"Restoration of Hip Mechanics"

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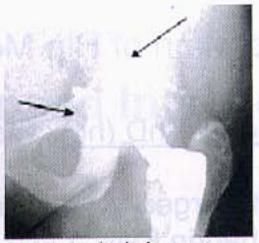
Acetabular considerations

The hip joint is not a perfect ball-and-socket joint; the femoral head is oval in shape and the articular surface of the acetabulum is horseshoe shaped. The dome of the acetabulum, which has been considered a weight-bearing area, is in-fact flexible. The horns of the acetabulum can thus close up and contact the femoral head when the joint is loaded. The degree of this movement is dependent upon age, load, and femoral anteversion. This mobility of the acetabular horns could explain biomechanically the development of aseptic loosening that occurs around acetabular components.

Pauwels describes a radiolucent triangular space above the dome of the acetabulum. The shape of this triangle is subject to modifications that are dependent upon femoral loading orientation. In advanced osteoarthritis of the hip the surface area of this triangle decreases and vanishes. It is interesting-to-note that with age, the hip becomes more congruent and the radiolucent triangle disappears while a trabecular pattern becomes apparent.

Pre-op 11 yr

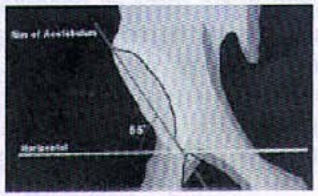


Post-op lysis in zone 1 & 3

Radioluncent Triangle

Apart from the initial stability at the acetabular implant bone interface some time after initial implantation is needed for the acetabular horns to become mobile again. This corresponds to radiographic evidence of radiolucent lines in zones 1 and 3. In - fact, clinical analysis of cemented devices demonstrates considerable progression of acetabular component loosening beyond the 12th year and even earlier in young, active patients. This mobility might further explain finding little or no bone-ingrowth on retrieved cementless implants. Mobility of the acetabular horns must be considered in design parameters if long-term fixation is to be achieved. Fixation is enhanced if the prosthesis is set in a position of less than 45' abduction to promote compression and eliminate tension at the interfaces.

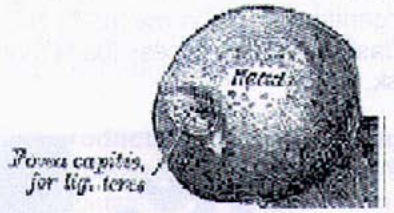
The acetabulum is generally spherical in shape and its opening is oriented closer to 55° than 45°, downward in the coronal and sagittal plane, and anteverted approximately 15° to 20° in the midsagittal plane.



Initial acetabular component stability is affected by the cup's ability to engage with the host bone. This is a function of cup design, size, and surgical technique. Cups of a true hemispherical design are more stable than low-profile designs.

Femoral Consideration

The femoral head is slightly larger than one half of a sphere, and the shape is more oval than spherical.



Mechanical Considerations

The stresses on the femoral head usually act on the anterior superior quadrant, and surface motion can be considered as sliding on the acetabulum. Two important angles need to be considered: the neck shaft angle and the angle of anteversion. In addition, to these two angles, femoral head offset affects the joint reaction force. It is also important to

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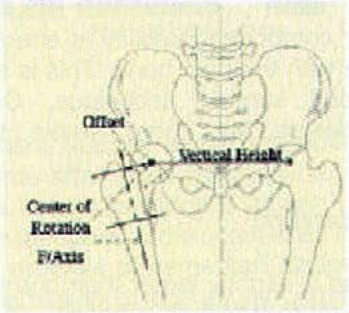
remember that while static force is considerably greater than body weight, even greater force is generated posteriorly in dynamic situations such as acceleration and deceleration: manifest in negotiating stairs or inclines, in changing from a sitting to a standing position or vice versa, and in other routine activities of daily living that load the hip in flexion.



Routine activities can result in significant forces acting on the hip joint and the bone implant interface. Historical torsional loads have been published demonstrating patient related activities can generate loads in the 12-23 Nm rage. However, patients can easily generate excess loads that can and do put implants at risk.

Torsional Loads

➢ Stumbling 30-40 Nm it only takes 30 Nm of torque to put implant stability at risk

What are the objectives of hip replacement?

- Pain relief
- Restoration of function
- Longevity

Young patients will live > 50 years

- Bearing Surface longevity
- Currently this is possible using hard/ hard bearings
- Optimal current couple (?) yet to be determined

Stem Longevity

- Currently there are several stems with a more than 20-year survival and show no signs of loosening.
- However osteolysis, especially of the Greater Trochanter may lead to pain, fracture and loss of function.

Prevention of osteolysis

- Osteolysis is particle disease
- All bearings produce particles.
- Hard/ hard produce many less particles than hard/ soft, but they still produce particles, especially with component malpositioning.

Increased particle production. Squeak is an indicator!

- Impingement between neck and cup. If severe, will result in subluxation/ relocation which produces impact and destroys fluid film lubrication.
- Failure to give adequate offset will allow micro-separation.
- Vertical cup placement allows the head to ride out of the cup thus destroying fluid film lubrication.

Cup Placement

- In an effort, to protect ceramic liners many companies inset the liner.

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- This means that while the centre edge angle of the outer shell may be at 45° the liner is then at 55°.
- Think of 35 therefore as being the new 45 i.e. with hard/ hard bearings the cup must be inserted more horizontally than previously.

Preventing impingement

- During trial reduction check that the head is centred in the cup.
- The neck must not hit the cup edge, especially in external rotation in extension.
- Proximal Modularity allows fine-tuning of joint mechanics
- Cameron-"What surprised me was that when I got a modular neck cemented stem I ended up putting the neck in retroversion in 75% of cases."

Impingement is important in heavily X-linked poly.

- The fracture toughness is reduced and repeated contact with the neck may result in rim fracture with subsequent liner separation.
- As well as of course, increasing particle production.

Micro separation – now recognized as being a problem

- Increase of wear may produce noise by cavitation and loss of lubrication.
- Currently there is no way of checking this intra-operatively. The Shuck test does not really help.
- The more closely offset can be restored, probably; the less likely it is to happen.

Major challenge is joint stability and leg lengths

- Joint stability takes precedent over desired leg length

Difficult to balance the joint mechanics

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