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Unstable Osteosynthesis of a Humeral Diaphyseal Fracture as a Cause of a Pseudoarthrosis and an Extensive Bone Defect (A Case Report)

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Abstract

Background. The causes of the humeral diaphyseal false joint formation can be various risk factors and their combination, including iatrogenic, associated with osteosynthesis technique non-compliance. This leads to instability of the metal constructions with the destructive consequences for the bone tissue and for the function of the injured limb in general. ***Clinical case description.*** A 60-year-old female patient received a right humerus diaphyseal fracture with displacement (AO/ASIF 12-A3) and underwent the locking intramedullary osteosynthesis. Subsequently, the fixation failure developed. In 3 years after the primary surgery, a combination of 2 complications was diagnosed: a false joint and a defect of the humerus with the formation of a traumatic bone cyst in the distal part of the humerus. The patient was reoperated: resection of the false joint and the right humerus cyst, and revision plate osteosynthesis with bone autografting. A positive result of the treatment was obtained in the form of false joint zone consolidation, reparation of the distal humerus bone structure and restoration of the right upper limb function. ***Conclusion.*** The presented clinical case demonstrates the importance of careful preoperative planning of osteosynthesis, namely: the selection of an appropriate implant size, and adequate intraoperative locking of the intramedullary nail to create a stable "bone-fixator" system. The careful follow-up of the patient at the outpatient stage, early detection of possible complications and timely surgical removal of the unstable implant with revision osteosynthesis are required.

Keywords: humeral diaphyseal fracture, humeral diaphyseal nonunion, bone defect, locking intramedullary osteosynthesis, complications.

Introduction

Humeral diaphyseal fractures occur in 1.0 to 13.5% of all skeletal fractures [1, 2, 3] and in 11 to 17% of the long bones fractures [4, 5]. More than half of them (60%) are localized at the middle third of the diaphysis. In the elderly patients of 60 to 70 years of age, the humeral diaphyseal fractures occur when they fall from their own height onto an outstretched hand or a bent elbow joint. 75% of these patients are women [6]. The most common method of such fractures treatment is surgical [7, 8]. At the same time, there is no consensus on the method of fixing the humerus fragments [9].

In modern medical practice, there exists a choice for osteosynthesis methods. The purpose of the surgery is to restore the axis, length of the limb and to eliminate the ro-

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tational displacement of the fragments. The modern requirements for osteosynthesis comprise the minimal trauma with the sufficient level of fixation stability. These conditions for the long bones of the extremities fractures could be met, to a greater extent, by intramedullary osteosynthesis with a locking nail. This type of osteosynthesis was a definite "breakthrough" in traumatology and orthopedics development, allowing treating fractures simultaneously with the restoration of the bone anatomy and the function of the injured limb joints. It excludes the need for external immobilization due to the better stability of the "fixator-bone" system and makes it possible the early activation and rehabilitation of the patients [9, 10]. However, this type of osteosynthesis is characterized by a long consolidation period. In addition, it could result in the fracture nonunion or even a false joint formation. These complications could lead the patient to permanent disability [3]. The rate of such complications in the treatment of humeral diaphyseal fractures reaches 10.0 to 15.7% [11, 12]. It was noted that more often the nonunion of such a fracture and the humerus false joint formation were recorded at the level of the middle and lower third of the humeral diaphysis [13].

We present a clinical case of the treatment of humeral diaphyseal fracture at the middle third of the bone with the locking intramedullary osteosynthesis. The treatment was complicated by the fixator instability, the false joint and the distal humerus traumatic bone cyst formation.

The purpose of this publication was to demonstrate on a clinical example a rare case of the combined formation of the false joint and an extensive traumatic defect in the distal humerus against the background of unstable locking intramedullary osteosynthesis of a humeral diaphyseal fracture.

Case report

A 60-year-old woman fell onto a street using her right hand on January 23, 2015. She was hospitalized for urgent indications at the trauma department of a general hospital on the same day. Her diagnosis was “Right humerus diaphyseal fracture at the middle third with displacement (AO/ASIF 12-A3), (Fig. 1).

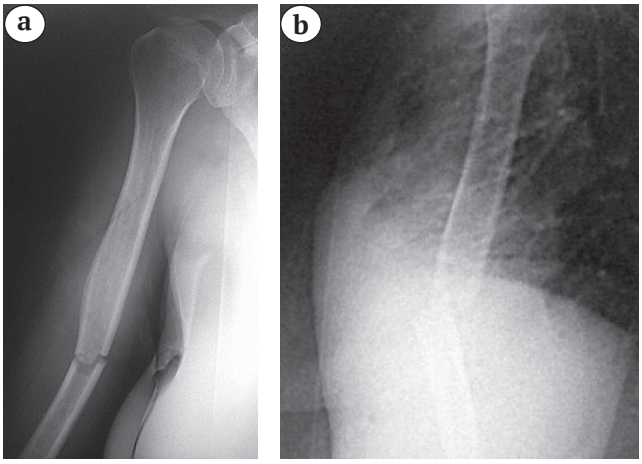

Figure 1. X-rays of the 60-year-old female patient on admission. The diaphyseal fracture of the humerus at the middle third with displacement of the fragments:
a – the frontal plane,
b – transthoracic plane.

The right upper extremity immobilization with the Tourner's plaster cast was carried out. The patient was examined for surgery.

The closed reduction of the fracture, blocking intramedullary right humerus osteosynthesis was performed on the 10th day after the admission (February 2, 2015). The proximal and the distal lockings were done with two screws. The external immobilization with a scarf bandage was used until the sutures were removed. The early postoperative period was uneventful. The patient was discharged for outpatient treatment. The medical rehabilitation was carried out to restore the joints and injured limb function.

A month after the surgery, the control right shoulder X-ray was performed. The satisfactory position of the fragments was determined. No radiological signs of intramedullary fixator instability were found (Fig. 2).

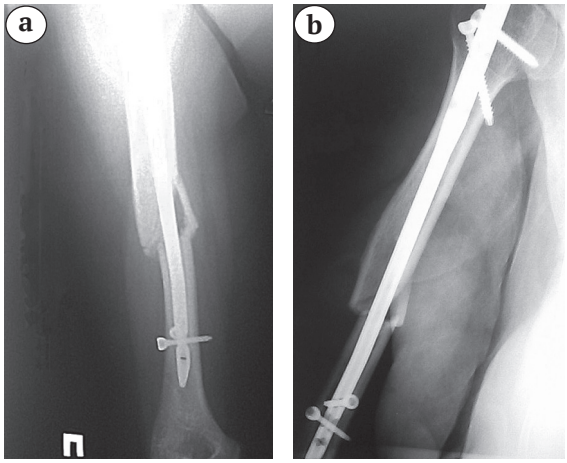

Figure 2. X-rays of the right humerus one month after the surgery: a – frontal plane, b – lateral plane. The position of the fragments is satisfactory, stable intramedullary fixation, a fragment is determined in the area of the proximal humerus.

The patient was periodically disturbed by short, mild pains in the right arm, about which she did not go to the doctor again. Only 2.5 years later, the pain syndrome became more pronounced. The right arm edema appeared. This forced her to go to the outpatient clinic, where an X-ray of the right arm was performed. The clinic orthopedist-traumatologist did not find any indications for surgical treatment at that time. The course of conservative treatment was continued. This included non-steroidal anti-inflammatory drugs, calcium preparations, physical and exercise therapy. 6 months later, an outpatient X-ray of the right arm was performed again. It revealed the signs of unstable intramedullary osteosynthesis, migration of an intramedullary nail and distal screws, a false joint with diastasis up to 2 cm between the ends of the fragments. A multi-chambered neoplasm was determined in the distal humerus. This was a deformity with swelling and sharp thinning of the bone cortical layer associated with disruption of the bone structure with the lysis of the bone trabeculae and migration of two distal screws to the bottom of the cavity (Fig. 3).

The patient was referred for a consultation to the regional oncological dispensary and hospitalized for further examination. The punch biopsy of the neoplasm was performed. Conclusion: “There are no data for oncological pathology, the diagnosis: the bone cyst of the distal right humerus”.

A week later, the patient was hospitalized at the Arkhangelsk Regional Clinical Hospital for a planned surgery. On April 24, 2018, the removal of metal structures from the right humerus, resection of the false joint and right humerus bone cyst, revision plate osteosynthesis with bone autografting were performed. The operation was carried out under conduction and endotracheal anesthesia with the patient being in the supine position.

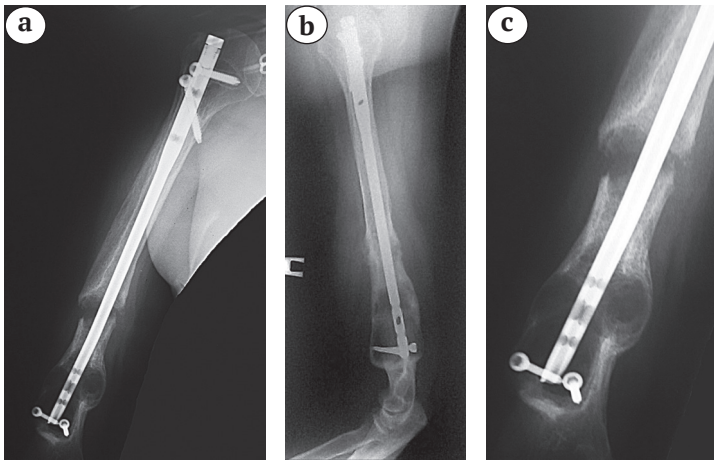

Figure 3. X-rays of the right humerus 3 years after the surgery: a – frontal plane, b – lateral plane, c – X-ray focused on the distal part. Migration of the intramedullary nail and distal screws, humeral diaphyseal fracture false joint and multicameral neoplasm in the distal part are visualized.

A 4-cm layer-by-layer incision of the soft tissues of the upper third of the right arm was accompanied by technical difficulties caused by deep immersion of the intramedullary nail and proximal locking screws into the humerus head. The fixator, plug and two proximal locking screws were removed from the right humerus. The wound was stitched in layers.

Abnormal mobility was noted in the middle third of the right arm. A 7 cm incision was made in the skin and underlying tissues at the ala of ilium area. 2 grafts 5.0 × 5.0 × 1.0 cm and 1.5 × 5.0 × 1.0 cm were cut out with an oscillator saw. Hemostasis was performed. Vacuum drainage was applied to the area of autograft harvesting. The wound was closed with layer-by-layer sutures with aseptic dressing. The patient was laid on her left side with her right hand on a support. A 25 cm incision was made in the skin and soft tissues along the back surface of the right arm. The areas of the right arm false joint and the cyst were exposed. Scars were observed in the wound. The radial nerve together with soft tissues was neatly retracted outward with a hook. The ends of the false joint fragments were smoothed and sclerosed with scar tissue in the bone marrow canal. The false joint proximal and distal ends were resected 4 mm on each side. The medullary canal was rimmed to bleeding bone, the scars were removed. The cortical layer of the lower third of the humerus was thinned, perforated in 2 places and "bulged" over 7 cm. A 4 × 2 cm window was formed in the area of the thinned cortical layer bulging. The cyst cavity was opened. It contained a small amount of hemorrhagic fluid, gray scar tissue and 2 loose screws (Fig. 4).

The contents of the traumatic bone cyst were removed and sent for histopathological examination. The walls of the cavity were processed with a spherical cutter to bleeding bone and washed with 70% alcohol and povidone iodine with potassium iodide. The bone autografts were tightly packed into the cyst cavity. 2 grooves of 1.5 × 1.0 cm were sawn out in the proximal and distal fragments of the false joint area. The ends were matched, a bone autograft of 4.0 × 1.0 × 0.7 cm was placed in the grooves with overlapping of the false joint zone. The revision osteosynthesis of the humerus was performed using a modeled plate with angular stability and screws. 2 ml of 0.5% procaine was injected into the radial nerve perineurium and a muscle bed was made for it. The intraoperative X-ray control was performed. The position of the fragments and the implant was satisfactory (Fig. 5).

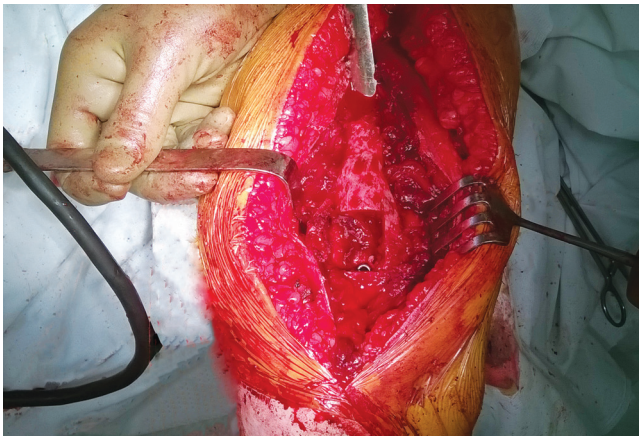

Figure 4. Surgical wound appearance: a window was formed in the distal humerus at the cyst projection.

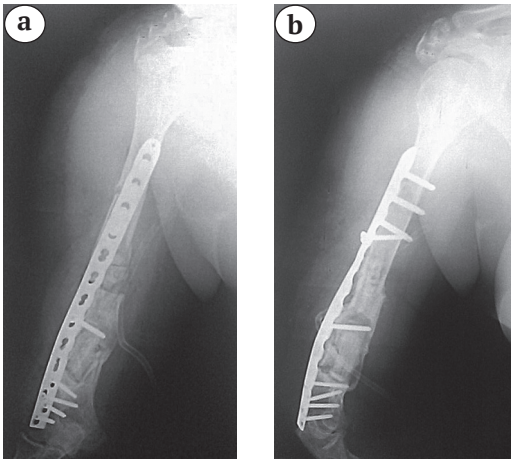

Figure 5. The intraoperative right humerus X-rays: a – frontal plane, b – lateral plane. The condition after the removal of the metal construction from the right humerus, resection of the false joint and the distal bone cyst, revision plate osteosynthesis with bone autografting.

The wound was drained through a separate puncture with a perforated plastic tube, layer-by-layer sutures were applied. The external immobilization with a kerchief bandage was applied. The operative time was 7 hours 10 minutes, the blood loss was 1.2 liters.

The results of biopsy material histopathological examination was as follows: the soft tissues with edematous foci; small petrifications; a piece of young connective tissue; cancellous bone with fibrosis of the bone marrow cavity and mature fibrous tissue, around which a single vascular lymphoid infiltration was revealed.

The postoperative period was uneventful. The drainage was removed on the 2nd day, the stitches –on the 12th day. The wounds healed by primary intention. In the postoperative period, the patient received analgesics, antibiotics (cefazolin 1 g twice a day), antiaggregant (pentoxifylline 400 mg 3 times a day). She was discharged on the 16th day in satisfactory condition for outpatient treatment with the following recommendations: immobilization of the right upper limb with an abduction orthosis bandage and limiting the load on the right arm for 3 months. Non-steroidal anti-inflammatory drugs for pain syndrome, calcium carbonate 1000 mg a day and bisphosphonates (alendronic acid 70 mg a week) were recommended for a long time. The patient was followed up by an orthopedist-traumatologist of the Arkhangelsk Regional Clinical Hospital with X-ray control in 3, 6, 12, 18 months after the surgery. The complete consolidation of the bone tissue of the false joint area took place in 1.5 years after the surgery. The bone grafts were restructured, the humerus structure and its cortical layer were restored (Fig. 6).

The results of the patient examination in 1.5 years after the surgery: the right arm pain, deformity and edema were absent. The right shoulder motions: flexion 170°, abduction 170°, external rotation 90°, internal rotation 90°. The right elbow motions: flexion 150°, extension 20°, supination 90°, pronation 90°. The sensitivity of the right upper limb was not disturbed. The motions of the right hand fingers were in full. The right arm postoperative scar was without signs of inflammation. There was a good functional score by the Disabilities of the Arm, Shoulder and Hand (DASH) Outcome Measure questionnaire – 27 points [14].

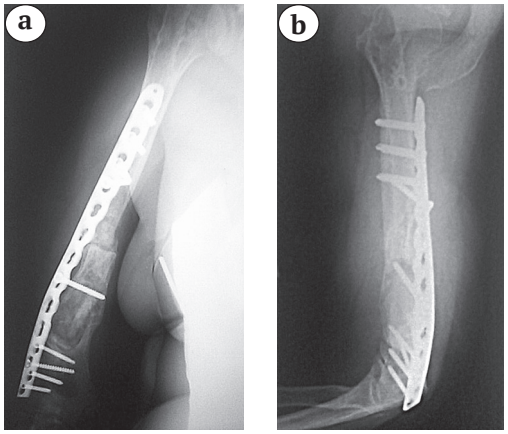

Figure 6. X-rays of the right humerus 1.5 years after the revision osteosynthesis with bone autografting: a – frontal plane, b – lateral plane. Consolidation of the false joint zone and restoration of the bone structure are ascertained.

Discussion

Commenting on the presented clinical case, it should be noted that not following the surgical methodology could resulted in the development of some specific errors and complications that are characteristic only of osteosynthesis with locking fixators. They are as follows: the absence of sufficient rotational stability and interfragmental compression in transverse and short oblique fractures, misalignment of holes and difficulty in blocking, the appearance of deformations and destruction of blocking elements, errors in the retainer size choice, blocking of the retainer in the presence of diastasis, or in the position of rotational displacement of the distal fragment [13]. The treatment outcome in these situations may be the bone tissue reparative regeneration impairment resulted

in revisions with bone grafting and additional metal structures [10, 12, 15]. Accordingly, high-quality intramedullary osteosynthesis with blocking nails requires the adherence to the osteosynthesis methodology, the correct selection of implants, the availability of appropriate instruments and skills of the operating surgeon [15]. The increase in surgical activity associated with internal fixation of fractures demonstrates new types of complications that were not previously encountered by traumatologists [16].

Undoubtedly, the problem of treating long bones fractures, including the humerus, cannot be considered solved at the present stage of the traumatology development [17]. For the development of complications or, conversely, a favorable outcome of a treatment, the combination of general and local factors depending on the patient (age, concomitant pathology severity, the location and type of the fracture, degree of soft tissue injury, duration of the period from the moment of injury to the surgery) is of great importance, and also depending on the method of bone fragments fixation etc. [18, 19].

It is known that bone tissue is plastic, and its architectonics is formed under functional load with average values of mechanical impact. A decrease or increase of the functional load on the bone activates the processes of remodeling with bone restructuring in accordance with the load [20]. After the osteosynthesis of bone fractures, the conditions of significant elastic deformations in the bone matrix could be created. This can trigger the redistribution of the mechanical load. The subsequent cascade of adverse events leads to the progression of bone resorption at the boundaries "bone–bone" or "bone–implant" [21]. The evaluation of the results of the humeral diaphyseal fractures osteosynthesis by specialists is ambiguous. This can be explained by the use of different surgical techniques, various types of implants and the absence of a universal assessment of treatment outcomes [22].

Conclusion

In our opinion, the cause of the false joint and the traumatic cyst of the right humerus formation in our patient was the methodological violation of the blocking intramedullary osteosynthesis technique. The retrospective analysis of the right humerus X-rays after the primary osteosynthesis revealed that the diameter of the rod of 7 mm was insufficient to fix this fracture, the proximal locking screws set on the nail, not on the humeral cortical layer, the distal locking was performed with 2 screws for a short distal fragment (short arm), one screw was installed in the oval hole. The swinging intramedullary nail injured the cortical layer from the inside during motions in the injured limb joints. This caused degenerative changes in the bone tissue leading to its resorption and lysis. The long absence of specialized care against the background of unstable metal structures led not only to the formation of a false joint, but also to the significant distal humerus destruction.

The presented clinical case demonstrates the importance of the careful preoperative planning of osteosynthesis, namely, the selection of the appropriate implant size, and adequate intraoperative blocking of the intramedullary nail to create a stable “bone-fixator” system. The further punctual follow-up of the patient at the outpatient stage, the early detection of possible complications and timely surgical removal of the unstable implant with revision osteosynthesis are required.

Publication Ethics

The patient gave an informed consent for the publication of this clinical case.

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Authors' contributions

S.V. Bragina – text preparation and editing, literature review, patients examination, data analysis and interpretation.

P.V. Iskusov – text preparation and editing, patients examination, performance of the surgery, data analysis and interpretation.

D.A. Lapidus – patients examination, performance of the surgery, data analysis.

A.G. Ivashov – patients examination, performance of the surgery, data analysis.

V.G. Kuroptev – patients examination, performance of the surgery, data analysis.

All authors made a significant contribution to the research and preparation of the article and read and approved the final version before its publication. They agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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