INTRODUCTION:

Periprosthetic femoral neck fractures following hip resurfacing arthroplasty is a recognized and significant post operative complication. Several retrospective reviews have correlated errors in surgical technique with the risk of periprosthetic femoral neck fracture. These include notching of the superior neck, varus position of femoral components, and inadequate coverage of the reamed femoral head. Based on these findings, the authors advocate the placement of the femoral neck component in 140 degrees of valgus, while avoiding notching and ensuring complete coverage of the reamed femoral head. To our knowledge, there have been no published reports of biomechanical testing to validate the advantage of valgus positioning of hip resurfacing femoral components. Given the increased risk of notching when placing the femoral component in valgus, we felt a more definitive approach to answer this question was warranted.

A biomechanical study and clinical review were completed in an attempt to determine the relative risk of femoral neck fractures for neutral and valgus oriented femoral components. The null hypothesis of our experiment is that valgus positioning of femoral hip resurfacing components does not provide a decreased risk of femoral neck fracture.

The purpose of the investigation was two-fold:

1. To complete a biomechanical analysis using matched fresh frozen cadaveric femurs with hip resuracing femoral components implanted in neutral and valgus position in order to determine ultimate failure load (i.e. load required for a periprosthetic femoral neck fracture).

2. To analyze a prospective case series of patients undergoing hip resurfacing using the valgus insertion technique, evaluating relative valgus angle, complication rates and clinical success.

METHODS:

Biomechanical Study

Ten fresh frozen cadaveric femurs, five matched pairs (right and left of same cadaver), were selected. All femurs underwent radiographic and dual energy xray absorbiometry (DEXA) scan evaluation to rule out asymmetric bone abnormalities as well as variations in bone mineral density. Radiographic neck-shaft angle and offset were measured and recorded for all specimens. The right and left femur of each cadaver was then randomly assigned to be implanted with either a neutral or valgus-oriented hip resurfacing femoral component.

The valgus oriented components were inserted using a specific insertion technique with a starting point 1 cm superior to the neutral axis of the femoral neck. The maximum possible valgus angle, while avoiding notching, was achieved for each of the specimens. The position of the guide pins were verified on x-ray for both the valgus and neutral oriented implants. The femoral heads were sized and then prepared with the appropriate reamers. Components were cemented in place ensuring complete coverage of the reamed femoral head. Post implantation x-rays were then completed in order to measure offset and component orientation.

All specimens were then loaded in an MTS machine using a validated load configuration. The load configuration, as described by Smith et al., represents the most likely orientation of the femur and direction of applied load that occurs during clinical hip fractures. All specimens were loaded to failure, defined as fracture of the femoral neck. Ultimate failure load was recorded for each specimen.

Results:

Biomechanical Study

Dexa scan results revealed that there was no significant difference in the bone mineral densities of the valgus and neutral-oriented femoral components: 0.775 g/cm^2 for neutral-oriented component cadaveric femurs versus 0.771 g/cm^2 for valgus-oriented component cadaveric femurs.

The average relative valgus angle achieved was 16.4 degrees and the valgus-oriented components had an average decrease in offset of 4.3 mm.

The ultimate failure load was found to be significantly increased for the valgus oriented components, with an average value of 9091 N for the valgus oriented components compared to 7257 N for the neutral oriented components (P value = 0.03).

In addition two trends were noted. An inverse relationship between percent change in ultimate failure load and bone mineral density (R = -0.76) and a direct relationship between percent change in ultimate failure load and relative valgus angle (R = 0.73).

Clinical Study

The patient demographics revealed a relatively young (average age 55.1 years), predominantly male study population (Male:Female – 86:15). The overwhelming diagnosis was osteoarthritis (98/101), with 2 cases of ankylosing spondylitis, and 1 case of avascular necrosis. An average relative valgus angle of 10.4 degrees was measured. All patients were included in the study and none were lost to follow-up (N =101). All patients had a minimum 56 week follow-up. Complications included 3 infections requiring surgical intervention, 1 deep vein thrombosis requiring anticoagulation, 1 asymptomatic heterotopic ossification. No fractures or dislocations occurred in the study patients.

DISCUSSION:

The biomechanical study revealed a significant increase in the ultimate failure load for the valgus oriented components. Thus the valgus-oriented components can withstand a significantly greater applied load prior to developing a periprosthetic femoral neck fracture. The multivariant analysis found that a lower bone mineral density and an increased relative valgus angle correlated with a greater increase in ultimate failure load. Clinically, this translates into an added advantage of valgus orientation for the more osteoporotic patient population. In addition, these results suggest that the greater the valgus angle that can be achieved the lesser the risk of periprosthetic fracture.

REFERENCES:


