

Surgical technique

What can the surgeon do to reduce the risk of junction breakage in modular revision stems?

Bernd Fink, MD

Department of Joint Replacement, General and Rheumatic Orthopaedics, Orthopaedic Clinic Markgröningen gGmbH, Markgröningen, Germany
 Orthopedic Department, University-Hospital Hamburg-Eppendorf, Hamburg, Germany

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ABSTRACT

Modular revision stems are very common in hip arthroplasty, but junction fracture remains a known failure mechanism. A review of the literature with description of cases with junction breakage of modular revision stems showed that in all 24 analyzed cases, there was a common finding: the combination of an effective osteointegration of the distal component and missing medial bone support of the proximal component. The result was a bending stress point of the stem construction in the region of the junction. A technique using the combination of short distal component and longer proximal components may alter this stress pattern, allow proximal implant support, and reduce the risk of junction fracture. Moreover, filling of gaps between the modular component and the medial region of the femoral calcar in endofemoral implantation, a double osteotomy in significant bowed femurs, and treating medial bone defects with structural allografts additionally can reduce the risk of junction breakage.

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Introduction

The advantage of modular revision stems lies in the fact that they enable the surgeon to achieve the objectives of femoral stem revision surgery in a step-by-step manner and so obtain reproducible results under the control of the surgeon [1–3]. In the first step, the distal component is fixed in the femoral isthmus under controlled conditions, and in the next step, the proximal trial component is selected for the correct stem length, antetorsion, and offset, which is later replaced by implantation of the original proximal component [1–3]. The disadvantage of the modular revision stem is related to the transmission of force through the line of the junction of the 2 components and the associated risk of breakage of the junction [1,4–15].

A review of the literature (with the keywords “breakage” or “fracture,” “junction,” and “modular revision stem”) resulted in 24

described cases of junction breakage where an analysis of the stem component combination and the bony support of the junction could be performed [1,5–15]. In all 24 cases, the same scenario of an effective osteointegration of the distal component almost up to the junction itself and a missing medial bone support of the proximal component could be seen [1,5–15]. Even though modular revision stems can have various fracture mechanisms, the described scenario seems to be the most reasonable for breakage of the junction [16]. In this scenario, the bending stress point of the stem construction is in the region of the junction. With time, this can lead to a breakage of the junction, especially in heavy patients [1,4–15].

All modular revision stems are biomechanically tested according to Deutsche Institut für Normung standards [17]. However, these tests simulate another scenario with fixation of the distal tip of the implant and the application of a load to the head of the implant. This results in stem oscillation with a bending stress point somewhat distant from the component junction; in other words, during this test procedure, the junction itself is not at a risk of breakage [1,17].

Surgical technique

After a review of the previous failures of the junction of modular revision stems, I propose the following surgical technique steps when using such a construct to avoid any situation that would lead

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Corresponding author. Kurt-Lindemann-Weg 10, 71706 Markgröningen, Germany. Tel.: +49 7145 9153201.

E-mail address: b.fink@okm.de.

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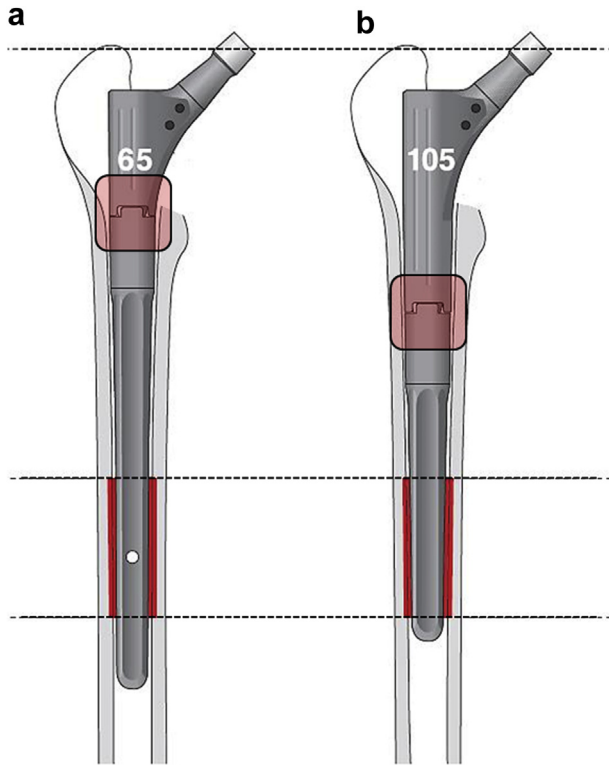


Figure 1. Comparison between the 2 possible combinations of modular components with the same fixation zone in the isthmus of the femur. (a) The combination of a longer distal component and shorter proximal component locates the junction at the level of missing medial bone support. (b) The combination of a shorter distal component with fixation at the tip of the stem (in a 2-degree tapered stem) in the isthmus of the femur and a longer proximal component locates the junction more deep in the femur below the lesser trochanter where the junction gets a medial bone support.

to a bending stress point of the stem construction in the region of the junction:

1. The use of short distal components, with fixation at the tip of the stem in the femoral isthmus, so as to reposition the junction with the correspondingly longer proximal component more distally within the femur (usually below the trochanter major; Fig. 1a and b). The surrounding bone supports the junction, and

a bending stress point at the junction is avoided. This concept can be realized, for example, with a 2-degree tapered stem, with a circular press-fit fixation at the tip of the stem in a transfemoral implantation (Fig. 2a and b) and with a so-called 3-surface fixation of a curved stem in an endofemoral implantation (Fig. 3a and b) [2,18].

2. If, after endofemoral implantation of the modular components, there is a gap between the proximal component and medial bone in the calcar region, this should be filled with autologous or homologous bone.
3. If, after a transfemoral procedure with an extended trochanteric osteotomy, there is a distinct gap between the medial femoral bone and the proximal bone component, the medial femoral region should be corrected by means of a double osteotomy, and the proximal bone should be brought into contact with the proximal component using cerclages or cables (Fig. 4a-c)
4. The use of a cortical strut allograft on the medial proximal femur in missing proximal femoral bone [19].

Discussion

The advantage of the combination of shorter distal and longer proximal components with the fixation of the revision stem at the tip is the protection of the junction. This combination results in a shorter stem, which has the advantage that the stem does not bypass the isthmus of the femur. As a consequence, the risk of periprosthetic fractures, especially in straight stems, is reduced, and a revision of these stems in cases of to periprosthetic joint infection is less difficult in comparison to longer well-osteointegrated revision stems [1].

The described technique can be performed with most contemporary modular revision stems. However, 2-degree tapered revision stems can address the fixation of the stem at the tip in the isthmus more easily because stems with a higher taper degree have the fixation zone above the tip [10]. Most contemporary revision stems have longer proximal components and instruments to assemble or disassemble the 2 components deep in the femoral bone. Revision stem systems including proximal components with various calcar lengths and different offsets have the advantage to prevent the need for very long necks and skirted femoral heads (as in Fig. 4b and c) which may increase the risk of mechanically assisted crevice corrosion and instability.

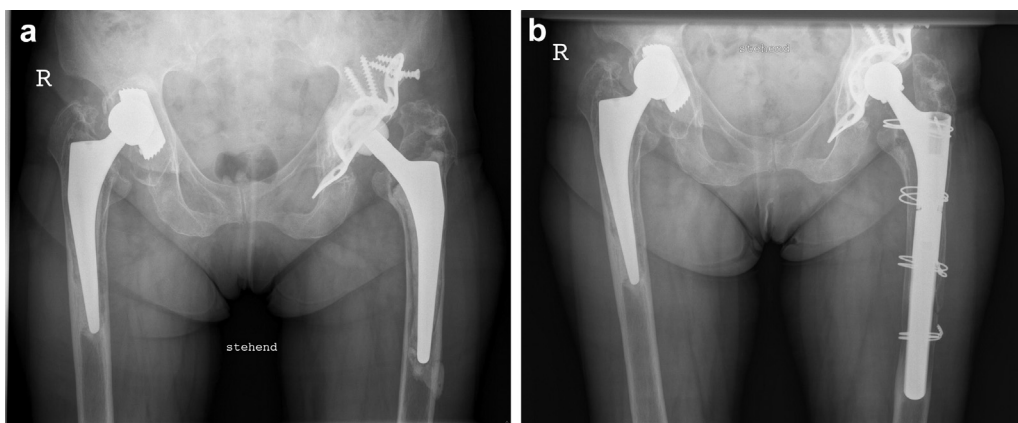


Figure 2. Revision of the left total hip arthroplasty using a transfemoral approach in a 79-year-old woman 18 years after primary total hip replacement. (a) Preoperative radiograph showing loosening of the left stem and both components on the right side. (b) Postoperative radiograph after transfemoral stem revision with the fixation of the new stem at the tip in the isthmus of the femur, showing the combination of a shorter distal and a longer proximal component which brings the junction more distal.

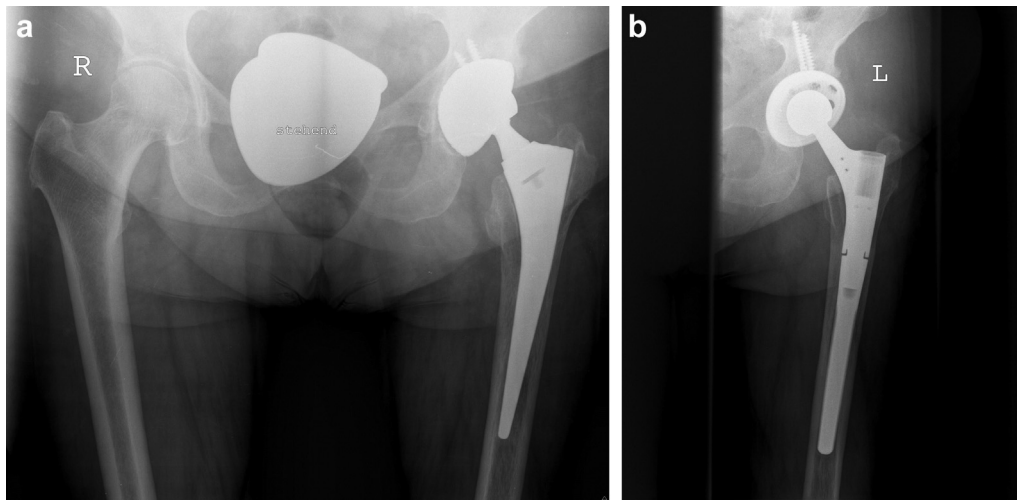


Figure 3. Endofemoral revision of a total hip arthroplasty in a 72-year-old woman 12 years after primary total hip replacement. (a) Preoperative radiograph demonstrating loosening of both components on the left side. (b) Postoperative radiograph after endofemoral revision with 3-surface fixation of the new modular revision stem and a cementless cup.

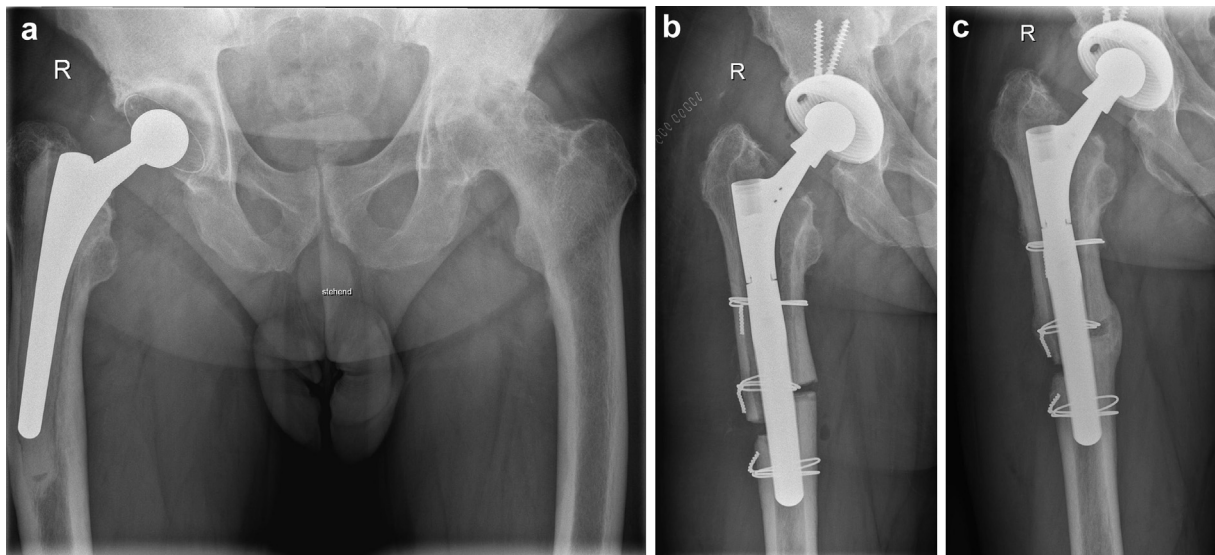


Figure 4. Revision of a total hip arthroplasty using a transfemoral approach 8 years after primary implantation in a severe bowed femur of a 69-year-old man with height of 198 cm and weight of 130 kg. (a) Preoperative radiograph showing a loosening of the stem in a significant bowed femur. (b) Postoperative radiograph after transfemoral stem revision with the fixation of the new stem at the tip in the isthmus of the femur and a double osteotomy to correct the shape of the femur and to bring the medial femoral bone in contact with the revision stem. A long neck was needed to adapt to the high offset in this tall patient. (c) One-year postoperative radiograph showing the osseous consolidation of the medial osteotomy and an osteointegration of the modular revision stem with unchanged position.

Summary

In my opinion, the described operative techniques should reduce the amplitude of the oscillations at the junction of the femoral stem construction and significantly lower the risk of junction breakage.

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