EFFECT OF ACETABULAR ORIENTATION ON HIP SUBLUXATION

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INTRODUCTION

Surgical re-orientation of the acetabulum by peri-acetabular osteotomy (PAO) is used to treat hip subluxation caused by congenital or acquired acetabular dysplasia. Although surgeons use center-edge (CE) angles and false profile views to estimate the direction and degree of correction needed, there are no objective criteria for decision-making. This study uses a rigid body spring method (RBSM) model of the hip to quantitate multidirectional subluxation as a function of acetabular orientation in the frontal and sagittal planes. It provides insights into causes of subluxation by acetabular deficiency, treatment by re-orientation in multiple planes, and effect of re-orientation on contact areas and pressures as well as subluxation.

RESULTS AND DISCUSSION

Composite graph of lateral subluxation (Figure 1) shows rapidly progressive instability as the acetabulum is adducted (tilted more vertically). Loss of as little as 10° CE angle from normal produced marked increases in lateral subluxation. As acetabulum is abducted 10° beyond neutral (increase of CE angle 10° above normal), lateral subluxation disappears, and this effect remains stable for all degrees of additional increases in lateral coverage.

METHODS

An RBSM model of the hip was created to include a spherical femoral head model (255 nodal points) and a spherical acetabular surface with rim contours and orientation derived from bony adult acetabular measurements. Soft-tissue elements (e.g., labrum) were excluded. All simulations were in static single-limb stance, with loading force directed 18° medially and 3° anteriorly upward. Acetabular orientation was varied in 5° increments between 20° adduction and 50° abduction in the frontal plane, and from 20° backward flexion to 45° forward flexion in the sagittal plane. Iterative model calculations were continued until the model reached equilibrium, at which point measurements of subluxation (degree and direction) and acetabular contact surface area were made.

Figure 1: Lateral subluxation as a function of frontal (x axis) and sagittal (y axis) acetabular orientation.
Composite graph of anterior subluxation (Figure 2) demonstrates progressive anterior subluxation as the acetabulum is rotated backwards (extended) more than 10°, corresponding to anterior acetabular dysplasia. As the acetabulum is flexed forward in this region, there is a strong tendency to counteract this, and to develop posterior subluxation instead (this might be interpreted as effective treatment for the subluxation noted in acetabular dysplasia). However, as the acetabulum is abducted 15°, increasing the CE angle, the sensitivity of the hip to acetabular flexion and extension diminishes, and stability occurs regardless of acetabular flexion.

which is inversely related to joint contact pressure.

The effective weight-bearing surface of the acetabulum falls above the “equator” of the spherical femoral head that lies normal to the loading force. As the acetabulum is abducted, the contact area of the joint gradually increases (Figure 3) by about 3% for every additional 5° of abduction (increased CE angle). As contact area increases, joint surface contact pressure decreases.

**Figure 2:** Anterior subluxation as a function of frontal (x axis) and sagittal (y axis) acetabular orientation.

A potential advantage of PAO is that the medial-lateral position of the acetabulum may be adjusted along with the orientation, reducing joint contact pressure by medializing the joint center, or by providing greater superior articulating surface. The model allowed quantitative measurement of effective articular surface with reorientation, which is inversely related to joint contact pressure.

**Figure 3:** Effective acetabular contact area as a function of frontal (x axis) and sagittal (y axis) acetabular orientation.

**SUMMARY**

Acetabular abduction is more effective than acetabular flexion at controlling the majority of clinical hip instabilities, and may allow reduced joint contact pressure. Relatively small degrees of anterior flexion (10-15°) can compensate for significant anterior subluxation, but it is the increase in CE angle afforded by acetabular abduction that leads to the greatest stabilizing effect of PAO.