

## Advancements in Unicompartamental Knee Arthroplasty

a report by

**Dr Leo Pinczewski**

*Smith & Nephew*

In the past decade, unicompartamental knee arthroplasty (UKA) has increased in frequency worldwide due to the introduction of the minimally invasive surgical technique. Despite some negative clinical data from the 1980s, recent reports have demonstrated positive long-term results with patients who receive a skillfully implanted modern design. As a result of this trend, many surgeons have started to look at UKA again as an option for the treatment of single compartment arthritis. A minimally invasive technique combined with third-generation instrumentation and improved bearing surfaces is driving the rapid growth in UKA procedures globally. This vastly improved, minimally invasive procedure now offers patients shorter hospitalisation time, quicker rehabilitation and a smaller incision, with equivalent results to a traditional patellar dislocating approach.

Early experiences with the minimally invasive technique, however, demonstrated that the combination of a smaller incision and limited instrumentation often created a steep learning curve that extended the operating time and increased the chance for errors in component orientation and alignment. One could certainly argue that a procedure that only offers short-term advantages to the patient is not a true advancement when the greater likelihood of technical errors means increased chances of wear, loosening or both in the long term.

The author has experienced the early challenges of performing a successful unicompartamental procedure using more traditional total knee instrumentation through a standard incision. When performed on an occasional basis, the technique is difficult to reproduce accurately, even with a full total knee arthrotomy. Furthermore, careful attention must be given to appropriate patient selection, as poor indications will ultimately lead to failure. This article will discuss three critical success factors for achieving acceptable clinical outcomes with UKA: patient selection, surgical technique and prosthetic design.

### Patient Selection

Excellent results with UKA can be achieved as long as patients are selected properly for the procedure

and critical surgical goals are met. Although there is some debate regarding the indications for UKA, the ideal surgical candidate has non-inflammatory arthritis isolated to the medial compartment or lateral compartment of the knee (95% of UKA procedures are for medial osteoarthritis (OA)). Both the anterior cruciate ligament (ACL) and the posterior cruciate ligament (PCL) should be intact and the knee should have adequate anterior–posterior as well as medial–lateral stability. Without adequate ACL and PCL function, excessive polyethylene wear or loosening of the prosthesis may occur due to the abnormal kinematics of the cruciate-deficient knee. A flexion contracture of greater than 15° may be difficult to correct with UKA and is considered a contraindication to the procedure. Furthermore, flexion range of motion should be 90° or more. The patient should present with less than 10° of varus deformity in the case of medial compartment OA or less than 15° of valgus deformity in the instance of lateral compartment OA. Some debate exists over the condition of the patellofemoral joint; however, Grade II or Grade III changes may be acceptable as long as patellofemoral symptoms are not present.

The selection criteria regarding patient age and weight is somewhat controversial. Early survivorship results in the younger and more active patients have been inferior to the lower demand patient. However, with improvements in polyethylene consolidation techniques and sterilisation, as well as the abandonment of thin polyethylene inserts (less than 6mm), the survivorship rates are significantly better. A new bearing material called Oxinium™ (oxidised zirconium) (Smith & Nephew Inc.) shows great promise in extending the indications further to more active patients. The Oxinium femoral component features a much lower coefficient of friction than the traditional components made from cobalt chrome. In addition, the surface of the Oxinium component is considerably harder and more scratch-resistant than cobalt chrome. These features should significantly decrease the development of both adhesive and abrasive polyethylene wear and should improve implant survivorship.

The UKA can be an ideal procedure for the elderly,

Dr Leo Pinczewski is a co-founder of the North Sydney Orthopaedic and Sports Medicine Centre and is internationally renowned for his research and development in the field of anterior cruciate ligament (ACL) reconstruction and joint replacement surgery. He has performed over 7,000 ACL reconstructions and continues clinical research in this and the joint replacement fields. He is a member of the Australian Orthopaedic Association, Australian Knee Society, Australian Society of Orthopaedic Surgeons, Australian Institute of Musculoskeletal Research, Posterior Cruciate Ligament Study Group and the International Cartilage Repair Society. Along with his many publications, Dr Pinczewski's commitment to research has resulted in many awards including the Evelyn Hamilton Trust Memorial Prize for Best Scientific Presentation (1981), American British Canadian Travelling Fellowship (1992), Sports Medicine Australia – Best Conference Paper in Clinical Science (1994) and the Sports Medicine Australia – Research Excellence Award (1995). He graduated from Sydney University in 1976 and completed orthopaedic training in 1983. Dr Pinczewski completed a Fellowship in Arthritis Surgery in Edinburgh in 1982 before returning and commencing practice in 1984.

deconditioned patient with symptoms isolated to the medial compartment of the knee. Because the procedure is less invasive, results in less blood loss and the recovery is easier, successful clinical outcomes can be achieved in patients who may not be ideal candidates for a total knee arthroplasty (TKA).

UKA has distinct advantages over other surgical options for the treatment of unicompartmental knee arthritis including high-tibial osteotomy and TKA:

- literature supports superior results with UKA in the elderly;
- shorter time to full weight bearing;
- faster and easier rehabilitation;
- less blood loss;
- fewer complications; and
- easier revision to TKA.

The advantages of UKA over TKA are as follows:

- preservation of bone stock;
- maintenance of normal cruciate ligament function;
- preservation of the normal joint line;
- preservation of the patellofemoral joint;
- more normal kinematics and proprioception;
- improved range of motion;
- less morbidity;
- rapid post-operative recovery; and
- shorter hospital stay.

In summary, to achieve successful clinical results with UKA, both in terms of short-term patient satisfaction and long-term survivorship, strict adherence to the proper patient selection criteria must be followed.

### Surgical Technique

It is generally accepted that the use of a minimally invasive surgical technique offers significant advantages over an open arthrotomy in UKA. However, if the limited incision compromises accurate balance and alignment of the components, we will be taking a significant step backwards by reproducing the errors of the past. In most cases, a medial parapatellar arthrotomy that does not extend past the proximal pole of the patella into the quadriceps mechanism provides all of the advantages of a minimally invasive technique while allowing adequate exposure. The benefits of the limited incision are realised when the patella is not everted, but rather displaced laterally, and the quadriceps tendon is not disrupted. Furthermore, the advantage of this exposure option is that it allows the surgeon to extend the incision as needed to gain adequate exposure.

Appropriate instrumentation for performing a UKA is essential for skillfully implanting the components in correct orientation. The principles of a successful

surgical technique are to minimise bone resection of both the femur and the tibia, to restore the joint line with respect to the healthy compartment, and to align the components throughout the flexion/extension arc.

In order to determine the appropriate joint line, an articular spacer, or joint balancing shim, is inserted into the affected compartment prior to making any cuts. The shim, designed to closely match the tibio-femoral anatomy, determines the proper joint line position and makes it possible to pre-balance the knee. With the shim intact, the tibial cut can be set to minimise the resection level while the joint line is restored. An extramedullary tibial guide allows the cutting blocks to be positioned appropriately in all planes of motion. The cutting guide used in this case resects both the proximal tibia and posterior femur, providing a perfectly parallel flexion space. The final outcome is minimal tibial resection and joint line restoration.

The femoral instrumentation consists of a device that resurfaces the distal femur by reaming only 3–4mm of bone. The system described here includes a femoral reamer that locks into the tibial baseplate trial and is designed to remove the thickness of the femoral implant. Because the reamer is now attached to the tibial trial, the distal femur can be resurfaced by slowly bringing the knee from flexion into extension with the cutter in motion. Using this range of motion reaming technique and by controlling the varus/valgus and internal/external rotation of the knee, the distal femur can be prepared to accept an implant that will be well aligned throughout the flexion/extension arc. As a result, the femoral and tibial components can be centred both in flexion and extension and through a range of motion.

The UKA procedure differs from the TKA procedure in a few important respects. First, careful attention must be given to balance the components properly to protect the healthy compartment – a leading cause of UKA failure. A slight undercorrection of the angular deformity will protect the opposite compartment from excessive stress.

A second important principle is to resect the proximal tibia at the appropriate varus/valgus angle. In tibiae where there is no bony varus deformity, a tibial resection that is made at a right angle to the mechanical axis of the tibia, similar to that of a TKA, is acceptable. However, in the normal event of a bony varus deformity of the tibia, the resection should be made at a right angle to the epiphyseal axis, resulting in a 2–5° slope downwards. Failure to follow this principle may result in subluxation in the frontal plane and painful contact of the femoral component on the spine eminence. Proper pre-operative planning as well as the use of instrumentation that reproduces this angle accurately is essential for a successful outcome.

Finally, proper centring of the femoral component on the tibial insert must be established both in flexion and extension but, more importantly, in extension due to the weight-bearing forces of the gait cycle. This principle is addressed successfully by careful attention to the alignment principles discussed previously and the use of a system that links the tibial and femoral resections.

**Prosthetic Design**

In order to minimise bony resection of the femur, the femoral component should be a resurfacing design in order to accommodate the 3–4mm of femoral resection. Furthermore, adequate sizes must be available to accommodate the variation of patient size. The femoral component should have a grit-blasted fixation surface, central keel and peg in order to maximise cement fixation. The femoral component should also feature a tapered and contoured anterior aspect so as to minimise the risk of patellar impingement.

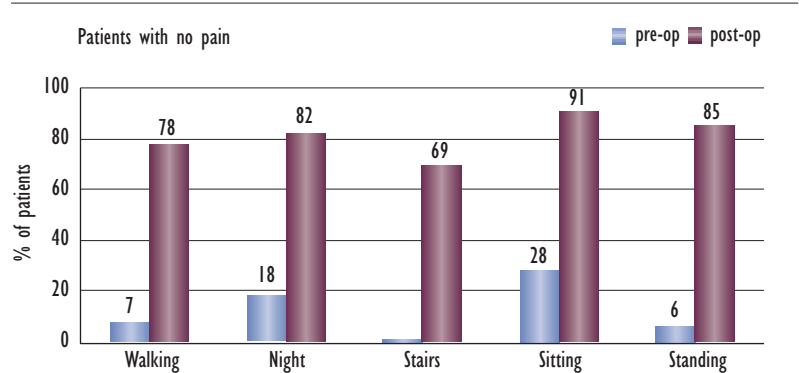
All fixed-bearing UKA designs must be unconstrained, i.e. the articular surface should be of a round, flat design instead of a high-contact area design as seen with TKA designs. This design concept is essential because the cruciate ligaments remain intact and will help dictate the knee motion throughout the flexion and extension arc. Also, high-contact area designs may lead to implants loosening due to the shear stress at the bone–cement interface.

There exists a debate regarding the use of a metal-backed tibia versus the all-poly component. The metal-backed component should be made out of titanium due to its superior mechanical strength compared with cobalt chrome. Also, when using the metal-backed component, a minimum polyethylene thickness of 6mm must be implanted.

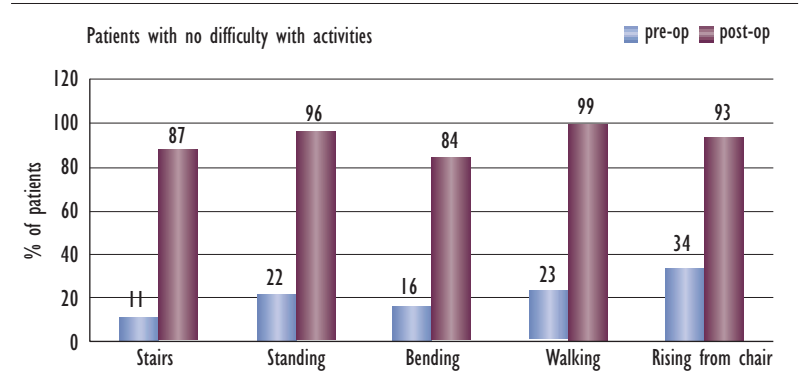
The advantage of the all-poly tibial component is the application of a thicker polyethylene insert. Because many of the early UKA failures were as a result of thin polyethylene, the use of the all-poly insert greatly reduces the risk of polyethylene wear as a mode of failure.

Technological advances have also been made to reduce the risk of polyethylene wear in UKA. Enhanced polyethylene consolidation techniques, as well as sterilisation that does not produce excessive oxidation of the plastic, have improved the performance of these materials. The use of Oxinium femoral components that feature a lower coefficient of friction to the metal component should also improve wear characteristics of UKA designs and significantly improve survivorship. In both instances, the geometrical design of the tibial component must be asymmetrical in order to match more closely the

**Figure 1: Pain**



**Figure 2: Degree of Difficulty**



anatomy of the proximal tibial resection. Finally, tibial implants that expand in thickness by 1mm increments allow the surgeon to fine-tune the balance of the knee and ensure that overcorrection is avoided.

**Initial Clinical Results**

In a study between January 2001 and August 2002, 109 unicompartamental knee replacements were performed. During this study period, one patient died of an unrelated illness at five months following surgery and one patient proceeded to total knee replacement at six weeks following surgery as a result of infection. At 12 months following surgery, 93% of patients were enthusiastic or satisfied with the results of the surgery, and 91% of patients would have the surgery again under the same circumstances. Pre-operatively, 36% of patients reported none to mild pain; this figure increased to 94% at 12 months (see *Figure 1*). At 12 months, 75% of patients reported an unlimited walking distance (see *Figure 2*).

**Conclusion**

The purpose of this prospective study was to report the results of UKA. Early results have been encouraging and as successful as total knee replacement, which was the procedure of choice until the beginning of this study. The low morbidity of UKA and rapid recovery, even in the medically unfit patient, encourage the continuation of this study. However, continued long-term follow-up is necessary to demonstrate that lessons have been learnt from past studies. ■