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Fracture in the middle of the femoral stem and relevant treatment after the revision total hip arthroplasty: A case report

Hui Xu, Lin Wang, Xunpeng Zhu, Hui Zhang

ABSTRACT

Introduction: Total hip arthroplasty (THA) remains one of the most effective treatments for grievous hip joint diseases. However, with an increase in the number of operations, the incidence of related complications has also increased dramatically. Prosthetic failure is a relatively rare but extremely serious complication. Reports related to this type of complication and the corresponding treatment are rare.

Case Report: Here we report the case of a 63-year-old man, who complained of sudden pain in the right lower limb thigh and was subjected to stem failure without obvious inducement after revision total hip arthroplasty. The patient was discharged from the hospital after undergoing relevant revision surgery, and was satisfied with the recovery at the 1-year follow-up.

Conclusion: Combining this report with previous literatures, it was not difficult to find that there were many reasons for prosthesis fracture. Therefore, prevention of this kind of complication should be considered in many aspects, to avoid the occurrence of this kind of situation to the greatest extent and improve the effect of surgery.

Keywords: Fracture, Prothesis, Revision, Total hip arthroplasty (THA)

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INTRODUCTION

Total hip arthroplasty (THA) has become one of the most significant treatment alternatives for end-stage hip joint diseases, including osteoarthritis, rheumatoid arthritis, and aseptic necrosis of the femoral head, and it can effectively relieve pain symptoms and significantly improve the postoperative quality of life with the advancement of technology [1, 2]. With the increase of total hip replacement surgery, the corresponding surgical complications, such as neurovascular injuries, are also increasing rapidly [3–6]. Failure of components, particularly in the neck [2, 7–11], occurred in early joint prostheses (first generation) [8]. However, such phenomena have been rarely reported under the progression of alloy coating of materials and improved accuracy of operation [9, 12, 13]. Moreover, most of the formerly reported prosthetic fractures were located at the weakness of the junctions [14]. Here, we present a case of fracture of the middle femoral stem and corresponding treatment methods after the revision of the total hip joint.

CASE REPORT

The reported patient was a 63-year-old man with a body mass index (BMI) of 28.2 kg/m² (height 1.63 m, weight 75 kg) who was obese and worked as an active farmer. The profession impelled him to perform strenuous manual labor in the long term. The patient underwent right total hip replacement (relative relevant hospitalization and the prosthesis information has been lost in a local hospital approximately two years back (March, 2019) owing to aseptic necrosis of the right femoral head. The past medical history revealed that the operation proceeded uneventfully with satisfactory recovery after discharge from the hospital. Approximately one year back (March, 2020), the patient developed right thigh pain after an accident and was sent to the same local hospital. Improving imaging examination, plain radiographs of double hips in the hospital depicted periprosthetic fracture of the right hip (Echelon revision stem, Smith&Nephew, size 11; Echelon revision femoral head, Smith&Nephew, 32 mm–12/14 s). Revision THA and wire cerclage were performed immediately in the right hip after diagnosis. Moreover, the patient expressed that daily life was not limited to the home. Without obvious trauma and another inducement, the patient developed sudden-onset groin pain, and an evident tenderness appeared over the upper and mid-thigh, which was progressively aggravated for ten days before visiting our department. Physical examination after admission demonstrated no swelling and ulceration of the skin at the right hip, and the range of motion of the right hip was limited. Furthermore, the patient refused to perform adduction and abduction. Following this, the radiograph and three-dimensional computed tomography reconstruction were performed. The results showed that the change in mechanical distribution due to a large number of losses in the proximal bone (Paprosky Type IIIA), which ultimately led to the absence of absolute stability and fracture of the right hip prosthesis (Figure 1). Moreover, the ultrasound of blood vessels in both lower extremities suggested no obvious thrombosis. The patient had previously undergone open reduction and internal fixation of the tibiofibular fracture and appendectomy 10 years back, and he had a history of cerebral infarction for more than 4 years and was regularly taking aspirin on his own until 1 week before surgery.

The patient's pre-operative inflammatory indicators and body temperature were in the normal range: erythrocyte sedimentation rate 18 mm/h; c-reactive protein 3.4 mg/L; white blood cells 7.4 × 10^9/L, which ruled out the possibility of suppurative infection. Therefore, the second revision THA was planned to be initiated on March 26, 2021. Fixing the patient in the left lateral position, surgeons dissected the skin along the original incision and exposed the prosthesis after three-fold antiseptic scrub using iodophor diluent disinfectant. With the help of assistants, the hip joint was fully flexed, adducted, and rotate to achieve dislocation. After decoupling the femoral head, it was found that the acetabular cup was well-fixed, and there was no evidence of polyethylene linear wear. Therefore, the part of the acetabulum was retained. Owing to proximal loosening of the femur, the femoral component was detached with a series of impacting and extracting blows using pincers. Moreover, the distal femoral prosthesis was challenging to be directly dissected out of the medullary cavity owing to its close connection with the bone tissue. It was, therefore, necessary to extend the original incision to the middle of the femur, perform extended trochanteric osteotomy (ETO) at the upper half of the femur using an ultrasonic osteotome, and then excise it using the distal prosthesis (Figure 2). The prosthesis was slightly separated from the bone tissue using an osteotome, and then the freeing bone fragments were reattached to the femur with five cerclage wires. After the medullary cavity was reamed using a power system, the inserted femoral stem (standard non-collared CORAIL Stem, DePuy Synthes, SZ 13) was driven with a tilt of 15° anteversion angle, and the short-necked femoral head prosthesis (BIOLOX delta Ceramic Heads, DePuy Synthes, 32 mm–12/14+1) was replaced. Then, the femoral reconstruction was completed. The limb movement was normal after reduction, and the incision was sutured layer by layer.

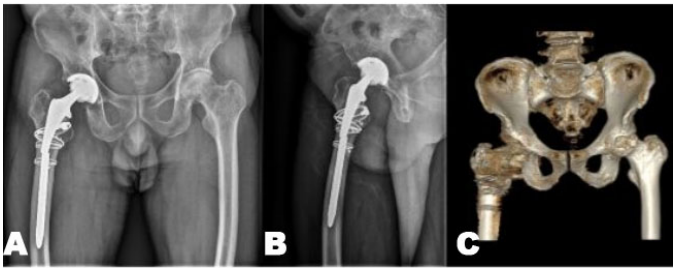

Figure 1: (A) and (B) The frontal and lateral plain radiographs, respectively, after the admission, indicating the fracture in the middle part of the prosthesis; (C) A three-dimensional reconstruction of the computed tomography (CT) of the hip, suggestive of a loss of bone mass in the right proximal femur.

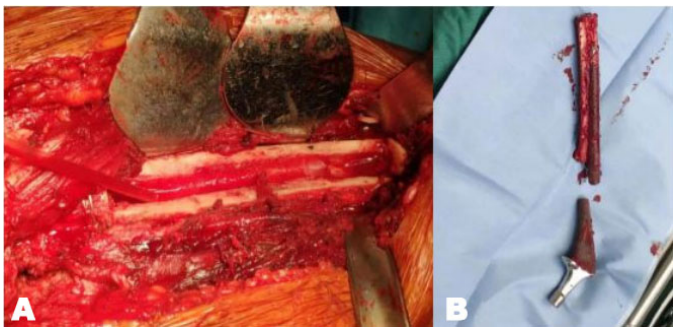

Figure 2: (A) The remaining part of the femur after fenestration with an intraoperative; (B) Proximal prosthesis and distal prosthesis attached to the fenestrated femoral portion individually.

A "T" shoe was fixed to his right lower extremity post-surgery and low-molecular-weight heparins calcium was intravenously injected every 12 hours to prevent thrombosis. Reexamination of postoperative radiograph demonstrated that the prosthesis was in place and the bone fragment after osteotomy was well aligned (Figure 3). Waiting for the general situation to stabilize, the patient was permitted to leave the hospital, and he was required to stay in bed strictly for two months. At subsequent follow-up, the patient was satisfied and pain-free.

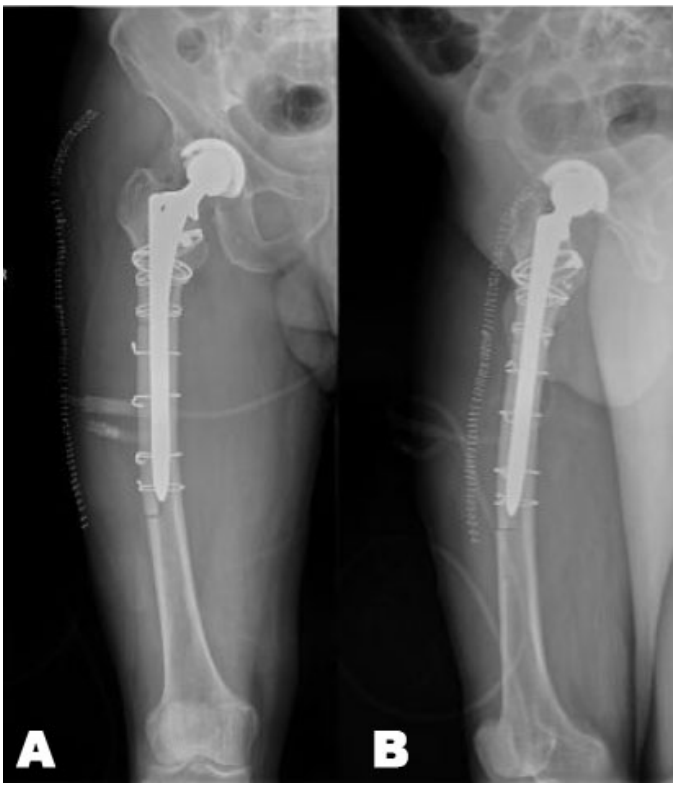

Figure 3: (A) and (B) Radiological examinations of the right femur after operation. It is suggested that the prosthesis is closely attached to the marrow cavity at an appropriate position.

DISCUSSION

According to the previous literature, the various factors of prosthesis fracture could be summarized as patient, surgical, and prosthesis. Therefore, for the prevention of such complications, the corresponding preventive measures could be taken considering these aspects. Lee and Kim [9] concluded that the fracture of the initial femoral prosthesis occurred in the middle third frequently. Following this, some articles mentioned that the fracture failure often began at the lateral side of the prosthesis, related to the distribution of muscle tension during different postures probably, through mechanical analysis and electron microscope observation of the cross-section of the fracture, which was consistent with the characteristics of this case [8, 13, 15, 16].

Owing to the trend of younger diseases, THA's surgical guidelines have gradually included young and middle-aged individuals. For young patients, particularly those with high BMI, to meet the requirements of high standards of daily activities, prosthesis was often under great pressure, which would increase the related risks [7, 8, 16, 17]. Therefore, for such high-risk individuals, Matsen et al. [7] assumed that the prognosis could be judged by regularly detecting the concentration of metal ions in the blood, and corresponding treatment could be administered at an early stage. Moreover, the tolerance of prosthesis to repetitive bending forces could be increased by placing femoral stem with a larger diameter during operation [14–16].

Similarly, the placement of the prosthesis during the operation also had a certain influence on the service life of the prosthesis. It has been reported that when the prosthesis was in a varus state, it would increase the stress burden on the inner side of the prosthesis [10, 16]. Simultaneously, excessive valgus could easily lead to dislocation of the prosthesis. Zeng et al. [18] reported that closed manual reduction after dislocation would also cause some damage to the prosthesis. Therefore, imaging examination and reduction plan should be fully prepared before reduction.

It was not challenging to determine that failure of the prosthesis more often occurred in revision THA compared to primary THA from the reported studies previously. As to the occurrence of this phenomenon, Botti et al. and Melnic et al. [11, 19] assumed that, particularly for patients who only were subjected to the revision, the risk of fracture may be related to the injury of the retained femoral part caused by the retractor during exposure in operation. Busch et al. and Abdelaziz et al. [16, 17] believed that ETO, which was often used in revision surgery, would cause a large amount of bone loss in the proximal femur, which would lead to the loose proximal prosthesis, sinking of prosthesis, and uneven stress on the prosthesis. Therefore, the method of ligation and fixation using wired cables should be adopted preventively in the greater trochanter during operation for patients undergoing ETO, and if necessary, it was essential to re-expand the medullary cavity for increasing the size of the prosthesis or switching to the prosthesis with extensible porous-coated stem to obtain the effect of diaphyseal fixation [12, 15, 17].

As to the prosthesis itself, the production process was also one of the factors affecting the strength. Previous literatures have reported that the probability of fracture of the new prosthesis was significantly lower than that of the primary prosthesis [2, 9, 12, 15]. Moreover, etching on the surface of the prosthesis was often the site where the prosthesis fracture occurred, and observation under an electron microscope also revealed that this site was often the origin of prosthesis fracture, which might be related to the change in prosthesis density caused by laser [8–10]. According to Norman et al. [13] joint fluid, like electrolyte, slowly destroyed the ionic structure with galvanic corrosion on the surface of the prosthesis,

resulting in a decrease in the strength of the prosthesis. Thus, it was clear that the manufacturer's control over the quality of the prosthesis and the appropriate selection of materials was indispensable.

Conventional prosthesis might be inadequate in some patients with complex congenital hip dysplasia or severe rheumatoid arthritis. However, the modular prosthesis has filled the gap in the field of joint replacement, which opened a new era. The advantage of it is adjusting the length of the lower limb and size of the offset, improving the accuracy of the prosthesis and facilitating the progress of secondary revision [17, 20]. However, compared with the common complications, like sinking and loosening, in a non-modular prosthesis, modular prosthesis had a significantly increased incidence of fracture at the junction, which possibly was related to the structural integrity of the prosthesis [12, 13]. Moreover, no case of fracture of non-modular prosthesis has been reported previously, field of which can be explored further.

CONCLUSION

The failure of prostheses demonstrated disastrous outcomes; therefore, doctors and manufacturers must make cooperative efforts to minimize the incidence of this complication. It was not difficult to find that the causes of such complications were often multi-factorial according to the reports in the relevant literature before, so the prevention of such complications should be multi-faceted. This report aimed to share the relevant possible influencing factors and feasible prevention methods through this rare case to achieve early diagnosis and treatment as far as feasible and minimize complications, to increase the prognostic effect of the surgery.

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Author Contributions

Hui Xu – Conception of the work, Design of the work, Acquisition of data, Drafting the work, Revising the work critically for important intellectual content, Final approval of the version to be published, 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

Lin Wang – Analysis of data, Interpretation of data, Drafting the work, Final approval of the version to be published, 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

Xunpeng Zhu – Conception of the work, Design of the work, Revising the work critically for important intellectual content, Final approval of the version to be published, 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

Hui Zhang – Conception of the work, Design of the work, Revising the work critically for important intellectual content, Final approval of the version to be published, 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

Guarantor of Submission
The corresponding author is the guarantor of submission.

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Written informed consent was obtained from the patient for publication of this article.

Conflict of Interest
Authors declare no conflict of interest.

Data Availability
All relevant data are within the paper and its Supporting Information files.