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Revision of Minimal Resection Resurfacing Unicondylar Knee Arthroplasty to Total Knee Arthroplasty

Results Compared With Primary Total Knee Arthroplasty

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Abstract: We compared a cohort of patients undergoing revision of a minimal resection resurfacing unicompartmental knee arthroplasty (UKA) to total knee arthroplasty (TKA) with a cohort of patients undergoing primary TKA. Both cohorts were matched in terms of age, sex, and body mass index. We collected data on preoperative and postoperative range of motion, International Knee Society scores, and radiologic data. We also collected data on the modes of failure of the primary UKA. There were 55 patients in each cohort. The average time the UKA was in place was 48.3 months. The average follow-up period from the time of revision was 39.2 months. The most common reason for revision was subsidence of the tibial base plate (58%). Forty percent of patients required particulate bone grafting for contained defects. Two patients required metal augments, and 1 required stems. There was no significant difference between the 2 groups in terms of range of motion, functional outcome, or radiologic outcomes. Revision of these types of implants to TKA is associated with similar results to primary TKA and is superior to revision of other forms of UKA. **Keywords:** minimal resection, resurfacing, revision, unicompartmental.

Reported advantages of unicompartmental knee arthroplasty (UKA) over total knee arthroplasty (TKA) include shorter operative time, reduced blood loss, quicker rehabilitation, better range of motion, improved proprioception and kinematics, and less postoperative pain [1-4]. These advantages have been enabled by improvements in prosthetic design, instrumentation, and surgical technique, as well as proper patient selection [5]. This has led to resurgence in the popularity of UKA. In the United States, UKA implantation is growing at triple the rate of TKA and accounts for just less than 8% of all knee arthroplasty procedures [6], as opposed to only 1% in the year 1997 [7].

The reported longevity of UKAs, regardless of design, still do not compare as favorably as that of TKA [8-10]. Conversion of a UKA to TKA is, therefore, not an uncommon procedure and likely to become more increasingly commonplace as the popularity of UKA grows and also as the indications expand, allowing UKA to be performed in younger more active patients.

There are several studies in the literature reporting the outcome of conversion UKA to TKA [11-15], and the conclusions are mixed. Some authors report poor outcomes where UKA is converted to TKA [13,14], whereas other authors report more favorable outcomes [15,16]. These differences may reflect the type of implant used and the initial indication for surgery. In addition, prostheses may need to be augmented when revising a UKA to TKA, and again, there are very contrasting results published, with some authors reporting less than 10% of revisions requiring augments [15], whereas others have reported 76% of revisions requiring augments [13].

Unicompartmental knee arthroplasties can be classified as being an "inlay"- or an "onlay"-type prosthesis.

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This relates to the type of tibial implant used. An inlay system uses a tibial component that is cemented into a defect created within the rim of the tibia. A free-hand burring technique is used, and the component is placed on subchondral bone, which, nevertheless, is cancellous in structure. The technique has the theoretical advantage of preserving the bone around the medial tibial rim. An onlay system uses an L-cut tibial osteotomy, rim purchase, and instrumentation systems that establish and reproduce proper alignment. It also allows for the use of thicker polyethylene.

The purpose of this study was to review our experience with the conversion of a resurfacing onlay-type UKA prosthesis to a TKA. We sought to determine the causes of failure and whether conversion of a UKA to TKA was associated with worse outcome than that of a primary TKA in terms of functional score, range of motion, and radiographic outcome. We also determined the use of graft and prosthetic revision supplements. We also describe our techniques for conversion to TKA.

Materials and Methods

We retrospectively reviewed the records of 55 patients (group A), all consecutive, who underwent TKA for a failed UKA from 2003 to 2008. All patients were identified via the senior author's (M.J.N.) database, and information recorded included the usual demographic data and data from the primary procedure, including whether the degenerative changes were confined to the compartment that was replaced, the initial postoperative hip-knee-ankle (HKA) alignment of the limb, and the position of the implant.

Based on the demographic data, we chose a cohort of 55 patients (group B) who had undergone a primary TKA from the same surgeon's database that most closely resembled the study cohort in terms of sex, age, and body mass index (BMI). We gathered data regarding the preoperative and postoperative range of motion and International Knee Society (IKS) scores to compare the 2 groups.

No patient who underwent a revision of a failed UKA was excluded from the study. The study was approved by the ethics review board of our institution. No patients were lost to follow-up.

In group A, there were 27 men and 26 women, 2 of whom had both knees revised from a UKA to TKA, giving a total of 55 revisions. The average age at the time of the primary procedure was 69.3 (range, 49-81) years. There were 32 right-side and 23 left-side UKAs revised. Forty-two of the UKA knees revised were Repicci UKA (Biomet, Warsaw, Indiana), whereas 13 were Active UKA (ASDM, New South Wales, Australia) designs. Both of these designs consist of a cemented femoral component and a cemented all-polyethylene tibial component. Part of the technique of implantation is the burring of the surface cartilage down to cancellous bone, leaving a rim of cortical bone to contain the implant both on the tibial and femoral sides. Fifty-two of the revisions were for medial compartment UKAs, with the remaining 3 for lateral compartment UKAs. The thickness of the polyethylene tibial component ranged from 6.5 to 9.5 mm.

A medial parapatellar approach was used in all revision surgical procedures including the revision of the lateral UKAs. The previous incision was used and incorporated for all revisions of medial UKAs. However, it was not possible to incorporate the initial incision from the lateral UKAs, so care was taken not to create flaps when performing the medial approach to the knee.

The femoral component of both types of UKA used has a flat fin, the purpose of which is to help in providing rotational stability. The femoral component was explanted by exposing the interface between the prosthesis and the cement using sharp osteotomes placed on either side of the component. It is important when performing this maneuver that the osteotomes are struck simultaneously by the operating surgeon and the assistant, to prevent iatrogenic fracture of the femoral condyle, because the purpose is to remove the component by axial distraction. The lugs from the femoral component leave a contained defect within the femur. An intramedullary alignment guide was used to resect the correct amount of bone from the distal femur, referenced off the unaffected condyle. Any defect was classified as per the system proposed by Engh and Ammeen [17], and defects were dealt with either by using morselized bone graft or by augmentation.

All polyethylene tibial components were explanted by cutting the cement-implant interface with a saw. We used an intramedullary guide and referenced the tibial cut off the unaffected compartment, which typically measured between 8 and 10 mm. This allowed for a normal cut because one would expect with a primary TKA (Fig. 1). Defects in the tibia were again classified

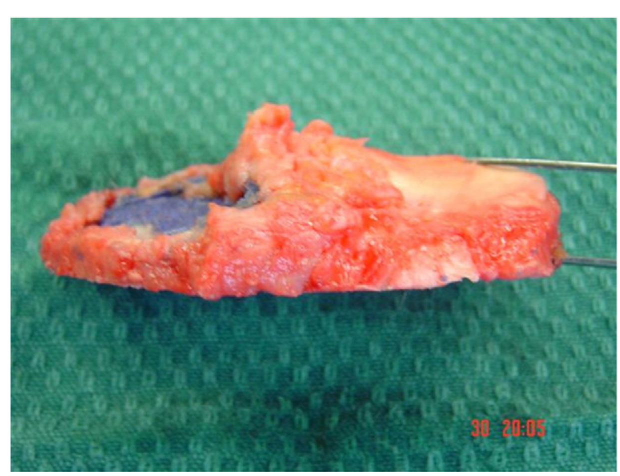

Fig. 1. Typical tibial cut during revision of UKA. Note that the cut is distal to the tibial implant.

based on the system proposed by Engh and Ammeen [17], and defects were filled with either morselized bone graft or augments.

Thirty of the revisions were revised to a Press Fit Condylar - Rotating Platform - High Flexion (PFC-RPF) (DePuy, Warsaw, Indiana), 20 were revised to Press Fit Condylar Posterior Stabilized (PFC-PS) (DePuy), and the remaining 5 were revised to the Active total knee system (ASDM). All patients had the patella resurfaced.

In group B, there were 27 men and 28 women. The average age was 69.1 years (range, 50-81 years). There were 32 right and 23 left TKAs performed. Thirty of the primary TKAs were PFC-RPF (DePuy), 20 were PFC-PS (DePuy), and the remaining 5 were Active (ASDM) TKAs. All patients had the patella resurfaced.

Clinical outcome measures including range of motion and functional scores were recorded preoperatively in both groups, as well as postoperatively at the most recent review. Intraoperative data such as tourniquet time, blood loss, use of augments, and bone graft were recorded. Knee scores were calculated based on the Knee Society clinical rating system [18]. Radiographs were assessed preoperatively and postoperatively based on the system described by Ewald [19], and we also recorded the HKA alignment of the limb, the tibial slope, and also the joint line as measured from the tip of the head of the fibula to the distal femoral line.

Statistical analysis was performed using a commercially available statistical medical program (MedCalc, Mariakerke, Belgium). Both groups were compared using the χ^2 test for the IKS scores. We used the Student t test to evaluate differences between the 2 groups in relation to continuous data such as range of motion and radiologic values such as HKA axis, joint line level, and tibial slope. The intertester reliability on measuring the radiologic values was evaluated with the use of the interclass correlation with a 95% confidence interval. The level of significance was set at $P < .05$.

Results

The average time the UKA was in place before revision was 48.3 months (range, 5-112 months). The average follow-up period in group A was 39.2 months (range, 6-127 months), and in group B, it was 38.4 months (range, 24-65 months).

Table 1 demonstrates the reason for failure of the UKA. The most common reason for revision was subsidence of the tibial base plate (Fig. 2), accounting for 58% of all revisions. The average time to revision for this complication was 40 months (range, 6-99 months). When excluding revisions for base plate subsidence, the average time to revision was significantly longer, at 60 months ($P < .05$). With regard to the knees that were revised due to base plate subsidence, the average age was 64.2 years (range, 49-81 years), and the average BMI was 30.5 kg/m^2 (range, 23-47 kg/m^2). Patients in this group were significantly older than patients with other modes of failure, who had an average age of 58 years (range, 49-79 years; $P < .05$), although there was no difference in terms of BMI, with an average of 29.8 kg/m^2 (range, 24-48 kg/m^2; $P > .1$). Three of the 55 conversions were for failed lateral UKAs. Two of these were due to progression of the disease process, and the remaining 1 was due to tibial base plate subsidence. There was no significant difference between these 3 patients and the rest of the cohort in terms of average time to failure ($P > .1$), postoperative IKS score ($P > .1$), or range of motion ($P > .1$).

Fig. 2. Anteroposterior radiograph demonstrating tibial base plate subsidence.

Table 2 shows the prevalence of other compartment disease at the time of the initial UKA. Concomitant patellofemoral joint (PFJ) and either lateral- or medial-side degenerative disease were present in 32% of patients at the time of the initial UKA. Isolated PFJ disease was present in 11% of patients, meaning that 43% of patients did not have an isolated disease at the time of the initial surgery. Five of the 12 patients who had revision of their UKA due to progression of disease had a concomitant multicompartmental disease at the

Table 1. Modes of Failure of the UKA

Reason for Failure	No. (n = 55)
Baseplate subsidence	32
Progression of disease to other compartments	12
Stress fracture of the tibia	5
Aseptic loosening	4
Avascular necrosis of the femoral condyle	1
Excessive cement debris	1

Table 2. Incidence of Other Compartment Diseases at the Time of Initial UKA

	Grade 2 PFJ	Grade 3 PFJ	Grade 4 PFJ
No LC/MC disease	5	1	–
Grade 2 LC/MC	15	2	1

Abbreviations: LC. lateral compartment; MC, medial compartment.

Table 3. Average Postoperative HKA Axis, Tibial Slope, and Level of Joint Line Postoperatively

	Group A	Group B	*P*
HKA axis	−0.45°	0.03°	>.1
Tibial slope	1.78°	1.45°	>.1
Joint line	20.5 mm	20.7 mm	>.1

time of the initial UKA. Nineteen patients who had a multicompartmental disease at the time of the initial UKA had the prosthesis revised for reasons other than progression of disease.

In group A, the average HKA axis before revision was −1.6° (range, −12°-10°). The average tibial slope before revision was 2° (range, 1°-5°). Table 3 shows the postoperative HKA axis, tibial slope, and level of joint line in both groups. There was no significant difference demonstrated between the 2 groups.

Particulate cancellous bone graft was used on the femoral side in 5 cases of revision, and a 4.5-mm fully threaded cancellous screw was used in 1 case of a fractured medial femoral condyle after revision of a medial UKA. Particulate graft was used in 19 cases (34.5%) of small contained tibial defects. Two of the cases that required femoral graft required tibial graft, so overall, 40% of cases had small contained defects amenable to grafting.

Three patients required a tibial stem, and 1 of these patients also required a femoral stem. All 3 patients required augments to the tibia (Fig. 3), as well as the femur in the case of the patient who had the femoral stem. No other patient required augments. One patient in group A had significant flexion gap instability, and the polyethylene tray had rotated 90° and was irreducible. He subsequently underwent revision to a hinged, stemmed prosthesis (S-ROM; DePuy).

The average polyethylene thickness in group A after revision to TKA was 10.2 mm (range, 7.5-12.5 mm). There was no significant difference in average intraoperative blood loss between the 2 groups, with an average of 259 mL in group A (range, 150-350 mL) and 270 mL in group B (range, 230-400 mL) ($P > .1$). There were no recorded cases of wound infection, deep infection, or venous thromboembolism in either group.

Table 4 shows the average postoperative range of motion, as well as the average preoperative and postoperative IKS scores of the 2 groups. There was no significant difference between the 2 groups in terms of postoperative extension ($P > .1$), flexion ($P > .1$), or improvement in IKS scores ($P > .1$).

Discussion

Unicompartmental knee arthroplasty is becoming an increasingly performed procedure for unicompartmental osteoarthritis in younger patients. This can be partly explained by the advent of minimally invasive techniques and better implant design.

However, there remains concern as to the longevity of the implants, especially in younger more active patients. In addition, the use of bone graft, augments, and stems may be required when converting a UKA to TKA.

The use of minimal resection techniques for UKA was pioneered by Repicci and Eberle [20]. The reported advantages include less perioperative morbidity, quicker rehabilitation, improved pain relief, and shorter hospital

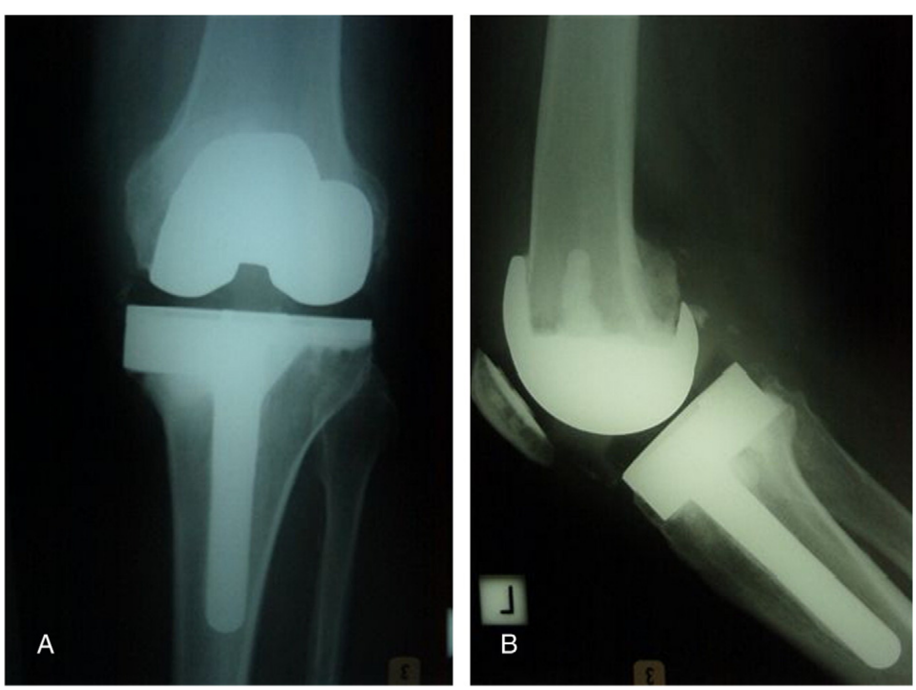

Fig. 3. (A and B) Radiographs showing revision using a medial tibial augment and stem.

Table 4. Average Postoperative Range of Motion and Preoperative and Postoperative IKS Scores

	Postoperative Extension	Postoperative Flexion	Preoperative IKS	Postoperative IKS
Group A	0.18°	127.9°	67.8	82.6
Group B	0.27°	130.7°	67.4	83.7

stay [1–4]. There is, however, few published studies on the long-term outcome after the use of this technique. Romanowski and Repicci [21] reported a survivorship of 96% at an average 8-year follow-up. In a previously published report from our center, we reported a 9-year survivorship of 79% [22]. These results compare poorly with those published for other types of UKA. For instance, Pandit et al [23] reported on the 10-year survivorship of the Oxford metal-backed mobile-bearing cemented UKA and reported that if all implant-related reoperations are considered failures, the 10-year survival rate is 96%. These results have been replicated from other centers [24]. Using the Miller-Galante UKA prosthesis (Zimmer, Warsaw, IN), Argenson [25] reported a 10-year survivorship of 94%.

Reported results on the performance of TKA after conversion from failed UKA are mixed. Barrett and Scott [26] reported that more than 50% of their conversions required the use of graft, augments, and tibial stems. Only 66% of patients had good or excellent results at an average of 4 to 6 years of follow-up. Padgett et al [27] reported on a small series of first-generation UKAs converted to TKA. The conclusion was that the procedure was as technically difficult as a revision TKA, and the results were comparable to revision, not primary, TKA. Pearse et al [14], reporting on the results from the New Zealand joint registry, concluded that converting a UKA to TKA gives a less reliable result than does a primary TKA and that the functional results are not significantly better than a standard revision from a primary TKA. The Oxford UKA (Biomet, Bridgend, UK) accounted for 61.2% of all implants, but the other 9 implants are not identified, making the drawing of conclusions difficult. At a mean follow-up period of 10.5 years, Järvenpää et al [13] compared a group of 21 revision UKAs to TKAs with a group of 28 patients who had primary TKA and concluded that conversion of UKA to TKA is associated with poorer clinical outcomes. However, the study size was small, and the groups were not matched with regard to either age or BMI. Becker et al [11] reported on 2 matched groups of 28 patients undergoing conversion of UKA to bicondylar arthroplasty and primary bicondylar arthroplasty, respectively. The group that was revised fared worse in terms of functional outcome, but no difference was demonstrated radiologically.

Other authors compare the ease and success of revision of a failed UKA with revision of a failed TKA. Saldanha et al [28] reported on a series of 36 Oxford metal-backed mobile-bearing UKAs converted to TKA and concluded that results were similar for a revision UKA to that for a revision TKA.

We could only find 1 report that favorably compared conversion UKA to TKA with a group of patients undergoing primary TKA. Johnson et al [15] reported on a series of 77 conversions, most of which were the St Georg Sledge (Waldemar-Link, Hamburg, Germany), and concluded that the results were comparable with TKA with respect to function and survivorship.

The purpose of this study was to report our experience with conversion of a minimal resection resurfacing UKA prosthesis to TKA, comparing it with a matched cohort of patients undergoing primary TKA to determine functional and radiologic results. We also wanted to document the need for graft, augments, and stems, as well as perioperative complications, and to furthermore describe the technique that we use.

We believe that one of the advantages of minimal resection arthroplasty is the ease of revision of the implant to TKA. Careful technique must be used when explanting the prosthesis to preserve as much bone as possible. Small contained defects can be dealt with by the use of particulate bone graft or, alternatively, with cement fill. Larger defects that are uncontained require the use of augments and stems on occasion. Springer et al [16] reported on a series of 22 conversion UKAs, mainly Duracon (Stryker, Mahwah, New Jersey). Sixty-eight percent of patients required a graft, augment, or stem. Their conclusion was that patients should be counseled of the fact that results may not be as durable as those for primary TKA. In the series of Saldanha et al [28] with 36 Oxford UKAs (Biomet, Bridgend, UK) converted to TKA, 6 patients required the use of a revision implant with both a femoral and a tibial stem. One patient required a femoral augment only, whereas another required a tibial augment only. A further 4 patients required the use of a cement/graft to fill contained defects. In their review of the New Zealand joint registry, Pearse et al [14] reported that revision “prostheses” were necessary in 28.3% of patients undergoing revision. No mention of the use of a graft or cement to fill defects is made. Johnson et al [15] reported on a series of 77 patients who had undergone revision of UKA. Only 3 patients required the use of augments or stems. However, 42 knees were lost to follow-up, and no mention is made as to whether any patients in this group required the use of augments or stems, so the validity of the study is diminished somewhat.

We required a particulate graft on either the tibia or the femur in 40% 0f cases. We used augments only in conjunction with stems in 5% of cases. Ninety-five percent of patients had a primary TKA prosthesis implanted without metal augmentation. Thus, the use of augments or stems is much lower when converting a resurfacing UKA to TKA than other designs. One of the reasons for this is the minimal resection of bone at the primary procedure. It is, therefore, possible to do the cut for the TKA (when revising from the UKA) on the bone at the same level as one would for a primary TKA. When preparing the tibia, by referencing 10 mm off the unresurfaced side, the saw cut is usually below the level of the polyethylene. We hypothesize that another reason for the low use of augments when converting is that there is a cortical rim of bone present on the tibia after primary UKA. Thus, any defect on the tibia, in particular, is usually a contained one, which can easily be filled with a particulate bone graft. However, in this study, 40% of patients required a particulate graft, and although the short-term results are similar to patients undergoing primary TKA, it is impossible at this stage to draw conclusions as to whether the use of a bone graft adversely affects the long-term outcome of TKA.

Failure of the all-polyethylene tibial tray, either by subsidence or by loosening, was the most common reason for failure of UKA in our series. Why this happens is not quite clear. Part of the technique of implanting the tibial tray is resurfacing of the tibial plateau, leaving a rim of cortical bone to “contain” the polyethylene. Therefore, the tray is only sitting on cancellous bone, and it is possible that this is not strong enough in some patients to support the implant, which, therefore, subsides. There was no correlation between subsidence and patient factors such as age or BMI, but it was significantly more prevalent in women, although the cohort was too small to draw definitive conclusions regarding this.

We only had 3 patients who required conversion of a lateral UKA to TKA in the study cohort. Obviously, the small number made the drawing of conclusions impossible, but there was no significant difference between these 3 patients and the rest of the cohort in terms of their outcome.

This is the first study that we are aware of looking specifically at the results of conversion of a resurfacing minimal resection UKA to TKA. This is also one of the few studies matching a cohort of patients undergoing primary TKA to the study cohort. We compared our cohort with an age- and BMI-matched cohort of patients undergoing primary TKA. In terms of functional outcome, we could demonstrate no significant difference in IKS scores or range of motion between the 2 groups. In terms of radiologic outcome, there was no significant difference in level of the joint line, the HKA axis, or the tibial slope between the 2 cohorts. This is in contrast to the overwhelming number of studies published on this topic.

There are some study limitations. It is a retrospective review of data, although the data were collected prospectively. It is a relatively small cohort of patients, although compared with most other studies on the topic, the cohort sizes are larger. The period of follow-up is short, at an average of 39.2 months. It is, therefore, impossible to draw the conclusion that in the long term, these patients will do as well as those undergoing primary TKA. This will require a further follow-up study at a later date to ascertain whether this is the case. However, given the parameters of the topic, we believe that the follow-up period is sufficient to draw relevant and important conclusions. Two separate UKA systems were used. However, these are similar designs with all-polyethylene tibial trays and very similar femoral components. In addition, 3 separate TKA systems were used. However, we matched the control group as closely as possible to the study cohort, but there is still obviously some potential for confounding bias. Lastly, we did not do an in-depth analysis of the modes of failure, but we believe that this is beyond the scope of this particular study and should be the focus of further investigation.

Furthermore, we have described our technique of explantation of the failed UKA, and provided care is taken when removing the UKA. We have demonstrated that most revisions do not require the use of metal augments or stems, although the use of a particulate graft to fill contained defects is often required. Although the survivorship of resurfacing UKA compares poorly with other types of implants, we believe that due to the minimal resection of bone and the superior results when converted to TKA, it should be considered a viable alternative to other implants, especially in younger patients, given that most of these patients will most likely require a revision to TKA at some stage. Surgeons who perform this type of surgery in younger patients should familiarize themselves with the techniques, and patients should be reassured that medium- to long-term revision to TKA is associated with a similar outcome to primary TKA. However, further follow-up is necessary to determine whether the long-term survivorship of TKA converted from a UKA compares with that of primary TKA.

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