THE EFFECT OF FEMORAL HEAD SIZE ON RANGE OF MOTION FROM IMPINGEMENT TO DISLOCATION IN TOTAL HIP ARTHROPLASTY

*Bartz, R L (A-Institute of Orthopedic Research); +*Noble, P C; *Tullos, H S 
+*Department of Orthopedic Surgery, Baylor College of Medicine, Houston, Texas. 6565 Fannin St. Suite F115, Houston, Texas 77030, 713-793-7085, Fax: 713-797-6658, pnoble@bcm.tmc.edu

INTRODUCTION: The process of dislocation of the prosthetic hip joint generally occurs in two stages: (1) impingement (bony or prosthetic) and (2) subluxation. Subluxation represents the period between impingement and frank dislocation. As impingement is fairly common following total hip replacement, the range of motion of the joint during subluxation probably has more influence over the incidence of dislocation than has been appreciated previously. This may help explain the effects of head size on the stability of THR. This study was performed to examine the hypothesis that the size of the prosthetic femoral head significantly affects the range of stable motion of the hip after impingement.

METHODS: Six fresh cadaveric specimens (3 male, 3 female, average age 61) were dissected and implanted with a cementless femoral prosthesis (Meridian, Howmedica, Inc.) and a porous coated acetabular component (Vitalok, Howmedica, Inc.). Each acetabular cup was implanted in 20 degrees of anteversion and 45 degrees of inclination and fixed in place with three cancellous screws. All cup positions were confirmed by measurements performed using a three-dimensional digitizing arm (Microscribe, Immersion Corp.). Neutral acetabular liners were used in all experiments. Each pelvis was mounted in a test rig that simulated motion of the hip joint to dislocation during rising from a chair. The pelvis was mounted on the vertical actuator of a bi-axial servohydraulic-testing machine (Bionix, MTS) while the femur was mounted on a second fixture attached to a linear sliding table. The prosthetic joint was then reduced and loaded via a system of seven cables acting in the line of action of the major muscle groups active during rising from a chair. The forces applied to each cable were calculated from quantitative EMG measurements performed during sit-to-stand activities.

Under computer control, the hip joint was moved through 90-130 degrees of flexion at 0.5 degrees/second with the femur maintained at 10 degrees of internal rotation and three different levels of adduction (10, 20, and 30 degrees). The occurrence of impingement and dislocation were recorded electronically and synchronized with measurement of three-dimension position of the femur was recorded at the points. The entire experiment was performed with four different sizes of standard femoral heads (22 mm, 26 mm, 28 mm, and 32 mm). The range of flexion of the hip from the point of impingement to subluxation was calculated and correlated with head size and joint adduction.

RESULTS: The range of flexion of the prosthetic hip during subluxation decreased significantly with addition for all of the head sizes examined (p<0.001). On average, the range of subluxation dropped from 6.94+/-.41 degrees in 10 degrees of adduction, to 4.89+/-.05 degrees at 20 degrees and only 2.71±0.58 degrees in 30 degrees. The effect of head size on the range of subluxation varied with the position of the joint. In minimal adduction (10 degrees), subluxation was not affected by head size (p=0.001). However, in 20 and 30 degrees of adduction, the range of motion prior to dislocation increase significantly (p=0.01). This effect was most pronounced in 20 degrees of adduction. In this position, the range of subluxation of the hip replacement was 6.33+/-.2.27 degrees with a 32mm head, but only 2.33+/-.04 degrees when the head was reduced to 22mm (p=0.01). This was associated with an increase of 11.5 degrees in the total range of flexion of the joint to dislocation (101.08±.86 vs. 112.67±1.8 degrees, p=0.0001). The site of impingement prior to dislocation also varied with the size of the femoral head. Bony impingement between the femur (usually the lesser trochanter) and the pelvis was observed in 75% of cases performed with a 32mm head, but only 17% of cases when the head was 22mm (p<0.001). In all other cases, contact occurred between the neck of the femoral prosthesis and the acetabular liner.

DISCUSSION AND CONCLUSIONS: The clinical significance of prosthetic motion during subluxation is unknown. However, it is possible that the prosthetic hip acts like the shoulder joint and that patients experience apprehension with the onset of instability. If this is indeed the case, an increased flexion interval from impingement to dislocation may serve as a safety factor to provide feedback to the patient of incipient dislocation of their joint. Our results indicate that, in positions of significant adduction, the artificial hip dislocates with little warning to the patient, independent of head size. In positions of less adduction, 5-7 degrees of flexion is provided by prostheses with 28mm and 32mm heads, but not smaller head sizes. In positions of minimal adduction, the range of subluxation of the joint is not affected by head diameter.

In view of these findings, head diameters of 28 and 32 mm are advocated to provide patients with increased safety should impingement occur during functional activities.