Case Report

Zimmer Modular Revision Stem Failure on Total Hip Arthroplasty Due to Stem Fracture From Cone Taper Stem Junction

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ABSTRACT

The incidence of Zimmer modular revision (ZMR) hip system fractures is rare. The material of the component decreases the risk of corrosion which titanium-based modular would lower the degree of degradation despite cold welding of the component. In this case presentation, we will discuss 2 cases of implant failure from the cone taper junction of the stem and discuss the susceptible causes of the failure. The new generation of surgery products has numerous successful outcomes and has facilitated the way for modern orthopedic surgeons. Despite the high rate of satisfying results, reports of implant failure are rare. We present 2 patients in similar situations referring to the same model implant failure. It can be noticed that the force tolerance because of their weight might be a risk factor and some other factors may be missed, including providing sufficient distal bone support for the implant.

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1. Introduction

Total hip arthroplasty first occurred in Germany in 1891. The literature endeavor was to facilitate surgical techniques and innovations to improve the devices for a better operation outcome that provides a better lifestyle for the patients who had undergone total hip arthroplasty [1, 2]. Recently, surgeons have faced different instruments and devices in hip arthroplasties orthopedics. Zimmer Biomet products as one of the popular brands in orthopedic procedures help in achieving good results; however, there are at least 3 failure report documents at the moment [3-5]. The femoral stem fractures in Zimmer modular revision (ZMR) hip system have been designed for revision hip surgery. The femoral component of the ZMR contains 3 modular components: the stem, the body, and the femoral head. The stem and the body are available in several lengths and sizes which provide a good variety and surgical flexibility [3-6]. It is designed to have proximal support for the implant in femoral revision hip surgery. If such support is not obtained, the risk of fatigue fracture of the stem increases.

Since the beginning of using modular in orthopedic surgeries, they have been mostly successful and there are few reports of failure in any modular component. In a study in 2011 evaluating 6 patients with stem fracture, obesity was common in all of them. Also, a fretting fatigue mechanism and a pure bending fatigue mechanism superior to obesity cause catastrophic failure of the stem. Lakstein et al. reported other factors that should be considered in a patient undergoing total hip arthroplasty, such as the appropriate osseous support and implant under-sizing [3]. In modular components (head, neck, and stem), it is almost suspected to see a fracture in the neck part. In another study of two patients with the same metal prosthesis (cobalt-alloyed head and stem), a fracture that occurred in the neck of the modular was reported. That may be due to corrosion, cyclic fatigue loading on the prosthesis, and the porosity of the boundaries. They mentioned that by sectioning the surfaces, intergranular corrosion was found at the region of the head-neck junction which penetrates the microstructure [4]. Since its introduction in 1999, this system has spread quickly worldwide. However, there is a report of 21 cases of modular failure, of which 19 patients had fractures with the tapered body. The incidence of ZMR fractures is 0.24%, overall (0.45% taper bodies and 0.044% other bodies, such as calcar, spout, and cone), according to Zimmer Biomet updates [5, 6]. The material of the component has a role in decreasing the risk of corrosion which titanium-based modular would lower the degree of degradation despite the cold welding of the component [5]. In this case presentation, we discuss 2 cases of implant failure from the cone taper junction of the stem and discuss the susceptible causes of failure.

2. Case Presentation

A 65-year-old and a 75-year-old man with severe obesity (body mass index >35) were referred to the hip and pelvic clinics because of pelvic pain after slow and light walking. Stem fracture from the stem junction was identified by X-ray imaging (Figures 1 and 2). It was noted that the Zimmer stem has failed catastrophically along the cone taper stem junction. They underwent hip arthroplasty revision with cemented tripolar cup and uncemented Wagner-SL stem. Using a Kocher-Langenbeck incision, revision of the total hip replacement, the cone-taper was removed and the distal part was removed by femoral extended osteotomy. Nonmodular Wagner-SL (size 18-305 mm) was used after the ZMR removal and then the tripolar head and insert (52-head -3.5) were used (Figure 3). After extended osteotomy of the distal femur using a narrow osteotome, the previous stem was taken off from the bone. Reconstruction of the abductors and greater trochanteric fragment was done and all implant removal rules were considered. To choose the acceptable sort of device for the revision surgery, many factors should be considered. The femoral stem reconstruction plan depends on the amount of femoral bone loss; therefore, we should precisely determine the femoral bone loss. To restore the desirable leg length, we had to determine the exact leg length discrepancy during the preoperative planning. During revision surgery, it is essential to restore the limb length considering the changes which have occurred after the device failure. We should evaluate this discrepancy in an anteroposterior pelvic X-ray which provides sufficient information about the exact leg length size. Following the restoration of leg length discrepancy, the surgeon should pay attention to the abductor and adductor muscle tension which restoring their function is equal to a greater chance of successful revision and a lower rate of postoperative dislocations. The canal distal femur should be prepared to insert the femoral stem (Figures 4 and 5). The revision of general principles was observed. Sending culture during operation was negative for probable organisms, and the erythrocyte sedimentation rate and C-reactive protein markers were in a normal range. The count of polymorphonuclear was under 5-10 in each power field. Cefazoline prophylaxis 2 g/kg was given in addition to 1 g/kg during the operation. A total of 2 g/kg of tranexamic acid

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Figure 1. Conventional radiography presenting zimmer modular revision stem failure in a 65-year-old man with sever obesity

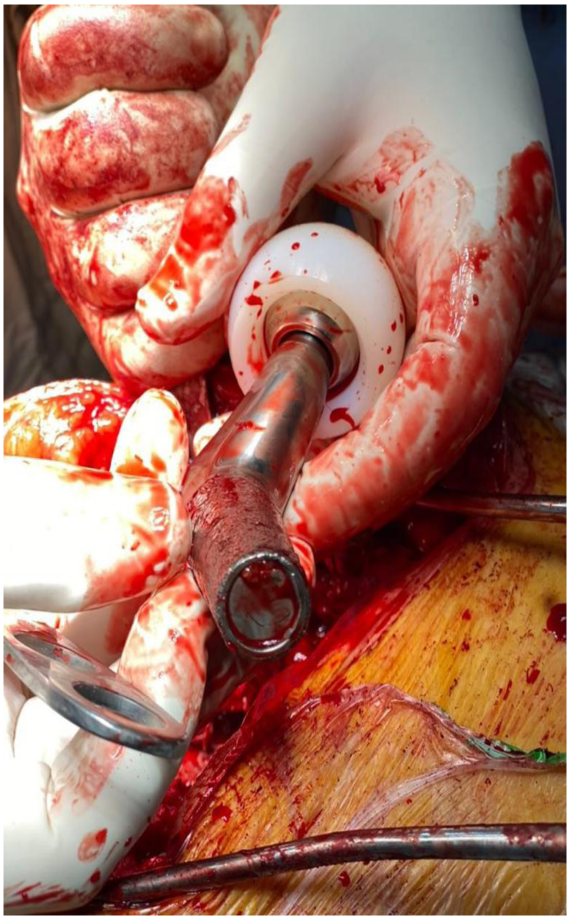

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Figure 2. Conventional radiography presenting zimmer modular revision stem failure in a 75-year-old man with sever obesity

Figure 3. Prepared nonmodular wagner-sl size 18-305 mm used after zimmer modular revision removal

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Figure 4. New implant wagner-sl placing

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Figure 5. Comparison of new and failed implant

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Figure 6. Postoperative radiography showing stable hip replacement

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(IV) before the surgery and 3 g after fascia repair were injected under the fascia (Figure 6). The operation lasted 1 h and 40 min. Then, the patient was transferred to the recovery zone. No complications occurred intra or post-operatively and the patient was discharged on even foot with a physiotherapy prescription and using a walker for 45 days after the surgery.

3. Discussion

As some popular implants have performed well in the arthroplasty results, failure is rare. More hopeful prognosis and clinical success are shown that increase patients' quality of life. This was improbable in the past 50 years. Therefore, this modularity became common in total hip arthroplasty for complex primary and revision cases. Meanwhile, the success of the implant is threatened by some additional risks, such as abnormal stress, fretting, fatigue of the matting surface, and secondary failure because of corrosion. Also, overweighting may be a risk in the first case. Among the above risk factors, fretting is the most common risk [4, 6]. Gilbert et al. reported that the porosity at the grain boundaries, inter-granular corrosion both at the head-neck taper and at the free surface, and cyclic fatigue loading of the stem fractures are the risk factors for the fractures which occurred at the grain boundaries of the microstructure [4]. The fretting mechanism occurs during oscillation with low amplitude. All modular total hip arthroplasties are vulnerable to this mechanism. The possibility of catastrophic fractures and great stress because of microcracks should also be considered. It was found that a measure as low as 0.125 to 3 μm between the matting surface levels is enough to lead to fretting debris [7]. In another study, the angular tolerance of the matting parts can minimize the fretting damage of the modular interfaces and decrease the amount of stress and micromotion fluctuation which leads to a higher rate of prosthesis life; therefore, the angular tolerance affects the predicting susceptible load [8]. Other factors, namely corrosion and inflammatory response in the area of the implant, are studied by Rodrigues et al. The surface qualitative investigation revealed that the corrosion attack in the matting interfaces witnessed etching, pitting, delamination, and surface cracking. The mechanism of degradation in modular connections that results from electrochemical reactions (hydrogen friability) induces the split of the tapers that finally lead to corrosion [9]. However, there are still debates about the effects of stem-sleeve fretting debris on femoral osteolysis. In ZMR implants, micromotion will lead to fretting as a result of inflammation caused by titanium particles that are released into the tissues. A study by Collier et al. demonstrated that the mixed metal implants, the geometry of the taper, and the surface area ratio can be effective in the corrosion rate [6]. A study by Bobyn et al. revealed that the usage of the modular component will cause unavoidable fretting because of normal physiological loading. Hence, we should reconsider the options for selecting the proper device [10]. Schutz and Thomas reported another theory that titanium alloys may induce titanium chlorides formation which is not stable, and this alloy can mix with water which leads to the formation of hydrochloric acid and titanium oxide. As a result of being thermodynamically unstable, the area gets an acidic pH level [11] that causes damage, including pits and corrosion in the body of the modular. Such damages can occur in both the same metal and mixed modular, however, it is documented that they may be less in the same metal because of the absence of cathode-to-anode reaction as the more degenerative procedures happen in the anodic area. Therefore, the single alloy implants lower the risk of force corrosion [6]. In a case study, corrosion and fretting led to the failure of the stem-sleeve interface. Mehran et al. reported that the stem-sleeve interface's low fusion heat may cause difficulties in the revision process which also leads to prosthesis fracture [12]. According to the literature, moderately elevated erythrocyte sedimentation rate or C-reactive protein in patients who do not have symptoms or clinical signs of infection is a contraindication for arthroplasty [13]. Steroid medications and smoking are associated with a shorter time interval to femoral head collapse. Also, diabetic patients are at higher risk for sciatic nerve injuries. These factors should be considered in any joint preserving treatments for patients [14, 15].

4. Conclusion

The new generation of surgery products had many successful outcomes and they facilitate the way for modern orthopedic surgeons. Despite the high rate of satisfying results, the failure of the implants is rare. In this case study, we presented two patients in similar situations referring to the same model implant failure. It can be noticed that the force tolerance because of their weight might be a risk factor. Some other factors may be missed, including providing sufficient distal bone support for the implant. The important point of these two implants failure, according to the patient's history, that was the cause of this catastrophic failure was not because of huge force bearing but a routine activity which is noticeable and unexpected to face this disaster in a short time (less than 5 years) after the previous implantation. As there is no national joint registry, we do not have any reliable data measuring the frequency of this complication. As we mentioned in the discussion about the factors that make the implant vulnerable, low bone support of the femur, corrosion, inflammatory cascades, and weight might have led to this implant failure.

Ethical Considerations

Compliance with ethical guidelines

There were no ethical considerations to be considered in this research.

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Authors' contributions

Conceptualization and Supervision: Afshin Taheriazam; Methodology: Behzad Khanmohammadi; Investigation, Writing original draft, and Writing review & editing: All authors; Data collection: Amin Dindar Mehrabani and Atieh Asadollah; Data analysis: Amin Dindar Mehrabani and Atieh Asadollah.

Conflict of interest

The authors declared no conflict of interest.

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