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Commentary: Ultra-Congruent Versus Cruciate-Retaining Inserts in Bilateral Simultaneous Total Knee Arthroplasty - A Randomized Controlled Trial

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Abstract

Insert selection in total knee arthroplasty (TKA) increasingly targets high-end satisfaction rather than basic function alone. Ultra-congruent (UC) bearings increase conformity to enhance anteroposterior stability and may substitute for variable posterior cruciate ligament behavior without a post-cam mechanism. In a recent Level I prospective bilateral contralateral randomized trial, Pathak et al. compared UC and cruciate-retaining (CR) inserts within the same patient undergoing bilateral simultaneous TKA using the Forgotten Joint Score-12 (FJS-12) as the primary endpoint. UC knees achieved statistically higher FJS-12, whereas legacy patient-reported outcome measures (Oxford Knee Score and Knee Society Score), radiographic measures, gait-laboratory outcomes, and clinical stability surrogates were similar. This pattern should be interpreted cautiously. First, FJS-12 is less prone to ceiling effects and may detect subtle patient-perceived differences that other measures miss. Second, commonly invoked mechanistic explanations - improved anteroposterior stability, greater mid-flexion confidence, and better performance in transitional tasks - remain hypotheses rather than proven causal pathways in the index trial. Third, although the trial is methodologically elegant, it remains limited by sample size, two-year follow-up, single-surgeon/single-center execution, and the external-validity constraints and perception biases inherent to bilateral simultaneous TKA. The broader literature still supports short- to mid-term equivalence of UC and CR/posterior-stabilized designs in most clinical and objective outcomes, with implant-specific survivorship data generally reassuring for UC. Current findings therefore argue more strongly for better outcome measurement than for routine superiority claims. Future work should link joint-awareness PROMs with task-specific biomechanics, prespecified subgroup analyses, and longer-term implant-family surveillance.

Where are we now?

Total knee arthroplasty (TKA) reliably relieves pain and restores basic function, yet a meaningful minority of patients remain dissatisfied or remain conscious of the reconstructed joint in daily life despite technically well-executed surgery[1-4]. In contemporary arthroplasty practice, success is therefore no longer defined only by pain relief or acceptable walking ability. Increasingly, the challenge is to discriminate among good, very good, and excellent results. The Forgotten Joint Score-12 (FJS-12) was developed around this problem: it measures joint awareness, has lower ceiling effects than several legacy instruments in well-performing cohorts, and may therefore be better suited to detect subtle between-design differences in high-functioning patients[5-8]. Published interpretation

tools provide important context, with reported FJS thresholds including a minimal clinically important difference (MCID) of 13.7 points[9,10].

Insert choice sits at the center of this high-end satisfaction problem. CR designs attempt to preserve posterior cruciate ligament (PCL) function and native rollback, but they depend on reproducible PCL competence and balancing. UC designs increase conformity to provide intrinsic anteroposterior stability without the additional box preparation and post-cam mechanism of many posterior-stabilized (PS) constructs[11,12]. Conceptually, UC occupies a middle ground between CR and PS: it aims to reduce dependence on variable biologic restraint while avoiding the mechanical features specific to PS knees.

The index randomized controlled trial (RCT) recently examined this philosophy using an elegant design: a prospective, randomized, blinded, within-patient bilateral trial in which each patient received a UC insert in one knee and a CR insert in the contralateral knee, with FJS-12 as the primary outcome. UC knees showed statistically higher FJS-12 across follow-up, with the greatest separation at 12 months, and an MCID of 5.7; though the caveat being MCID thresholds are defined for unilateral knee, and need further research for Bilateral simultaneous TKA. There were no significant between-design differences were seen in legacy PROMs, radiographic parameters, gait-laboratory measures, or clinical stability surrogates[13]. The strengths of this design are substantial. By comparing both inserts in the same host, the study minimizes confounding from age, sex, comorbidity burden, pain threshold, rehabilitation environment, and baseline activity profile.

At the same time, the limitations must be acknowledged; which include the small size of the cohort, limited follow-up of two years and the trial reflecting a single-surgeon/single-center experience. No doubt the bilateral simultaneous approach is a powerful way to isolate insert-related differences, but it introduces its own biases. Direct comparison of knees by patients tends to magnify subtle experiential differences or create perception bias independent of meaningful functional separation[14]. Also, factors like limb dominance, asymmetric postoperative pain, side-specific rehabilitation, and cross-comparison effects may influence preference or joint awareness. Further, bilateral simultaneous TKA patients comprise a small cohort and may not represent the broader unilateral TKA population mostly encountered. These issues do not negate the trial's value; rather, they define the boundaries of inference and should be acknowledged accordingly.

These findings should also be placed within the broader UC literature rather than interpreted in isolation. A recent systematic review and meta-analysis concluded that most short-term comparative studies do not show a consistent clinical advantage of UC over CR or PS inserts and emphasized the need for longer-term, more standardized comparisons[15]. At the same time, registry-linked survivorship data within a single implant family suggest no excess revision risk for UC relative to CR and, in some comparisons, lower revision risk than PS in selected systems[16]. Other cohort studies likewise report satisfactory mid- to long-term survivorship of anterior-stabilized or UC bearings in selected implant families[17]. Importantly, implant-specificity matters as well; outcomes from one UC platform cannot be generalized automatically to all conforming inserts. A recent bilateral preference study illustrates this point and also tempers any sweeping claim of superiority; at a mean follow-up of 5.4 years, 50% of patients had no preference between knees, 26% preferred the CR knee, and 24% preferred the highly congruent knee[14]. The totality of available evidence therefore suggests that any advantage of UC, if present, is likely modest, context-dependent, and potentially system-specific and not universal.

Where do we need to go?

The first important step is to focus on each secondary parameter separately, rather than grouping heterogenous outcomes under the broad term 'objective metrics. The Oxford Knee Score is a legacy PROM; the Knee Society Score mixes patient report and clinician-rated domains; radiographic alignment is a structural descriptor; gait-laboratory outputs are controlled biomechanical measurements; and stability (static and dynamic) are simplified clinical proxies. Each of these construct answers a different question. A more precise reading of the index RCT is that statistically higher joint awareness scores occurred despite similar legacy PROMs, similar radiographic findings, similar steady-state gait-laboratory outputs, and similar clinical stability surrogates[13].

Published thresholds such as the MCID, minimal detectable change, and PASS are useful anchors for judging relevance, but they were derived primarily for patient-level longitudinal change or for absolute postoperative states, not for side-to-side comparisons between two knees in the same patient[9,10]. Accordingly, a statistically significant between-knee difference in FJS-12 should not automatically be equated with clinically important superiority. It is more defensible to state that the index RCT demonstrated a statistically higher patient-reported joint-awareness score in UC knees, at the same time the clinical importance of that difference at the individual-patient level remains uncertain.

Now the question is why were there no significant differences in objective parameters? One plausible explanation is that conventional gait protocols emphasize steady-state level walking, whereas joint awareness is more

often triggered by transitional or high-demand situations such as stair negotiation, turning, pivoting, uneven terrain, or fatigue states[18,19]. Another plausible explanation is that conformity-based UC geometry may reduce sensitivity to subtle PCL imbalance and mid-flexion anteroposterior instability that patients can feel even when standard laxity tests or force-plate analyses appear similar[20-22]. However, the index RCT did not directly measure fluoroscopic kinematics, dynamic anteroposterior laxity during demanding tasks, fatigue-state behavior or perturbation responses[13]. These explanations therefore remain biologically plausible hypotheses rather than established mechanisms.

Finally, any notion of UC benefit must be balanced against possible tradeoffs. Historical concerns around more conforming polyethylene inserts have included pitting, delamination, and fatigue-related material failure, particularly with older polyethylene formulations and under adverse loading conditions[23,24]. From a tribological perspective, the potential advantage of UC inserts should not be interpreted solely in terms of constraint. Greater articular conformity may reduce peak contact stress and thereby theoretically limit focal damage such as pitting or delamination. However, the larger contact area may also increase the sliding interface and raise concerns regarding volumetric polyethylene wear. Modern highly cross-linked polyethylene appears to mitigate some of these concerns, with registry data suggesting comparable or improved revision performance compared with conventional polyethylene, particularly for wear and loosening[25]. Contemporary material processing and implant-specific registry data are no doubt reassuring with the currently available comparative studies do not demonstrate a clear survivorship penalty for UC in selected systems[15,16]. Even so, the absence of a short-term penalty is not equivalent to proof of long-term equivalence across all implant families. Hence, there is a need for a more cautious interpretation of superiority of UC over CR inserts.

How do we get there?

In our view, three pragmatic directions can move the field forward. First, comparative insert studies should align objective testing with the lived experience of TKA. Future protocols should incorporate day-today task-specific biomechanics including stairs, slopes, sit-to-stand under speed or fatigue, turning, pivoting, perturbation testing, and uneven-surface walking. These should be paired with joint-awareness PROMs such as FJS-12. Wearable inertial sensors and ecologically valid activity monitoring may help bridge the gap between gait-laboratory measurements and daily function[26,27]. Also, instrumented gait analysis, fluoroscopy, or marker-based motion analysis should prioritize tibial axial rotation, anterior tibial translation, flexion-extension coupling, stance-phase stability, and side-to-side symmetry during demanding tasks such as stair negotiation, pivoting, turning, sit-to-stand transitions, and rapid direction change. These parameters will better capture the dynamic constructs that influence whether a replaced knee feels 'forgotten' during routine activity.

Second, the next question is not simply whether one insert is better on average, but which patient may benefit from which insert. The most likely explanation for a modest average FJS advantage is effect heterogeneity. Potentially informative subgroups include knees in which CR balancing is less predictable, such as those with marked coronal deformity, high flexion contracture, large preoperative laxity, inflammatory synovitis, or specific alignment phenotypes. A good example would be the constitutional varus knee with borderline PCL behavior, in which a more conforming insert might plausibly improve perceived confidence; however, this remains a prespecified hypothesis to be tested rather than a recommendation supported by the current trial. Registry-linked analyses and randomized studies with predefined subgroup hypotheses are the most efficient way to address this question[28].

Third, longer-term surveillance remains essential. Early patient-perceived benefit should persist without later compromise in polyethylene durability, kinematic behavior, noise, loosening, or revision. Implant-family-specific registry analyses, comparative cohort studies, and long-term randomized follow-up are therefore mandatory[15,16,29,30]. At present, the strongest immediate implication of the index RCT is methodological rather than prescriptive: if our goal is for patients to "forget" their knee, we must measure that construct directly and test it under conditions that actually make knees memorable[13].

Conclusion

In the index bilateral randomized trial, UC inserts had statistically higher FJS-12 than CR inserts, while legacy PROMs, radiographs, gait-laboratory outputs, and clinical stability parameters were similar[13]. What is suggested, but not proven, is that FJS-12 may be more sensitive than traditional measures to subtle, patient-perceived design differences and that UC conformity may improve confidence during demanding tasks. The question remains whether this change is clinically important at the individual-patient level, whether it generalizes beyond bilateral simultaneous TKA and beyond specific implant systems, and whether any early joint-awareness benefit persists without long-term tradeoffs. For now, these data should refine how success is measured after TKA more than they should dictate routine insert selection in primary practice.

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