Fracture of an Exeter stem 3 years after impaction allografting—a case report

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A 52-year-old woman of 70 kg experienced a sudden click followed by sharp pain in the right leg during walking with a rollator. On clinical examination, the right leg was found to be shortened and motion was extremely painful. On the radiograph, we saw a broken Exeter stem, about 9 cm above the tip (Figure 1).

3.4 years earlier, she had undergone a third revision of a THA on the right side. A lateral approach with trochanteric osteotomy was used. The proximal femur looked like a sclerotic shell. Medially, there was a segmentary defect of the proximal femur, extending to the lesser trochanter, which was closed with an X-change wire mesh and two cerclages. Impaction bone grafting of the femur was performed, as described by Gie et al. (1993a) and an Exeter no. 1 femoral stem was cemented in. The postoperative radiograph showed a stem in neutral position with good cementing technique and graft packing in all visible zones.

At the last control-visit 5 months earlier, she reported no pain and had good function of the right hip. She was independent in her activities of daily life and used the rollator for shopping. The stem had not subsided compared to the first postoperative radiographs (Loudon and Charnley 1980).

She was admitted to our department and scheduled for revision of the broken stem. At operation, we found fibrous union of the previous trochanteric osteotomy. The segmental defect medially was largely unchanged from the previous operation. Proximally to the upper edge of the lesser trochanter, the impacted graft had resorbed. Distally to this level, the graft had become incorporated in the femur. The stem had fractured at this transition. A distal femoral window was created to remove the well-fixed distal fragment of the stem. After removing the cement, Partridge cerclages were used to secure the window and a Charnley long neck long stem 2 was cemented in. The trochanter was distalized on the femur and reattached with a double springwire technique. At the last control-visit 10 months after surgery, she reported

Figure 1. Fractured Exeter stem. Graft shows incorporation distal to the lesser trochanter and resorption proximal to it.

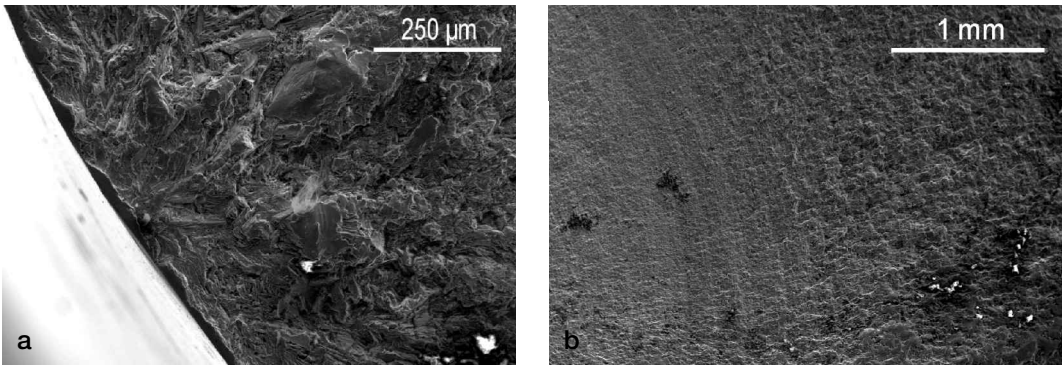

Figure 2. Scanning electron microscopy (SEM) images of (a) the probable site of origin of the crack, identified by radial ridges emanating from the site, and (b) the fatigue surface of the stem, identified by striations (running approximately vertically on the left side of the picture). The distance between striations increases from left to right, indicating increasing speed of crack propagation.

no pain and good function of the right hip.

Scanning electron microscopy was used to analyze the fracture surface of the stem. The site of initiation of the crack was on the anterolateral border of the stem. We found fatigue striations on the the fracture surface, indicating fatigue failure (Figure 2). Close study of the initiation site failed to identify any significant metallurgical or other defects.

Discussion

In revision surgery, resorption of the proximal femur is a common finding. One of the techniques to deal with this is impaction of allograft bone particles. Since 1993, we have performed impaction allografting in combination with the Exeter stem for revision of failed femoral stems in 62 patients, especially for severely damaged femora (van Biezen et al. 2000). The Exeter stem has been advocated for use with this technique, because it will radially load the proximal femur and therefore the impaction graft as it subsides within the cement mantle (Gie et al. 1993b, Shen, 1998).

The use of stronger materials has made fracture of a femoral stem a rare occurrence. Of the original series of polished Exeter stems, 8 of 426 stems fractured during mean follow-up of 13 years (Fowler et al. 1988). In 1976, the stem thickness had been increased slightly and the surface changed to a matt finish. The fracture rate of these stems has been reported to be about 0.2% (Gie et al. 1996). However, Røkkum et al. (1995) reported fracture of 3 of 27 matt surfaced stems after 1.3, 8.6 and 9 years. In 1986, the polished finish was reintroduced because of the high incidence of aseptic loosening seen with the matt surfaced stems (Howie et al. 1998). In the same year, the material was changed from 316L stainless steel to wrought high nitrogen stainless steel (Orthinox). Since then, this is the first report, so far as we know, of a broken stem.

In this case, the combination of the fatigue striations and the absence of any defects of the stem indicate that the fracture may be due simply to overloading of the stem. Absence of medial calcar support has been found to be an important contributor to increased tensile stress in the midlateral part of prosthetic stems (Andriacchi et al. 1976). When proper containment in the proximal femur cannot be achieved, the stem will have little proximal support, which in combination with good distal fixation, results in a longer moment arm that exerts its force on the slender distal part of the prosthesis. This type of failure mechanism has been described for the matt surfaced Exeter stem (Røkkum et al. 1995) and the similar shaped, forged cobalt-chromium CPT stem (Jazrawi et al. 1999), both without any evidence of manufacturing defects, as well as for the forged cobalt-chromium Precoat stem with evident manufacturing defects secondary to laser etching (Woolson et al. 1997).

The combination of a large moment arm on the slender distal cross-section of the no. 1 stem may be responsible for the accumulation of enough fatigue loads to induce fracture of the stem after only 3.4 years in the patient described in this report.

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