Introduction

Unicompartmental knee arthroplasty (UKA) has been part of the orthopedic surgeon's armamentarium for the treatment of unicompartmental osteoarthritis for the past thirty years. Its basic premise is that one can resurface only those portions of the knee that are severely involved with degenerate change, whilst allowing relatively normal articular surfaces to remain in situ. This allows for improved restoration of the biomechanics of the knee, leaving the uninvolved compartments and ligaments to function normally. These factors have enabled UKA surgery to develop over the years to become a valuable alternative to total knee replacement and high tibial osteotomy. Many advantages over total knee replacement and high tibial osteotomy in the treatment of isolated medial compartmental osteoarthritis have been advocated, including decreased soft-tissue disturbance, improved physiological gait, preservation of bone stock, decreased blood loss, quicker operation time, and a decrease in hospitalization for the patient [1,2].

The recent orthopedic literature has reported excellent mid- to long-term results in both fixed and mobile bearing UKAs, performed for medial compartment disease [3–10]. Outstanding survivorship of 95% and 98% have been reported by Carr et al. [11] and Svard et al. [2]. With such positive clinical results, the potential for more orthopedic surgeons to perform UKA surgery is inevitable. However, many factors are associated with successful UKA surgery, including appropriate patient selection, good implant design and meticulous surgical technique [12–16]. Strict patient selection is crucial in order to achieve successful results. Patients with significant patello-femoral symptoms, dysfunctional anterior cruciate ligaments, fixed flexion greater than 10° and poor correction of leg alignment in the coronal axis are poor candidates for UKA surgery.

UKA surgery is technically demanding and less forgiving than other forms of arthroplasty surgery. In particular, poor surgical technique can result in poor soft-tissue balance, component mal-position and incorrect alignment in the coronal tibio-femoral axis. One of the most important predictors of success in UKA surgery is the accuracy with which the components are implanted. Accurate alignment in the coronal plane is important in relation to the survivorship of the prosthesis. In particular, if a varus deformity is over-corrected at the time of surgery, this will lead to excessive loads on the unresurfaced compartments of the knee, leading to disease progression, anterior cruciate ligament dysfunction and ultimately early failure of the prosthesis [17–21]. Biomechanical computer-stimulated models show that over-correction causes increased stress patterns in the lateral compartment allowing a kinematic conflict to develop [22]. Survivorship analysis in many studies shows disease progression to account for as many as 10% of revision procedures [1,7,8,23,24]. Other studies have shown that at the time of revision as many as 57% of patients show lateral compartment disease progression [25–27]. Over-correction also leads abnormal stresses on the bearing surface of the implant which lead to premature failure of the prosthesis [4]. These studies highlight the importance of achieving the correct intra-operative leg alignment to promote the long-term survivorship of the implant.

Minimally invasive surgery (MIS) is the accepted gold standard in performing UKAs. The advantages of performing small para-patellar incisions include less disruption to the soft-tissue sleeve, a decrease in blood loss and a quicker rehabilitation program. However, this comes at the expense of overall exposure to the knee joint and the anatomical landmarks needed for achieving correct, repro-
ducible component positioning. Improvements in instrumentation have tried to address the problems associated with the limited exposure but are still far from the ideal in achieving consistently reproducible accurate component position. Is computer-assisted orthopedic surgery (CAOS) the way forward in achieving the surgical aims in UKA?

CAOS enables the orthopedic surgeon to have a higher degree of intra-operative control in performing accurate surgery and can be achieved through small incisions. Its aim is to provide excellent intra-operative feedback so that errors resulting from mal-alignment or poor bone cuts can be addressed immediately and rectified. This has the potential to decrease morbidity, improve functional outcome, improve patient satisfaction and decrease revision rates. It has the potential to have a significant impact in achieving correct component position in minimally invasive UKA surgery. The potential for accurate and reproducible leg alignment this system theoretically achieves will improve the biomechanical forces within both the replaced compartment and that of the unresurfaced compartment. This will lead to less disease progression and, hopefully, an improved environment for the implant to function with the ultimate goal being an improvement in long-term survivorship and reduced revision rates.

**Surgical Results**

A recent study performed at our unit involved thirty consecutive patients undergoing UKA surgery. Of this group, fifteen had MIS with no CAOS whilst fifteen had MIS with CAOS. Post-operatively, all patients had long-leg weight-bearing radiographs and CT scanograms of the limb to assess alignment (Figs. 17.1, 17.2). Analysis of this data showed that the implants that were aligned with CAOS had no over-correction of the original deformity unlike the group which did not involve CAOS. This was supported statistically with a Fisher’s exact test of p<0.05. This improved accuracy in radiological leg alignment using CAOS was achieved without significant inconvenience and little change to conventional operating techniques.

**Surgical Technique**

The EiUS unicompartmental knee system (Stryker Howmedica Osteonics) allows CAOS to act as an adjunct in performing UKA surgery. It relies on an “image-free
system” i.e. an anatomical model is embedded in software and upgraded by the process of intra-operative navigation. Six main steps are involved in performing this type of surgery.

- **Pin placement:** Two fixed pins are drilled into position; one on the medial side of the distal femur, the other on the proximal tibia just below the tuberosity (Fig. 17.3). These allow for attachment of infra-red beacons which relay back to the computer allowing anatomical and kinematic data to be collected.

- **Registration of anatomical landmarks:** This involves a pre-determined sequence in which the surgeon identifies key anatomical landmarks using an infra-red pointer (Fig. 17.4). These landmarks are logged onto the computer. There are fourteen landmarks including center of rotation of femoral head, landmarks relating to the distal femur, landmarks relating to the proximal tibia and landmarks relating to the ankle. Accuracy is fundamental.

- **Kinematic analysis:** Data is collected and recorded on the computer relating to the coronal and sagittal axis prior to surgery, i.e. any fixed flexion deformity or varus-valgus leg mal-alignment present.

- **Cutting block set-up and performance of cuts:** The cutting blocks for both tibia and femur are computer-navigated into position (Figs. 17.5, 17.6). Leg alignment and thickness of cuts are verified (Figs. 17.7, 17.8). Varus mal-alignment is never over-corrected. Cuts generated are checked and if the surgeon is not satisfied these are repeated until acceptable.

- **Analysis of alignment and kinematics following insertion of trial prosthesis:** Analysis in real-time allows assessment of the position and performance of the prosthesis. Leg alignment is assessed allowing no over-correction of varus deformities.

- **Final analysis of alignment and kinematics following definitive insertion of prosthesis:** The definitive prosthesis is assessed and data stored on computer in relation to its alignment and kinematic performance.
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**Fig. 17.4.** Photograph showing the use of the mobile beacon to register anatomical landmarks

**Fig. 17.5.** Photograph showing instrument set-up to achieve tibial cut. The cutting block is computer-navigated into the correct position with continuous feedback from the visual display unit.

**Fig. 17.6.** Photograph showing instrument set-up to achieve femoral cut. The cutting block is computer-navigated into position in order to achieve correct rotation and cut depth.

**Fig. 17.7.** Visual display of tibial cut verification. Data analyzed enables the correct alignment and depth of cut to be achieved.
Fig. 17.8. Visual display of femoral cut verification. Data analyzed enables the correct orientation of the prosthesis to be achieved.

References

1. Murray DW, Goodfellow JW, O’Connor JJ. The Oxford medial unicompartmental arthroplasty. JBJS 1998; 80B: 983–989
13. Andriacchi TP, Galante JO, Ferrier RW. The influence of total knee replacement design on walking and stair climbing. JBJS (Am) 1982; 64A: 1328–1335