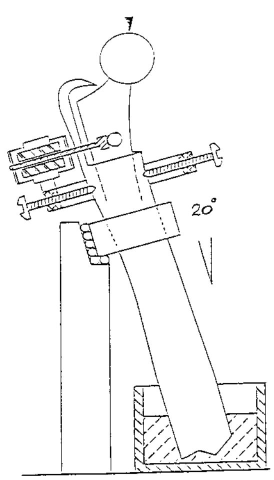
TORSIONAL STABILITY OF UNCEMENTED REVISION HIP STEMS

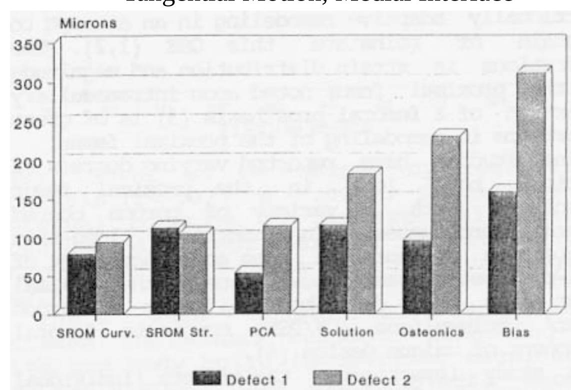
J.A. Longo*, T. McTighe, J.B. Koeneman*, R.L. Gealer*
*Harrington Arthritis Research Center
*Joint Medical Products Corporation, Stamford, CT

INTRODUCTION - Excessive interfacial motion can be detrimental to the functioning of non-cemented joint replacements. Significant torsional moments are applied to the proximal femur at the extremes of flexion and extension during gait, rising from a chair, and in stair climbing [1]. Revisions of loose femoral stems often leaves a femur with proximal bone loss, segmental and often cavitary in form, thus reducing the inherent implant rotational stability provided by normal proximal femur geometry. Previous studies have examined the effect of stem length and curvature on torsional stability [2]. The purpose of this study is to investigate the torsional stability of different revision stem designs in a segmental proximal deficient femur and a segmental cavitary proximal deficient femur with a bent-hip load.

METHODS - Six prostheses were tested in identical adult size left synthetic composite bone (Pacific Research Labs). The bones have approximately the same bending stiffness as human bones [3]. The prostheses tested were the long stem PCA (size 6, 250 mm. long), a long stem Osteonics (size 10, 250 m long), a Solution (15 mm, 10 inches long), a BIAS (16mm, 232 m long), a straight stem SROM (20 X 15. 225 mm. long), and a curved stern SROM (20 X 15, 225 mm. long). A segmental defect was prepared in the proximal femur to the lesser trochanter and the implants were implanted according to manufacturer's instructions. The centers of all femoral heads were sized to match the center of the natural head, and the femurs were potted distally. Each femur was placed in 20 degrees of flexion as shown in Figure 1. A circular collar was fixed to the proximal femur. This collar was supported by a circular bushing support which allowed rotation of the femur but prevented bending. Loading was applied as shown in Figure 1 at a rate of 50 Newtons per second up to a maximum load of 2500 Newtons. Relative motion was measured by two LVDTs (050HR, Schaevitz) that were attached to the proximal femur. Pins were bonded into the lateral and medial surface of each implant these moved the cores of the LVDTs. Tangential motion at the prosthesis-bone interface was calculated. At least three runs were made for each prosthesis and then the LVDT frame was dismantled and reassembled and *the tests* repeated. A total of three setups with three runs per setup were conducted for each prosthesis. A/P and lateral radiographs were taken of each implant and the respective fit and fill recorded using the method of Gruen [4]. After completion of the testing for the segmental defects, *the implants* were atraumatically removed, and the metaphyseal bone removed from the proximal femur to simulate a segmental cavitary type defect. The prostheses were reimplanted, tested as before and then cycled one hundred loads and retested.



Tangential Motion, Medial Interface



RESULTS - All implants had excellent fit and fill (> 94%). Figure 2 shows the tangential motion at the medial interface for each implant. The PCA and Solution stems, and to a lesser extent the Osteonics stem demonstrated settling during *the initial* runs. Once settling had occurred, *then all* stems demonstrated repeatable measurements both before and after cycling. Stems with both a medial-lateral and anterior-posterior wedging had the least motion with both types of defects. In the absence of metaphyseal supporting bone, the rotational stability of the prostheses were markedly reduced except for the SROM stem which demonstrated little change. A curved stem appeared to enhance the rotational stability.

DISCUSSION - Rotational and axial stability limiting interface micromotion a crucial to the functioning of revision femoral stems. Certain prosthetic design features allow immediate press-fit stability despite large segmental or metaphyseal bone defects. Stem designs which may subside during cyclical loading, my ultimately achieve rotational stability, but at the expense of possible change in version, length and bone graft position. In similar proximally *deficient prepared* bones, stem design and the ability to achieve metaphyseal fit in AP and lateral planes are paramount in achieving torsional stability with revision femoral prostheses.

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