Advances in treatment for osteoarthritis of the knee

Osteoarthritis is the most common form of arthritis. Properly treated, patients can enjoy good joint function and maintain their desired level of activity. This article discusses the relative value of treatment options available today for osteoarthritis of the knee.

WUI K. CHUNG FRACS

Dr Chung is Director, Nepean Centre for Joint Replacement and Reconstruction, Nepean Private Hospital; Head, Orthopaedic Department, Nepean Hospital; and Visiting Orthopaedic Surgeon, Jamison Hospital, Penrith, NSW.

Osteoarthritis is a clinical spectrum ranging from localised chondral defects to established arthrosis resulting from hyaline cartilage failure (see Figure 1 and Figures 2a and b). It is estimated that 85% of the population will have radiologically detectable primary osteoarthritis or progressive wear and tear degeneration of the joint by the age of 65 years. The association with age is not linear; the incidence increases exponentially after the age of 50. Primary osteoarthritis is more common than secondary, although the latter may occur much earlier, usually as a result of bone, joint or ligament injury.

Treatment options depend on the patient's age, the severity of arthrosis and physical expectations, and are discussed in the flowchart on page 30.

Nonpharmacological treatment

Mild or moderate osteoarthritis of the knee may be responsive to nonpharmacological interventions, such as:

IN SUMMARY

- **There is no disease-modifying drug for osteoarthritis. Mild and moderate symptoms may be responsive to nonpharmacological interventions or simple analgesics, but many patients resort to anti-inflammatory medications.**
- **Studies of glucosamine hydrochloride–chondroitin sulfate in patients with osteoarthritis suggest that these compounds can produce prolonged symptom relief, but no evidence for disease modification *in vivo* has yet been established.**
- **Arthroscopic debridement has a limited and specific role for the treatment of osteoarthritis. Abrasive arthroplasty yields even less predictable outcomes and is not generally recommended.**
- **Some 20 to 30% of patients treated by high tibial osteotomy require conversion to a total knee replacement. Osteotomy may maintain the patient's active lifestyle and deter the need for replacement surgery for a number of years.**
- **More than 50% of cases of knee arthrosis affect a single compartment of the knee. Unicompartmental knee replacement is an effective treatment for the condition. The minimally invasive surgical technique increases the appeal of this form of treatment but is more technically demanding.**
- **Total knee replacement is the definitive treatment for advanced arthritis. More than 95% of total knee replacements are expected to remain functioning 15 years after implantation, but there are ongoing concerns with articular wear and related particulate-induced osteolysis.**



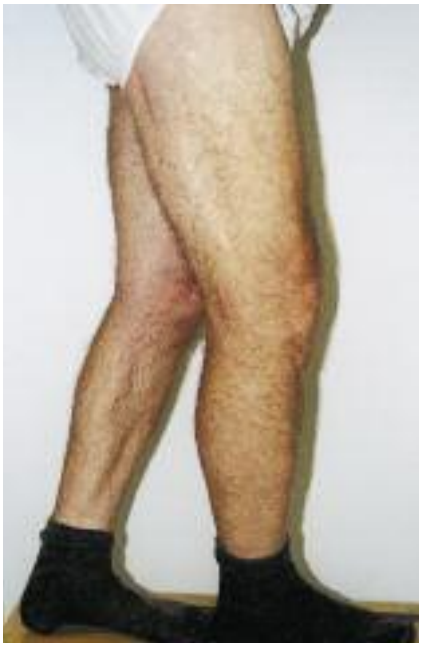


Figure 1 (left). Mild osteoarthritis affecting the medial compartment of the right knee (grade 3 out of 5) with an associated varus deformity.
Figures 2a (middle) and b (right). Moderate medial compartment osteoarthritis in a 42-year-old man.
a. Note the varus deformity. b. A fixed flexion deformity is visible.

- weight reduction
- lifestyle changes
- assist devices
- braces
- footwear modifications.

Obesity is a risk factor for osteoarthritis, and weight loss has been demonstrated to decrease the risk of developing and exacerbating osteoarthritis.[1] Individuals with osteoarthritis of the knee should be advised to combine dietary changes with an exercise program directed at maintaining joint mobility as well as muscle strength and flexibility. Impact exercises should be avoided, but low-impact activities (such as swimming, cycling and isometrics) will help to reduce symptoms and maintain joint function.

Symptoms can also be minimised by reducing pain provoking activities such as standing for prolonged periods, sitting in low chairs and climbing stairs. Using high stools and toilet seats can also reduce stresses to the knee. A walking stick used in the opposite hand is often effective during periods of pain exacerbation.

Individuals with single compartment knee arthrosis can use an unloader knee brace. The device works on a three-point principle to reduce joint reactive forces in the diseased compartment. A number of recent studies found the valgus unloader brace to be effective for medial compartment arthrosis.[2,3] Bracing is a reasonable option for the young individual and for patients who cannot undergo or wish to avoid operative treatment.

Pharmacological treatment

Anti-inflammatory medications

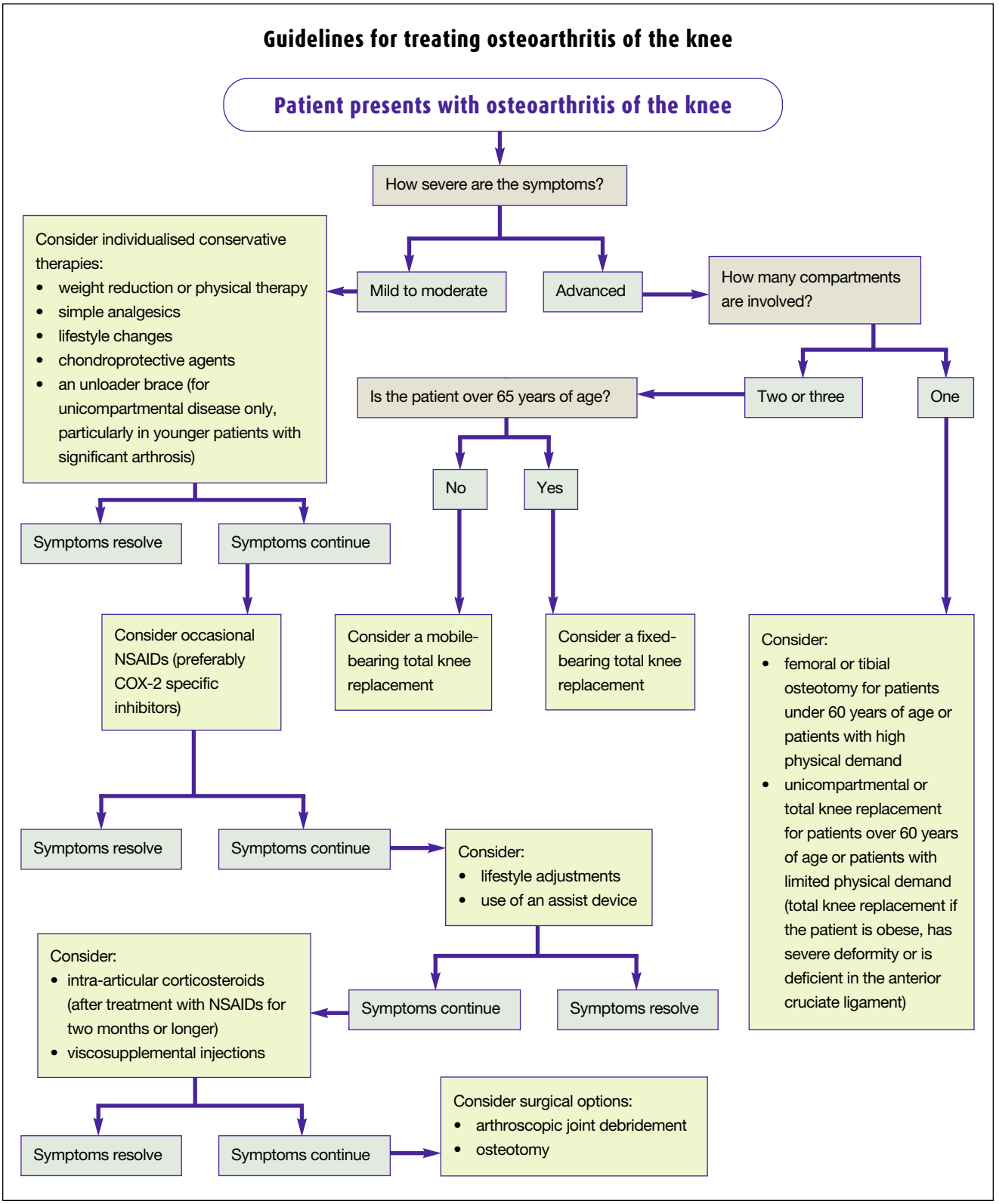
At present there is no established disease modifying drug for osteoarthritis. Mild or moderate symptoms may respond to simple analgesics, but many patients resort to anti-inflammatory medications for symptom relief.

Most side effects are dose related and more severe in elderly individuals. Among patients with osteoarthritis who are aged 65 years or older, approximately 2% of patients treated with NSAIDs for one year will be hospitalised with ulcer complications – especially if a history of ulcer disease is present. Patients with a history of gastrointestinal disease, hepatic disease or chronic renal disease, should be considered for alternative treatment.

A new generation of anti-inflammatory agents known as COX-2 specific inhibitors (celebrex [Celecoxib] and rofecoxib [Vioxx]) was recently introduced. Unlike NSAIDs, which inhibit cyclo-oxygenase-1 (COX-1) and cyclo-oxygenase-2 (COX-2), the new anti-inflammatory agents specifically inhibit COX-2. Both NSAIDs and

continued

Guidelines for treating osteoarthritis of the knee



COX-2 specific inhibitors are beneficial in blocking the production of prostaglandins; however, COX-2 specific inhibitors do not affect platelet aggregation and are less likely to produce upper gastrointestinal ulceration.

Oral chondroprotective agents

A number of chondroprotective substances have been identified that counter the degenerative processes and encourage normalisation of the synovial fluid and cartilage matrix – hyaluronic acid, sodium chondroitin sulfate and glucosamine are believed to have such properties.

Recently, there has been a surge of interest in the use of chondroprotective agents to treat osteoarthritis. Oral glucosamine and chondroitin sulfates have been shown to be absorbed effectively from the gut to localise in joint tissues. Concurrent use of glucosamine and chondroitin sulfates has been advocated because glucosamine induces increased synthesis of matrix compounds whereas chondroitin sulfate inhibits breakdown. The combined effect of the two compounds may not be merely additive; some degree of synergism has been suggested.[4]

A number of preparations of glucosamine hydrochloride–chondroitin sulfate are available. Studies among patients with osteoarthritis suggest that these compounds can produce prolonged symptom relief, but no evidence for disease modification *in vivo* has yet been established. Oral chondroprotective agents are convenient, cost effective and well tolerated.

Viscosupplemental injections

Hyaluronan is the component of synovial fluid that provides lubrication and shock absorption. The disease process of arthritis alters the viscoelastic property of synovial fluid by diluting it and decreasing the average molecular weight of hyaluronan in the joint, making the joint more vulnerable to effects of mechanical loading.

Viscosupplemental injections aim to replace the low elastoviscous synovial fluid in the arthritic joint with a high elastoviscous solution of hyaluronan or its derivatives. Earlier preparations of hyaluronan solutions had lower elastoviscosity than natural, healthy synovial fluid; newer preparations are now commercially available that have greater elastoviscosity than natural synovial fluid and enhanced intra-articular residence (e.g. hylan [Synvisc]).

Treatment consists of three injections given at weekly intervals. Up to 80% of patients with arthritis of the knee joint may expect useful relief of activity-related and nocturnal pain (compared with a placebo effect of 15%). In one Canadian study, the mean duration of efficacy was 8.2 months.[5] Local transient postinjection pain and joint effusion may occur in a variable proportion of patients depending on the technique of injection. Extra-articular injection will cause pain and quite possibly adverse local reaction. It has been reported that more than 80% of patients obtained benefits from a second course of viscosupplemental injection.[5]

Surgery may be deferred by treatment with viscosupplemental injections of hyaluronic acid gels.

Intra-articular steroids

Intra-articular injection of corticosteroid is an effective means to control pain and swelling for the patient who fails to respond to first line anti-inflammatory therapy, provided there are no significant symptoms from mechanical impingement. Although the positive response rate is high, the injection provides variable relief, lasting from a few weeks to a few months. Microcrystalline preparations provide prolonged symptom relief compared with more soluble preparations. Steroid injections carry minimum risk of systemic side effects of complications, but temporary post-injection pain from reactive synovitis is an occasional complication. Injections should be limited to a maximum of three or four per year.[6]

Surgical treatment

Arthroscopic surgery

Arthroscopic joint debridement and abrasive arthroplasty represent limited interventions; however, results are variable and symptom relief is temporary. Neither procedure is suitable for advanced arthrosis.

Arthroscopic debridement involves: removal of loose or unstable articular flaps; debridement of torn, degenerate menisci; limited synovectomy; and removal of impinging osteophytes and loose bodies. Current indications are:

- early to moderate osteoarthritis
- normal alignment or minor deformity
- reasonable preservation of joint space
- evidence of internal derangement
- impinging osteophytes.

Slightly more than 50% of patients are made better with arthroscopic debridement; one in eight patients will suffer worsening of symptoms after treatment. However, arthroscopic debridement remains a useful method for treatment of mild and moderate arthrosis with symptoms attributable to mechanical impingement.

In the past, abrasive arthroplasty had been advocated that involves shaving of diseased articular cartilage, mechanical abrasion and drilling of the subchondral bone and the radical removal of osteophytes.[7] Abrasive arthroplasty yields even less predictable outcomes than arthroscopic debridement and is not generally recommended: 20% of patients treated by abrasive arthroplasty are made worse, and 50% of all patients treated by arthroscopic abrasion require total knee replacement at five years.[8,9]

Cartilage repair

Damaged articular cartilage has limited ability to repair. Recently, a number of repair techniques have emerged, some of which appear to be promising. Treatment

Osteotomy

Figures 3a (left), b (middle), and c (right). Osteotomy. a. A knee treated by high tibial osteotomy shown within a year of surgery. b. Two years after surgery, progression of the arthritis is visible. c. The knee shown at the limit of motion two years after the surgery.

Figures 4a (right) and b (far right). Medial compartment arthritis treated by high tibial osteotomy eight years earlier. a. The anatomy has been distorted and the patient has significant problems due to progression of the arthritis. b. The knee after high conformity total knee replacement. The stem of the tibial component is close to impinging on the lateral tibial cortex – one of a number of technical problems associated with total knee replacement after high tibial osteotomy.

is presently limited to small chondral defects.

There is still no effective method of inducing regeneration of articular cartilage. Small areas of articular cartilage loss involving the femoral condyle are effectively treated by autologous osteochondral graft harvested from noncritical areas of the femoral surface; larger defects require multiple grafts (mosaicplasty). The transferred hyaline cartilage has been shown to survive for up to seven years; however, the repaired articular cartilage generally fails to replicate the structure, composition and function of normal articular cartilage.

In autologous chondrocyte implantation, chondrocytes harvested from the patient are reimplanted after three to four weeks of culturing. Cultured chondrocytes replaced in the host produce a hyaline-like articular cartilage that lacks the normal structure of articular cartilage. Good early results have been reported but long term survival is uncertain.

Osteotomy

Unicompartmental disease can benefit from realignment osteotomy. However, osteotomy of the tibia or femur provides only partial relief of symptoms for a limited period: 85% of high tibial osteotomies are satisfactory at two years, but only 50% are satisfactory at 10 years (see Figures 3a to c). Within seven years some 20 to 30% of patients treated by high tibial osteotomy require conversion to a total knee replacement. The conversion operation gives a less satisfactory result than primary knee replacement surgery (see Figures 4a and b). Furthermore, osteotomies are major operations associated with higher morbidity, less pain relief, less functional return and a higher complication rate than unicompartmental knee replacement.

Knee replacement surgery

Knee replacement is the definitive treatment for advanced arthritis. It is one of the most successful orthopaedic procedures, with a very high rate of patient satisfaction and excellent long term clinical results.

Fixed-bearing and mobile-bearing designs are available for partial (unicompartmental) or total (tricompartmental) knee replacement surgery. Partial knee replacement surgery, including the minimally invasive technique, is discussed in the box on page 35.

The fixed-bearing knee

The current fixed-bearing knee is designed to have closely matching geometry of the femoral and tibial articular surfaces (see Figures 7a to e). Conformity increases the footprint of the femoral component on

Unicompartmental knee replacement

Unicompartmental knee replacement was introduced in the late 1960s. Lessons learnt over the last two decades have led to better implant design and instrumentation, surgical techniques and patient selection, and results have improved accordingly (see Figures 5, 6a and b).

The mobile-bearing design is proving to be more durable than its fixed-bearing counterpart: the Oxford mobile-bearing knee has been reported to have a survivorship of 97% at 15 years, and a polyethylene wear rate of less than 0.01 mm per year.[9] However, component instability is a concern with mobile-bearing designs, and the excellent results obtained in some centres are not duplicated elsewhere.

One of the aims in prosthetic knee design is the reproduction of natural knee kinematics, but this is not achieved with even the new designs. It is unlikely that natural kinematics can be simulated in total knee replacement as long as the anterior cruciate ligament is sacrificed. Preservation of natural ligaments such as the anterior cruciate ligament is possible in partial replacement surgery, and this is one argument in its favour.

Patient selection

Almost 50% of cases of osteoarthritis involve only one compartment of the knee joint (the vast majority affect the medial compartment). The disease tends to remain confined to one compartment for many years, although secondary patellofemoral arthritis and intercondylar changes occur as a consequence of altered mechanics. It is highly attractive to be able to confine treatment to the involved compartment in order to limit the extent of surgery and preserve healthy tissues.

Unicompartmental knee replacement is preferable to a high tibial osteotomy for single compartment arthritis in the older patient. It is often the better choice for the patient with unicompartmental arthritis because associated complications are less frequent, pain relief is better and recovery is faster. However, individuals receiving a knee replacement may not return to high impact activities. Therefore, young individuals and those patients who have high physical expectations are better treated by osteotomy.

Contraindications

Contraindications for unicompartmental knee replacement are:

- severe deformity
- obesity
- rheumatoid arthritis
- unstable knee
- high impact activities.

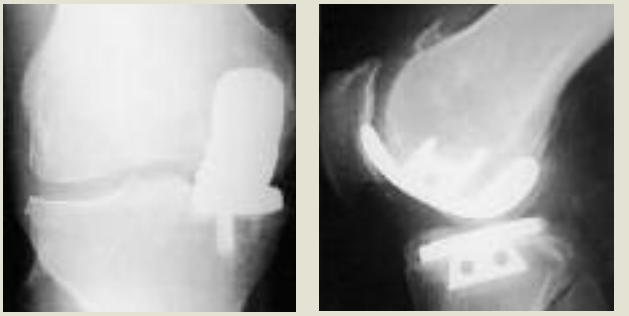
For unicompartmental knee replacement, the disease must largely be confined to a single compartment. However, secondary patellofemoral arthritis is not considered to be a contraindication.

Rehabilitation

The minimally invasive technique has greatly increased the popularity of unicompartmental knee replacement, as surgeons and patients are attracted to the substantially reduced morbidity and much quicker rehabilitation. The average blood loss following surgery is less than 100 mL.

Patients are encouraged to mobilise the knee and to walk with suitable walking aids within hours of the surgery. Younger patients who receive unilateral surgery can generally be discharged on the same day; older patients and patients who receive bilateral surgery generally prefer to stay in hospital for another day or two. Most patients are capable of more than 125 degrees of flexion within three weeks. Walking aids are generally not required after four to five days, and after three weeks most patients are able to drive a car and return to sports such as bowling and golf.

Figure 5. The surgical exposure during minimally invasive knee replacement.



Figures 6a (left) and b (right). X-rays of a unicompartmental knee replacement of the medial compartment after 11 years. a. Anterior–posterior view. b. Lateral view.

Fixed-bearing knee replacement



Figures 7a (left), b (middle), c (right). Advanced knee arthritis in a patient who required a total knee replacement. a and b. X-rays shown in the anterior–posterior and lateral views prior to surgery. c. The arthritis involved the medial compartment and patellofemoral articulations.


Figures 7d (far left) and e (left). X-rays taken immediately after surgical treatment with a modern high conformity, fixed-bearing total knee replacement shown in the anterior–posterior and lateral views.

Figure 8 (left). A retrieved specimen with a damaged tibial component from a failed fixed-bearing total knee replacement. The polyethylene insert and the supporting titanium tibial tray are worn on one side. This patient had extensive bone loss as a consequence of particle-induced osteolysis.

the surface of the tibia and inhibits excessive translation of the prosthetic components; consequently, polyethylene wear and damage are expected to be significantly lower (see Figure 8).

Medium term reports suggest that the present generation of fixed-bearing knee replacements is likely to perform well in the long term. More than 95% of modern fixed-bearing total knee replacements may be expected to survive beyond 20 years in low demand and older patients. There is, however, concern about the durability of total knee replacement carried out on high demand and younger patients. As confidence in the operation increases, there is an inevitable broadening of the age limit. Younger and more physically expectant patients require knee designs that wear less readily, and provide good mobility and natural kinematics.

To minimise wear, the articulating surfaces must be fully conforming in order to maximise contact. A fixed-bearing knee cannot be fully conforming and yet capable of rotation, and this limitation was the stimulus for development of the mobile-bearing knee.

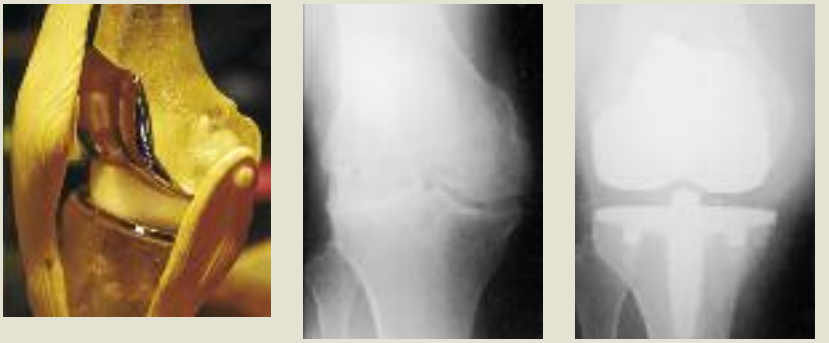
The mobile-bearing knee

The modern mobile-bearing knee features full conformity in the proximal articulation between the femur and tibia. In this interface, there is no freedom of rotation or translation – these movements take place in the second or distal interface between the polyethylene insert (meniscal bearing) and a highly polished tibial tray (see Figures 9a to c). The mobile-bearing knee can be designed to have a contact area that is five to eight times that of a fixed-bearing design, and plastic wear and damage are therefore likely to be much lower.

Results of the first generation of mobile-bearing knee replacements have been very encouraging. There are more than 17 different mobile-bearing knee prostheses on the market today, differing

continued

Mobile-bearing knee replacement



Figures 9a to c. Mobile-bearing knee replacement. a (left). A SAL prosthesis. b (middle). Lateral compartment arthritis requiring total knee replacement. c (right). The total knee replacement with the SAL mobile-bearing prosthesis.

substantially in design philosophy, and it is likely that differences in long term results will appear.

The future

The new millennium is likely to witness exciting biotechnological advances, such as cartilage restoration techniques. Meniscal transplantation and techniques for grafting cartilage will improve, as will medical treatment to retard cartilage degradation. Disease modifying methods will be developed, such as gene therapy and growth factors. The role of polymer interposition arthroplasty will be defined better, and it is likely that development will take place in areas of prosthetic design.

Summary

Early stages of symptomatic osteoarthritis of the knee may be responsive to conservative treatment. Nonresponsive or more severe grades of arthrosis usually require surgical treatment, for which there are several options – the patient's age, physical expectations and grade of arthrosis influence the choice of surgical treatment.

In more than 50% of cases of osteoarthritis, only one compartment of the knee joint is affected. For these patients, minimally invasive surgery allows partial knee replacement to be performed without major blood loss and prolonged hospitalisation. There are distinct kinematic advantages of the unicompartment knee replacement; however, total knee replacement is the definitive treatment for advanced osteoarthritis. More than 95% of total knee replacements are expected to remain functioning 15 years after implantation, but there are ongoing concerns about articular wear and related particulate-induced osteolysis.

The fixed-bearing total condylar knee remains the main type of knee implant, promising good functional results with practical durability, but there is growing interest in newer, mobile-bearing designs, which offer possibilities for better durability and function. Properly treated, patients with osteoarthritis of the knee can enjoy good joint function and maintain a reasonable lifestyle. MT

A list of references is available on request to the editorial office.

Dr Chung is the design surgeon of the SAL-AP knee and the minimal invasive system for the allegretto knee.

Advances in treatment for osteoarthritis of the knee

WUI K. CHUNG, FRACS

MEDICINE TODAY August 2000 pp. 28-38

References

1. Felson DT, Zhang Y, Anthony JM, Naimark A, Anderson JJ. Weight loss reduces the risk for symptomatic knee osteoarthritis in women. The Framingham Study. Ann Intern Med 1992; 116: 535-539.

2. Horlick S, Loomer R. Valgus knee bracing for the osteoarthritic knee. Clin J Sports Med 1993; 3: 251-255.

3. Hewett TE, Noyes FR, Barber-Westin SD, Heckmann TP. Decrease in knee joint pain and increase in function in patients with medial compartment arthrosis. A prospective analysis of valgus bracing. Orthopedics 1998; 21: 131-138.

4. Lippiello L. Synergistic effect of glucosamine HCl and chondroitin sulfate on *in vitro* proteo - glycan synthesis by bovine chondrocytes [poster]. American Academy of Orthopaedic Surgeons meeting, Orlando, Florida, USA; February 2000.

5. Lussier A, Cividino AA, McFarlane, et al. Viscosupplementation with hylan for the treatment of osteoarthritis: findings from clinical practice in Canada. J Rheumatol 1996; 23: 1579-1585.

6. Fadale PD, Wiggins ME. Corticosteroid injections: their use and abuse. J Am Acad Orthop Surg 1994; 2: 133-140.

7. Tabor OB Jr, Tabor OB. Unicompartmental arthroplasty: a long-term follow-up study. J Arthroplasty 1998; 13: 373-379.

8. Rand JA. Role of arthroscopy in osteoarthritis of the knee. Arthroscopy 1991; 7: 358-363.

9. Howell G, Crawford R, Murray D, Goodfellow J. Oxford mobile-bearing knee: 5- and 10-year results. British Orthopaedic Association, Cardiff, 1997.