

COMPARISON OF ASIA-SPECIFIC SLIDING INTRAMEDULLARY HIP SCREW, INTRAMEDULLARY FIXED ANGLE HIP SCREW, AND SLIDING HIP SCREW PLATE USING PHOTOELASTIC ANALYSES

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INTRODUCTION

Sliding intramedullary hip screws, intramedullary fixed angle hip screws, and sliding hip screw plates have been successful in treating intertrochanteric hip fractures. While sliding intramedullary hip screws may be preferred for unstable intertrochanteric fractures, sliding hip screw plates remain the preferred treatment for most stable intertrochanteric fractures (Baumgaertner *et al*, 1998). It is thought that the sliding intramedullary hip screw used with a centering sleeve behaves similar to the sliding hip screw plate, but it is not proven that this sliding intramedullary hip screw provides a clinical or biomechanical advantage over the fixed angle hip screw without a sleeve. The purpose of this study was to investigate the load distribution on the femur when treating unstable intertrochanteric fractures with sliding intramedullary hip screws, intramedullary fixed angle hip screws, and sliding hip screw plates. Specifically, we chose hip screws that are designed for the Asian population.

METHODS

Medium composite femora (Pacific Research Laboratories, Vashon, WA, USA) were used to simulate an Asian adult femur. Each femur was potted with 0° of flexion and 20° of adduction in a custom base fixture. This 20° force angle is representative of one legged stance during gait. One femur was tested intact in order to serve as a control; one femur was implanted with an Asian IMHS nail with a centering

sleeve and sliding hip screw, (IMHS-A, Smith and Nephew, Memphis, TN, USA); one femur was implanted with an IMHS-A and subtrochanteric screw [a Gamma-type nail] (Smith and Nephew, Memphis, TN, USA); one femur was implanted with a titanium sliding hip screw plate (CHS Ti Classic, Smith and Nephew, Memphis, TN, USA). A four-part unstable intertrochanteric fracture was created in each implanted femur (Figure 1).



Figure 1: Four part unstable intertrochanteric fracture.

After implantation, PhotoStress coating (Vishay Intertechnology, Malvern, PA, USA) was applied to each femur. Prior to loading, low-viscosity lubricant was applied to the lag screw in each construct to simulate *in vivo* sliding conditions. Each specimen was loaded and held in axial compression at 0, 600, 1200, and 1800 N. As the specimens were each loaded, the resulting strains produced proportional optical effects in the photoelastic coating. When viewed with a reflection polaroscope, isochromatic fringes correspond to the stress distribution on the surface of the femur. Color images were

obtained at each load, and the fringe patterns were noted.

RESULTS

Both the sliding IMHS-A and CHS exhibited localized stress near the fracture at the medial cortex, which extended distally into the diaphysis. This similar medial stress distribution was seen in the intact bone. The Gamma-type nail depicted a very localized high stress area just distal to the fracture in the medial cortex, which did not extend into the diaphysis. These observations were independent of load (Figure 2).

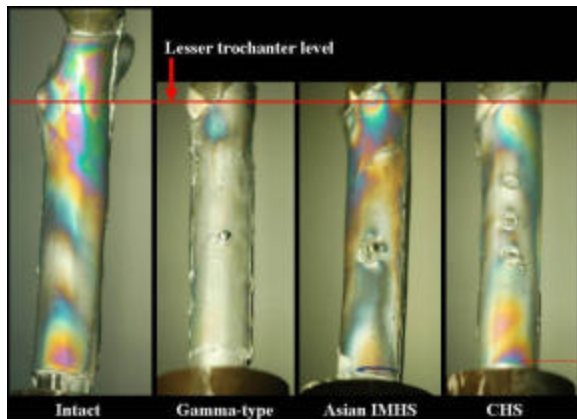


Figure 2: Medial View of Stress Distribution at 1800 N load. (blue represents region of highest strain)

DISCUSSION

Photoelastic analyses showed differences between sliding IMHS-A and CHS versus the Gamma-type nail. The sliding capabilities of the IMHS and CHS allowed for the transfer of compressive load through the fracture contact surface, indicating that the IMHS and CHS are effective load sharing devices. The Gamma-type nail showed a high localized stress distribution with no extension into the diaphysis, which seemed to be caused by varus bending of the proximal fragment, in which the medial fracture site acted as a fulcrum. Such resistance to sliding for the Gamma-type

nail is likely attributed to its rigid behavior during one legged stance of gait. The sliding IMHS and CHS load sharing phenomenon may lead to decreased cut-out, hasten fracture healing, and increase overall fracture fixation strength. The new visual method shown through this testing indicated clear advantages of load sharing (sliding IMHS and CHS) over load bearing (subtrochanteric Gamma-type nail) devices as compared to intact bone.

REFERENCES

Baumgaertner *et al.* Intramedullary Versus Extramedullary Fixation for the Treatment of Intertrochanteric Hip Fractures. *CORR* 348:87-94, 1998.