



Isolated compartment arthrosis of the knee: contemporary concepts, persistent controversies, and future directions in unicompartmental knee arthroplasty

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Unicompartmental knee arthroplasty (UKA) has undergone a substantial evolution, transitioning from a highly selective procedure to a refined and increasingly versatile solution for isolated compartment osteoarthritis. The body of work presented in this special issue of *Archives of Orthopaedic and Trauma Surgery* reflects a field that is not only maturing but also actively redefining its principles, indications, and technical boundaries.

In an era increasingly oriented toward personalized medicine, UKA stands as perhaps the clearest embodiment of individualized knee arthroplasty, offering a tailored solution for patients with isolated compartment degeneration while respecting the native identity of the knee joint. In contrast to total knee arthroplasty (TKA), which replaces the entire articular environment, UKA selectively addresses the diseased compartment while preserving the uninvolved structures of the native joint. The importance of this distinction cannot be overstated. The native knee is a uniquely complex organ of motion, stability, and sensorial feedback. Its kinematics are governed by subtle interactions between ligaments, menisci, bone morphology, and articular surfaces that no implant can fully replicate once entirely removed. By preserving these structures, UKA offers the opportunity to reproduce a more physiological gait, more natural joint perception, faster recovery, and often a higher degree of patient satisfaction. For many patients, the difference is not merely radiographic or statistical, it is experiential. A well-performed UKA frequently feels less like an artificial joint and more like a restored native knee.

Historically, UKA was reserved for a narrowly defined patient population, typically characterized by advanced age, low functional demand, and established bone-on-bone

degeneration. However, contemporary evidence challenges these traditional criteria. The study entitled *Clinical outcomes of unicompartmental knee arthroplasty in early osteoarthritis without bone-on-bone contact* demonstrates that, in carefully selected patients, satisfactory outcomes can be achieved even in early-stage disease. This finding supports a broader conceptual shift toward individualized, pathology-driven indications rather than rigid radiographic thresholds. The modern question is no longer whether a patient fits historical criteria, but whether the patient's specific pattern of disease is best addressed through compartmental resurfacing.

A central advantage of UKA lies in its ability to preserve native knee anatomy and biomechanics. By maintaining cruciate ligament function, joint line orientation, and the kinematic behavior of the unaffected compartments, UKA offers a more physiological reconstruction compared with TKA. This concept is further reinforced by the study *Does the preoperative CPAK classification influence clinical outcomes after medial and lateral unicompartmental knee arthroplasty?*, which reports no significant variation in patient-reported outcomes across different alignment phenotypes. Such findings suggest that UKA may be inherently less sensitive to preoperative coronal alignment variability, supporting its role as a function-preserving procedure capable of adapting to individual constitutional anatomy rather than forcing the knee into a standardized mechanical model.

Despite these advantages, UKA remains technically demanding. Precision in implant positioning is critical, as even minor deviations can lead to mechanical complications, pain, progression of arthritis, or early failure. The importance of alignment is highlighted in *Investigation of component alignment and patient factors for the risk of subsidence in cementless unicompartmental knee arthroplasty*, where suboptimal component positioning was associated with an increased risk of tibial subsidence. Similarly, *Favorable midterm clinical results of medial unicompartmental*

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knee arthroplasty guided by coronal limb alignment using an image-free navigation system emphasizes the role of alignment-guided techniques in improving surgical accuracy and reducing complications. If UKA is the highest form of personalization in knee arthroplasty, then precision is the indispensable prerequisite for achieving it.

Technological advancements have played a significant role in addressing these challenges. Robotic and navigation-assisted techniques aim to enhance reproducibility, optimize implant positioning, and improve restoration of patient-specific anatomy. The broader implications of these developments are discussed in *Current concepts of medial unicompartmental knee replacement: part 2—hot topics and further directions*, where technological innovation is positioned as a key driver in achieving more accurate anatomical restoration. However, it is important to recognize that technology does not eliminate the learning curve. The study *Starting up a cementless Oxford medial unicompartmental knee arthroplasty practice: a prospective cohort study of 200 knees* clearly demonstrates that surgical efficiency improves after approximately 55 cases, underscoring the importance of experience, structured training, and procedural consistency.

The issue of implant design and fixation strategy remains unresolved. While debates continue regarding cemented versus cementless fixation and mobile- versus fixed-bearing implants, current evidence does not demonstrate clear superiority of one approach over another. As noted in *Current concepts of medial unicompartmental knee replacement: part 2—hot topics and further directions*, outcomes appear largely comparable, suggesting that implant selection should be guided by patient-specific factors, bone quality, compartmental anatomy, activity level, and surgeon expertise rather than adherence to a single philosophy. This again reinforces the personalized nature of UKA: there is no universally ideal implant, only the most appropriate implant for a given knee.

Infection remains one of the most serious complications in arthroplasty. The registry-based study *Data from the Swiss National Arthroplasty Registry SIRIS suggest that unicompartmental knee arthroplasty is associated with a lower risk of periprosthetic joint infection than total knee arthroplasty* provides compelling evidence that UKA carries a lower risk of infection compared with TKA, likely due to reduced implant surface area, shorter operative times, and less invasive exposure. Nevertheless, the management of infection in UKA remains challenging, particularly due to limited options for debridement and local antibiotic delivery.

Beyond traditional clinical outcomes, functional biomechanics is gaining increasing attention. The systematic review *Stair negotiation following unicompartmental knee arthroplasty: a systematic review of biomechanical*

outcomes highlights that, despite favorable clinical scores, patients may exhibit persistent alterations in gait and loading patterns during activities such as stair ascent and descent. These findings suggest that while UKA better approximates native knee function than TKA, full restoration of physiological biomechanics remains an ongoing challenge. Yet this also underscores the rationale for UKA itself: preserving native structures remains the most rational pathway toward recreating native function.

Another critical factor influencing outcomes is surgeon experience and institutional volume. Evidence from *Early institutional adoption and outcomes from 154 consecutive medial mobile-bearing unicompartmental knee arthroplasties: a single-center experience after implant introduction* demonstrates that excellent outcomes can be achieved even during early adoption phases, provided that surgical techniques are standardized and performed in structured environments. Conversely, registry data consistently indicate higher revision rates in low-volume settings, emphasizing the importance of expertise, patient selection, and dedicated practice. UKA is a procedure in which indication and execution are inseparable.

Expanding indications for UKA are also explored in this issue. The study *Feasibility of medial parapatellar approach in unicompartmental knee arthroplasty for moderate to severe varus deformity* suggests that UKA may be successfully applied in more complex deformities when performed in carefully selected patients. Similarly, *Unicompartmental knee arthroplasty in patients with Parkinson's disease* provides encouraging data supporting its use in selected high-risk populations. Furthermore, evolving techniques in lateral UKA, as described in *Lateral unicompartmental knee arthroplasty through a medial parapatellar approach: surgical technique and mid-term results in 108 patients* and *Lateral unicompartmental knee arthroplasty anatomy, indications, technique, and outcomes: a narrative review*, highlight the growing interest in expanding UKA beyond the medial compartment. These developments reflect increasing confidence in applying compartment-specific solutions to increasingly diverse clinical scenarios.

Finally, UKA must be considered within the broader context of knee joint preservation and reconstruction. Alternative procedures such as high tibial osteotomy, as discussed in *Clinical outcomes after medial open-wedge high tibial osteotomy are not affected by joint space in extension and flexion on standing radiographs*, continue to play a role in selected patients. The decision-making process is therefore increasingly nuanced, requiring a comprehensive understanding of patient-specific factors, disease progression, alignment phenotype, biological age, and functional demands. The future of knee surgery lies not in a single

procedure, but in selecting the right procedure for the right patient at the right time.

Conclusion

Unicompartmental knee arthroplasty has evolved into a mature and reliable surgical option that aligns closely with the principles of modern orthopaedic practice: preservation of native anatomy, restoration of function, and individualized patient care. The studies presented in this special issue reinforce that UKA can deliver excellent outcomes when performed with appropriate indications, meticulous technique, and sufficient surgical experience.

However, its success remains highly dependent on precision and expertise. The future of UKA lies in optimizing its application through continued technological innovation, refined patient selection, and deeper insights into knee biomechanics.

The critical question is no longer whether UKA is effective, but how it can be performed with greater accuracy, consistency, and functional fidelity to the native knee.

Indeed, among contemporary reconstructive options, UKA may represent the most advanced form of personalization in knee arthroplasty: a procedure that treats disease while preserving identity, and replaces only what truly needs to be replaced.

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