Introduction

Arthroplasty is an operation to restore pain-free motion to a joint and function to the muscles, ligaments, and other soft tissue structures that control the joint.

If one side of the joint surface is replaced, it is a hemiarthroplasty. Because of the unsatisfactory results of hemiarthroplasty designs, total joint replacement arthroplasty in which both surfaces of the joint are replaced, evolved.

The modern era of total joint replacement arthroplasty began in the 60s. Sir John Charnley developed a total hip replacement consisting of a stainless steel femoral stem with the head articulating with a high density polyethylene acetabular cup. Both the femoral and acetabular implants were fixed to the supporting bone by polymethylmethacrylate (bone cement). Similar total joint designs were soon developed for most of the other major joints including the knee, ankle, shoulder, elbow and wrist. Nowadays most total joint replacement arthroplasty operations are for the hip and the knee, with a small number for the shoulder and the elbow.

Thus most of the new developments for total joint replacement arthroplasty centre around the hip and the knee.

Fixation

In the beginning the total hip replacement implants were fixed by bone cement. Aseptic loosening of the implants was attributed to bone cement and it was called “cement disease”. Thus in the 80s cementless implants were developed. Fixation was by press-fit and bony in-growth. Bony in-growth onto the implants is induced by the porous coating or biologically active calcium phosphate ceramic coating of the implants. The porous coating of the implant surface is created by metal beads or wire mesh. The two commonly used calcium phosphate ceramic materials are hydroxyapatite and tricalcium phosphate. However, it was found that cementless implants were not without aseptic loosening.

Later it was discovered that aseptic loosening of cemented implants in total hip replacement arthroplasty was actually due to wear particles mainly arising from the articulating surfaces. The wear particles induced periprosthetic osteolysis leading to aseptic loosening of the implants. It was called “particle disease”.

With quality enhancement of bone cement and improvement in cementing technique, cemented total hip replacement arthroplasty is shown to have long survivalship.

Most surgeons use both cemented and cementless implants depending on the clinical assessment.

Tribology

Tribology is the science of the mechanisms of friction, lubrication, and wear of interacting surfaces which has evolved into one of the most discussed topics in the orthopaedic community in recent years.

The particle disease leading to aseptic loosening of the implants led the scientists to search for alternative articulating systems:

1. Metal-on-metal articulation
   The first metal-on-metal articulation was implanted in 1938 by R.P. Wiles in London. Excellent long-term results from the 60s spurred a company to reintroduce a technologically enhanced second generation of metal-on-metal articulation under the trade name Metasul in 1988.

2. Ceramic-on-ceramic articulation
   The first implantation of ceramic-on-ceramic articulation was by P. Boutin in France in 1970. Extensive multicentre study of this particular hard/hard articulation had been conducted in Europe in the late 90s. Aluminium oxide and zirconium oxide are the two commonly used ceramics.

3. The highly crosslinked polyethylene Durasul was developed in late 90s, which demonstrates greater wear resistance than the conventional polyethylene. The improvement in tribological solutions in total joint replacement arthroplasty may further increase the implant longevity.

Asian Total Hip Replacement

There are a lot of total hip replacements in the market. Different surgeons have their own preference according to their training, philosophy and experience.

Most total hip replacements in the market are manufactured according to the tomographic osteometry of the Caucasians. However the hip osteometry of the
Chinese is different from that of the Caucasians and the surgeon may occasionally encounter difficulty during implantation of the prosthesis. Thus Dr. David Fang, in cooperation of the Biomet, designed the Asian total hip replacement basing on his studies of the Chinese osteometry of the hip in 1988. The Asian total hip is of cementless fixation.

**Hip Resurfacing Arthroplasty**

The survivalship of total hip replacements in younger patients is not satisfactory. Thus hip resurfacing is being advocated by some surgeons for young and active patients. Hip resurfacing has the advantages of preserving proximal femoral bone stock and optimising stress transfer to the proximal femur. Because of the large diameter of the articulation it offers inherent stability and optimal range of movement.

Hip resurfacing can be dated back to early 50s. However because of the use of inappropriate materials, poor implant design and inadequate instrumentation, the early generations of hip resurfacings were disastrous.

In late 90s, there was a renaissance of hip resurfacing. Most implants are of metal-on-metal hip resurfacing systems and of hybrid fixation (cementless acetabular fixation and cemented femoral fixation). Examples of hip resurfacing systems include Birmingham Hip Resurfacing, Durom, and Conserve Plus etc..

The early results of contemporary hip resurfacings are encouraging and hip resurfacing offer bone preservation and restoration of function in appropriately selected young patients. However long-term results of hip resurfacing are pending especially the biological effects of the elevated metal ion levels in patients with metal-on-metal bearings.

**Surgical Approaches**

There are many surgical approaches for total hip replacement arthroplasty, including posterior, anterior and lateral. For the knee joint, the anterior approach is the usual one. Recently with new designs of instruments surgical approaches in total hip replacement become minimally invasive.

The minimally invasive total hip replacement arthroplasty can either be the minimal incision approach or the two-incision approach.

The minimal incision approaches are modifications of the standard surgical approaches performed through wounds 7-10 cm in length. The two-incision approach uses intermuscular planes to gain access to the hip joint and thus minimise the dissection of muscles and tendons.

Minimally invasive surgery techniques allow early recovery of the patients apart from the better cosmetic results.

However the minimally invasive surgery techniques have to be applied to properly selected patients.

**Computer-assisted Surgery (CAS)**

Implants positioning is very important in total joint replacement surgery.

Minimally invasive surgery may not allow visualisation of all anatomical landmarks for accurate placement of the implant components. Computer-assisted surgical tools can allow intra-operative navigation for accurate placement of implants in a minimally invasive manner.

The navigation system consists of a computer with softwares for different kinds of surgeries, trackers coupled with the instruments and a camera picking up signals from trackers and feeding to the computer. After pre-registration of the anatomical landmarks of the operative limb, the navigation system can provide a real time visualisation of the positioning of the instruments (usually the bone cutting blocks), and thus allow adjustment if necessary.

**Conclusion**

With advance in material science and prosthesis design, better implants will be produced and available for clinical use.

Better surgical instrumentation and advance in computer-assisted surgical tools allow accurate implantation of the artificial joint components in a minimally invasive manner allowing faster recovery.

However appropriate patient selection is still the main determinant for good clinical outcome in total joint replacement surgery.