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The Combination of Preoperative Bone Marrow Lesions and Partial-Thickness Cartilage Loss Did Not Result in Inferior Outcomes After Medial Unicompartmental Knee Arthroplasty

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ABSTRACT

Background: The purpose of this study is to compare patient-reported outcomes and revision rates between medial unicompartmental knee arthroplasty (UKA) patients based on the presence of medial bone marrow lesions (BMLs) and/or partial- vs full-thickness cartilage loss.
Methods: BMLs were graded on preoperative magnetic resonance imaging (MRI) findings from 174 UKAs performed between 2009 and 2013 using the MRI Osteoarthritis Knee Score criteria by a single evaluator blinded to the patient's outcome. A second evaluator blinded to the MRI findings and postoperative outcomes assessed medial joint space present on both weight-bearing and valgus stress radiographs. Preoperative and postoperative Knee Society Knee Scores, Pain Scores, and Function Scores were then compared between 4 groups of patients: patients with BML with either partial- or full-thickness cartilage loss, and patients without BML with either partial- or full-thickness cartilage loss.
Results: In total, 152 of 174 (87%) patients had minimum 2-year follow-up. One patient in the no BML/full-thickness loss group was converted to total knee arthroplasty secondary to arthrofibrosis; however, there were no statistical differences in revision rate between the 4 groups as no other revisions were performed ($P = .61$). Similarly, preoperative and postoperative Knee Society Knee Scores, Pain Scores, and Function Scores did not differ between groups, nor did postoperative University of California, Los Angeles activity scores.
Conclusion: Medial tibial BMLs were not associated with inferior outcomes, either in patients with partial- or full-thickness cartilage loss. Although the current results do not allow for the presence of preoperative BML to be considered an indication for UKA, these results definitively support that BMLs are not a contraindication for medial UKA.

It has been previously reported that preoperative magnetic resonance imaging (MRI) evidence of medial tibial bone marrow lesions (BMLs) was not associated with inferior postoperative outcomes after medial unicompartmental knee arthroplasty (UKA) [1]. However, it remains unclear if patients with medial tibial BMLs with only partial-thickness cartilage loss may experience inferior outcomes when compared to other UKA patients, as patients with partial-thickness cartilage loss have been reported to have inferior postoperative patient-reported outcomes [2,3] and tend to have slightly higher reoperation rates [3,4]. As such, the purpose of this study is to compare patient-reported outcomes and revision rates between medial UKA patients based on the presence of medial BML and/or partial- vs full-thickness cartilage loss. We hypothesized that the combination of preoperative medial tibial BML and partial-thickness cartilage loss would not result in either inferior patient-reported outcomes or increased revision rates.

Methods

Patients included in this analysis provided informed consent to participate in this Institutional Review Board–approved outcomes registry. First, all medial UKA patients with procedures performed

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between March 2009 and October 2013, who had a preoperative MRI ($n = 174$), were identified. In this series, MRIs were utilized in select cases to evaluate the condition of the anterior cruciate ligament and/or lateral compartment to help determine the most appropriate surgical option. The presence of preoperative BML was considered an indication for UKA in cases where full-thickness cartilage loss was not present on weight-bearing radiographs. All UKA procedures were performed by 2 experienced, high-volume arthroplasty specialists (K.R.B., A.V.L.) using a single implant design (Oxford Partial Knee; Zimmer Biomet, Warsaw, IN). Both prior to and following surgery, patients completed the Knee Society Score questionnaire, with the overall Knee Score, Pain Score, and Function Scores being calculated. In addition, patients completed the University of California, Los Angeles (UCLA) activity scale postoperatively.

A single investigator (C.A.J.) not affiliated with the operating surgeons' practice and blinded to the patient's postoperative outcome retrospectively recorded the location and severity of preoperative BMLs using previously described methods [1,5]. Specific to this analysis, BMLs in the medial tibia were graded from 0 to 3 based on the volume of the lesion: 0 = no lesions, 1 indicative of a lesion filling less than one-third of the boney region, 2 representing lesions filling between one-third and two-third of the region, and 3 indicative of BMLs filling more than two-third of the region per the MRI Osteoarthritis Knee Score criteria [5]. A second investigator (K.R.B.) who was blinded to the BML results and postoperative outcome scores assessed the presence of partial- or full-thickness cartilage loss. To do so, medial joint space was measured on the weight-bearing standing posterior-anterior, posterior-anterior flex, and valgus stress radiographs. The smallest value from the 3 radiographs was recorded, thus representing the least joint space measurable.

In order to evaluate whether medial tibial BMLs and/or partial-thickness cartilage loss negatively influenced postoperative patient-reported outcomes or implant survival, patients with minimum 2-year follow-up were categorized into 4 groups: (1) patients with medial tibial BML and full-thickness cartilage loss, (2) those with medial tibial BML and partial-thickness loss, (3) those without BML and full-thickness loss, and (4) those without BML and partial-thickness loss. Patient age, body mass index, and postoperative UCLA scores were compared between the 4 groups using a one-way analysis of variance. Preoperative and postoperative Knee Society Knee Scores, Pain Scores, and Function Scores were then compared between the 4 groups using a 4 × 2 analysis of variance (Group × Time). Bonferroni *post hoc* analyses were utilized to determine the location of pairwise differences. Patient gender and conversion to total knee arthroplasty (TKA) was compared between groups using χ^2 or Fisher's exact tests as appropriate. An alpha-level of $P \leq .05$ was used for all analyses, and all analyses were performed using SPSS Statistics 23 (IBM, Armonk, NJ).

Results

Of the 174 UKAs with preoperative MRIs, 152 (87%) had minimum 2-year follow-up (Table 1). Preoperative medial tibial BMLs were present in 92 of 152 (61%) knees. Partial-thickness cartilage loss was noted in 60 of 152 (39%) knees, with the mean medial joint space of 2.3. ± 1.1 mm (range 1-5). One patient in the no BML/full-thickness loss group was converted to TKA secondary to arthrofibrosis; however, there were no statistical differences in revision rate between the 4 groups as no other revisions have been performed to date ($P = .61$). Similarly, preoperative and postoperative Knee Society Knee, Pain, and Function Scores did not differ between groups, nor did postoperative UCLA activity scores (Table 2).

Table 1
Patient Demographics and Need for Revision for the Four Groups of Medial UKA Patients.

	No BML: Full Thickness Loss	BML: Full Thickness Loss	No BML: Partial Thickness Loss	BML: Partial Thickness Loss	*P* Value
n	32	60	28	32	–
Age (y)	61.5 ± 8.2	62.7 ± 9.4	62.4 ± 9.6	61.6 ± 9.2	.91
Sex	16 F, 16 M	36 F, 24 M	14 F, 14 M	13 F, 19 M	.36
BMI (kg/m^2)	32.3 ± 6.2	30.2 ± 5.1	31.5 ± 6.9	31.6 ± 4.7	.32
Follow-up (y)	3.9 ± 1.4	4.3 ± 1.3	4.3 ± 1.1	4.3 ± 1.3	.42
Revisions	1	0	0	0	.61

BMI, body mass index; F, female; M, male.

Discussion

The purpose of this study is to compare patient-reported outcomes and revision rates between medial UKA patients based on the absence or presence of medial BML with either partial- vs full-thickness cartilage loss. We hypothesized that the combination of preoperative medial tibial BML and partial-thickness cartilage loss would not result in either inferior patient-reported outcomes or increased revision rates, and the current results largely supported our hypotheses as no group differences were noted.

In the osteoarthritic knee, the volume of BMLs has been reported to increase as osteoarthritis (OA) progresses, with larger lesions being associated with increased pain [6–8]. Both the formation and progression of BMLs are driven by an underlying chronic bone remodeling process. For knees with full-thickness cartilage loss, the articular cartilage cannot shield the BML from cyclical mechanical and hydrodynamic stress. Fluid shift through the lesion site as well as the inability for the articular cartilage to attenuate force perpetuates a cycle of bone remodeling and chronic pain [6,9,10]. However, if this stress can be removed, the BML can resolve. Whether the result of endurance running, an acute anterior cruciate ligament injury, or secondary to OA, BMLs appear to resolve when the inciting mechanism is removed [1,11–15]. In the OA knee with full-thickness cartilage loss, arthroplasty appears to successfully break the cycle of bone remodeling associated with tibial BML, as evidenced by equivalent outcomes regardless of the presence of preoperative BML [1].

In the case of the OA knee with medial tibial BML but only partial-thickness cartilage loss, the BML may be related to the

Table 2
Comparison of Preoperative and Postoperative Knee Society Knee, Pain, and Function Scores, and Postoperative UCLA Activity Scores Between the Four Groups of Medial UKA Patients

	No BML: Full Thickness Loss	BML: Full Thickness Loss	No BML: Partial Thickness Loss	BML: Partial Thickness Loss	*P* Value[a]
Knee (/100)[b]					.53
Pre	40.5 ± 13.8	40.3 ± 13.4	43.7 ± 13.6	42.2 ± 13.2	
Post	90.7 ± 11.5	85.5 ± 18.7	86.8 ± 16.6	83.3 ± 17.0	
Pain (/50)[b]					.45
Pre	6.9 ± 11.0	7.5 ± 9.7	5.4 ± 6.9	6.6 ± 9.0	
Post	44.4 ± 11.2	41.9 ± 15.6	38.9 ± 16.2	40.5 ± 15.9	
Function (/100)[b]					.50
Pre	58.1 ± 13.5	61.2 ± 19.3	53.0 ± 14.4	58.6 ± 15.1	
Post	71.8 ± 25.2	76.5 ± 23.5	75.2 ± 24.9	78.6 ± 26.3	
UCLA (/10)	5.2 ± 1.4	6.0 ± 1.9	5.5 ± 1.4	5.3 ± 1.6	.08

[a] *P*-value represents the assessment for group differences.
[b] Knee Society Knee, Pain, and Function Scores demonstrated significant improvements between preoperative and postoperative visits regardless of group ($P < .001$).