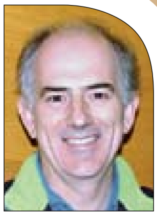
Advances in knee replacement

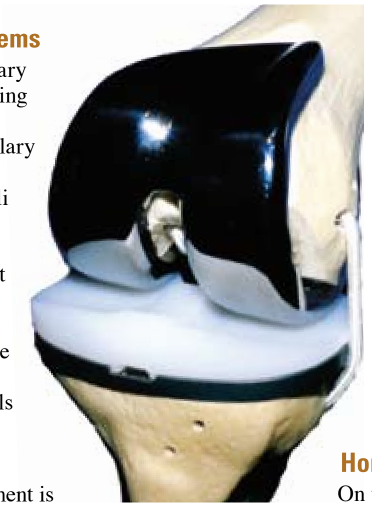
By Dr Keith Holt,
Orthopaedic Surgeon,
West Perth.



Knee prosthetic design has been subtly changing since the advent of the resurfacing models of the 1970s, and not always successfully. Indeed, some changes proved retrograde such as polyethylene sterilisation by radiation in air (early component failure, see Fig 2), and some surface changes to uncemented components (leading to inadequate bony ingrowth). These problems have mostly been resolved, leading to prosthetic life spans of 20 years or more. Current focus therefore has shifted more towards improving function.

Better alignment systems

The move to extra-medullary alignment systems (including computer based systems), means that the intramedullary canal of the femur is not breached and no fat emboli created. This leads to much less post-operative sickness (systemic, not just respiratory) and makes simultaneous bilateral knee replacement safe. The computer has also helped achieve 3D alignment goals in a reproducible manner.



■ Knee prosthesis.

Better fit and balance

The goal of good replacement is perfect ligamentous tension with isometry maintained throughout the whole range of movement. This is where the surgeon's skill comes into play but a larger range of components can be very helpful. In the arthritic knee, collateral ligaments may be scarred and contracted, and hence, no longer isometric throughout the range of motion: so it is very advantageous to be able to individually adjust flexion and extension tension by altering component size and shape (rather than by changing the bone cuts).

Recent designs incorporate 'high flex' geometry, which allows better functioning at higher ranges of knee bend (up to 155 degrees). These designs have a decreased radius of curvature on the posterior femoral condyle, which is the part used in flexion, and for which greater bone resection from the posterior condyles is required to admit a 2mm thicker, but more curved, metallic component.

Having a standard prosthesis with 2mm more metal on the posterior condyles means that the 2mm can also be taken off. 'Minus' sizes in the Zimmer® NexGen® knee system have a femoral component that is the same thickness distally (just as tight in extension) but 2mm thinner posteriorly (2mm looser in flexion). This has made a big difference to our ability to fine tune the ligamentous balance of the replaced knee (Fig 1).

Gender specific prostheses

In the last year, Zimmer (with other companies certain to follow) have released the Gender Solutions™ knee prosthesis that deals with another femoral sizing problem seen mostly in females where, for a given antero-posterior dimension, the femur is not as wide as in a male (Fig 5).

Normally, the femoral component size is governed by the A-P measurement because this determines the flexion mechanics (i.e. collateral ligament tension). In women, a correctly chosen A-P size may result in medial and lateral overhang that rubs on collateral ligaments during flexion, leading to pain and abnormal ligament tension (Fig 6). Avoiding this is important.

The gender specific prosthesis also has another feature – a shallower and differently angled trochlear groove for the patella, which more closely matches the normal female knee. This results in less tightness of the retinacular structures in the first 45° or so of flexion, which in turn means easier and less painful flexion.

The Gender Solutions comes in both standard 'high flex' and minus sizes and seems to be required in about a third of knee replacements.

Honeycomb design aids fixation

On the tibial side of a knee prosthesis, one new design feature of note is the use of Trabecular Metal™ baseplates to hold the polyethylene articular surface. Made of tantalum, the honeycomb design mimicks cancellous bone to allow good and rapid bony ingrowth.

■ Fig 1. A minus prosthesis - narrower posteriorly.

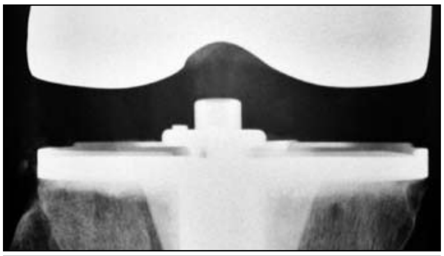
Tantalum is also soft, with a modulus like bone, so it transmits force much more physiologically (i.e. evenly). Standard rigid baseplates transmit force very unevenly so that in some areas stress shielding leads to bone resorption, whilst in other areas there may be points of high load transmission leading to painful stress reactions or stress fractures in the underlying tibia.

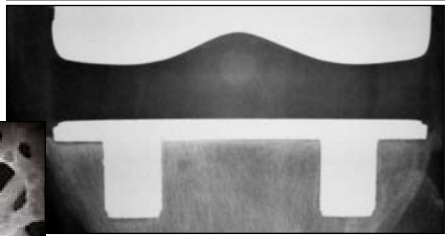
Although it is early days for Trabecular Metal technology, the more physiologic load transmission it provides to the tibia seems to considerably lessen these problems (Figs 3 & 4).

The big picture

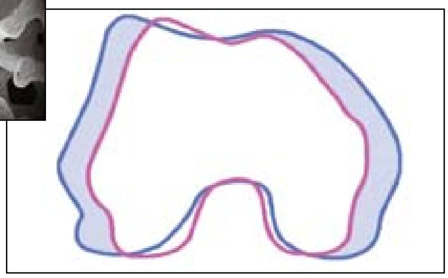
The down side for all of this flexibility is the requirement for prosthetic companies and hospitals to maintain a larger inventory of prostheses – four times as many femoral components, different styles of tibial component, etc. This does mean increased cost but, for the patient, there are the advantages of a better fitting knee with potential to get a better range of motion, more rapid recovery and less pain. ■

■ Fig 2. Worn out poly due to irradiation in air.





■ Figs 3 & 4. Trabecular Metal (inset) is used on tibial base plate as opposed to the cemented standard plate (upper image).



■ Fig 5. Comparison of male-female femoral condyle profiles.

■ Fig 6. Red area depicts possible prosthesis overhang in the female knee.

This clinical update is supported by an unrestricted educational grant to Medical Forum from Zimmer Pty Ltd.