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# Unicompartmental Versus Total Knee Arthroplasty Database Analysis

## Is There a Winner?

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**Abstract**

*Background* TKA and unicompartmental knee arthroplasty (UKA) are both utilized to treat unicompartmental knee arthrosis. While some surgeons assume UKA provides better function than TKA, this assumption is based on greater final outcome scores rather than on change in scores and many patients with UKA have higher preoperative scores.

*Questions/purposes* We therefore asked whether TKA would demonstrate (1) better change in clinical outcome scores from preoperative to postoperative states and (2) better survivorship than UKA.

*Methods* We evaluated 4087 patients with 5606 TKAs and 179 patients with 279 UKAs performed between 1978 and 2009. Patients with TKA were older and heavier than patients with UKA (mean age, 68 versus 66 years; mean BMI, 32 versus 29). We compared preoperative, latest postoperative, and change in Knee Society Clinical Rating System (KSCRS), SF-12, and WOMAC scores. Minimum followup was 2 years (UKA: mean, 7 years; range, 2.0–23 years; TKA: mean, 6.5 years; range, 2.0–33 years). Preoperative outcome measure scores (WOMAC, SF-12, KSCRS) were higher in the UKA group.

*Results* Patients with UKA had higher postoperative KSCRS and SF-12 mental scores. Changes in score for all WOMAC domains were similar between groups. Total KSCRS changes in score were similar between groups, although patients with TKA had higher knee scores (49 versus 43) but lower function scores than UKA (21 versus 26). Cumulative revision rate was higher for UKA than for TKA (13% versus 7%). Kaplan-Meier survivorship at 5 and 10 years was 95% and 90%, respectively, for UKA and 98% and 95%, respectively, for TKA.

*Conclusions* While patients with UKA had higher pre- and postoperative scores than patients with TKA, the changes in scores were similar in both groups and survival appeared higher in patients with TKA.

*Level of Evidence* Level III, therapeutic study. See the Guidelines for Authors for a complete description of levels of evidence.

## Introduction

TKA and unicompartmental knee arthroplasty (UKA) are both utilized to treat unicompartmental knee arthrosis. TKA has long been considered the gold standard operative intervention for knee arthrosis due to demonstrated predictability, durability, and effectiveness in the treatment of pain and restoration of function [3, 9, 11, 16, 17, 53]. Advocates of UKA cite several advantages over conventional

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Each author certifies that his or her institution has approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

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TKA, including minimal access surgery, preservation of bone stock, and ease of revision [5, 32, 37, 41, 56], as well as superior knee ROM and kinematics, less blood loss, faster recovery, and a decreased hospital admission [4, 20–22, 25–27, 50, 62]. Satisfaction after either TKA or UKA is similar [54]. UKA has demonstrated survivorship of greater than 90% for more than 10 years after implantation in multiple studies [6, 12, 39, 40, 48, 49, 59]. The cumulative revision rate is higher for UKA than for conventional TKA, ranging from 82% to 98% at 5 to 22 years for UKA compared to 91% to 98.9% at 5 to 19 years for TKA (Table 1) [5, 6, 10, 12, 28–30, 33, 52].

**Table 1.** Comparison of survivorship of UKA and TKA in our study and other studies in the literature

| Study | Intervention | Number | Survival (%) | Years |
|---|---|---|---|---|
| Argenson et al. [6] | UKA | 160 | 94 | 10 |
| Emerson and Higgins [13] | UKA | 55 | 85 | 10 |
| Gioe et al. [19] | UKA | 516 | 88.6 | 10 |
| Murray et al. [39] | UKA | 143 | 98 | 10 |
| Naudie et al. [40] | UKA | 113 | 90 | 10 |
| O'Rourke et al. [43] | UKA | 136 | 84 | 20 |
| Price et al. [48] | UKA | 439 | 93 | 15 |
| Price and Svard [49] | UKA | 85 | 91 | 16 |
| Squire et al. [57] | UKA | 140 | 84 | 22 |
| Steele et al. [58] | UKA | 203 | 85.9 | 20 |
| Svard and Price [59] | UKA | 124 | 95 | 10 |
| Tabor and Tabor [60] | UKA | 67 | 91 | 5 |
| Tabor and Tabor [60] | UKA | 67 | 84 | 10 |
| Vorlat et al. [61] | UKA | 140 | 82 | 10 |
| Whittaker et al. [64] | UKA | 79 | 89 | 5 |
| Australian Orthopaedic Association National Joint Replacement Registry [7] | UKA | 31,884 | 86.6 | 9 |
| Current study | UKA | 219 | 94.6 | 5 |
| Current study | UKA | 219 | 90.4 | 10 |
| Abdeen et al. [1] | TKA | 100 | 92.4 | 19 |
| Emmerson et al. [14] | TKA | 109 | 95 | 10 |
| Gill and Joshi [18] | TKA | 404 | 92.6 | 17 |
| Keating et al. [28] | TKA | 4583 | 98.9 | 15 |
| Parsch et al. [45] | TKA | 141 | 91 | 14 |
| Petrou et al. [47] | TKA | 100 | 96.1 | 15 |
| Ranawat et al. [52] | TKA | 112 | 94.1 | 15 |
| Australian Orthopaedic Association National Joint Replacement Registry [7] | TKA | 231,409 | 94.9 | 9 |
| Current study | TKA | 5606 | 98.4 | 5 |
| Current study | TKA | 5606 | 94.9 | 10 |

UKA = unicompartmental knee arthroplasty.

The therapeutic effect of UKA and TKA is widely assessed with validated clinical outcome measures, with many studies describing better functional results in UKA [40–42]. Historically, authors have focused on absolute preoperative and postoperative scores; however, the change in score from preoperative to postoperative has been reported recently to represent the effect of the intervention under investigation [31, 35, 38, 51]. Since patients receiving UKA are typically younger with a higher level of preoperative function, the postoperative results tend to be higher.

We asked whether TKA would demonstrate (1) better change in clinical outcome scores from preoperative to postoperative states and (2) better survivorship than UKA.

## Patients and Methods

We retrospectively identified from our database two cohorts of patients, those having a primary TKA and those having a UKA between 1978 and 2009. There were 4087 patients with 5606 primary TKAs and 179 patients with 219 UKAs performed at a single institution. For UKA to be undertaken, the patient must have satisfied the following criteria: isolated medial compartmental osteoarthritis; fixed flexion deformity of less than 5°; an active ROM of greater than 90°; and less than 15° of varus deformity. TKA was undertaken in patients who did not satisfy the criteria for UKA or who satisfied the criteria but elected a TKA.

Patients undergoing joint arthroplasty had demographic data collected prospectively, which was then entered into an institutional clinical database. This information included surgical information and preoperative and postoperative scores using WOMAC (pain, stiffness, function, total) [8], SF-12 (physical component summary [PCS] and mental component summary [MCS], Version 1) [63], and Knee Society Clinical Rating System (KSCRS) (function, knee, total) [24]. The minimum followup was 2 years for both groups (UKA: mean, 7.12 ± 4.45 years; range, 2.0–23.24 years; TKA: mean, 6.50 ± 3.96 years; range, 2.0–33.36 years). No patients were recalled specifically for this study; all data were obtained from medical records and no patients were lost to followup. Survivorship was defined as revision surgery for any aseptic cause. Institutional review board approval was obtained before initiation of this study.

A post hoc power analysis was performed and it was demonstrated our available sample size would result in 100% power to detect a significant change. The mean (± SD) age was greater ($p < 0.001$) in the TKA group (67.65 ± 9.31 years) than in the UKA group (66.02 ± 8.18 years) at surgery (Table 2). The BMI was higher ($p < 0.001$) in the TKA group (31.8 ± 6.55) than in the UKA group (29.3 ± 4.69). The TKA cohort had a higher ($p < 0.001$) percentage of female patients than the UKA cohort (60.9% versus 47.3%).

The mean followup tended to be shorter (p = 0.07) in the TKA group (6.50 ± 3.96 years) than in the UKA group (7.12 ± 4.45 years). All preoperative outcome measure scores (WOMAC [Table 3], SF-12 [Table 4], KSCRS [Table 5]) were higher in the UKA group.

**Table 2.** Patient demographics by procedure

| Variable | Procedure | | p value |
|---|---|---|---|
| | TKA | UKA | |
| Sex (% female) | 60.9 | 47.3 | < 0.001 |
| Followup time after surgery (years)* | 6.50 ± 3.96 | 7.12 ± 4.45 | 0.07 |
| Aseptic revisions (%) | 6.40% | 12.9% | < 0.001 |
| Age (years)* | 67.65 ± 9.31 | 66.02 ± 8.18 | < 0.001 |
| Height (cm)* | 165.3 ± 10.39 | 167.2 ± 10.08 | 0.001 |
| Weight (kg)* | 86.9 ± 18.9 | 81.7 ± 15.8 | < 0.001 |
| BMI* | 31.8 ± 6.55 | 29.3 ± 4.69 | < 0.001 |

* Values are expressed as mean ± SD; UKA = unicompartmental knee arthroplasty.

**Table 3.** Preoperative, latest, and change in WOMAC scores

| WOMAC domain | Procedure | Mean | SD | p value* |
|---|---|---|---|---|
| Preoperative | | | | |
| Stiffness | TKA | 40.67 | 19.98 | 0.06 |
| | UKA | 43.70 | 20.37 | |
| Pain | TKA | 46.15 | 17.77 | 0.06 |
| | UKA | 48.63 | 18.16 | |
| Function | TKA | 45.44 | 17.47 | < 0.001 |
| | UKA | 51.42 | 17.68 | |
| Total | TKA | 44.76 | 16.14 | 0.002 |
| | UKA | 48.75 | 16.52 | |
| Latest | | | | |
| Stiffness | TKA | 67.84 | 24.09 | 0.79 |
| | UKA | 68.45 | 23.41 | |
| Pain | TKA | 74.83 | 23.32 | 0.56 |
| | UKA | 76.40 | 22.09 | |
| Function | TKA | 69.25 | 23.13 | 0.002 |
| | UKA | 74.15 | 22.79 | |
| Total | TKA | 71.41 | 21.66 | 0.11 |
| | UKA | 73.97 | 21.05 | |
| Change | | | | |
| Stiffness | TKA | 28.23 | 27.03 | 0.32 |
| | UKA | 25.41 | 23.78 | |
| Pain | TKA | 29.97 | 24.79 | 0.89 |
| | UKA | 30.04 | 22.96 | |
| Function | TKA | 25.64 | 23.66 | 0.97 |
| | UKA | 25.61 | 20.14 | |
| Total | TKA | 27.96 | 22.47 | 0.70 |
| | UKA | 27.25 | 19.63 | |

* Grouped by procedure; UKA = unicompartmental knee arthroplasty.

All TKAs were performed by a midline incision with a medial parapatellar approach and eversion of the patella. UKAs received a medial parapatellar approach with an

**Table 4.** Preoperative, latest, and change in SF-12 scores

| SF-12 domain | Procedure | Mean | SD | p value* |
|---|---|---|---|---|
| Preoperative | | | | |
| MCS | TKA | 52.74 | 10.99 | 0.17 |
| | UKA | 54.24 | 10.18 | |
| PCS | TKA | 30.19 | 7.72 | 0.03 |
| | UKA | 32.04 | 8.74 | |
| Latest | | | | |
| MCS | TKA | 52.22 | 10.18 | 0.41 |
| | UKA | 52.96 | 9.59 | |
| PCS | TKA | 36.97 | 10.98 | 0.005 |
| | UKA | 39.15 | 11.13 | |
| Change | | | | |
| MCS | TKA | −0.34 | 11.03 | 0.76 |
| | UKA | −1.20 | 11.09 | |
| PCS | TKA | 7.64 | 11.67 | 0.03 |
| | UKA | 9.88 | 11.37 | |

* Grouped by procedure; MCS = mental component summary; PCS = physical component summary; UKA = unicompartmental knee arthroplasty.

**Table 5.** Preoperative, latest, and change in KSCRS scores

| KSCRS domain | Procedure | Mean | SD | p value* |
|---|---|---|---|---|
| Preoperative | | | | |
| Function | TKA | 44.52 | 15.63 | < 0.001 |
| | UKA | 53.21 | 13.18 | |
| Knee | TKA | 41.09 | 15.34 | < 0.001 |
| | UKA | 47.82 | 15.92 | |
| Total | TKA | 85.73 | 24.45 | < 0.001 |
| | UKA | 101.10 | 22.71 | |
| Latest | | | | |
| Function | TKA | 65.74 | 27.06 | < 0.001 |
| | UKA | 79.55 | 22.42 | |
| Knee | TKA | 89.72 | 13.48 | 0.33 |
| | UKA | 90.58 | 13.64 | |
| Total | TKA | 155.63 | 33.96 | < 0.001 |
| | UKA | 170.87 | 29.88 | |
| Change | | | | |
| Function | TKA | 21.36 | 26.22 | < 0.001 |
| | UKA | 25.65 | 22.26 | |
| Knee | TKA | 49.24 | 19.45 | 0.001 |
| | UKA | 42.88 | 21.29 | |
| Total | TKA | 70.62 | 36.21 | 0.76 |
| | UKA | 69.56 | 32.80 | |

* Grouped by sex/procedure; KSCRS = Knee Society Clinical Rating System; UKA = unicompartmental knee arthroplasty.

incision from the superomedial border of the patellar to 1.5 cm distal to medial tibial plateau articular surface. The patella was subluxated for exposure and the ACL and the patellofemoral and lateral compartments were inspected critically to ensure a UKA was a suitable intervention. Both prostheses had all components cemented. The patellar was selectively resurfaced in the TKA cohort. We inserted a drain in all knees on closure and routinely removed the drain on the first postoperative day.

Patients were routinely mobilized fully weightbearing on the first postoperative day under the supervision of a physiotherapist. Walking aids were utilized as required. Ongoing outpatient physiotherapy was employed to ensure patients regained an adequate ROM and strength. This was continued to the satisfaction of the physiotherapist and surgeon, typically ceasing at the 6-week review.

The followup regime for all patients was a 2-week wound review with clinical assessments performed at 6 weeks, 3 months, 1 year, 2 years (± 2 months), and alternate years thereafter unless there was clinical concern for earlier review. At each review, a clinical and radiographic review was undertaken. ROM was assessed with a goniometer. Patients completed WOMAC, SF-12, and KSCRS questionnaires. All scores were entered in the hospital database at the time of review. All elements of the KSCRS (knee, function, total) were individually analyzed. Preoperative and latest postoperative scores were analyzed. Changes in score were also analyzed. Recent studies have suggested the change in clinical outcome scores represents the effect of the intervention under investigation [31, 35, 38, 51]. We believe this allows a valid comparison between treatment groups. We determined differences in demographics between the TKA and UKA groups. Differences in sex distribution was assessed using crosstabs with the chi square test. Differences in BMI, age, and followup time between the TKA and UKA groups were asessed using a Mann-Whitney U-test for two-group comparison. All of our outcome measures (WOMAC, SF-12, KSCRS) were evaluated preoperatively and postoperatively by the Mann-Whitney U-test. Kaplan-Meier survivorship was undertaken to assess durability of the implants. We used SPSS® v.19 (SPSS Inc, Chicago, IL, USA) for all analyses.

## Results

In all latest outcome measure scores, the UKA group had higher scores than the TKA group. The change in score (preoperatively to latest postoperatively) demonstrated no between-group differences for the WOMAC (Table 3) and SF-12 MCS (Table 4). The change in score for the SF-12 PCS was higher in the UKA sample. The latest KSCRS score was higher in UKAs for both total and function scores; however, the knee scores were not different. The change in score for KSCRS scores was not different between the groups for total scores but favored TKA over UKA for knee scores (49 versus 43; $p < 0.001$) and UKA over TKA for function scores (26 versus 21; $p < 0.001$) (Table 5).

The cumulative revision rate was higher ($p = 0.006$) for UKAs than for TKAs (37 revisions [13.3%] versus 399 revisions [7.1%]). Kaplan-Meier survivorship at 5 and 10 years was 98.4% (95% CI, 98.2%–98.6%) and 94.9% (95% CI, 94.6%–95.2%), respectively, for TKA and 94.6% (95% CI, 93.2%–96%) and 90.4% (95% CI, 88.4%–92.4%), respectively, for UKA (Fig. 1). Indications for revision were comparable between groups, with two of 37 UKAs (5.4%) and seven of 399 TKAs (1.8%) revised for pain of unknown origin (Table 6). There were some failure modes that were unique to TKAs (periprosthetic fracture and metal-backed patella failure being the most common).

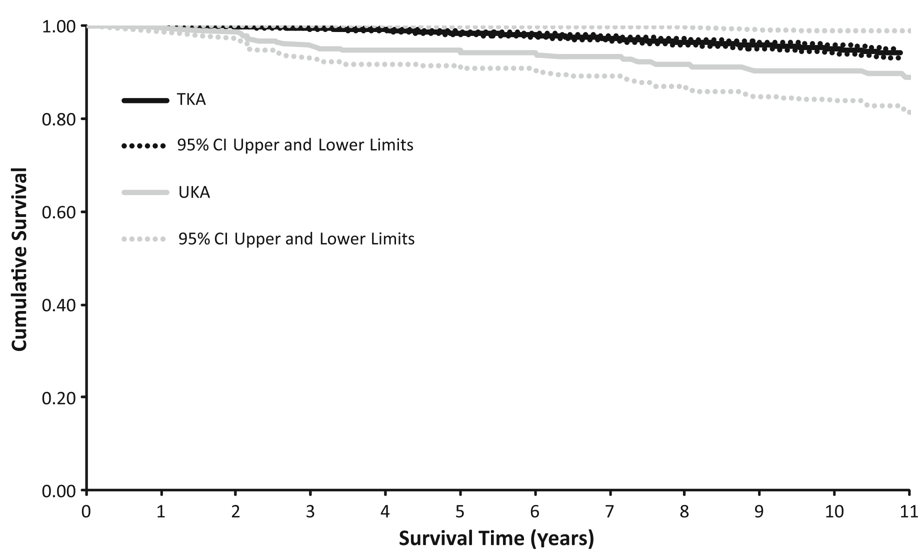


**Fig. 1** Kaplan-Meier survivorship at 5 and 10 years with aseptic revisions as the end point was 98.4% (95% CI, 98.2%–98.6%) and 94.9% (95% CI, 94.6%–95.2%), respectively, for TKA and 94.6% (95% CI, 93.2%–96%) and 90.4% (95% CI, 88.4%–92.4%), respectively, for UKA.

**Table 6.** Indications for revision arthroplasty

| Reason for revision | TKA (n = 399 of 5606) | UKA (n = 37 of 279) |
|---|---|---|
| Overall all cause revision rate | 7.1% | 13.3% |
| Disease progression | 47 (0.8%) | 19 (6.8) |
| Polyethylene wear/ osteolysis | 148 (2.6%) | 6 (2.2%) |
| Aseptic loosening | 63 (1.1%) | 5 (1.8%) |
| Instability | 34 (0.6%) | 1 (0.3%) |
| Pain unknown origin | 7 (0.1%) | 2 (0.7%) |
| Infection | 40 (0.7%) | 1 (0.3%) |
| Stiffness | 7 (0.1%) | |
| Periprosthetic fracture | 25 (0.4%) | |
| Implant failure (metal-backed patella) | 16 (0.3%) | |
| Malalignment | 5 (0.1%) | |
| Extensor mechanism failure | 3 (0.1%) | |
| Other | 4 (0.1%) | 3 (1.1%) |

TKA = total knee arthroplasty; UKA = unicompartmental knee arthroplasty.

## Discussion

Treatment options for knee arthrosis include both UKA and TKA. Proposed advantages of UKA over TKA include both technical factors (less invasive surgery, preservation of bone stock, comparative ease of revision) [5, 32, 37, 41, 56] and improved clinical outcomes (superior knee kinematics, less blood loss, faster recovery, shorter inpatient stay) [4, 20–22, 25–27, 50, 62]. Clinical outcome scores have previously focused on absolute values at preoperative and postoperative review. Recent studies have identified the change in score (preoperative to postoperative) as a measure of the effect of the intervention [31, 35, 38, 51]. Survival analysis is an accepted method of evaluating the durability of a prosthesis and both prostheses have documented survival rates in excess of 90% at 10 years (Table 1). Nevertheless, TKA is more frequently performed due to the perception that TKA is a more durable operation [36]. We hypothesized TKA would demonstrate (1) better change in clinical outcome scores from preoperative to postoperative states and (2) better survivorship than UKA.

Limitations of this study include the following. First, the cohorts were nonrandomized and unevenly distributed, with UKA numbers representing 4.6% of the TKA population. The Australian Joint Registry reports UKA represents 7.5% of the TKA numbers [7]. It is possible surgeon proficiency could affect the outcome of UKA; however, surgeon-specific differences in outcome were not identified. We believe our patient cohorts reflect the relative UKA/TKA usage in the general population having knee arthroplasty. Furthermore, changes in score were employed to allow comparisons between groups. Second, the data derived for this study span three decades. While this is almost certainly a confounding factor with respect to temporal variations for operative indications, technique, and implants, the same confounding variables are applied to both prostheses. The orthopaedic community's understanding of prosthetic design and surgical technique has evolved over that time period. Notwithstanding the narrower indications for UKA, TKA is utilized in all remaining cases of knee arthrosis requiring surgical intervention. The longevity of a database is the premise of its use and is an invaluable tool for observing large patient populations over a period of time. Third, UKA demonstrates a higher failure rate but tends to have a marginally better function. This effect can be ascribed to nonmatched patient cohorts as UKAs are performed in younger, leaner males with less severe disease confined to a single compartment, better ultimate function, and the capacity for disease progression in the lateral compartment. The perception that UKA is revised more frequently than TKA because it is easier to do so is not consistent with our study or that of the Australian Joint Registry [7]. Pain of unknown origin accounted for 6.2% and 6.0% in UKA and TKA revisions, respectively, in the Australian Joint Registry [7]. Only 0.7% of our UKA series were revised for pain of unknown origin compared with 0.1% for TKA. Most revisions were undertaken in both groups for definable indications.

Improvement in function is well documented in both TKA and UKA [2, 3, 5, 15, 40, 42, 55, 57, 64]. UKA advocates purport a marginally better functional outcome over TKA [5, 20, 62]. This study confirms previous reports of patients with UKA having higher absolute postoperative clinical outcome measures (SF-12, WOMAC, KSCRS). These patients, however, also had higher preoperative scores and it is the change in score (preoperative versus postoperative) that determines the effect of the intervention. The change in score for all WOMAC and SF-12 domains demonstrated no difference between the groups. The changes in KSCRS score were not different between the groups for total scores and favored TKA over UKA for knee scores and UKA over TKA for function scores. When changes in scores are considered, both interventions are equally effective in improving function. When comparing outcomes between these interventions, it is critical to evaluate change in scores and not raw postoperative scores alone. It is also important to recognize there is a ceiling effect to scoring systems currently in use when evaluating patients with knee arthroplasty postoperatively. Often the final scores are at, or close to, the maximum score. Therefore, subtle improvements, or advantages, of one implant or another would not be perceived due to this ceiling effect.

Early survival studies of UKA demonstrated revision rates of 15% to 28% [23, 34, 44]. More recent articles report substantial increases in survival, with midterm survivorship for UKA of 84% to 98% (Table 1) [10, 12, 14, 19, 39, 40, 42, 46, 48, 57–61]. O'Rourke et al. [43] followed by Price and Svard [49] documented long-term survival rates of UKA at 20 years of 84% and 91%, respectively. TKA has established survivorship of 92% to 100% in long-term studies [2, 3, 5, 15, 19, 28, 52, 53]. We demonstrated cumulative revision rates of 13.3% and 7.1% at a mean followup of 7.12 ± 4.45 years and 6.50 ± 3.96 years for UKA and TKA, respectively. Kaplan-Meier survivorship at 10 years was 94.9% for TKA and 90.4% for UKA (Fig. 1). This study is consistent with the most recent Australian Joint Registry cumulative revision rates at 9 years of 5.1% and 13.4% for TKA and UKA, respectively [7]. Our study and the body of literature confirm TKA is the more durable therapeutic intervention.

In summary, consistent with the literature, we found patients with UKA had higher absolute clinical outcome scores for function preoperatively and at followup than patient with TKA. Change in clinical outcome scores were similar in both groups. The durability of both prostheses was assessed by survival analysis, showing TKA was revised less frequently than UKA.

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