9 Unicompartmental Knee Osteoarthritis: Unicompartmental Knee Arthroplasty

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9.1 Introduction

Knee osteoarthritis (OA) is the most common form of lower limb OA [1]. It is estimated that 6% of those aged 30 years and older and 15% of those aged 45 years and older experience the condition [2], with a lifetime risk of 45% [3]. For most patients with knee OA, the illness is restricted to the medial compartment [4]. In the 1950s, MacIntosh [5] started the use of a metal spacer in single tibiofemoral compartment cases. In the 1960s and 1970s, the St Georg and Marmor [6] prostheses were introduced, with good outcomes [7]. Both of these designs had polycentric metal femoral condyles that articulated on flat, fixed polyethylene tibial components, with the femoral and tibial components cemented to the bone. In 1974, the first mobile-bearing unicompartmental knee arthroplasty (UKA), the Oxford Knee (OUKA), was introduced and in 1982, it was first used [8].

UKA surgery has gained interest in recent years because it can diminish postoperative pain and has a shorter recuperation time than a total knee arthroplasty (TKA). In the last 2–3 years, research has been conducted in this field. Several authors have reported on the safety of outpatient UKA and have concluded that, in general, this approach is safe [9–13]. It is important, however, to adhere to a clear standardised protocol [9]. Important financial savings to the healthcare system can be accomplished with such a protocol for outpatient UKA.

UKA is a surgical procedure in which the degenerated parts of the knee are replaced to alleviate OA in one of the knee compartments. Election of either TKA or UKA is a matter of debate. UKA has some published advantages over TKA, but it also seems to possess important disadvantages in terms of revision rates [14]. The aim of this chapter is to analyse the indications, technical issues, and results of UKA.

9.2 Indications for UKA

The best indication for UKA is painful osteoarthritis in an isolated tibiofemoral compartment (medial or lateral). An age younger than 60 years, a body weight of 180 lb. (82 kg) or more, performing heavy work, having chondrocalcinosis, and having exposed bone in the patellofemoral (PF) joint are not contraindications for UKA. Severe wear of the lateral facet of the PF joint with bone loss and grooving is a contraindication for UKA. Medial UKA should only be performed in cases of severe OA as shown in preoperative X-rays, with medial bone-on-bone contact and a medial/lateral ratio of <20% [14].Lateral osteophytes have been suggested to be related to lateral compartment disease. However, it is difficult to

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determine whether medial UKA should be performed in the presence of lateral osteophytes. Hamilton et al. found that the presence of lateral osteophytes is not a contraindication for medial meniscal-bearing UKA [15]. The clinical significance of this report was that it emphasised the importance of an adequate preoperative evaluation of the lateral compartment, given that, in the context of full-thickness cartilage at surgery, lateral osteophytes did not compromise long-term functional results or implant survival.

Knifsund et al. analysed the impact of the preoperative grade of OA on the risk of reoperation after UKA [16]. They suggested that UKA should only be performed in cases exhibiting severe OA in preoperative X-rays, with medial bone-on-bone contact, and a medial/lateral ratio of <20% (Figs. 9.1 and 9.2).

Fig. 9.1 Painful osteoarthritis of the medial compartment of the left knee (varus deformity) of a 58-year-old woman. Unicompartmental knee arthroplasty (UKA) was indicated. (**a**) Anteroposterior preoperative radiograph; (**b**) Lateral preoperative view; (**c**) Anteroposterior postoperative radiograph; (**d**) Lateral postoperative view; (**e**) Anteroposterior radiograph 1 year later; (**f**) Lateral view 1 year later

Fig. 9.2 Painful osteoarthritis of the medial compartment of the right knee (varus deformity) of a 51-year-old woman. Unicompartmental knee arthroplasty (UKA) was indicated. (**a**) Anteroposterior preoperative radiograph; (**b**) Lateral preoperative view; (**c**) Anteroposterior postoperative radiograph; (**d**) Lateral postoperative view; (**e**) Anteroposterior radiograph 9 years later; (**f**) Lateral view 9 years later

Hamilton et al. analysed the long-term results of a group of patients, some of whom had anterior knee pain and PF joint OA managed with UKA [17]. Severe impairment to the lateral facet of the PF joint with osseous loss and grooving is a contraindication for mobile-bearing UKA. Less severe impairment to the lateral facet of the PF joint and involvement of the medial side, no matter how severe, did not affect the comprehensive function or implant survival, so should not be considered a contraindication. If a patient presents full-thickness cartilage loss on the lateral facet of the PF joint, however, they could have a slight problem with their ability to walk downstairs. Preoperative anterior knee pain also did not affect the functional result or implant survival and should not be considered a contraindication.

PF chondromalacia has historically been suggested to be a contraindication for UKA. Adams et al. evaluated the effect of medial patellar and/or medial trochlear PF chondromalacia on comprehensive and PF-related results at 2 years following fixed-bearing medial UKA [18]. Functional results of fixed-bearing medial UKA

Table 9.1 Indications of unicompartmental knee arthroplasty (UKA) in the literature

Author	Year	Comments
Hamilton et al. [15]	2017	According to these authors, the presence of lateral osteophytes was not a contraindication for medial meniscal-bearing UKA. The clinical relevance of this study was that it highlighted the importance of an appropriate preoperative assessment of the lateral compartment, given that at the setting of full-thickness cartilage at operation, lateral osteophytes did not compromise long-term functional outcome or implant survival
Knifsund et al. [16]	2017	These authors suggested that UKA should only be performed in cases showing severe OA in preoperative radiographs, with medial bone-on-bone contact, and a medial/lateral ratio of <20%. Surgery was performed on 294 knees in 241 patients between 2001 and 2012 at a single institute, using cemented Oxford phase III UKA. The mean age at the time of operation was 67 years, and the mean follow-up time was 8.7 years. The knees with a preoperative Kellgren–Lawrence grade of 0–2 osteoarthritis had a higher risk of reoperation than those with a Kellgren–Lawrence grade of 3–4. In addition, the knees with a medial joint space width of more than 1 mm or a high medial/lateral joint space width ratio had an increased risk of reoperation
Hamilton et al. [17]	2017	Severe damage to the lateral side of the PF joint with bone loss and grooving remains a contraindication for mobile-bearing UKA. Less severe damage to the lateral side of the PF joint and damage to the medial side, however severe, does not compromise the overall function or survival, so should not be considered to be a contraindication. However, if a patient does have full-thickness cartilage loss on the lateral side of the PF joint they might have a slight problem with their ability to descend stairs. Preoperative anterior knee pain also does not compromise the functional outcome or survival and should not be considered to be a contraindication
Adams et al. [18]	2017	Functional results of fixed-bearing medial UKA were not adversely impacted by the presence of PF chondromalacia involving the medial patellar facet and/or the medial or central trochlea
Hamilton et al. [19]	2017	The indications for UKA remain controversial. Previously recommended contraindications included the following: Age younger than 60 years, weight 180 lb. (82 kg) or over, patients undertaking heavy labour, chondrocalcinosis, and exposed bone in the PF joint. This study provided evidence that patients with the previously reported contraindications did as well as, or even better than, those without contraindications. Therefore, these contraindications should not apply to UKA
Rodríguez-Merchán and Gómez-Cardero [14]	2018	An age younger than 60 years, a body weight of 180 lb. (82 kg) or more, performing heavy work, having chondrocalcinosis, and having exposed bone in the patellofemoral (PF) joint are not contraindications for unicompartmental knee arthroplasty (UKA). Severe wear of the lateral facet of the PF joint with bone loss and grooving is a contraindication for UKA. Medial UKA should only be performed in cases of severe osteoarthritis (OA) as shown in preoperative X-rays, with medial bone-on-bone contact and a medial/lateral ratio of <20%

UKA Unicompartmental knee arthroplasty, *OA* Osteoarthritis, *PF* Patellofemoral

were not unfavourably impacted by the presence of PF chondromalacia affecting the medial patellar side and/or the medial or central trochlea. Table 9.1 summarises the most important data on the current indications for UKA [14–19].

9.3 Technical Issues

The role of coronal alignment in the improvement of functional results after UKA is controversial. Most reports on the control of coronal alignment and implant positioning observed no influence on functional results and quality of life at the 1-year follow-up. However, the influence of implant positioning on the failure rate and durability is better supported in the literature**.** Some authors have reported that robotics or patient-specific instrumentation (PSI) can increase the likelihood of achieving good alignment during surgery.

9.3.1 Patient-Specific Instrumentation (PSI)

In 2016, Ollivier et al. reported that PSI might provide little, if any, benefit in alignment, pain, or function following UKA [20]. They also stated that this assertion could therefore not be used to justify the extra cost and uncertainty associated with this surgical technique.

Table 9.2 Patient-specific instrumentation (PSI) in unicompartmental knee arthroplasty (UKA) in the literature

Author	Year	Comments
Ollivier et al. [20]	2016	Ollivier et al. stated that PSI might provide little, if any, benefit in alignment, pain, or function following UKA
Ng et al. [21]	2017	This study offered some evidence that PSI can improve the capacity of orthopaedic surgeons in training to reproduce a preoperative plan
Alvand et al. [22]	2018	Although PSI was equivalent to standard instrumentation based on Oxford knee score improvements at 12 months, these authors continued to use standard instrumentation for UKA at their Centre until further ameliorations to the PSI guides were shown
Leender et al. [23]	2018	Functional result was in line with literature on the conventional method
Flury et al. [24]	2019	Excellent accuracy regarding component placement in UKA can be achieved with PSI. However, despite excellent survivorship and clinical results, these data indicate that the PSI system is not superior to conventional UKA implantation methods

PSI Patient-specific instrumentation, *UKA* Unicompartmental knee arthroplasty

Ng et al. have reported that PSI can improve the capacity of orthopaedic surgeons in training to reproduce a preoperative plan [21]. However, their results suggested the necessity for larger-scale clinical studies to ascertain the role of PSI in this surgical technique.

In 2017, Alvand et al. reported a prospective randomised controlled study to compare the precision of implantation and the functional result of mobile-bearing medial UKAs implanted with and without PSI by expert UKA orthopaedic surgeons [22]. They found that PSI was equivalent to standard instrumentation based on Oxford Knee Score ameliorations at 12 months.

In a study of 122 patients (129 knees) reported in 2018 by Leender et al. it was stated that the PSI technique was a reliable tool for the placement of the femoral component. A total of six (4.9%) adverse effects were observed in this study, with four (3.3%) tibial fractures being the main complication. Functional result was in line with literature on the conventional method. Leender et al. strongly recommended that the surgeon approves every preoperative plan in order to optimize the accuracy during the PSI surgery [23].

In 2019 Flury et al. reported that excellent accuracy regarding component placement in UKA can be achieved with PSI. However, despite excellent survivorship and clinical results, these data indicate that the PSI system is not superior to conventional UKA implantation methods [24]. Table 9.2 shows the most recent reports on the role of PSI in UKA [20–24].

9.3.2 Robotic-Assisted UKA

Robotic assistive systems are robotic appliances that perform specific tasks according to preoperative data. There are three main categories of robotic-assisted systems: passive systems, semi-active robotic systems, and active robotic systems [25]. Passive systems perform part of the surgical procedure under the continuous and direct control of the orthopaedic surgeon. A semi-active robotic system is a tactile feedback system that increases the surgeon's ability to control the tool, typically by restricting the cut volume by defining constraints of the cut motion in space; however, the system still requires the surgeon to manipulate the cutter. Finally, an active robotic system performs a surgical task without direct intervention of the orthopaedic surgeon, such as permitting the robotic arm to cut the bone without direct manipulation of the cutter by the surgeon [26].

Many of these types of systems have been developed and prototyped. However, only the following have been used successfully in clinical settings throughout the world [26]. The ROBODOC System (Curexo Technology Corporation, Fremont, CA), the CASPAR system (URS Ortho Rastatt, Germany), the Robotic Arm Interactive Orthopaedic System (RIO; MAKO Surgical Corporation, Fort Lauderdale, FL, USA), and the Stanmore Sculptor Robotic Guidance Arm (RGA) System (Stanmore Implants, Elstree, UK), formerly known as the Acrobot System. MAKO's RIO and the Stanmore Sculptor RGA System are semi-active systems, whereas the CASPAR and ROBODOC systems are active robotic systems [23]. Table 9.3

Table 9.3 Robot-assisted unicompartmental knee arthroplasty (UKA) in the literature

Author	Year	Comments
Moschetti et al. [27]	2016	In 2016, these authors devised a Markov decision analysis to assess the costs, results, and incremental cost-effectiveness of robot-assisted UKA in 64-year-old patients with advanced unicompartmental knee OA. The system was cost-effective when case volume exceeded 94 cases per year, 2-year failure rates were below 1.2%, and total system costs were <$1.426 million
Song et al. [28]	2016	These authors studied whether the use of imageless navigation can improve implant positioning and clinical results of UKA at a long-run follow-up compared with the standard surgical technique. Their results showed that the use of navigation significantly improved component placement as compared with the standard technique
Bell et al. [29]	2016	Bell et al. assessed the precision of component positioning in UKA, comparing robot-assisted techniques using the MAKO RIO system and standard implantation techniques. They observed that robotic-assisted surgical procedures with the use of the MAKO RIO led to improved precision of implant positioning compared with standard UKA surgical techniques
Van der List [30]	2016	Results in this systematic review and meta-analysis implied that computer navigation or robotic assistance could improve results
Pearle et al. [31]	2017	Pearle et al. reported a prospective multicentre study that evaluated results of robot-assisted UKA. In this analysis, robot-assisted UKA was found to have high survivorship and satisfaction rate at short-term follow-up
Chowdhry et al. [32]	2017	These authors observed that computer-assisted UKA, to manage medial tibiofemoral joint arthritis, yielded 5-year survival rates that were comparable with TKA
Gaudiani et al. [33]	2017	Gaudiani et al. stated that changing posterior tibial slope, while keeping PCOR, was paramount in accomplishing native kinematics and optimising range of motion in the sagittal plane. This could be best achieved using robotic techniques for UKA
Rauk et al. [34]	2018	The effect of implant positioning on long-term clinical outcomes and implant survivorship remains unclear. Long-term follow-up studies are needed to determine the role of robotic-assisted arthroplasty in the future
Chona et al. [35]	2018	There was not a difference in the rate of conversion to total knee arthroplasty
Lonner and Klement [36]	2019	Robotic assistance has been advanced to improve the precision of bone preparation, component alignment, and quantified ligament balance in UKA, with the ultimate goal of improving kinematics and implant survivorship. Two currently available semi-autonomous robotic platforms have demonstrated improved accuracy, and emerging short-term follow-up has demonstrated satisfactory functional outcomes
Lonner and Kerr [37]	2019	Current semi-autonomous robotic methods are safe, with few complications using meticulous surgical techniques
Dretakis and Igoumenou [38]	2019	Excellent overall satisfaction rates and clinical outcomes can be expected, at intermediate follow-up, along with excellent survival of implants and minimal to none surgery-related morbidity
Zambianchi et al. [39]	2019	Although little correlation was found between intraoperative robotic data and overall clinical outcome, surgeons should consider information regarding 3D component placement and soft-tissue balancing to improve patient satisfaction. Reproducible and precise placement of components has been confirmed as essential for satisfactory clinical outcome
Zambianchi et al. [40]	2019	Robotic-assisted medial and lateral UKAs demonstrated satisfactory clinical outcomes and excellent survivorship at 3-year follow-up. Continued patient follow-up is needed to determine the long-term device performance and clinical satisfaction
Robinson et al. [41]	2019	Implant positioning with robotic-assisted UKA is more accurate and more reproducible than that performed manually and may offer better functional outcomes, but whether this translates into improved implant survival in the mid- to longer-term remains to be seen
Suda et al. [42]	2019	The portable navigation system improved the accuracy of tibial implant alignment in UKA. These authors found that 100% of the implants were aligned within 3.0° of both target coronal and sagittal implant alignment. The portable navigation system decreased the outliers of tibial coronal and sagittal alignment
Clement et al. [43]	2019	*Robot-assisted* UKA (rUKA) is a cost-effective alternative to manual TKA and UKA for patients with isolated medial compartment OA of the knee. The cost per QALY of rUKA decreased with reducing length of hospital stay and with increasing case volume, compared with TKA and UKA

Table 9.3 (continued)

Author	Year	Comments
Matsui et al. [44]	2019	This is the first report on the usefulness of an accelerometer-based portable navigation system in UKA. The use of this system improves the accuracy of implantation of the tibial component beyond the experience of the surgeon

UKA Unicompartmental knee arthroplasty, *OA* Osteoarthritis, *RIO* Robotic Interactive Orthopaedic, *TKA* Total knee arthroplasty, *PCOR* Posterior condylar offset ratio

summarises primary data on the robotic-assisted UKA in the orthopaedic literature [27–44].

9.3.3 Mobile-Bearing Versus Fixed-Bearing UKA

There is controversy in the literature regarding which type of bearing is preferable: mobile or fixed. In 2015, Ko et al. reported a systematic review of comparative studies between fixed and mobile bearings focusing on complications [45]. The comprehensive reoperation rate per 100 component years was comparable between the mobile bearings and the fixed bearings. Nevertheless, the mobile bearings were more prone to reoperations in patients with aseptic loosening, progression of OA, and implant dislocation. The comprehensive frequency of complications was analogous for fixed- and mobile-bearing designs in UKA.

In 2017, Choy et al. analysed the results of minimally invasive mobile-bearing medial UKA for Korean patients [46]. Their hypothesis was that because Asian patients have distinct lifestyles from those of Western patients, such as squatting and sitting on the floor, it was plausible that the clinical outcomes and survival rate of UKA for Asian patients could be distinct. A total of 164 knees were treated with mobile-bearing UKAs in 147 patients. The mean follow-up period was 12 years. The clinical results demonstrated statistically significant improvement from preoperative to final follow-up. A total of 26 UKAs (15.8%) needed revision; the most common cause was bearing dislocation. The implant survival rate at 12 years with revision for any reason as the end point was 84.1%. Minimally invasive mobile-bearing UKA in Asian patients who needed high degrees of knee flexion demonstrated rapid recovery and good clinical results. Nonetheless, they also had relatively high percentages of bearing dislocation and aseptic loosening.

In 2019 Cao et al. reported a systematic review and meta-analysis comparing fixed-bearing and mobile-bearing UKA. They found that both the arthroplasty types provided satisfactory clinical results for patients with classic indications. However, mobile-bearing UKA tended to fail in early postoperative years whereas fixed-bearing UKA in later postoperative years [47].

In a systematic review reported by Burger et al. found that mobile-bearing lateral UKAs had a higher rate of revision compared to fixed-bearing lateral UKAs with regard to short- to mid-term survivorship; however, the clinical results were similar [48].

9.3.4 All-Polyethylene UKA

Whether all-poly tibial components give similar results as metal-backed modular components during UKA remain debatable. In 2016, Hawi et al. found that an all-polyethylene tibial component has a similar survivorship to modular designs [49]. Implant selection did not appear to have great impact on the result, but rather success depended on adequate indications and surgical technique. One hundred patients indicated for UKA for isolated medial knee compartment osteoarthritis were analysed. The survival likelihood of the all-polyethylene UKA implant was 95.4% after a mean follow-up of 8 years, which is similar to reports from studies utilising metal-backed modular designs for UKA. The reasons for failure were progression of OA in contiguous compartments (2%) and loosening of the tibial component (2%).

In 2017, Koh et al. compared the results between all-poly and metal-backed modular components in UKA [50]. All-poly tibial component use during UKA augmented the risk of initial failure, which could have been due to a failure in tibial loading distribution. Some 101 UKAs were analysed. Overall, 51 UKAs were performed using all-poly tibial components; 50 others used metal-backed modular components. Despite the lack of group differences in clinical and radiographic results, adaptive bone remodelling at 2 years after surgery of all-poly UKAs was more progressive compared with metal-backed UKAs (1.2 in the all-poly UKA group vs. 0.9 in the metal-backed UKA group). In addition, six of 51 all-poly UKAs failed postoperatively within 2 years, whereas no metal-backed UKAs failed (11% in the all-poly UKA group vs. 0% in the metal-backed UKA group).

9.4 Inpatient Versus Outpatient UKA

The demand for TKA and UKA is increasing rapidly due to the established success of these surgical techniques and an augmentation in the ageing population. However, resources are limited and healthcare allowances are restricted. Recently, some care providers have begun performing these surgical techniques on an outpatient basis, with the patients discharged from the hospital on the day of surgery [45, 46, 49–51].

Bradley et al. have reported that patients can be safely and efficaciously discharged on the day of surgery after UKA, with high satisfaction [52]. This plainly offers improved management of assets and financial savings to the health care system. The most common cause of failure was logistical (the operation was too late in the day), inappropriate control of pain, and leaking wounds. No readmissions were found. All patients had a high level of satisfaction.

In 2019 Gruskay et al. reported that ambulatory discharge following UKA is increasing in popularity. However, it not increase risk for perioperative complications or readmission, and may even portend a safer postoperative course [53].

In 2020 Ford et al. compared UKA in an ambulatory surgery centre with those who underwent the procedure in a traditional hospital inpatient setting. There was no difference in complication rates. These results suggest that outpatient UKA in a freestanding ambulatory surgery center is a safe and reasonable alternative to the traditional inpatient hospital setting [54].

9.5 Outcomes of UKA

The major advantage of UKA compared with TKA appears to be the higher rate of satisfaction and meeting expectations (return to work and return to sports) in young patients.

Results reported after UKA are generally favourable in the literature [55–85]. In 2015, Parrate et al. stated that medium- and long-term studies indicated acceptable results at 10 years with survival >95% in UKA performed for medial OA or osteonecrosis, and also for lateral UKA, especially when fixed-bearing implants were used [56]. Walker et al. reported that patients aged 60 or younger after medial UKA were able to return to their regular physical activities, with approximately two-thirds of the patients attaining a high activity level [58].

The study by Pandit et al. also supported the continued use of minimally invasive UKA for the advised indications [59]. There were some implant-related reoperations at a mean of 5.5 years. The most common causes for reoperation were OA in the lateral compartment (2.5%), bearing dislocation (0.7%), and unelucidated pain (0.7%). When all implant-related reoperations were considered failures, the 10-year rate of implant survival was 94% and the 15-year rate 91%. When failure of the implant was the endpoint, the 15-year survival was 99%. In the systematic review reported by Howieson et al. on UKA in the elderly, it was found that in patients over the age of 70 there was no perioperative mortality and the 10-year prosthesis survival rate was 87.5–98%. In addition, revision due to periprosthetic infection was low at 0.13–0.30% [60].

In 2016, Ali et al. reported that high activity did not jeopardise the result of the OUKA and might improve it [62]. Activity should not be limited nor considered to be a contraindication. Foster-Horvárth et al. observed that fixed-bearing Uniglide UKA with an all-polyethylene tibial component is a useful tool in the treatment of medial compartment OA, providing good short-term survivorship [70]. The 5-year survival rate was 94.1%, with implant revision surgery as an end point. The predicted 10-year implant survival rate is 91.3%.

The systematic review reported in 2017 by Campi et al. showed that cementless fixation was a safe and efficacious alternative to cementation in medial UKA [71]. Clinical results, failures, reoperation percentages, and implant survival were analogous to those reported for cemented implants. In 2017, Kerens et al. compared cementless Oxford UKA with cemented OUKA [74]. Implant survival percentages were 90% at 34 months for the cementless UKA and 84% at 54 months for the cemented UKA. Clinical results were not significantly different. In the systematic review published in 2017 by Hamilton et al., the authors stated that to achieve optimal results, surgeons, whether high or low caseload, should follow the advised indications such that ≥20%, or ideally >30% of their knee arthroplasties are UKA [75]. If they take this into account, then they can anticipate outcomes comparable to those of the long-term series, all of which had high usage (>20%) and an average 10-year implant survival of 94%.

In 2017, Blaney et al. supported the use of the cementless OUKAs outside the design centre [77]. The number of patients needing revision at 5 years was lower than that typically published for UKA. The accumulated implant survival at 5 years was 98.8%, and the survival time was 5.8 years on average.

In 2018 Hutt et al. reported that survivorship at 7 years with endpoints of reoperation, revision and aseptic loosening at surgery or radiographically was 88.4%, 93.1%, and 97.3%, respectively [85].

According to Rodríguez-Merchán and Gómez-Cardero, the postoperative outcomes of UKA are generally good. Medium-term and long-term studies have reported acceptable results at 10 years, with implant survival >95% for UKAs carried out for medial OA or osteonecrosis and for lateral UKA, especially when fixed-bearing implants are used. When all implant-related reoperations are considered, the 10-year survival rate is 94%, and the 15-year survival rate is 91% [14].

Reported 5- and 10-year pooled medial UKA survival estimates are 95.3% and 91.3%, respectively [86]. Ten-year survival for UKA in cohort studies has shown to be >90% with results after conversion to TKA being similar to results for revision TKA. Registries have consistently shown lower implant survival for UKA compared with that for TKA, which is likely secondary to use of several different implants by surgeons of varying levels of experience [87]. Table 9.4 summarises primary data regarding outcomes and prosthetic survival following UKA [55–87].

Table 9.4 Results of unicompartmental knee arthroplasty (UKA) in the literature

Author	Year	Comments
Liddle et al. [55]	2015	UKA provided better early patient-reported outcomes than TKA; these differences were most marked for the very best outcomes. Complications and readmission were more likely after TKA
Parrate et al. [56]	2015	Medium- and long-term studies suggested reasonable outcomes at 10 years, with implant survival >95% in UKA performed for medial OA or osteonecrosis, and similarly for lateral UKA, particularly when fixed-bearing implants were used
Vasso et al. [57]	2015	This study demonstrated excellent outcomes and implant survivorship for the ZUK UKA
Walker et al. [58]	2015	The results of this study demonstrated that patients aged 60 or younger following medial UKA were able to return to regular physical activities, with almost two-thirds of the patients reaching a high activity level
Pandit et al. [59]	2015	The results of this study supported the continued use of minimally invasive UKA for the recommended indications. There were some implant-related reoperations at a mean of 5.5 years. When all implant-related reoperations were considered as failures, the 10-year rate of survival was 94% and the 15-year survival rate 91%. When failure of the implant was the endpoint, the 15-year survival was 99%

(continued)

Table 9.3 (continued)

Author	Year	Comments
Howieson et al. [60]	2015	This systematic review on UKA in the elderly showed that there was no perioperative mortality, and the 10-year prosthesis survival rate was 87.5–98% revision for periprosthetic infection was low at 0.13–0.30%
Iacono et al. [61]	2016	These authors stated that UKA was a viable option for treating unicompartmental knee OA. With the proper indications and an accurate technique, UKA might also be indicated for very elderly patients with reduced complications and morbidity, and excellent implant survivorship
Ali et al. [62]	2016	High activity levels did not compromise the outcome of the Oxford UKA. Activity should not be restricted nor considered to be a contraindication. The study included the first 1000 phase 3 cemented Oxford UKAs implanted between 1998 and 2010
Zuiderbann et al. [63]	2016	This study suggested that greater pain relief can be expected in patients aged <65 years and that a postoperative lower limb alignment of 1°-4° varus should be pursued. Taking these factors into consideration will help to maximise clinical outcomes, fulfil patient expectations after medial UKA, and subsequently minimise revision rates
Lee et al. [64]	2016	The study included 724 UKAs. Minimum duration of follow-up was 2 years, with an overall patient satisfaction rate of 92.2%
Konan and Haddad [65]	2016	Topographical location and severity of cartilage damage of the patella can significantly influence function after successful Oxford medial UKA
Bottomley et al. [66]	2016	This study demonstrated that good results can be achieved by a heterogeneous group of surgeons, including trainees, if performed within a high-volume centre with considerable experience with the procedure. It was an implant survival analysis of 1084 knees of the Oxford UKA (a comparison between consultant and trainee surgeons)
Emerson et al. [67]	2016	This 10-year follow-up study of the Oxford UKA undertaken in the United States showed good implant survival and excellent function in a wide selection of patients with anteromedial OA and avascular necrosis. It included 213 knees (173 patients)
Lisowski et al. [68]	2016	This study supported the use of UKA in medial compartment OA, with excellent long-term functional and radiological outcomes and an excellent 15-year implant survival rate
Van der List et al. [69]	2016	This meta-analysis critique showed that findings of increased revision risk in younger patients and increased revision risk with inferior outcomes in females gave a more nuanced perspective on historical criteria, such that surgical decision-making can be based on UKA outcome data for subgroups rather than strict exclusion criteria
Foster-Horváth et al. [70]	2016	Fixed-bearing Uniglide UKA with an all-polyethylene tibial component was a valuable tool in the management of medial compartment OA, affording good short-term implant survival. The 5-year survival rate was 94.1%, with implant revision surgery as an end point. The estimated 10-year survival rate is 91.3%
Campi et al. [71]	2017	This systematic review demonstrated that cementless fixation was a safe and effective alternative to cementation in medial UKA. Clinical outcome, failures, reoperation rate, and implant survival were similar to those reported for cemented implants with lower incidence of RLL
Streit et al. [72]	2017	Minimally invasive Oxford medial UKA was reliable and effective in a young and active patient cohort, providing high patient satisfaction at the mid-term follow-up
Pandit et al. [73]	2017	This study included 512 cementless phase 3 Oxford UKAs. The clinical results of this study were as good as or better than those previously reported for cemented fixation. The radiographic results were better, with secure bony attachment to the implants in every case. There were 8 reoperations of which 6 were revisions, giving a 5-year implant survival of 98%
Kerens et al. [74]	2017	In this multicentre retrospective study, a cohort of 60 consecutive cases of cementless Oxford UKA was compared with a cohort of 60 consecutive cases of cemented Oxford UKA. Survival rates were 90% at 34 months for the cementless group and 84% at 54 months for the cemented group. Mean operation time was 10 min shorter in the cementless group, and clinical results were not significantly different
Hamilton et al. [75]	2017	Medial UKA should be reserved for patients with full-thickness cartilage loss on both the femur and tibia
Hamilton et al. [76]	2017	In this systematic review the authors stated that to achieve optimum results, surgeons, whether high or low caseload, should adhere to the recommended indications such that ≥20%, or ideally >30% of their knee arthroplasties are UKA. If they do this, then they can expect to achieve results similar to those of the long-term series, which all had high usage (>20%) and an average 10-year survival of 94%

Table 9.3 (continued)

Author	Year	Comments
Blaney et al. [77]	2017	The findings of this report added support for the use of the cementless Oxford UKAs outside the design Centre. The cumulative survival at 5 years was 98.8% and the mean survival time was 5.8 years. A total of seven Oxford UKAs (2.7%) were revised; three within 5 years and four thereafter, between 5.1 and 5.7 years postoperatively. Five (1.9%) had reoperations within 5 years
Kleeblad et al. [78]	2017	This was the first study showing that physiological femoral RLL occur later than tibial RLL. A total of 352 patients were included who underwent robotic-assisted medial UKA surgery and received a fixed-bearing metal-backed cemented medial UKA
Van der List et al. [79]	2017	This systematic review showed that good to excellent extrapolated implant survival and functional outcomes are observed following modern cementless UKA, with a low incidence of aseptic loosening
Kim et al. [80]	2017	Oxford medial UKA was reliable and effective in young, active Asian patients, providing good clinical results and implant survival rates in the mid-term follow-up. Including 3 bearing dislocations, 1 medial tibial collapse and 1 lateral osteoarthritis, the total complication rate was 6.1% (5/82). The 10-year cumulative survival rate using the Kaplan–Meier survival method was 94.7%
Tadros et al. [81]	2018	The 2-year short-term functional outcome, revision rates, and satisfaction of UKA in the octogenarian population did not differ statistically from other age groups. No significant difference in implant survival was found between the groups. The overall revision rate was 28/395 (7%). The 90-day mortality in this series was one patient
Panzram et al. [82]	2017	Cementless fixation showed good implant survival rates and clinical outcome compared with cemented fixation. The 5-year survival rate of the cementless group was 89.7% and of the cemented group 94.1%. Both groups showed excellent postoperative clinical scores
Xue et al. [83]	2017	This study demonstrated that Oxford UKA was a good option for the treatment of anteromedial OA and spontaneous osteonecrosis of the knee in Asian patients
Mohammad et al. [84]	2018	The annual revision rate was 0.74% corresponding to a 10-year survival of 93% and 15-year survival of 89%. The non-revision reoperation rate was 0.19%. The reoperation rate was 0.89%. The most common causes of revision were lateral disease progression (1.42%), aseptic loosening (1.25%), bearing dislocation (0.58%), and pain (0.57%). The incidence of medical complications was 0.83%
Hutt et al. [85]	2018	Survivorship at 7 years with endpoints of reoperation, revision and aseptic loosening at surgery or radiographically was 88.4%, 93.1%, and 97.3%, respectively
Rodríguez-Merchán and Gómez-Cardero [14]	2018	The postoperative outcomes of UKA are generally good. Medium-term and long-term studies have reported acceptable results at 10 years, with implant survival >95% for UKAs carried out for medial OA or osteonecrosis and for lateral UKA, especially when fixed-bearing implants are used. When all implant-related reoperations are considered, the 10-year survival rate is 94%, and the 15-year survival rate is 91%
Heaps et al. [86]	2019	Reported 5- and 10-year pooled medial UKA survival estimates are 95.3% and 91.3%, respectively
Jennings et al. [87]	2019	Ten-year survival for UKA in cohort studies has shown to be >90% with results after conversion to TKA being similar to results for revision TKA. Registries have consistently shown lower implant survival for UKA compared with that for TKA, which is likely secondary to use of several different implants by surgeons of varying levels of experience

UKA Unicompartmental knee arthroplasty, *TKA* Total knee arthroplasty, *OA* Osteoarthritis, *MRI* Magnetic resonance imaging, *RLL* Radiolucent lines

9.6 Complications of UKA

In 2016, Kim et al. analysed the causes and types of complications following UKA, and determined appropriate prevention and management methods [88]. The most common complication after UKA was dislocation of the mobile bearing. The authors concluded that when a complication happens after UKA, adequate treatment should be performed after a proper analysis of the cause of the complication.

In 2016, van der List et al. reported a level III systematic review [89]. They recognised aseptic loosening and OA progression as the dominant failure forms. Aseptic loosening was the principal failure form in the early years and in mobile-bearing implants, whereas OA progression produced the majority of failures in later years and in fixed-bearing implants. In 2016, Inui et al. reported two cases of snapping pes syndrome following UKA [90]. Conservative treatment was efficacious in one case, whereas surgical excision of the gracilis tendon was needed to alleviate painful snapping in the other case. The main reason for the first case was probably posteromedial overhang of the tibial tray, which reached up to 5 mm. The potential cause of the second case was posteromedial overhang of the mobile bearing.

In 2016, Cheng et al. studied the amount of postoperative fixed flexion deformity that is clinically appropriate following UKA [91]. Their data suggested that postoperative fixed flexion deformity of >10° following UKA was associated with significantly poorer functional results.

Ahn et al. noted the likelihood of postoperative malalignment during medial UKA in patients with a greater varus angle in preoperative distal femoral varus angle (DFVA), tibial bone varus angle (TBVA), and valgus stress angle, particularly with a greater varus DFVA, which was the strongest predictor for malalignment [92].

Inclining of the mobile bearing relative to the tibial tray in the flexion position could be the consequence of implanting the femoral components more laterally relative to the tibial components during UKA using the Oxford Knee. Inui et al. compared femoral component positions after UKA using the phase-3 device and a novel device [93]. They also assessed the placement of the femoral components with the new device in the flexion position to define the association with short-term prognosis. They observed that to prevent implantation of the femoral component too laterally using a new device during UKA, knee surgeons should set the drill guide more medially, such that the centre of the drill is aligned with the middle of the medial femoral condyle. Impingement of the mobile bearing on the lateral wall of the tibial tray in UKA must be avoided.

Van der List et al. performed a systematic review to evaluate failure mechanisms in lateral UKA and compared failure mechanisms in cohort studies with those encountered in registry-based studies [94]. The most common failure forms in lateral UKA were progression of OA (29%), aseptic loosening (23%), and bearing dislocation (10%). In cohort studies, progression of OA was more common (36%) than bearing dislocation (17%) and aseptic loosening (16%), whereas in the registry-based studies, aseptic loosening (28%) was more common than progression of OA (24%) and bearing dislocation (5%). These authors concluded that progression of OA is the most common failure mechanism in lateral UKA. They also recommended that in the future, both cohort studies and registry-based studies should report the failure mechanisms of medial and lateral UKA independently.

In 2019 Hernández et al. analysed infection after UKA. Infection-free survivorship was 71% at 5 years. Treatment success was higher for patients undergoing two-stage exchange 100% at 5 years versus débridement, antibiotics, and implant retention (DAIR) 61% at 5 years. Survivorship free of any revision was 49% at 5 years [95].

In 2019 Bae et al. studied bearing dislocations after 1853 mobile-bearing UKAs. There were 67 (3.6%) bearing dislocations. The mean time to bearing dislocations after medial UKAs was 33 months; 55% of the bearing dislocations occurred within 2 years after the index medial UKAs. Primary bearing dislocations (n = 58) were the most common, followed by secondary (n = 6) and traumatic dislocations (n = 3). There was no significant difference in the incidence of bearing dislocation between the first 50 and second 50 UKAs for each surgeon [96]. Table 9.5 summarises the primary complications of UKA in the orthopaedic literature [88–96].

Table 9.5 Complications of unicompartmental knee arthroplasty (UKA) in the literature

Author	Year	Comments
Kim et al. [88]	2016	A total of 1576 UKAs were performed for OA of the knee. These authors retrospectively analysed complications after UKA and investigated proper methods of treatment. A total of 89 complications (5.6%) occurred after UKA. Regarding the type of complications after UKA, there were 42 cases of dislocation of the mobile bearing, 23 cases of loosening of the prosthesis, six cases of periprosthetic fracture, three cases of polyethylene wear, three cases of progression of OA in the contralateral compartment, two cases of medial collateral ligament injury, two cases of impingement, five cases of infection, one case of arthrofibrosis, and two cases of failure due to unexplained pain. The most common complication after UKA was mobile-bearing dislocation in the mobile-bearing knees and loosening of the prosthesis in the fixed-bearing knees, but polyethylene wear and progression of OA were relatively rare. The complications were treated with conversion to TKA in 58 cases and simple bearing change in 21 cases
Van der List et al. [89]	2016	This level III systematic review identified aseptic loosening and OA progression as the major failure modes. Aseptic loosening was the main failure mode in early years and in mobile-bearing implants, whereas OA progression caused most failures in later years and in fixed-bearing implants. Aseptic loosening (36%) and OA progression (20%) were the most common failure mechanisms. Aseptic loosening (26%) was the most common early failure mechanism, whereas OA progression was more commonly seen in mid-term and late failures (38% and 40%, respectively). Polyethylene wear (12%) and instability (12%) were more common in fixed-bearing implants, whereas pain (14%) and bearing dislocation (11%) were more common in mobile-bearing implants
Inui et al. [90]	2016	These authors reported two cases of snapping pes syndrome after UKA. Conservative treatment was effective in one case, while surgical excision of the gracilis tendon was necessary to relieve painful snapping in the other case. The main cause of the first case might have been posteromedial overhang of the tibial tray that reached up to 5 mm. The probable cause of the second case was posteromedial overhang of the mobile bearing
Cheng et al. [91]	2016	These authors studied the amount of postoperative FFD that is clinically appropriate following UKA. Their data suggested that postoperative FFD of >10° following UKA was associated with significantly poorer functional results
Ahn et al. [92]	2016	These authors analysed 92 patients who had 127 medial UKAs. According to postoperative limb mechanical axis (HKA), 127 enrolled knees were sorted into acceptable alignment with HKA angle within the conventional ±3-degree range from a neutral alignment ($n = 73$) and outlier with HKA angle outside ±3-degree range ($n = 54$) groups. Multivariate logistic regression was used to analyse risk factors including age, sex, body mass index, thickness of polyethylene tibial insert, preoperative HKA, DFVA, FBA, TBVA, mechanical distal femoral and proximal tibial angles, varus and valgus stress angles, size of femoral and tibial osteophytes, and femoral and tibial component alignment angles. Preoperative DFVA, TBVA, and valgus stress angle were identified as significant risk factors
Inui et al. [93]	2016	Inclining of the mobile bearing relative to the tibial tray in the flexion position could be the consequence of implanting the femoral components more laterally relative to tibial components during UKA using the Oxford Knee. These authors compared femoral component positions after UKA using the phase 3 device and a novel device. They also assessed the placement of the femoral components with the new device in the flexion position to define the association with short-term prognosis. They observed that to prevent implantation of the femoral component too laterally using a new device during UKA, knee surgeons should set the drill guide more medially such that the centre of the drill is aligned with the middle of the medial femoral condyle
Van der List et al. [94]	2016	These authors performed a systematic review to evaluate failure mechanisms in lateral UKA. Progression of OA was the most common failure mechanism in lateral UKA
Hernandez et al. [95]	2019	Infection-free survivorship was 71% at 5 years. Treatment success was higher for patients undergoing two-stage exchange 100% at 5 years versus DAIR 61% at 5 years. Survivorship free of any revision was 49% at 5 years
Bae et al. [96]	2019	There were 67 (3.6%) bearing dislocations after medial UKA. The mean time to bearing dislocations after medial UKAs was 33 months; 55% of the bearing dislocations occurred within 2 years after the index MEDIAL UKAs. Primary bearing dislocations ($n = 58$) were the most common, followed by secondary ($n = 6$) and traumatic dislocations ($n = 3$). There was no significant difference in the incidence of bearing dislocation between the first 50 and second 50 UKAs for each surgeon

UKA Unicompartmental knee arthroplasty, *OA* Osteoarthritis, *FFD* Fixed flexion deformity, *HKA* Hip-knee-angle, *DFVA* Distal femoral varus angle, *FBA* Femoral bowing angle, *TBVA* Tibial bone varus angle

9.7 High Tibial Osteotomy (HTO) Versus UKA

In 2019 Song et al. reported that long-term survival was similar between closed-wedge HTO and UKA in patients with similar demographics. The 5-, 10-, 15-, and 20-year survival rates were 100%, 91.0%, 63.4%, and 48.3% for closed-wedge HTO, respectively, and 90.5%, 87.1%, 70.8%, and 66.4% for UKA (n.s.). The survival rate was higher than that for UKA until 12 years postoperatively but was higher in UKAs thereafter, following a remarkable decrease in HTO. The most common failure mode was degenerative osteoarthritic progression of medial compartment in HTO and femoral component loosening in UKA [97].

9.8 UKA Versus TKA

En 2019 Arias-de la Torre et al. reported that mortality and revision rates after TKA and UKA at higher-volume hospitals were similar [98]. The main findings of the meta-analysis reported by Migliorini et al. in 2019 were that UKA reported a reduced survivorship but better clinical and functional performances compared to TKA. Furthermore, shorter surgical duration, lower total estimated blood loss, and quicker hospitalization length were observed in the UKA cohort [99].

9.9 Revision to TKA

In 2018 Lombardi et al. found that re-revision rates of failed UKA are equivalent to revision rates of primary TKA and substantially better than re-revision rates of revision TKA [100]. In 2019 Lim et al. encountered similar results following revision of failed UKA to TKA and primary TKA. There were significant improvements in patient-reported outcome measures (PROMs) for revision UKA to TKA, which is comparable to that of primary TKA [101]. En 2019 El-Galaly et al. found that TKA converted from medial UKA has a threefold higher risk of revision when compared with primary TKA. The implant survival resembled that of revision TKA but with a higher prevalence of unexplained pain and instability [102].

9.10 Optimal Usage of UKA

According to Liddle et al., UKA has advantages over TKA; however, national joint registries communicate a significantly higher revision rate for UKA [103]. As a consequence, the majority of surgeons are highly selective, proposing UKA only to a small proportion (up to 5%) of patients needing arthroplasty of the knee, and accordingly performing few procedures each year. Nevertheless, surgeons with large UKA practices have the lowest percentages of revision. The comprehensive size of the practice is frequently beyond the surgeon's control; thus, case volume might only be augmented by broadening the indications for surgery and proposing UKA to a greater proportion of patients needing arthroplasty of the knee.

Liddle et al. stated that UKA usage has a complicated, non-linear relationship with the rate of revision [103]. Reasonable outcomes are obtained with the use of 20% or more. Optimal results are accomplished with usage between 40% and 60%. Surgeons with the smallest usage (up to 5%) have the highest rates of revision. Revision rates per 100 implant years, according to Liddle et al., ranged from 1% to 4.5%, depending on UKA usage (expressed as % UKA) [103].

9.11 Conclusions

UKA has considerable advantages, including lower perioperative morbidity and earlier recovery, compared with TKA. The traditionally stringent indications for UKA have been called into question by reports that extended the indications based on a diagnosis of anteromedial OA of the knee and showed successful results. Both fixed- and mobile-bearing UKA implants show excellent clinical results at more than 10 years postoperatively but continue experiencing distinct forms of long-term implant failure. Appropriate patient selection and execution of surgical technique are paramount to optimising patient results.

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