Unicondylar Knee Arthroplasty: An Overview

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ABSTRACT

The unicondylar knee arthroplasty (UKA) was first introduced in the early 1970's with a wide range of reported clinical results from high failure rate to favorable outcome. All UKA prostheses available in the market are based on two different concepts of design: fixed and mobile bearing knee systems. With better implant designs and surgical technique, the mid to long-term outcomes following UKA have improved and are beginning to challenge the results of total knee arthroplasty (TKA). Appropriate patients selection is mandatory for successful results. Indications for surgery have been expanded to the younger age group and UKA is often considered as an alternative to TKA or high tibial osteotomy. Since the introduction of UKA, the surgical approach has been a standard medial parapatellar arthrotomy with patellar eversion. The rebirth of UKA is partially a result of the introduction of the minimally invasive surgical technique (MIS). The MIS procedure facilitates the patient's clinical result in terms of early postoperative pain, range of motion, ambulation, hospital stay, and rehabilitation. However, there are only a few mid term results of the MIS technique in the literature with no long term reports.

INTRODUCTION

The UKA is a surgical procedure that resurfaces the medial or lateral compartment of the tibiofemoral joint of the knee. The procedure is sometimes used as an alternative to high tibial osteotomy (HTO) or TKA when only one side of the knee has been involved. Surgeons have been interested in UKA because the prosthesis, itself, was designed to rest on the subchondral bone without interfering with both cruciate ligaments and major capsular structures of the knee joint. Theoretically, all UKA's are designed to yield a knee with more normal kinematics than TKA. The UKA design should allow the patients to retain more normal proprioception and stability of the remaining knee joint. However, the clinical results have been controversial and many orthopaedic surgeons disregarded this procedure because of the previous poor results. Several recent publications have demonstrated that long-term survivorship of UKA is about the same as that recorded in TKA. The development of better implants, appropriate patient selection, the use of thicker and better polyethylene, and better surgical technique has contributed to the improved outcomes. With the use of the MIS technique instead of a standard median parapatellar approach with patellar eversion, UKA can facilitate earlier postoperative range of motion and ambulation with a shorter hospital stay and a shorter period of rehabilitation. The indications for surgery have been extended to the younger age group and this has led to comparisons between UKA and HTO.

Development of UKA Implants

The Polycentric knee prosthesis was designed by Gunston(1) in 1968 as a replacement for both the medial and lateral compartments of the knee. The component design included significant constraint. The radius of the femoral runner and the tibial polyethylene were identical and the tibial component had a narrow mediolateral dimension. Gunston's prosthesis fostered some of the early ideas concerning UKA. Marmor(2) introduced the first unicompartmental knee prosthesis in 1973. The Marmor knee was originally designed to mimic the resurfacing concepts of Gunston and addressed both compartments of the knee. Marmor subsequently used the implant to resurface a single side of the knee and published some of his results in the late 1970's. The prosthesis had a narrow femoral runner with a single peg and an inlay tibial component. In Europe the St. Georg sled prosthesis was designed by Engelbrecht and associates in 1969 with a wider tibial component. Many of the later fixed bearing UKA designs were modifications of both the Marmor and the St Georg sled prostheses.

The designs evolved as surgeons attempted to improve the early results and decrease the failure rates. It became apparent that a narrow tibial component in the coronal plane led to subsidence and early loosening.(3) The less constrained knee designs improved the incidence of loosening.(4)

TKA designs had shown that high point contact loads led to early polyethylene wear and failure; yet, flat on flat designs that increased the surface contact also showed failure.(5) The Oxford meniscal bearing system was designed by Goodfellow and O'Connor(6) to address these problems by allowing more conformity between the femoral component and the tibial insert to reduce the surface forces and, then, allowing the polyethylene to move on the underlying tibial tray to avoid the problems of increased constraint.

Contemporary UKA's usually have 2-anchor lugs for the femoral component or a single lug with a keel. Tibial components usually have multiple lugs, a keel or a rough surface to enhance implant fixation (Fig.1). The width of mediolateral projection of the femoral component is different according to knee system (Fig.2). The prostheses are designed to have the same thickness as the resected bone of the distal and posterior aspect of the femoral condyle. The cutting guides allow the femoral runner to replace the resected bone and match smoothly with the femoral sulcus. The tibial trays are sized with respect to the anteroposterior and medial to lateral dimensions of the cut surface of the tibia. The polyethylene thickness is varied according to the residual space in flexion and full extension. The tibial components are either modular or a single, monoblock polyethylene implant.

Type of Fixation in UKA

Most unicondylar devices are fully cemented on both the femoral and tibial sides. The tibial components have been reported to have some increased loosening when they are all polyethylene with a smooth under surface.(7) Cementless designs have been fraught with problems of loosening and sinkage. Bernasek(8) reported on a series of 28 UKA's that only showed fibrous ingrowth into the component surfaces. Bert and Smith

(9) reported on 31 metal backed, cementless UKA's and found that 19% of the failures were secondary to lack of bone ingrowth with subsequent loosening. However, Magnussen(10) did report good results with the PCA unicondylar prosthesis in 51 knees with a cementless technique. There were 5 failures in the series; and they were a result of technical errors, inappropriate patient selection, and synovitis. The literature tends to support cemented techniques for better results with respect to loosening.

Fig .1 Examples of unicompartmental knee systems.

- Fixed bearing design that the femoral component has 1-anchor lug with keel and the tibial component is all-polyethylene with 2 lugs.
- Fixed bearing design that the femoral component had 2-anchor lugs and the tibial component is modular type with keel
- Mobile bearing design that the femoral component has a single radius and the polyethylene can slide on the tibial base plate.

Fig. 2 Demonstrates femoral components of unicondylar knee system with different mediolateral width. The femoral component that has narrow mediolateral dimension was reported to relate to subsidence of the component.

Development of Surgical Technique for UKA

The original surgical approach for this procedure was a standard medial or lateral parapatellar arthrotomy with associated eversion of the patella and division of the quadriceps tendon. This technique is identical to the TKA surgery and the postoperative rehabilitation is essentially the same. Subsequently, the concept of minimally invasive surgery (MIS) was introduced into orthopaedic surgery with a less invasive technique for the partial replacement. The MIS UKA can be performed with an 8 cm long incision in combination with a full range of specifically designed instruments. The new surgical technique and instrumentation leads to less invasion of the extensor mechanism The patella is not everted and the suprapatellar synovial pouch remains untouched. Reppici (11) introduced the MIS technique and he has recently reported his 9-year follow up with only a 9% failure rate for all cases.

Results of UKA

Results of UKA should be separated into two groups: UKA reports using standard TKA surgical techniques and UKA reports that included changes specific to the different implant and to the different surgery. The initial high failure rate in the early reports was related to improper patient selection, incorrect surgical technique, and poor implant design. Since 1996, the publications for UKA have shown a steady improvement in the results.

1. *Early Published Results of UKA*

Marmor(12) reported on 56 UKA's at a minimum of four years of follow-up with 75% good to excellent results and no difference between the medial and lateral replacement. Insall(13) published a completely different outcome in 24 UKA's with a follow-up of two to four years. Only 58% of his patients had a good or excellent result. 15 knees in the group had undergone patellectomy previously or at the same time of UKA. In a later publication, Insall and Aglietti(14) reported 28% failure rate of UKA with an average 6-year follow-up. Laskin(15) confirmed Insall's unfavorable results when he reported only 65% satisfactory pain relief at a minimum of 1-year after a medial UKA in 37 knees using the Marmor prosthesis. Although he emphasized the strict criteria for surgery, the failure rate in this series was still 20%. Swank(16) presented another unfavorable outcome of UKA with 8 years follow up on 82 unicondylar arthroplasties with a total failure rate of 12%. Most surgeons concluded from these studies that UKA was not a predictable operation and that the results of UKA were far inferior to those of TKA.

Towards the end of the 1980's, some favorable results began to appear. Thornhill (17) reported 92% excellent results at 42 months follow-up. Capra(18) had a 93% survivorship at 10 years in 52 UKA's. Scott3 reviewed 100 unicondylar knee arthroplasties after 8 to 12 years of follow up and reported 85% survivorship rate. A multicenter study of the Marmor prosthesis in 294 UKA's reported a 91.4% survivorship at 10 years.(19) All of the improved reported results stressed the importance of proper patient selection and careful surgical technique with correction of the tibiofemoral angle. Although excellent clinical results began to appear, the early generations of UKA did not

have the long term survivorship of the TKA's. UKA results remained in question. Some surgeons began to use UKA but considered it to be a surgical procedure preceding TKA as the final outcome of the intervention.

2. *Recent Published Results of UKA*

Recent publications concerning UKA are far more encouraging with results now entering the second decade after the initial operation. Many authors are now reporting a survival rate from 84-98% at 10 to 12 years. (Table I).(20-27) Tabor(23) reported only an 84% long term survival rate but admitted to problems in the early years with the technique of the surgical procedure and difficulties with the tibial component. His reported complications were reduced twelve fold when the tibial component was allowed to cover the tibial peripheral cortex. Most of the favorable long-term out come studies included patients with a mean age greater than 60 (range: 61-71 years). Most of the reports included conventional criteria for patient selection (ages over 60 years with low demand for activity, weight less than 180 pounds, more than 90 degrees range of motion of the knee, angular deformity less than 10-15 degrees, and no opposite or patellofemoral compartment erosion). Some authors accepted mild tibiofemoral subluxation, patellofemoral arthritis, younger patients or obesity as listed in table I. The longest report of follow-up after UKA was the study on 140 knees, including 125 medial and 15 lateral compartments, at 15-22 years follow-up with 84% survivorship rate at 22 years using revision for any reason as the endpoint.(26)

Results of MIS-UKA

With the combination of long-term favorable results and the introduction of the MIS procedure, UKA has undergone somewhat of a rebirth. Repicci(11) compared MIS-UKA with conventional UKA and showed that MIS-UKA provided much earlier ambulation and weight bearing with decreased postoperative pain. The patients gained 90 degrees of motion with less need for physical therapy and the operative blood loss was less than 200 cc. Repicci went on to report his 8-year follow-up of 136 MIS-UKA's on 126 patients.(28) Eighty-six percent of patients had good to excellent results. Revision was performed in 10 patients due to the advancement of disease in the remaining compartments in 5 patients, surgical error in 3 patients, poor pain relief in 1 patient and fracture in 1 patient. The authors do not discuss the details of the surgical errors. Price29 documented that the accuracy of implantation with MIS-UKA was the same as that with the standard open technique.

UKA versus TKA

Since reports of inferior long-term results of UKA to TKA, the former procedure has been much less performed than the latter. With the rapid progress of instrument development of the total knee system, most surgeons feel that the surgical technique of TKA is reproducible and are familiar to the procedure. On the other hand, many surgeons having limited experience on UKA may concern on the surgical technique and the expected clinical results. In the retained compartment of the knee of patients underwent UKA, disease may progress. Regarding the patellofemoral joint,

patellofemoral tracking is not affected with the UKA. However, patients may develop anterior knee pain due to impingement of the femoral component that causes increased arthritic change. Advantages of UKA over TKA are obvious at postoperative period. In general, UKA provided better early postoperative results than that of TKA. A study comparing 120 unicompartmental with 81 tricompartmental knee arthroplasties(30) has addressed that patients underwent unicompartmental arthroplasty had better range of motion and ambulatory function than patients being treated with tricompartmental knee replacement. They also found no statistically significant differences in aseptic loosening between these two patient groups. Laurencin(31) in a series of 23 patients demonstrated better early range of movement of the knee and pain control after surgery in the same patients underwent 2 different procedures on each knee. In addition, patients felt that the knee with UKA was more natural. Newman and associates(32) showed that the recovery time of patients who underwent UKA was shorter than that in TKA as well the length of hospital stay. A recent comparative study reported that UKA patients were better able to descend stair than the TKA patients; however, there was no significant difference in final pain and functional outcome.(33) In addition, revision UKA has been reported of good results and the surgical procedure was easier than that of revision TKA.(34)

UKA vs. HTO

The advantages of UKA compared with osteotomy include higher rates of initial success and fewer early complications. A retrospective study comparing between 49 HTOs and 42 UKAs with the same criteria for surgery(35) showed that at 5-10 years of follow-up, 76% of UKA patients still had good result as only 43% of HTO patients had the same result. In addition, ten knees of HTO group were revised. A match-paired study on 20 patients regarding rehabilitation after surgery(36) revealed that after 6 months, the arthroplasty group had better clinical results than the osteotomy group.

A series of long-term comparative study between UKA and HTO(37) demonstrated that UKA provided superior early and long-term results than that of osteotomy. Regarding bilateral procedure, UKA could be done simultaneously whereas osteotomy was best done apart. UKA may be appropriated for female patients who are indicated for valgus tibial osteotomy, because the cosmetic appearance of the lower extremity after UKA is much accepted to female patients than that after valgus tibial osteotomy. Although a successful UKA can eliminate pain and improve patient's functions, heavy functional activities after surgery are still doubtful. In contrary, a matched-pair comparative study of revision total knee arthroplasty after failed unicompartmental knee arthroplasty and high tibial osteotomy on 60 knees(38) showed that with the same level of difficulty for revision, the former group needed more osseous reconstruction than the latter. At an average 3.8-year follow-up, the latter group had a significant higher Knee Society Knee Score.

Patient Selection for UKA

Most authors stated that this procedure should be selected for patients whose ages were physiologically more than 60-65 years with a sedentary live style. In general, disease should be in specific unilateral knee compartment without anatomic deformity more than 10-15 degrees in any plane and limited knee flexion less than 90 degrees. Due to results learnt from experiences, some specific patient conditions were recommended to be

contraindicated for UKA including, inflammatory or crystal induced arthritis, absent or unhealthy anterior cruciate ligament (ACL), advanced patellofemoral arthritis, knee subluxation or gross ligamentous laxity and obesity. With the use of these criteria for patients who undergo unicompartment replacement, a study(39) demonstrated that only 6% of patients were good candidates. Due to a variable of contraindications among several favorable outcomes that were reported, specific issues have to be addressed.

1. *ACL Issue*

Unicondylar arthroplasties in patients without or poor functioning ACL were reported of high failure rate. In the series of first 103 cases of Goodfellow et al,(40) they found that 6 of 37 knees that lacked of a normal anterior cruciate ligament were failed. The failure rate was 16.2% compared to 4.8% of the intact anterior cruciate ligament group. Chassin and associates(41) studied gait analysis in patients with intact ACL who underwent medial UKA and found that 7 of 10 studied patients had normal biphasic flex and extension moment pattern after UKA. They concluded that an intact anterior cruciate ligament in patients underwent this procedure allowed them to maintain normal quadriceps mechanics. A recent study regarding in vivo three-dimensional determination of kinematics of 20 clinical successful unicompartmental knee replacements (42) demonstrated that knee kinematic pattern after UKA was variable depending on the integrity of the anterior cruciate ligament.

While some authors(3, 12, 41) believed that intact ACL is a strict prerequisite for the procedure, Christensen(43) found that absence of the ACL ligament was not a contraindication. According to the latter, the effect of the absence of the ACL in terms of sagittal instability was less pronounced in the arthritic knee than that found in the young knee. Regarding translatory deformity that was frequently found in this type of patients, the procedure could be indicated as long as the collateral ligaments were not attenuated. Laskin(44) questioned that loosening or abnormal wear of the polyethylene might not be truly associated with UKA in patients whose ACL were not normal. He also emphasized that the postoperative knee alignment that was not a physiologic one might have role on this type of failure. Regarding the common figure of medial arthritic knees seen in our office, our criterion of abnormal ACL condition for UKA is not strict contraindication.

2. *Obese Patients*

Several analyses of failure UKA have stated that patients with heavy body weight were found to have a high rate of early failure and it was recommended not to do the procedure in this group of patients. Scott and coworkers(3) found that patients with loosening of the femoral or tibial component had overweight as a cause of failure. They suggested that the best candidates should not be obese and the ideal body weight should be less than 180 pounds. Heck et al(19) reported in affirmative to the proposed indication that failure was associated with patient bodyweight higher than 82 kilograms (180 pounds). In contrary, studies using Oxford meniscal bearing knee(22, 27) reported long-term clinical good to excellent results with no contraindication on bodyweight. Tabor23 reported 17.7% failure rate for patients under 180 pounds compared to 4.8% failure for patients more than 180 pounds. Concerning body mass index (BMI) more than 30 determined as obese, they found similar long-term outcomes of the obese group and the non-obese group. Due to the contemporary tibial component design to cover the tibial cortex, reducing the risk of subsidence of the component, it may be reasonable to extend the indication for surgery of the obese group up to the body weight of 250 pounds.

3. *Patellofemoral Arthritis*

Patellofemoral symptom has been one of the reasons for revision of unicondylar arthroplasty. According to Marmor,(12) inappropriate placement or sizing of the femoral component caused impingement of the patellofemoral tracking. Kozinn and Scott(45) have emphasized that pain at the patellofemoral joint is a relative contraindication for surgery. If subchondral bone of the patella is exposed they recommended replace the whole knee. The Oxford group have showed that no correlation between the state of the patellofemoral joint at operation and the clinical outcome.(46) Furthermore, they reported no radiographic arthritic change of the patellofemoral joint after ten years follow-up.(47)

Recently, a long term follow up of UKA demonstrated patellar impingement in 29% of unrevised cased.(48) Degenerative changes of the patellofemoral joint also affected the patients' function, but symptoms were less severe than that in patients with patellar impingement.

4. *Lateral UKA*

Lateral and medial UKAs results have often been grouped as unicompartmental knee arthroplasty and therefore one might be led to believe that outcomes of these two procedures are similar. However, a large majority in most series was medial UKA. Thus reports represented the outcome of the medial UKA more than that of the lateral UKA. In Marmor's series,(12) the results of 5 lateral UKAs were not different compared to 54 medial UKAs. Some authors(14,15) documented that lateral UKA had more predictable results than the medial UKA. Of the 27 lateral compartment arthroplasties in a series of first 103 UKAs of Oxford meniscal knee,(40) the Oxford group had reported a specific complication, bearing instability caused 5 cases of polyethylene dislocation. This complication occurred only 1 case in 76 medial compartment arthroplasties. A radiographic study of the meniscal bearing knee(49) showed that during the knee moving from 0 to 90 degrees of flexion the lateral bearing had average moved distance more than the medial one. The later study from the same institution(50) demonstrated that lateral UKA had survival rate of 67% at 10 years by using revision as endpoint. This may imply that meniscal bearing is not suitable for lateral compartment of the knee. However, the study of Odera et al (51) reported on satisfactory outcome of 38 lateral UKA at a 5- year follow-up with the use of 4 different types of prostheses. In this series, only 18 knees were available for evaluation. They found that 89% of evaluated knees had satisfactory results in terms of function and pain relief without any radiolucent line. With an appropriate patient selection and proper surgical technique, we believe that lateral UKA provides early favorable outcome; however, more long-term follow-up studies may support the use of this procedure.

5. *UKA in Younger-Aged Group*

Previously, most series(3, 12, 25) selected patients whose age was more than 60 years old with sedentary life style to undergo surgery. Since UKA was an attractive alternative to osteotomy or TKA in middle-aged group and it provided a reliable 8-to10-year satisfactory result, Scott(52) proposed an expansion of the indications for unicompartmental knee arthroplasty to the younger age group with osteoarthritis, especially in middle-aged women. A study from the same institution of a 2- to 6- year results in patients under 60 years old on 28 knees,(53) showed that 90% of patients had good to excellent results in terms of function and pain relief. They also reported an improved average activity level according to Tegner and Lysholm score. However, UKA

in this age group was inferior to that of TKA in terms of revision. In the long-term study of Cartier et al, (20) they reported no difference between the younger-aged group and the patients whose age were more than 60 years old.

Early Failure of UKA

Previously, major problem to cause a disregard of UKA was the high early failure comparing to TKA. This failure has been related to multiple factors. Beside the issue of patients selection, four important factors that have been evidenced to cause early failure including implant designs, overcorrection of the deformity, inadequate thickness of polyethylene and surgical error.

1. *Implant Designs*

Implant designs contributed an effect on the longevity of prosthesis. A specific UKA system had been reported of poor results. In a series of revision UKA in 29 patients of Barrett and Scott,(54) femoral component failures was found related to the narrow designed component. The study on 3777 UKAs comparing the revision rate of the Porous-Coated Anatomic prostheses (PCA, Howmedica, Rutherford, NJ) with another two types of prostheses (Marmor and St. Georg).(55) As early as 2 years after operation, the PCA prostheses had 15 % cumulative revision rate and was 3 times higher than both of the rest at 6 years. Meanwhile, there was no difference between the Marmor and St Georg prostheses. Fifty percent of the PCA failure cases had femoral component loosening. The study of Bergenudd(56) emphasized the effect of poor prosthetic design with a 28% rate of failure of the PCA femoral component and excessive polyethylene wear in the series of 108 UKAs. Riebel et al(57) did a biomechanics test on cadaver limbs implanted with PCA prosthesis and showed a high rate of early loosening due to shear at the bone-prosthesis interface. In fact, it is prudent to perform the surgery with the use of prosthesis with having a good track record.

2. *Overcorrection of Deformity*

Biomechanically, correction of the deformity especially in the mediolateral plane causes change of load to the other compartment of the knee. According to Squire, (26) major failure cases were from progressive arthritis on the opposite compartment which would not be occurred if surgeons had avoided overcorrection of the deformity. Weale and associates(58) supported this concept by demonstrating a very low incidence of progressive osteoarthritis within the knee at 5- year follow up in a series of 50 UKAs. A study(59) reported on a series of 82 knees that 17% percent of patients had impending radiographic failure after a minimum 4-year follow-up. One major reason of failure was progression of arthritis on the other side. Due to being a common cause of failure, the amount of deformity correction was addressed.

Generally, preoperative ligament stability, angular deformity are needed to be evaluated. A standard knee radiographic series including standing AP and axial views of the patella may help for evaluation of existing degenerative joint disease as well as the degree of deformity of the knee. Although no consensus exists on how many degrees should be corrected, most authors reporting a high success rate of long-term results recommended not to over correct the preoperative alignment. Regarding correction of varus deformity, most long-tem studies with favorable results reported the angle after correction of deformity from 0 degree of anatomical axis to just less than 0 degree of mechanical axis. In the study of Kennedy and White60 on 100 UKAs, they reported that

superior results were obtained when the postoperative mechanical axis of the operated limb fell in the center of the knee or slightly medial to the center. According to this study, in varus knee, if the medial release was significant or excessive, it will produce a postoperative valgus knee. Reports of degrees of correction for mediolateral deformity and radiographic arthritic change on the opposite compartment are listed in Table II.(23, 25, 26, 61) To predetermine the correctable knee, the Oxford group routinely use one of criteria for surgery that the deformity must be a passively correctable varus deformity, preoperatively. A recent study on 40 medial UKAs with the mean follow-up of 6 years (62) presented a 7 times higher failure rate when the postoperative alignment was out of 2 degrees of anatomical varus to 6 degrees of anatomical valgus.

3. *Polyethylene Issue*

According to Marmor's series, poor results were usually associated with use of a polyethylene 6-mm tibial component. After reporting a long-term follow-up,(63) he recommended a minimal 8-mm thickness and the widest tibial component be used to allow the prosthesis to seat on the peripheral cortical rim. Bartley et al(64) have found that the wear pattern of polyethylene in UKA was characterized by delamination, pitting, peripheral tear, deformation, and abrasion. A retrieved study of Blunn et al(65) had shown that the most severe type polyethylene wear in UKA was delamination. In short-term failure, it was associated with the manufacturing process of polyethylene and it happened in specific type of prosthesis. In medium- and long-term failures, it was associated with high polyethylene conformity that restricted the rotation of the femoral component on the polyethylene. Delamination in a knee with laxity was due to wear toward the edges of tibial component. The progression of osteoarthritis, subsidence of tibial component, attenuation or rupture of ACL after surgery may cause secondary subluxation of implants and aggravate a high contact stress on polyethylene. McCallum and Scott(66) had demonstrated that the pattern of polyethylene wear duplicated the preoperative wear pattern of the arthritic knee. To minimize this problem, they suggested using a thicker polyethylene especially at the anterior and peripheral margins. Besides the problem of insufficient thickness of polyethylene, Palmer et al (67) also found that, fusion defect of the polyethylene, increased rotational freedom and reduced conformity in the design of the prosthesis were possible causes of failure. On the other hand, reports of polyethylene wear on meniscal bearing UKA have shown a low annual wear rate. A study(68) on 23 retrieved polyethylene meniscal bearings from failed UKAs evidenced that the wear rate was 0.026 mm per year. Psychoyios and coworkers(69) in the study of 16 retrieved polyethylene inserted in the Oxford UKA found that the average polyethylene wear rate was 0.036 mm per year without the influence of thickness. They concluded that congruent meniscal bearing polyethylene provided a negligible polyethylene wear rate, but great care was needed at implantation to avoid any impingement. An investigation of Engh et al (70) reported that significant polyethylene cold flow was observed on the back side of the metal-backed tibial component related with time after surgery. They also found that polyethylene back side wear was related to delamination in load-bearing areas of thin polyethylene insert. Regarding the problem of polyethylene manufacturing, recently, more durable polyethylene has been developed. However, most authors believe that it is safer to use at least 8-mm thickness of contemporary polyethylene tibial component.

4. *Technical Error*

A series of the 42 knee procedures(71) at average 67-month follow-up reported that major causes of 13 failures were related to technique and prosthetic design. A review of the Scandinavian study(72) that demonstrated the 5-year cumulative revision rate of UKA had been reduced from 11% to 5%. Comparing to cumulative revision rate of TKA, this improvement of UKA with time was statistically significant. The authors concluded that factors provided the continuous improvement over time included improved surgical skill, better instruments and improved cementing technique. Due to the technical demanded procedure, the meniscal bearing knee has been reported a higher the revision rate than that of the fixed bearing knee.(73) According to the review of revision cases in 29 patients of Barrett and Scott(54) technical error was found as associated cause in 16 of the 29 patients. To avoid technical error, it is mandatory for orthopaedic surgeons who are unfamiliar to the unicompartmental knee surgery to understand the principle of deformity correction and to have a learning curve for the surgical technique especially with the use of new minimally invasive surgery technique. Most orthopaedic companies have developed instruments to provide more accurate knee alignment and bone cut that will make this procedure to be more reproducible.

Radiographic Change after UKA

Radiographic assessment for component loosening was usually defined as component migration, cement fracture or a complete radiolucent line greater than 2 mm thick. Radiolucent lines increased related to number of years of follow-up. A long-term follow-up series of Scott et al(3) reported 55% incomplete radiolucent line of the tibial component and 10% for the femoral component at 8-12 years of follow-up without symptom of loosening. Femoral components seemed to have fewer incidences of lucent lines. Mallory and Dolibois(74) reported that patients with radiographic evidence of loosening of UKA were constantly associated with clinical symptoms of mild pain. In an average 5- year follow-up study on 33 UKAs(75) they found that there was no relationship between periprosthetic radiolucency and clinical knee scores or failures resulting in revision. Regarding medial arthroplasty, they reported that superior clinical results were associated with a central or slightly medialized mechanical axis. A study of Weale et al(58) reported that recurrent 2 degrees varus of limb alignment was observed between eight months and five years after operation with no correlation between the postoperative tibiofemoral angle and the extent of recurrent varus. They concluded that minor polyethylene wear or of subsidence of the tibial component might cause changes in knee alignment.

For disease progression, most studies assessed by grading the remaining compartments using Ahlbäck's criteria. Studies reporting on progression of arthritic change on the opposite compartment or patellofemoral joint were variable. Marmor(12) reported no significant increasing arthritic change on the opposite compartment.

Revision surgery after UKA

Previous studies(54,76) have stated that revision of unicompartmental arthroplasty were problematic because of technical difficulties for restoring of significant bone loss. This caused subsequent need for bone augmentation with either allograft or metallic wedges and the results were not as good as with primary total knee arthroplasty reported. Later on, Lai and Rand(34) published their retrospective review of 48 patients undergoing

revision of UKA at 5.4-year mean interval from index of surgery. All revisions were done with condylar-type prosthesis and 50% of knees had contained defects that could be filled with cement. Their results were 81% good or excellent and 13% surgical complication rate. A retrospective matched pair analysis comparing 30 TKA following HTO with 30 following UKA was reported by Gill et al(77) The authors found no difference in difficulty of exposure between two groups but there were more bone defects requiring osseous reconstruction in UKA group. However, the overall results of TKA after UKA approached did not have equal results as that of TKA after HTO. Levine and associates (78) reported a series of successful conversion of failed 31 UKAs to TKAs with the use of cancellous graft or simple metal augments to fill defects. In this study, the posterior cruciate ligament could be spared in most cases.

According to Chakrabarty, (79) reporting on 73 revision UKAs to TKAs, with the use of presently available range of revision instrument system, only minimal tibial bone was sacrificed and the average tibial insert thickness series was 11.5 mm of thickness. All recent findings documented newer prostheses are more resurfacing in nature and have decreased the need for augmentation at the time of revision.

CONCLUSION

After nearly 30 years of controversy, many recently favorable reports of the outcome have produced evidence that unicondylar knee arthroplasty needs to be reconsidered. With the use of minimally invasive technique, MIS-UKA for this type of surgery, this procedure has been highlighted as it provides advantages on some specific group of patients. The past experience of early failure that we have learnt leads us to have an appropriate patient selection, appropriate implant designs, thickness of polyethylene, correct surgical principle and technique. Studies of long-term results and revision of failed UKA have supported the idea that UKA may be concerned as a pre-TKA for younger-aged patients. In addition, this less invasive surgery, is suitable for symptomatic patients whose medical conditions do not allow them to tolerate such a total replacement.

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