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Review Article

Unicompartmental Knee Arthroplasty in the ACL Deficient Knee

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Abstract

Unicompartmental osteoarthritis in young, active patients with concomitant ACL deficiency is controversial problem. Several different operative treatment options exist including unicompartmental knee arthroplasty, high tibial osteotomy (HTO), and total knee arthroplasty [1]. Total knee arthroplasty (TKA) has a very high success rate and is a comprehensive procedure that would address knee pain as well as instability related to ACL insufficiency [2,3]. However, contemporary literature benefits of UKA over TKA including preservation of bone stalk, physiologic knee kinematics, lower perioperative morbidity and accelerated rehabilitation [4-9]. TKA may also impart unacceptable activity restrictions in a physiologically young patient with specific physical demands. As an alternative, UKA and HTO have been used with or without concomitant ACL reconstruction. Early results for UKA have been most promising; however, controversy still remains as to its role in the treatment of this population.

Keywords: Unicompartmental; Knee; Arthroplasty; ACL Deficient

Introduction

Traditional contraindications to unicompartmental knee arthroplasty as described by Kozinn and Scott in 1989 include isolated unicompartmental knee osteoarthritis, age greater than 60, low demand, weight less than 82 kg, arc of motion greater than 90° with less than 5° fixed flexion, secondary osteonecrosis, less than 15° angular deformity, no inflammatory arthritis and competent cruciate ligaments [10]. Using these criteria Ritter., *et al*. showed that just over 6% of 4,021 knees were indicated for UKA [11]. Since this time the indications have expanded due to the availability of improved bearing surfaces and component design [12]. Subsequent studies over the past decade have shown younger, heavier patients are undergoing UKA with good results [13-19].

The necessity of an intact anterior cruciate ligament has also recently been called into question. Preliminary studies demonstrated an early failure rate of 16.2-87% in ACL deficient knees who underwent a UKA [20,21]. The most common cause was aseptic loosening of the tibial component followed by eccentric polyethylene wear. Deschamps and Laperye reported increased 7-year failure rate in patients with at least 10mm of anterior tibiofemoral translation prior to UKA [20]. Two subsequent studies by Goodfellow., *et al.* had similar findings of reduced UKA survivorship and a failure rate over 3 times higher at in ACL deficient knees [21,23]. Bohm and Landsiedl found that 5 of 35 failed UKA patients had absent ACL at the time of revision surgery [22]. Furthermore, increased anterior tibial translation [24,25], reduced quadriceps force and increased posterior medical compartment stress [26-29] in the ACL deficient knee poses a possible threat to the outcomes following UKA. These results suggested concluded that ACL deficiency may lead to clinical instability accelerating progression of patellofemoral and lateral compartment degeneration [27].

UKA without ACL reconstruction

These findings are in contrast with a growing body of recent literature describing favorable outcomes of UKA in ACL deficient knees. A retrospective comparison between forty-two patients with medial UKA in ACL deficient knees and a matched cohort showed no significant differences in survivorship or clinical outcomes at 5 year follow up [30]. A biomechanical investigation based on the same study group challenged whether or not previously proven kinematic differences between ACL intact and ACL deficient knees directly resulted in increased failure after UKA. Pegg., *et al*. used fluoroscopy to characterize the sagittal kinematic behavior of 16 knees from the study and control groups from the study by Boissonneault., *et al*. The ACL deficient group had similar kinematic differences as previously described however this did not correlate with inferior functional scores [29].

Hernigou and Deschamps studied the outcome of 99 patients after UKA including 18 with ACL deficient knees. At an average 16 years of follow up, 7 of 18 ACL deficient knees with a tibial slope < 5 degrees failed at final follow up. They concluded that there was no difference between ACL intact and deficient knees when the tibial slope was < 7degrees [31]. A study of 575 fixed-bearing UKA showed only 1.2% revision rate an average follow up of 9 years. The authors noted that many of these knees were ACL deficient [32]. Most ACL deficient patients remained asymptomatic and required no revision arthroplasty procedures 10-18 years following UKA in another small series [7].

The difference between previous and current results could be explained by improved implant design and indications that have been further refined. Of emerging importance is the concept of functional instability versus attritional wear of the ACL. Krishnan [33] described patients with isolated medial compartment arthritis and ACL deficiency as originating from two subgroups. The first group is comprised of those with previous traumatic ACL tear and functional instability with medial compartment arthritis as a result of ACL deficiency. These patients tend to be younger and more athletic, with expectations to return to a higher level of function. In a biomechanical study, ACL reconstruction restored physiologic anterior translation during Lochman and pivot shift exam in four cadaveric knees with medial UKAs [26]. This subgroup would most benefit from ACL reconstruction and UKA to address not only pain but their functional instability.

In the second subgroup, there is attritional wear of the ACL as a result of medial compartment arthritis and functional instability may be absent for some time. Tight capsular structures, osteophytes and the scarred ACL remnant may play a role as secondary stabilizers [7,34]. These patients therefore have little functional instability, making an acceptable outcome more likely after isolated UKA. In addition to choosing a patient without functional instability, technical factors may contribute to good outcomes. Decreasing the tibial slope [28,31,35] proper collateral ligament tension, [7] use of fixed bearing implant, and sparing the ACL remnant on the femur [34]. have been suggested in order to mitigate possible postoperative destabilization. The prognostic differences between these two subgroups have not been borne out in the literature. Further study is needed before conclusions can be made regarding surgical indications for each group.

Lateral UKA

The lateral compartment is primarily involved in 5-10% of unicompartmental knee osteoarthritis [36-39]. The limited data available supports lateral UKA as a suitable option for the treatment of this relatively uncommon clinical problem [23,37,39,40,41,43,44]. A consecutive series by Argenson., *et al*. examined 39 lateral UKA showed significant improvement in KSS pain and function scores at a mean follow-up of over 12 years. Most patients (63%) in this series also returned to preoperative levels of activity and had restored range of motion and acceptable radiographic outcomes [40,42].

In a second retrospective review, 101 patients who underwent a lateral fixed bearing unicompartmental arthroplasty over a 9-year period had a significant improvement in pain scores with a survivorship of 95.5% at 5 years [43]. The mean time to failure for lateral UKA was 9.4 years in a retrospective review, with the most common reason for failure was progression of arthritis in other compartments and aseptic loosening [26]. Lateral UKA survivorship has been comparable to medial prosthesis in several studies especially when a fixed bearing implant has been used [21,23,37,39,40,41,43,44].

Despite similarities in survivorship, lateral UKA may not impart similar improvements in quality of life. Liebs and Herzberg reviewed 558 patients who underwent mobile-bearing UKA and examined functional scores as well as health-related quality of life.

Similar survival rates at a mean 2.1 years were similar however those receiving medial UKA had higher health related quality of life scores [45].

Additionally, the use of lateral UKA in ACL deficient knees has not been well studied. Most of the available information is based on kinematic studies and investigations that include patients with an intact ACL [23,27,41,46]. Most failures in the study by Argenson., *et al*. were due to dislocation of the tibial bearing. In a subsequent *in vivo* kinematic analysis, there was increased posterior femoral translation of the lateral condyle in lateral UKA compared with medial implants. Therefore, they recommended the use of a fixed-bearing component for lateral UKA [40].

The use of lateral UKA in ACL deficient knees has not been thoroughly investigated. There is greater translation of the tibia on the lateral femoral condyle in an ACL deficient knee, and therefore a propensity for instability following UKA. Clinical studies also suggest that due to a high complication rate, ACL deficiency is a contraindication for lateral UKA [23,41,46].

Unicompartmental knee arthroplasty with ACL reconstruction

Preoperative assessment

A thorough preoperative assessment is crucial in determining eligibility for a unicompartmental knee arthroplasty in an ACL deficient knee. This entails a history including previous inflammatory conditions, documentation of all previous ipsilateral knee procedures, and pain localized exclusively to the medial compartment. The surgeon should ensure that all reasonable non-operative modalities have been exhausted prior to considering arthroplasty and ACL reconstruction. Additionally, the consenting provider should have a thorough discussion regarding the risks, benefits and alternatives of surgery in order to align the postoperative expectations of the operating surgeon and the patient. This is of pivotal importance in order to ensure the best possible outcome and high patient satisfaction [47]. Physical examination should focus on excluding tenderness in the lateral or patellofemoral compartments, collateral ligament dysfunction, fixed contractures, or large coronal deformity. Positive findings are a contraindication to proceeding with a UKA. The radiographic evaluation should include weight bearing anteroposterior, lateral, Merchant, and Rosenberg views. A hip-to-ankle scanogram may be considered to exclude large aberrations in mechanical alignment that would be a contraindication to UKA. The role of magnetic resonance imaging or computed topography in this setting is unclear and may be considered on a case-by-case basis. In the setting of previous ACL reconstructive procedure, CT to assess tunnel position and size will assist in the decision to proceed with a one or two stage procedure or abandon a UKA for TKA. Previous tibial tunnel position and size in particular is important as a structurally sound tibial plateau is required to prevent subsidence of the tibial tray or tibial stress fracture following UKA.

MRI may be used to rule out large cartilage defects or meniscal pathology in the lateral compartment as well as assess the PCL and collateral ligaments should suspicion for injury arise during physical examination.

Order of procedure

The surgical procedure for concomitant UKA and ACL reconstruction varies widely between surgeons. However, all strategies attempt to optimize component placement, minimize graft damage, and achieve proper ACL tension. Krishnan and Randle made the tibial and femoral cuts then drilled the ALC tunnels and passed the graft prior to cementing the UKA and fixation of the graft. While this strategy avoids impingement of the ACL graft, it does not allow an arthroscopically assisted ACL reconstruction. Tinius., *et al*. performed a diagnostic arthroscopy prior to graft harvest and placed guide wires prior to UKA cuts in order to ensure the ACL tunnels did not compromise UKA position. Regardless variations in operative procedure, in almost all cases the ACL graft tensioning and fixation occurred last [33,48-50].

There is also the question of whether or not to perform staged or simultaneous UKA or ACL. Pandit., *et al*. based their decision on whether the patient presented with primarily pain or instability symptoms. If the main symptom was pain, a simultaneous UKA and ACL were performed. Those with a main complaint of instability first underwent an ACL reconstruction followed by a UKA an average of 9 months later only if their knee remained symptomatic. In a subsequent study by this group, there was no difference in clinical outcome, complications or implant survival between staged and simultaneous procedures [49].

Clinical outcomes

Several series reporting on unicompartmental knee arthroplasty with ACL reconstruction have shown generally favorable clinical results with low complication rate. In retrospective comparative study, 76 ACL deficient knees that underwent fixed-bearing UKA had similar survivorship compared to 706 ACL intact UKA performed in the same time interval. Survivorship at 6 years was 94% in ACL deficient group, 93% in ACL intact group. There was only one patient in the ACL deficient group who required a conversion to TKA due to tibial loosening. One weakness of this study is the exclusion of patients with preoperative subjective instability for which this procedure may also be indicated.

Krishnan and Randel., *et al*. specifically included patients with functional instability and unicompartmental arthritis in theirs study [33]. The 9 patients in this series underwent UKA and concomitant ACL reconstruction with improvement in WOMAC, Oxford Knee and KSS scores with no complications at a mean follow up of 2 years. In another series of 10 patients with concomitant UKA and ACL reconstruction, *in vivo* knee kinematics was restored to that of 22 ACL intact knees [50]. A different study showed that at mid-term follow up, combined UKA and ACL reconstruction restored knee stability and prevents UKA failure in young active patients. In this retrospective series of 27 patients with a mean age of 44 years there was a significant improvement in KSS, no revisions and no evidence of loosening at a mean of 4 years [48]. All patients in this study had symptomatic instability and isolated medial joint line pain and arthroscopically confirmed ACL rupture. Weston-Simons and Pandit also reported favorable results in a series of 51 patients with symptomatic instability and medial compartment arthritis who underwent UKA and ACL reconstruction. At a mean 5 year follow up, all 51 patients were pleased or very pleased with the outcome of their surgery, there was no clinical evidence of instability, and only one conversion to TKA after progression of arthritis to the lateral compartment.

Conclusion

The requirement of competent anterior cruciate ligament for medial UKA remains a controversial topic. In addition to expanding indications for UKA alone, one must consider indications exclusive to UKA the with staged or simultaneous ACL reconstruction. Early results using this strategy have been favorable. Further study is needed to answer remaining questions about this useful treatment strategy for the active patient ACL deficient knee with single compartment arthritis.

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