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Tissue Sparing Hip Implants

NE Bishop[1] MM Morlock[1]

[1] *TUHH Hamburg University of Technology, Biomechanics Section, Germany.*

INTRODUCTION: Hip joint replacement is an extremely successful procedure, with failure rates of less than 10% at 10 years reported in national registers. Particular stems are shown to perform even better than this. However, small proportions still relate to large numbers, which are continually increasing, particularly the proportion of younger patients. In these cases, implants must last longer, under harsher loading conditions.

On the femoral side there is a trend towards uncemented implants without the traditional diaphyseal shaft. The latter has a number of potential advantages: One is more physiological loading of femur, which can reduce the phenomenon of "stress shielding" and consequent bone loss. Another is the possibility for less invasive insertion and decreased disruption of both hard and soft tissues.

The potential disadvantages of removing the distal stem are loss of implant stability. The stem must be sufficiently stable to allow bony ingrowth and must distribute loads so as to prevent bone overload. To maximise the chance of safe mechanical integration of such implants preclinical simulation and testing is necessary. Furthermore, careful monitoring of clinical failures is invaluable.

In this paper a number of examples of such "proximal femoral implants" is introduced and their clinical testing is described. An example of a retrieval study is also presented.

METHODS: Various modern implants, all anchored in the proximal femur, have been tested for stability. They have been subjected to mathematical analysis and experimental testing to investigate potential implant stability in bone. Mathematical models were developed with friction simulated at the implant-bone interface, allowing relative motion to be estimated under joint loading.

Implants have also been tested for stability by implantation in cadaveric bone. Simulated joint loading was applied and relative displacement between stem and bone was measured using an optical system, with markers mounted to each component.

Finally, a retrieval study is described in which over 250 failed "resurfacing" implants were collected from clinics internationally and examined for failure mechanisms.

RESULTS: Mathematical models indicated that the proximal femoral implants analysed could lead to low relative motion between the stem and bone. It was also demonstrated that bone loads increase with neck offset and varus implantation.

The experimental studies indicated that relative motion was less than for conventional "stemmed" implants and that strength was not compromised by the shorter shaft. Furthermore, it was shown that there was greater flexion of the bone for the proximal stems. However, stems with high neck offset led to failure of the medial Calcar.

The retrieval study showed that more than two thirds of resurfacing failures resulted from fracture of the femoral neck. These occurred within the first year after surgery.

DISCUSSION & CONCLUSIONS:

Proximal femoral implants provide a new generation of solutions for an ever expanding number of patients, including a more demanding group that are both younger and more active. They can better preserve soft and hard tissues by being smaller than conventional stems but also demonstrate potential for integration in the bone, based on low relative motion between stem and bone. This has been demonstrated both in mathematical models and experimentally. Furthermore, the greater deformation of the femur demonstrated shorter stems indicates that there may be less chance of stress shielding and bone loss for such implants.

At the same time, it should be noted that such proximal implants may be less forgiving regarding implantation, and demonstrate a distinct learning curve. Damage to the femoral neck during reaming has been blamed for fracture. Varus placement and high neck offset increase the moment arm and lead to higher bone loads, which can be particularly dangerous in bone of poor quality.

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