THE INFLUENCE OF FEMORAL STEM’S NECK ANGLE ON PRESSURE DEVELOPMENT IN THE HIP JOINT DURING SINGLE LEG STANCE

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ABSTRACT
INTRODUCTION:
Instability of a total hip arthroplasty can lead to disabling subluxation or frank dislocation. Primary causes of hip instability include component malposition and poor soft tissue balancing. Soft tissue laxity can be improved by using a longer modular head at the expense of leg lengthening. This may be undesirable because a leg length discrepancy may be poorly tolerated. Hip prosthesis with variable offset has been introduced to allow adjustment of the soft tissue tension without a need for changing neck and leg length. The change in offset however changes the abductor moment acting on the hip joint potentially increasing the joint reactive force. This could contribute to increased arthroplasty wear. The purpose of the current study is to create a model to examine the pressure development between the femoral head and liner with alteration in neck offset during single leg stance.

We hypothesized that decrease in neck angle will decrease joint reaction force in the hip with increase in offset and varus angulation. Changing neck angle and increasing offset without affecting limb length decreases the pressure development by 5-10%.

METHODS:
Three-dimensional finite element (FE) model of hip joint musculoskeletal anatomy was developed. The model includes modular total hip prosthesis components (acetabular cup, liner, femoral stem and femoral head) together with twenty-one hip joint muscles, pelvis and femur (see figure 1). Tension-only link elements were used to represent the hip joint muscles. Contact was enforced between the femur head and liner as well as between back side of the liner and the acetabular cup. Several assumptions were introduced to our model: straight line model of lower limb musculature was used; coefficient of friction between femur head and liner and liner and acetabular cup was 0.083; no micromotion between prosthesis and adjacent bone.

Simulation was performed at two levels of angulation of the femoral neck to the femur: 127 degrees and 132 degrees with the Stryker Accolade TMZF prosthesis used as a template for the design.

RESULTS:
Results of the study indicated that increase in neck angle would decrease contact stress at the liner/femoral head interface (see figure 2). FE model predicted peak von Misses stress of 15.0 MPa at 125 degrees and 17.6 MPa for 135 degrees of angulation; this represents a difference of 14.3%. Stress increases are seen on liner edge at inferior lateral portion.

DISCUSSION:
No previous studies have examined the influence of neck angle alteration without change in stem length on stress development in hip joint. The computational results demonstrated that small changes in neck angle produced small changes in peak contact stresses as expected. Decrease in neck angle causing increase varus angulation of neck with increased offset produced decrease stress and strain at the hip joint. Increasing the effective lever arm of the abductor muscles decreases the muscle force necessary to maintain equilibrium in single leg stance. This diminishes the stress and strain in the acetabulum and theoretically will reduce polyethylene wear.

The techniques and results of this study will provide the basis for future efforts to analyze effect of neck angle variability on stress/strain distribution and alteration of muscle forces in the hip joint after THR. To truly understand how this small chance in stress/strain affects wear patterns and rates gait analysis is necessary for more comprehensive study.

REFERENCES:

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