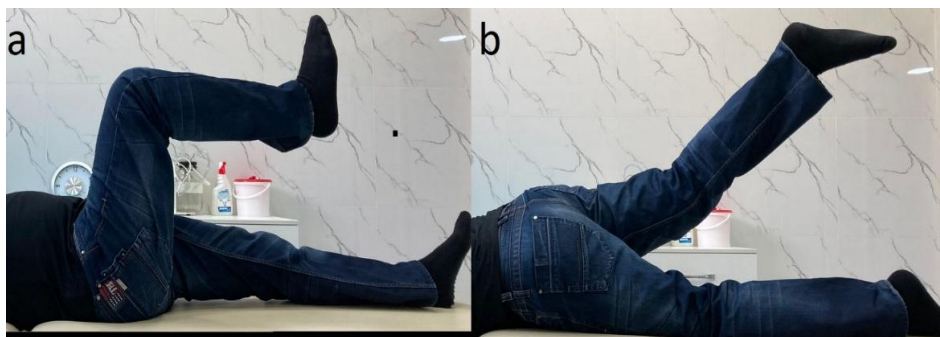


Figure 6 - Clinical assessment of hip flexion (a) and extension (b) at 28 weeks postoperatively

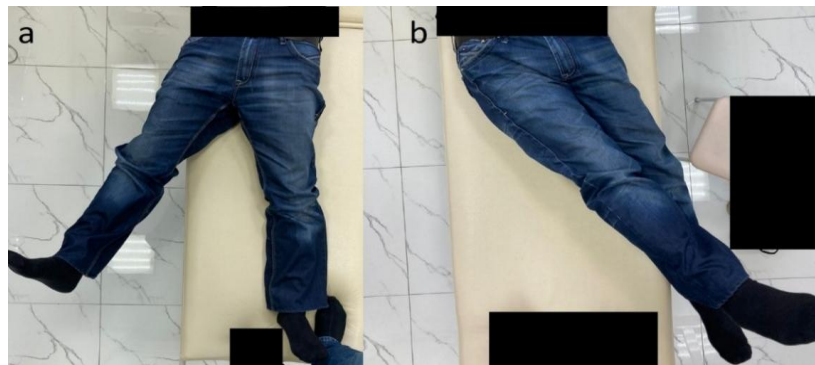


Figure 7 - Clinical assessment of hip abduction (a) and adduction (b) at 28 weeks postoperatively

Abduction and adduction reached 25° and 20°, respectively, at the final follow-up examination (Figure 7a, 7b).

Functional Scoring: By the end of the observation period, the patient had successfully returned to his baseline level of physical activity and was able to move independently with full weight-bearing on the operated limb. The patient's Harris Hip Score (HHS) increased

from 54 points at the 6-week mark to 91 points by the 28th week, transitioning from a «poor» to an «excellent» clinical grade. Similarly, the Oxford Hip Score (OHS) improved from 21 to 42 points during the same interval, reflecting a substantial reduction in pain and improvement in the quality of daily activities (Table 1).

Table 1 - Longitudinal Assessment of Clinical Outcomes and Hip Range of Motion

Follow-up Interval	Flexion (°)	Extension (°)	Abduction (°)	Adduction (°)	Harris Hip Score	Oxford Hip Score
6 weeks	50	10	10	15	54	21
15 weeks	90	10	20	15	71	28
28 weeks	90	15	25	20	91*	42

*Indicates an "Excellent" functional outcome according to clinical grading.

Radiographic and Clinical Status: Control radiographs at 28 weeks confirmed complete consolidation of the periprosthetic fracture. No

evidence of hardware failure, locking plate migration, or prosthesis instability was detected (Figure 8a, 8b).

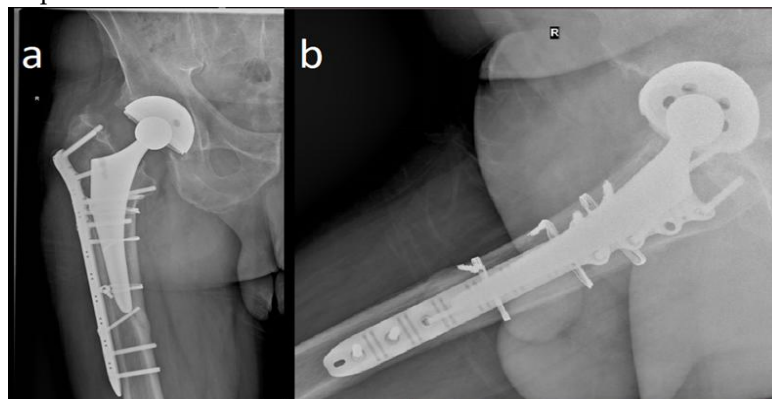


Figure 8 - Follow-up radiographs of the right hip joint: (a) anteroposterior and (b) lateral views. The images demonstrate complete consolidation of the periprosthetic fracture, stable positioning of the internal fixation (plate and screws), and correct alignment of the endoprosthesis components.

3. Discussion

Mechanical complications following total hip arthroplasty, including aseptic instability and periprosthetic fractures, represent a significant challenge that leads to limb dysfunction and a substantial decline in patient quality of life. Our previous research has demonstrated that the incidence of various paraprosthesis complications remains high, with technical errors during primary implant installation and specific design features playing a critical role in the development of postoperative instability. This clinical experience underscores the urgent need for the development and implementation of innovative fixation systems, such as the anatomical locking plate presented in this study, to minimize risks during revision interventions [11].

The clinical outcomes obtained in this case, specifically a Harris Hip Score (HHS) of 91 points, are comparable to the parameters of successful revision arthroplasty reported by Alfonso et al. [1] (mean HHS of 91 points) and exceed the average clinical values for osteosynthesis reported by Spina and Scalvi (mean HHS of 71.8) [7]. The high efficacy of utilizing locking plates for a loose stem is corroborated by the findings of Schmid et al., who demonstrated excellent and good radiographic results in 93% of patients when employing contralateral reversed LISS plates [5].

Furthermore, Spina and Scalvi emphasize that internal fixation for Vancouver B2 fractures is a justifiable option in cases where the fracture does not extend beyond the tip of an uncemented straight stem (Johansson type 1), thereby facilitating the restoration of primary mechanical stability [7].

In contrast to standard protocols that recommend prolonged weight-bearing restrictions of up to 6 weeks, early mobilization and activation in our case did not result in clinically significant subsidence or destabilization of the prosthetic stem. Secure fixation provided by the anatomical plate, in conjunction with cerclage wiring, ensured high construct rigidity and effectively mitigated the risk of implant migration.

The substantial improvement in the range of motion (ROM) and the alleviation of pain by the 28-week follow-up substantiate the adequacy of the implemented rehabilitation protocol and the stability of the fixation, as confirmed on follow-up radiographs.

Therefore, osteosynthesis utilizing anatomical locking plates constitutes a safe and efficacious treatment modality for Vancouver B2 fractures in high-surgical-risk patients, offering a viable means to circumvent the highly traumatic procedure of stem revision.

5. Conclusions

Internal fixation with an anatomic locking plate in a fracture type B2 according to the Vancouver scale provided stable consolidation, as evidenced by a Harris hip score of 91 and an Oxford hip score of 42. Restoration of range of motion up to 90 degrees of flexion without implant migration demonstrates that this method can be an effective, less traumatic alternative to revision surgery. Such an approach can allow to stabilize the bone-implant structure and start the early mobilization of patients with a high surgical risk.

Conflicts of Interest: The authors declare no conflicts of interest.

Funding. This study is funded by the Committee of Science of the Ministry of Science and Higher

Education of the Republic of Kazakhstan "Development, study of safety and effectiveness of premium innovative domestic implants for surgical treatment of patients with injuries and diseases of the musculoskeletal system" (BR21881815).

Author Contributions. Conceptualization - S.B.; methodology - S.B., A.B.; validation - A.B.; formal analysis - A.K.; investigation - A.B.; resources - A.B., A.R.; data curation - R.A.; writing – original draft preparation - A.B.; writing – review and editing - S.B., R.B.; visualization - R.A.; supervision - A.B.; project administration, S.B.

All authors have read and agreed to the published version of the manuscript.

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В2 типті проксимальды сан сүйегінің перипротетикалық сынығын анатомиялық бұғаттаушы пластинаны қолдана отырып остеосинтездеу. Клиникалық жағдай

[Балгазаров А.С.](#)¹, [Балгазаров С.С.](#)², [Абилев Р.С.](#)³, [Ботаев Р.С.](#)⁴,
[Крикливый А.А.](#)⁵, [Альжанов Е.Е.](#)^{6*}

¹ №4 травматология бөлімінің травматолог-дәрігері, Академик Н.Д. Батпенев атындағы ұлттық ғылыми травматология және ортопедия орталығы, Астана, Қазақстан. E-mail: amanzhol.balgazarov@gmail.com

² Медицина ғылымдарының кандидаты, жоғары біліктілік санатты травматолог-ортопед дәрігері, клиникалық жұмыс жөніндегі директордың орынбасары, Академик Н.Д. Батпенев атындағы ұлттық ғылыми травматология және ортопедия орталығы, Астана, Қазақстан. E-mail: serik.bal@mail.ru

³ №4 травматология бөлімшесінің меңгерушісі, Академик Н.Д. Батпенев атындағы ұлттық ғылыми травматология және ортопедия орталығы, Астана, Қазақстан. E-mail: abilovruslan79@gmail.com

⁴ Политравма, эндопротездеу және комбустиология бөлімшесінің меңгерушісі, №1 көпбейінді қалалық аурухана, Астана, Қазақстан. E-mail: Botayev_76.kz@mail.ru

⁵ №4 травматология бөлімінің травматолог-дәрігері, Академик Н.Д. Батпенев атындағы ұлттық ғылыми травматология және ортопедия орталығы, Астана, Қазақстан. E-mail: kriklivyalexandr@gmail.com

⁶ PhD докторанты, Қарағанды медицина университеті, Қарағанды, Қазақстан. E-mail: ersyltan@gmail.com

Түйіндеме

Буындарды алмастыру операцияларының жаһандық көлемінің артуы сан сүйегінің перипротездік сынықтары жиілігінің айтарлықтай өсуіне әкелді. Бұл ауыр ілеспелі аурулары бар және жоғары операциялық қаупі бар науқастар үшін аз инвазивті хирургиялық балама әдістердің шұғыл қажеттілігін көрсетеді.

Мақалада Ванкувер жіктемесі бойынша В2 типіндегі сынықты ашық репозициялау және ішкі бекітудің сәтті клиникалық жағдайы ұсынылған. Емнің нәтижесінде науқаста Харрис жамбас ұпайы бойынша 91 және Оксфорд жамбас ұпайы бойынша 42 баллды құрады. Импланттың миграциясынсыз қозғалыс диапазонын 90

градуска дейін бүгу қалпына келтіру қолданылған әдістің қайталау хирургиясына тиімді, аз жарақатты балама болуы мүмкіндігі бар екенін көрсетеді. Тәсіл сүйек-имплант конструкциясын сәтті тұрақтандыратын және хирургиялық қауіп жоғары науқастар үшін ерте жұмылдыруға мүмкіндік ретінде қарастырылады.

Түйін сөздер: сан сүйегінің перипротездік сынықтары, Ванкувер жіктемесі, ашық репозициялау және ішкі бекіту, анатомиялық құлыпталатын пластина, ревизиялық артропластика.

Остеосинтез перипротезного перелома проксимального отдела бедренной кости типа В2 с использованием разработанной анатомической блокирующей пластины. Клинический случай

[Балгазаров А.С.](#)¹, [Балгазаров С.С.](#)², [Абиллов Р.С.](#)³, [Ботаев Р.С.](#)⁴,
[Крикливый А.А.](#)⁵, [Альжанов Е.Е.](#)^{6*}

¹ Врач-травматолог отделения травматологии №4, Национальный научный центр травматологии и ортопедии имени академика Н.Д. Батпенова, Астана, Республика. E-mail: amanzhol.balgazarov@gmail.com

² Кандидат медицинских наук, врач-травматолог-ортопед высшей квалификационной категории, заместитель директора по клинической работе, Национальный научный центр травматологии и ортопедии имени академика Н.Д. Батпенова, Астана, Казахстан. E-mail: serik.bal@mail.ru

³ Заведующий отделением травматологии №4, Национальный научный центр травматологии и ортопедии имени академика Н.Д. Батпенова, Астана, Казахстан. E-mail: abilovruslan79@gmail.com

⁴ Заведующий отделением политравмы, эндопротезирования и комбустиологии, Многопрофильная городская больница №1, Астана, Казахстан. E-mail: botaev_76.kz@mail.ru

⁵ Врач-травматолог отделения травматологии №4, Национальный научный центр травматологии и ортопедии имени академика Н.Д. Батпенова, Астана, Казахстан. E-mail: kriklivyialexandr@gmail.com

⁶ PhD докторант, Карагандинский медицина университете», Караганда, Казахстан. E-mail: ersyltan@gmail.com

Резюме

Рост числа операций по эндопротезированию суставов привел к увеличению количества перипротезных переломов бедра, что требует поиска менее травматичных способов лечения для пациентов с выраженными сопутствующими заболеваниями и высокими операционными рисками. В данной работе представлен опыт успешного остеосинтеза перелома типа В2 по Ванкуверской классификации с использованием новой анатомической блокирующей пластины в качестве альтернативы технически сложной ревизионной артропластике. Внутренняя фиксация с помощью анатомической блокирующей пластины по Ванкуверской шкале обеспечила стабильную консолидацию, о чем свидетельствуют баллы 91 по шкале Харриса для оценки состояния тазобедренного сустава и 42 по Оксфордской шкале для оценки состояния тазобедренного сустава. Восстановление диапазона движений до 90 градусов сгибания без миграции имплантата демонстрирует, что этот метод может являться эффективной, менее травматичной альтернативой ревизионной хирургии. Такой подход может позволить стабилизировать костно-имплантатную конструкцию и начать раннюю мобилизацию пациентов с высоким хирургическим риском.

Ключевые слова: перипротезные переломы бедренной кости, Ванкуверская классификация, открытая репозиция и внутренняя фиксация, анатомическая блокирующая пластина, ревизионная артропластика.