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ORIGINAL ARTICLE

# Promising outcomes of medial unicompartmental knee arthroplasty in anterior cruciate ligament deficiency patients

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## ABSTRACT

**Aim** Recent studies challenge the initial belief that medial unicompartmental knee arthroplasty (UKA) is contraindicated for patients with anterior cruciate ligament deficiency (ACLD) due to increased risk of periprosthetic tibial fractures, revealing promising outcomes with advancements in surgical techniques and patient selection. This study aimed to evaluate the outcomes of patients who received medial unicompartmental knee arthroplasty with anterior cruciate ligament deficiency.

**Methods** Five patients, aged 59-74, with knee pain, joint instability, and limited mobility, were treated for medial compartment osteoarthritis and ACLD using an Oxford design mobile-bearing unicompartmental knee prosthesis.

**Results** Medial UKA offers excellent clinical outcomes in ACL-deficient patients, improving knee function and reducing pain. It challenges the traditional view of ACLD as a contraindication, preserving knee kinematics and offering enhanced postoperative recovery. Advances in surgical techniques and prosthesis design expand their suitability.

**Conclusion** Medial UKA may be a viable treatment option for osteoarthritis patients with ACLD, potentially offering an alternative to total knee arthroplasty.

**Keywords:** anterior cruciate ligament injuries, knee replacement arthroplasty, osteoarthritis

## INTRODUCTION

Osteoarthritis is the most prevalent form of arthritis, accounting for 62% of all arthritic conditions globally between 2017 and 2018. It commonly affects the hands, hips, knees, feet, and spine, making it a significant cause of disability among musculoskeletal disorders. Since OA primarily impacts older adults, approximately 70% of those affected are over the age of 55, the global prevalence of OA is expected to rise as populations age. Although OA typically begins in a person's late 40s to mid-50s, it can also affect younger individuals, particularly athletes or those who have suffered joint injuries or trauma (1).

Osteoarthritis (OA), a prevalent and progressive musculoskeletal disorder, significantly affects weight-bearing joints, such as the hips and knees, resulting in the structural deterioration of articular cartilage, subchondral bone, and adjacent structures (2). Joint cartilage degeneration and irregular bone formation cause severe pain, functional disability, and limited mobility, impacting 80% of affected patients and 25% experiencing complete incapacitation (3). Knee osteoarthritis (KOA), a global health issue primarily affecting individuals over 50, has increased due to obesity and aging populations, affecting around 250 million people globally (4,5). KOA is categorized into primary and secondary types, with primary KOA originating from mechanical stress, inflammation, and genetics, and secondary KOA linked to trauma or congenital abnormalities (6).

Varus alignment, a key factor in medial compartment OA, alters knee load distribution, leading to excessive stress and cartilage wear. Anterior cruciate ligament insufficiency (ACLD) further destabilizes the knee, exacerbating degenerative processes (7). KOA diagnosis involves clinical evaluation, imaging, and laboratory studies, with X-rays being the most commonly used diagnostic tool. The Kellgren and Lawrence grading system assesses severity, especially in advanced stages with severe joint space narrowing (8).

Functional assessments, such as Knee Injury and Osteoarthritis Outcome Score (KOOS) (9) and Lower Extremity Functional Scale (LEFS) (10), are commonly used to evaluate patient outcomes and monitor disease progression.

KOA treatment can involve non-surgical interventions or surgical procedures, with total knee arthroplasty (TKA) being the preferred method. Unicompartmental knee arthroplasty (UKA), an alternative for isolated medial compartment OA,

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has gained popularity (11). Historically, UKA was contraindicated for patients with ACLD due to knee instability and tibial fracture risk. However, recent advancements in surgical techniques and prosthesis design have expanded its application to ACL-deficient knees (12,13).

UKA, a minimally invasive alternative to TKA, was developed by Ahlback in 1968. Early milestones included McIntosh and Hunter's unicompartmental arthroplasty in 1954, McKeever's tibial prostheses in the 1960s, and the St. Georg Sled in the 1970s. However, concerns about survivability, patient selection, and technology remain, leading to the Ten Enigmas of UKA (14).

UKA offers faster recovery, shorter hospital stays, and superior knee kinematics compared to TKA. Its patient satisfaction is often higher than TKA due to its preservation of essential structures, leading to improved long-term outcomes and bone stock, which is beneficial for future revision surgery (11,15). UKA is recommended for unicondylar osteoarthritis or osteonecrosis, with specific parameters such as frontal deformity, flexion contracture, and an intact anterior cruciate ligament, as well as anteromedial osteoarthritis with fully functional stabilizing structures (16). UKA, once contraindicated for ACLD patients, can now be successful in ACL-deficient knees, achieving comparable survival rates to those in ACL-intact knees, due to advancements in prosthesis design and surgical techniques (17).

The aim of this study was to evaluate the outcome of patients who received medial UKA with anterior cruciate ligament deficiency.

## PATIENT AND METHODS

### Patient and study design

Five patients (three males and two females) underwent unicompartmental knee arthroplasty (UKA) for medial compartment knee osteoarthritis at Dr. Saiful Anwar General Hospital. The mean age of patients was 62 (range 59–74) years. Four patients had comorbidities, including obesity (BMI ≥30 kg/m²) in two, hypertension in three, and type 2 diabetes mellitus in one. Despite these conditions, all patients met the criteria for medial UKA based on symptom severity, radiographic findings, and ligamentous integrity.

All patients reported chronic medial knee pain persisting for almost two years, exacerbated by weight-bearing activities such as prolonged standing, walking on uneven surfaces, and stair descent. Three patients described episodes of knee instability, particularly when changing direction while walking or bearing weight on the affected limb. None exhibited features suggestive of inflammatory arthritis, systemic connective tissue disease, or major ligamentous insufficiency.

Radiographic assessments of the patients in this study revealed joint space narrowing, osteophyte formation, and varus deformities, indicating advanced-stage osteoarthritis.

The Kellgren and Lawrence grading system was used to evaluate the severity of OA, which ranges from Grade 0 (no signs of OA) to Grade 4 (severe joint space narrowing and bone sclerosis) (18). Grade 0 represents no evidence of OA, with normal joint space and no osteophytes or other abnormalities. Grade 1 is considered doubtful OA, where small osteophytes may be present, but no significant joint space narrowing or other signs are evident. Grade 2 is mild OA, characterized by definite osteophytes and slight joint space narrowing, with some subchondral sclerosis. Grade 3 indicates moderate OA, with more pronounced osteophytes, significant joint space narrowing, moderate subchondral sclerosis, and possible cyst formation. Grade 4 is severe OA, with complete joint space loss, large osteophytes, marked sclerosis, and substantial cyst formation, often leading to significant pain and functional impairment. This grading system is crucial for evaluating OA progression and informing treatment decisions (19).

Stability tests, including the Lachman and posterior drawer tests, were performed. The Lachman test was used to assess the integrity of the anterior cruciate ligament (ACL) by evaluating the tibia's forward movement relative to the femur. The patient lies supine with the knee flexed at 20-30 degrees, and the examiner applies an anterior force to the tibia. A positive test is indicated by excessive tibial translation, suggesting ACL instability. The Posterior Drawer test is used to assess the posterior cruciate ligament (PCL) by applying a posterior force to the tibia with the knee flexed at 90 degrees. A positive result, indicated by excessive posterior displacement of the tibia, suggests PCL injury. Both tests are critical in diagnosing ligament injuries in the knee, often guiding further imaging or surgical decisions (20).

Functional recovery was assessed using both the Knee Injury and Osteoarthritis Outcome Score (KOOS) (9) and the Lower Extremity Functional Scale (LEFS) (10) at four key time points: pre-operatively, and at 1 month, 3 months, and 6 months post-operatively (Table 1 and 2). The KOOS is a patient-reported measure that evaluates knee-related pain, symptoms, function, and quality of life. It comprises five subscales, with a higher score indicating better knee function. KOOS helps assess changes over time and is widely used in clinical practice and research for knee injuries and osteoarthritis (9). The LEFS is a validated questionnaire used to assess lower extremity function in individuals with musculoskeletal conditions. It consists of 20 items scored from 0 to 80, with a higher score indicating better functional ability. It is commonly used in rehabilitation settings (10).

### Methods

Medial unicompartmental knee arthroplasty (UKA) was performed. First, the patient was positioned supine with the knee flexed to 110°, and a medial parapatellar incision was made, extending about 3 cm distal to the joint line. The patella was subluxed, and the medial meniscus was excised. The ACL was then inspected for integrity. After that, osteophytes from the medial femoral condyle and intercondylar notch were excised using a 6 mm narrow chisel. The tibial saw guide was applied with a 7° posterior slope and secured in place with pins. Next, vertical resection of the tibial plateau was performed, ensuring the cut was 2-3 mm below the deepest part of cartilage erosion. Following that, an intramedullary rod was inserted, and the femoral drill guide was aligned. Bone was drilled with 4 mm and 6 mm drills to ensure accurate component placement. Afterward, a posterior resection guide was inserted, and femoral condyle resection was performed with a 12 mm oscillating saw, ensuring the ACL and MCL were not damaged. Then, milling begins with the zero spigot to remove bone for the femoral component, followed by subsequent milling passes using spigots 3, 4, or 5, as needed to balance flexion and extension gaps. Subsequently, the tibial template and twin-peg femoral trial component were inserted at 100° knee flexion. Feeler gauges were

used to assess the gaps, and adjustments were made to ensure they are equal. After that, excess bone was removed with the anterior mill, and posterior osteophytes were excised to avoid impingement. Then, the tibial template was inserted and pinned, followed by performing the keel cut with the tibial groove cutter to prepare the tibial surface for the final component.

Following that, the femoral trial component and meniscal bearing were inserted. The knee was manipulated to check bearing and tracking, ensuring no impingement occurs, and reassessing joint stability and ligament tension. Finally, cement was applied to the tibial and femoral components, and they were impacted into place. Feeler gauges ensure proper cement pressure. After the cement had hardened, the trial components were removed, and the definitive meniscal bearing was inserted. The wound is closed using standard techniques.

### Statistical analysis

Given the repeated-measures nature of the data, where the same group of patients was evaluated at multiple intervals, and the small sample size, the Friedman test was selected as the most appropriate statistical method. This non-parametric test does not assume normal distribution. It is specifically designed to detect differences in ordinal or interval-level data across related groups, making it suitable for clinical outcome scores like KOOS and LEFS.

## RESULTS

Gait assessment revealed an antalgic pattern in all patients, with two demonstrating a slight varus thrust during ambulation. On inspection, mild quadriceps atrophy was noted in three patients. Medial joint line tenderness was a consistent finding, accompanied by crepitus during passive knee flexion. Varus malalignment was observed in three patients, with mechanical axis deviation averaging 5° (range: 3°–8°). Knee range of motion varied among patients, with flexion ranging from 110° to 130° and full extension preserved in all cases. No significant flexion contracture or recurvate was detected. Stability tests, including the Lachman and posterior drawer tests, were positive in two cases, confirming the instability of the anterior cruciate ligaments.

Radiographic findings, including weight-bearing anteroposterior, lateral, and Merchant views, confirmed medial compartment osteoarthritis in all patients. Three had Kellgren-Lawrence grade IV osteoarthritis, and two patients had grade III osteoarthritis but experienced persistent symptoms despite extensive conservative management. None exhibited severe patellofemoral arthritis or advanced lateral compartment degeneration, ensuring they remained suitable candidates for medial UKA. Two patients exhibited anterior tibial translation, as observed in the radiographic examination. Long-leg alignment radiographs in the standing position confirmed varus alignment in three patients.

Functional impairment was assessed using validated scoring systems. The mean KOOS in the sixth month was 73%, with a pre-operative score of 24.6% (Table 1). The preoperative LEFS score ranged from 10 to 17 and increased to 56-66 six months postoperatively, indicating a significant improvement in daily living and activity capabilities (Table 2).

For the KOOS scores, the Friedman test demonstrated a statistically significant difference across time points (p=0.0018), indicating consistent improvement in knee-specific function following surgery. Similarly, the LEFS scores also showed a statistically significant increase over time (p=0.0018), reflecting enhanced lower extremity functional performance throughout the postoperative period. These findings collectively support a positive and progressive recovery trajectory in joint-specific and overall limb function across the patient cohort.

The diversity in patient characteristics underscores the suitability of medial UKA for a broad spectrum of individuals, including those with obesity and metabolic conditions, provided that appropriate indications are met. None of the patients in this series experienced contraindications related to BMI or comorbidities, highlighting the feasibility of UKA beyond traditional patient selection criteria.

**Table 1. Knee Injury and Osteoarthritis Outcome Score (KOOS) of five patients***

| Patient's gender/ age | Knee Injury and Osteoarthritis Outcome Score (KOOS) (%) | | | |
|---|---|---|---|---|
| | Pre-operative | 1-month post-operative | 3 months post-operative | 6 months post-operative |
| M/62 | 33 | 50.5 | 73.25 | 76.35 |
| F/71 | 26.7 | 40.9 | 64 | 76.82 |
| F/74 | 30.5 | 49.82 | 61 | 71 |
| M/67 | 17.88 | 32.44 | 50.78 | 72 |
| M/59 | 15 | 26.27 | 48.71 | 68.82 |
| The mean score | 24.6 | 40 | 59.5 | 73 |

p=0.0018 across time points
M, male; F, female

**Table 2. Lower Extremity Functional Scale (LEFS) scoring of all patients***

| Patient's gender/age | LEFS score | | | |
|---|---|---|---|---|
| | Pre-operative | 1-month post-operative | 3 months post-operative | 6 months post-operative |
| M/62 | 14 | 26 | 60 | 66 |
| F/71 | 13 | 24 | 50 | 62 |
| F/74 | 17 | 25 | 41 | 56 |
| M/67 | 11 | 19 | 43 | 58 |
| M/59 | 10 | 29 | 51 | 63 |
| The mean score | 13 | 24.6 | 49 | 61 |

p=0.0018 increase over time
M, male; F, female

## DISCUSSION

The study found that patients with severe knee pain, stiffness, and limited mobility, common symptoms of OA, were affected in their overall quality of life due to increased stiffness, fatigue, sleep disturbances, and reduced activity levels (18). Varus deformity, a common factor in medial compartment OA, shifts load distribution unevenly across the knee joint, leading to further degeneration and pain during weight-bearing activities (21).

Knee osteoarthritis patients often show tenderness along joint lines and patellar facets. Clinicians assess the patellofemoral compartment by moving the knee, checking for pain, crepitus, clicking, and locking. Normal knee ROM is 0 degrees for ex-

tension and 135 degrees for flexion (22). This ROM is often restricted in knee OA, so using a goniometer for precise measurement is crucial.

Clinical examinations for patients with OA reveal joint tenderness, patellar facets, and neurovascular issues. Assessments include quadriceps, hamstring strength, sensory, and vascular checks to rule out neurogenic or vascular problems (23). The study found significant improvements in pain relief and functional mobility post-surgery, as indicated by the KOOS and LEFS scores, with one patient's score increasing from 33% to 76.35% (24,25). UKA offers advantages over TKA in unicompartmental OA, including shorter surgery times, less blood loss, quicker recovery, and higher patient satisfaction, preserving bone stock and key structures (11). UKA's surgical techniques, including single-use instrumentation (SUI), have improved operational and economic efficiency. SUI reduces costs associated with instrument reprocessing and sterilization, resulting in improved operating room turnover times and increased patient throughput (26). Patients with medial UKA experience better range of motion, improved knee function, reduced future surgery risk, fewer complications, and higher satisfaction rates compared to TKA, even with well-positioned implants (14).

Osteoarthritis treatment typically involves nonoperative methods, but surgical options like arthroscopy, cartilage repair, osteotomy, and knee arthroplasty are considered when conservative treatments fail. UKA is increasingly preferred for isolated medial compartment OA due to its shorter hospital stays, quicker recovery, and improved knee kinematics (11,21). Recent advancements in prosthetic design and surgical techniques have expanded the use of unicompartmental knee arthroplasty (UKA) in patients with ACLD, yielding positive functional outcomes and significant pain relief comparable to those in ACL-intact knees (17). This study suggests that ACLD should no longer be a contraindication for UKA, as it offers advantages such as shorter hospital stays, faster recovery, and better preservation of knee kinematics (12,21).

UKA is recommended for patients with isolated unicompartmental osteonecrosis, a varus or valgus angular deformity of less than 15°, a flexion contracture of less than 5°, a knee flexion range of motion greater than 90°, and an intact anterior cruciate ligament (ACL) and peripheral knee ligaments over 60 years old (11,25,26). UKA postoperative outcomes and longevity are primarily influenced by alignment, with better outcomes associated with mechanical axis angles of ≤7°, which prevents excessive tibial component wear and reduces deformity recurrence (27,28).

Recent evidence challenges the traditional belief that ACLD is a contraindication for UKA, highlighting no significant differences in survivorship between ACL-deficient and ACL-intact knees (29). Additionally, another study reported a 96% combined survivorship rate at 10 years in both ACL-deficient and ACL-intact knees (17).

UKA's minimally invasive approach preserves joint kinematics and proprioception, contributing to better long-term outcomes. The Oxford Unicompartmental Knee Prosthesis, a widely studied and utilized system, aims to replicate natural knee motion and minimize polyethylene wear through improved congruity and reduced stress on the articular surface (13). The Oxford prosthesis also allows for a greater degree of knee flexion. It has been associated with better functional outcomes and faster recovery than fixed-bearing implants, especially in active patients.

UKA postoperative rehabilitation involves a brace-free approach, restoring passive and active range of motion. Isometric exercises begin immediately, partial weight-bearing is allowed for six weeks, proprioceptive exercises are introduced, and strength training is started at six weeks (30). A study of 1,000 Oxford UKA procedures found a 2.9% complication rate, with common causes being OA progression, mobile inlay dislocation, and unexplained pain. UKA failure is primarily caused by aseptic loosening and progression of osteoarthritis, accounting for over half of revisions within the first five years, with infection and polyethylene wear being less common (31).

UKA's revision-free survival rate has not improved as much as TKA, possibly due to a lower threshold for revision. However, evidence suggests UKA-to-TKA conversions may have similar complication and outcome profiles (32). The impact of ACLD on UKA outcomes is debated, with some studies suggesting increased failure rates, while others report no significant difference. Careful planning is required for severe varus deformities (27,33).

In conclusion, UKA is a viable surgical option for patients with knee OA and Anterior Cruciate Ligament Deficiency (ACLD), despite traditional concerns. It offers advantages over TKA, including the preservation of native knee structures, enhanced postoperative recovery, and maintenance of natural knee kinematics. The study supports the use of UKA in ACL-deficient patients when carefully selected and managed, challenging the notion of an intact ACL.

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## TRANSPARENCY DECLARATION

Conflicts of interest: None to declare.

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