Clinical case
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Lateral cortical notching for impaired healing of extra-articular proximal femur fractures (case report)

R.A. Shafigulin[2]✉, I.F. Akhtyamov[1], I.A. Aglyamov[2], A.A. Gornaev[2]

[1] Kazan State Medical University, Kazan, Russian Federation
[2] Republican Clinical Hospital, Kazan, Russian Federation

Corresponding author: Rashid A. Shafigulin, rashid 221@ yandex.ru

Abstract

Introduction Dynamization of the nail can be used to improve osteoreparation during intramedullary interlocking nailing (IIN). The procedure can be difficult to perform in some sub- and intertrochanteric femoral fractures due to anatomical and functional features.

The **objective** was to demonstrate a case of successful use of an original version of the lateral cortical notching (LCN) technique for dynamization of an intramedullary proximal nail in a patient with a nonunited subtrochanteric fracture.

Material and methods The treatment was performed for a 66-year-old patient with a non-united intertrochanteric fracture of the right femur complicated by the breakage of an intramedullary nail. The LCN technique was successfully used to dynamize the IM nail.

Results Radiological healing of the fracture and functional recovery of the patient were observed at a two-month follow-up. The absence of interfragmental compression in IIN could be caused by blocking of the sliding screw by the lateral cortical bone of the peripheral femur fragment. The complication could be prevented with LCN during primary osteosynthesis of the above fractures.

Discussion Based on scientific publications and our clinical experience, we assumed that LCN can be indicated for failed healing of intertrochanteric AO/OTA 31A3.1–3 fractures, type 3 Boyd and Griffin trochanteric fractures and all types of subtrochanteric fractures as graded by Seinsheimer with a vector of interfragmental compression to be created along the femur axis during cephalomedullary osteosynthesis. The case report showed the mechanism of impaired consolidation in some intertrochanteric and subtrochanteric fractures of the femur.

Conclusion The case report demonstrateed the successful use of the original version of the lateral cortical notching (LCN) technique for dynamization of an intramedullary proximal nail.

Keywords: subtrochanteric fracture, intramedullary nailing, lateral cortical notching

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INTRODUCTION

Treatment of proximal femur fractures can be associated with technical difficulties due to the anatomical and functional features and result in complications [1, 2]. Intramedullary nailing is an established treatment [3], however, despite the advanced technology and implant design, the method has limitations. Failure in fracture consolidation can lead to adverse events such as infection, loss of reduction, implant failure, etc. Pin dynamization is a standard method stimulating fracture consolidation with IM nail which involves removing the locking screw [4–10]. The technique can be impracticable in some extra-articular fractures. An original surgical technique of the lateral cortical notching (LCN) was offered to dynamize the pin during blocking intramedullary osteosynthesis (BIOS) and improve fracture consolidation. Analysis of literature sources in PubMed and Google Scholar indicated three foreign publications reporting the method applied in 9 cases that urged to present our own results.

The **objective** was to demonstrate a case of using original treatment using lateral corticotomy to dynamize an intramedullary proximal pin in a patient with a nonunited subtrochanteric fracture.

MATERIAL AND METHODS

We report the result of a patient treated at the trauma department No. 1 the Republican Clinical Hospital (Kazan). Victim S.,The 66-year-old man S. sustained a domestic injury in September 2021 from a fall from his own height. On the same day, he was admitted to the trauma department and diagnosed with a closed displaced intertrochanteric fracture of the right femur (AO/OTA 31A3.3; Boyd and Griffin type 3) (Fig. 1 a). The operation produced the next day included closed reduction, blocking intramedullary osteosynthesis of the subtrochanteric fracture of the left femur using a 10/360 DC pin in a dynamic way (Fig. 1 b, c).

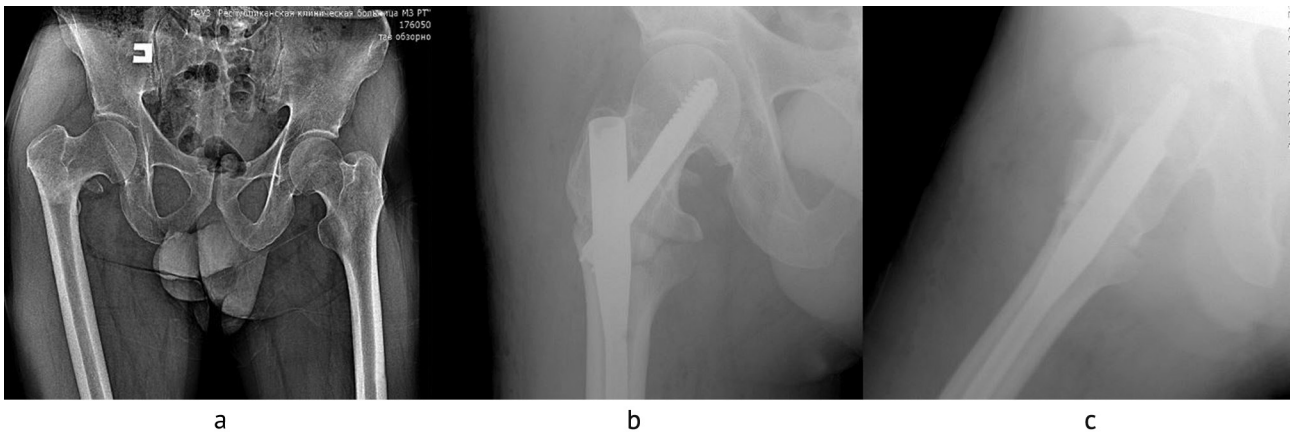

Fig 1 Radiographs of the fracture site: (*a*) AP view of the pelvis, showing intertrochanteric fracture of the right femur; (*b, c*) AP and axial views of the right hip joint, cephalomedullary osteosynthesis of the intertrochanteric fracture

The patient was verticalized at two days and began to ambulate using a walker. The postoperative period was uneventful. He was followed up at the emergency room at his place of residence. The patient was allowed to walk without additional support at 12 weeks. With fully restored limb function the patient experienced sharp pain in the right hip joint, lameness and gradual shortening

of the lower limb at nine months for which he sought medical help. Radiological examination of the hip joint was performed at the hospital. An AP view of the right hip showed a non-united intertrochanteric fracture and a broken intramedullary nail at the dynamic screw hole and the patient was readmitted to the hospital (Fig. 2 a). Although the distal blocking was performed in a dynamic way, the nail was not dynamized. The screws and broken nail were removed under regional anesthesia after appropriate examination. Broken fragments of the intramedullary nail were removed using an original technique developed in our clinic [11]. A conical Shants-type nail with cortical thread was screwed into the channel of the distal fragment of the broken pin with the impaction after removal of the proximal fragment. The nailing fragment was removed cranially after removal of the distal locking screws. Reduction was performed on an orthopedic table, and a new DC 10/360 proximal femoral nail was placed. The implant size was similar to the size of the previous one. The cervical screw was positioned in the previous channel to ease the procedure and trauma. The nail was locked using a dynamic method. Considering the fact that the outer end of the dynamic screw passed through the cortical layer of the peripheral fragment to prevent dynamization of the pin, the lateral corticotomy was performed under the dynamic screw (Fig. 2 b, c).

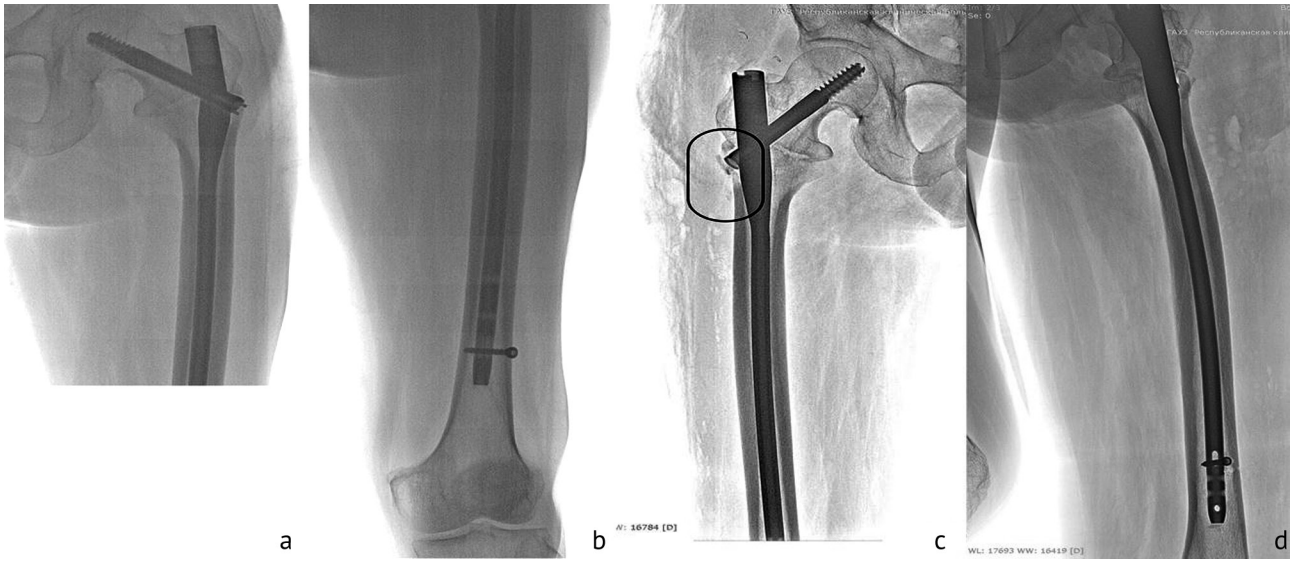

Fig. 2 Radiographs of the patient's hip joint showing (*a, b*) failed union of intertrochanteric fracture and deformed nail on preoperative AP view; (*c*) cephalomedullary reosteosynthesis of the intertrochanteric fracture, the lateral corticotomy of the femur under the entry point of the dynamic screw circled with an oval on the AP view; (*d*) cephalomedullary reosteosynthesis of the non-united intertrochanteric fracture of the femur on the axial view

In contrast to the original technique described in the literature, where a chisel with expanded surgical access is used to perform the corticotomy, we did not expand the surgical wound after dismantling the guide. The wire was placed along the channel of the dynamic screw, and a guide bushing made from a standard set of femoral pins was installed along onto the screw. A similar sleeve was placed parallel to the previous one and the wire was mounted in the lateral cortical layer of the femur using image intensifier. A corticotomy was performed using a drill along the wire to form a canal in the femoral neck. The next day the patient was verticalized and could walk using a cane. Postoperative period was uneventful and the patient was discharged from the hospital after five days to receive outpatient treatment.

RESULTS

The patient reported no complaints and could ambulate unassisted without additional devices at two-month follow-up and was radiologically diagnosed with healing intertrochanteric fracture of the right femur (Fig. 3 a). He had equal length of the lower limbs with no limitations in the range of motion in the joints of the target limb (Fig. 3 b, c).

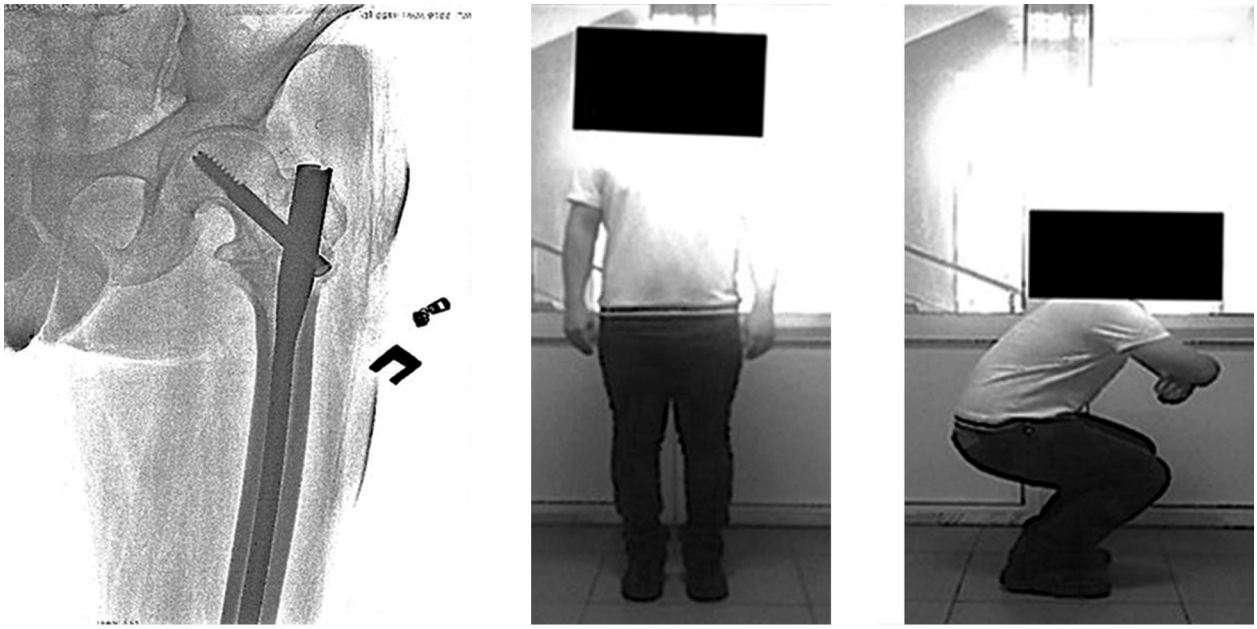

Fig. 3 The result of the treatment: (*a*) AP view of the hip joint showing healing intertrochanteric fracture fixed with a proximal femoral nail; (*b, c*) photo of the patient showing functional result with equal length of the lower limbs and range of motion restored in the joints of the lower limbs

Radiographs of the right femur were produced at 23 months of revision surgery (Fig. 4). The patient reported no complaints; the limb functions being completely restored with intertrochanteric fracture of the right femur consolidated.

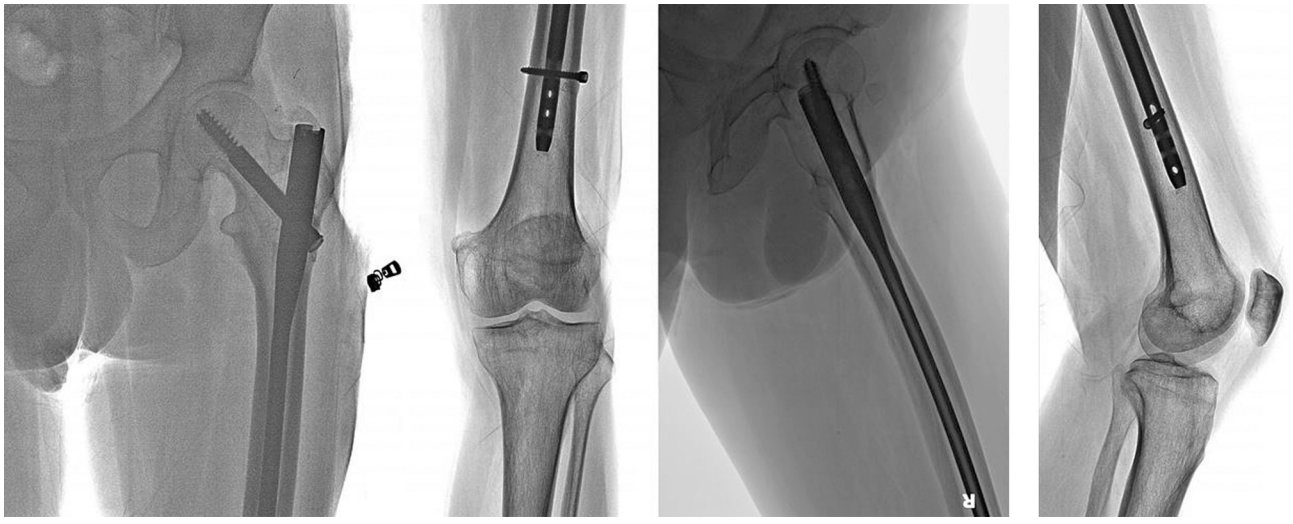

Fig. 4 The treatment resulted in the consolidated intertrochanteric fracture fixed with proximal femoral nail: (*a, b*) AP view of the femur; (*c, d*) lateral view

DISCUSSION

The first generations of intramedullary nails were characterized by blocking produced proximally and distally by a static method to provide additional stability and increase the rigidity of the bone-implant system. In some cases this led to imbalance between mechanical and biological factors of bone healing and impaired fracture consolidation [12]. Gross and Kempf developed the concept of intramedullary nail dynamization through removing a proximal or distal locking screw off the fracture turning a rigid system into a "flexible" one [13]. The concept was employed for constructs with a longitudinal hole for the nail blocking [14]. Now the nail dynamization technique is successfully used in orthopaedic practice. Failure to conform with this technology or anatomical changes in subtrochanteric fractures fixed with cephalomedullary constructs can result in impractical dynamization and a fatigue fracture of the nail [15–18]. The majority of extracapsular fractures of the proximal femur are treated with cephalomedullary constructs using the principle of a dynamic screw sliding along the axis of the femoral neck creating interfragmental compression. However, useful cephalomedullary constructs, originally designed for repair of transtrochanteric fractures, may fail to provide interfragmental compression for intertrochanteric fractures (AO/OTA 31A3.1–3; Boyd and Griffin type 3 trochanteric fractures) and for all types of subtrochanteric fractures according to the Seinsheimer classification with interfragmentary compression required along the axis of the femoral diaphysis to be provided by removing the locking screw, or initial fixation using a dynamic method avoiding the axis of the femoral neck. Biber et al. reported 8 cases of axial interfragmentary dynamization being complicated by the fact that the dynamic screw rested on the lateral cortical layer of the femur underlying the distal end [19]. This led to pain, implant instability, impaired fracture consolidation and to implant failure. It was caused by the sliding screw blocked by the lateral cortex of the distal peripheral femoral fragment. A biomechanically substantiated technique of lateral corticotomy was developed to dynamize the nail along the femoral axis and facilitate fracture healing. The authors offered and successfully implemented a surgical method with corticotomy of the lateral cortical layer right under the dynamic screw to block the nail using the dynamic method.

Biber et al. recommended to use this technique for patients who showed signs of impaired fracture consolidation and nail dynamization can be practical for interfragmental compression along the axis of the femoral diaphysis, without specifying specific nosologies of fractures. Tinner et al. reported a case of successful use of the technique in a patient with impaired consolidation of an intertrochanteric fracture, accompanied by breakage of the intramedullary pin [20]. Hinz et al. reported biomechanical effectiveness of the LCN in the dynamization of proximal femoral nails based on the finite element method with lateral corticotomy facilitating dynamization of the nail along the axis of the femoral shaft [21]. Based on the above publications and our own clinical practice, we suggested that the technique is useful for impaired consolidation of intertrochanteric fractures AO/OTA 31A3.1–3, type 3 trochanteric fractures as classified by Boyd and Griffin and all types of subtrochanteric fractures according to the Seinsheimer classification, i.e. fractures to be repaired with cephalomedullary osteosynthesis and interfragmental compression to be provided along the axis of the femur.

The clinical case showed the mechanism of impaired consolidation of intertrochanteric and subtrochanteric fractures of the femur reported by Biber et al. [19]. The dynamic (cervical) screw acts as a "spacer"passing through the central (femoral neck) and peripheral fragments (subtrochanteric region) preventing interfragmental compression along the axis of the femoral diaphysis and maintaining the diastasis between fragments with the distal blocking performed in a dynamic way. This results in failure of fracture healing with increased loading on the implant and breakage at the weakest point — the hole of the dynamic (cervical) screw — with a tendency to varus displacement of the central fragment. The lateral corticotomy performed under the dynamic (cervical) screw can help the "spacer" facilitating interfragmental compression along the axis of the femoral diaphysis and fracture consolidation. The assumption requires biomechanical justification, which we will try to present in future publications. Projecting the mechanism of fracture consolidation in our patient, we can assert the success of the technique. The construct collapsed because of nonunion despite the timely and high-quality cephalomedullary osteosynthesis performed according to indications. The failure was caused by the dynamic (cervical) screw blocked by the underlying lateral cortical layer which prevented interfragmental compression along the axis of the femoral diaphysis. A "spacer" effect maintained the existing diastasis between the fragments preventing fracture healing.

CONCLUSION

The clinical case presented demonstrated successful use of the lateral corticotomy technique for dynamization of the proximal femoral nail, its reproducibility and safety. Such an observation allows us to continue studying the relevant topic.

Conflict of interests *None of the authors has any potential conflict of interest.*

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Compliance with ethical standards *The authors confirm that the rights of the patient who took part in the study were respected. Informed consent was obtained from all patients for being included in the study.*

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Information about the authors:

Rashid A. Shafigulin — Candidate of Medical Sciences, orthopaedic surgeon, rashid 221@ yandex.ru, https://orcid.org/0009-0008-6146-4470;

Ildar F. Akhtyamov — Doctor of Medical Sciences, Professor, Head of Department, yalta 60@mail.ru;

Ilnar A. Aglyamov — orthopaedic surgeon, aia3008@mail.ru;

Andrey A. Gornaev — orthopaedic surgeon.