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Comparison of Clinical Outcomes Between Cheilectomy and Proximal Phalangeal Dorsiflexion Osteotomy With and Without Bone Marrow Aspirate Concentrate and Extracellular Matrix for Hallux Rigidus

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Abstract

Background: Hallux rigidus with an associated osteochondral lesion is a common condition that can effectively be treated with a cheilectomy and Moberg osteotomy (CM). The use of biological adjuncts such as extracellular matrix (ECM) and bone marrow aspirate concentrate (BMAC) have been suggested to facilitate healing and restore forefoot function. The aim was to report if the addition of ECM and BMAC improves clinical outcomes for the treatment of hallux rigidus.
Methods: Patients who received open cheilectomy with first proximal phalangeal dorsal closing wedge osteotomy with and without ECM and BMAC for the diagnosis of hallux rigidus between February 2016 to July 2022 by the principal investigator were reviewed. A total of 137 patients were included, 71 in the cheilectomy with Moberg osteotomy group (CM) and 66 in the cheilectomy with Moberg osteotomy and ECM/BMAC group (CM + ECM/BMAC). All patients received Patient-Reported Outcomes Measurement Information System (PROMIS) surveys preoperatively and at minimum 1 year postoperatively. Postoperative complications were also noted for the patient cohort.
Results: The average time from surgery to final follow-up was 21.6 (range, 12-36.2) months for CM patients and 27.8 (range, 12-82.5) months for CM+BMAC patients ($P = .001$). Both CM and CM+BMAC cohorts demonstrated significant improvement in physical function, pain interference, pain intensity, and global physical health. However, there were no significant differences in preoperative or postoperative PROMIS domains between the 2 cohorts.
Conclusion: In conclusion, this study compares short-term patient-reported clinical outcomes and complications of cheilectomy and Moberg osteotomy against cheilectomy and Moberg osteotomy with ECM and BMAC for hallux rigidus. This study suggests that any potential differences in outcomes between groups are not large enough to be clinically meaningful in the short term and that other factors may be more relevant in determining the best course of treatment. A longer follow-up is required to evaluate long-term functional and clinical outcomes, and to see if addressing the cartilage has long-term effects.
Level of Evidence: Level III, retrospective case control study.

Keywords: hallux disorders, hallux rigidus, bone marrow aspirate concentrate, cartilage repair

Introduction

Hallux rigidus consists of progressive degenerative changes of the first metatarsophalangeal (MTP) joint characterized by the proliferation of osteophytes at the dorsal articular surface as well as progressively increasing pain and restriction of motion at the first MTP joint.[23] First mentioned by Davies-Colley in 1887, it is the second most common disorder affecting the great toe after hallux valgus deformities and is commonly associated with pain, stiffness, difficulty in shoewear, and limitations in physical activity.[12] Historical operative options for hallux rigidus management include joint-preserving procedures such as cheilectomy and

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phalangeal osteotomies or joint-sacrificing procedures such as arthrodesis and arthroplasty.[9,11,13,19,30,32,36] As a rule of thumb, joint-preserving procedures are indicated for early stages of hallux rigidus whereas joint-sacrificing procedures are indicated for advanced stages of hallux rigidus.

Cheilectomy in conjunction with a proximal phalangeal dorsal closing wedge (Moberg) osteotomy is a popular strategy to manage early- to moderate-stage hallux rigidus because of its ability to preserve or improve MTP joint motion, maintain MTP stability, demonstrate relatively low morbidity, and allow for future secondary procedures should they be necessary.[28,31,34] Recent gait analysis studies have suggested that cheilectomy alone does little to alter the pathologic biomechanics of more severe cases of hallux rigidus, thereby rendering the first MTP joint vulnerable to further degeneration and progression of arthritis.[6,10] To address these concerns, a cheilectomy and Moberg osteotomy (CM) are used together to increase dorsiflexion and offload the diseased MTP dorsal cartilage by shifting contact pressure of the first MTP joint plantarly and decompressing the joint.[28] Although the cheilectomy and Moberg osteotomy procedure has demonstrated good results, there are questions concerning how articular cartilage damage or an accompanying osteochondral lesion of the first MTP joint should be addressed during this procedure. This is a cause of concern because of the inability of a standard CM procedure to address cartilage defects in the plantar 50% of the metatarsal head, as well as the proximal phalanx articulation, which could lead to persistent anterior symptoms despite a technically well-performed operation.[8] To address associated osteochondral lesions of hallux rigidus, we propose that bone marrow aspirate concentrate (BMAC) and extracellular matrix (ECM) can be a viable adjunct that has demonstrated excellent outcomes in the treatment of osteochondral lesions in other joints.[14,15,17,25]

The purpose of this study was to compare clinical and patient-reported outcomes for patients who underwent CM with and without ECM/BMAC. We hypothesize that the addition of ECM and BMAC will demonstrate greater improvements in clinical and patient-reported functional outcomes and lower rates of revision surgery.

Methods

This was a single-center retrospective study conducted from the institutional review board-approved Foot and Ankle Registry data, and the protocol was approved by the steering committee at the investigators' institution. Patients who received open cheilectomy with first proximal phalangeal dorsal closing wedge osteotomy with and without ECM/BMAC between February 2016 and July 2022 by the principal investigator were reviewed. Inclusion criteria were patients aged 18 years or older who underwent cheilectomy with a Moberg osteotomy with ECM/BMAC for a primary diagnosis of moderate to advanced hallux rigidus and had preoperative patient-reported outcome scores. Excluded were patients who received an interposition arthroplasty or synthetic cartilage implant arthroplasty, and patients with histories of previous ipsilateral forefoot surgeries, rheumatoid arthritis, or gout. Operative notes were reviewed, and all procedures performed were noted. Retrospective review of the registry was performed, and 231 patients were identified and screened for inclusion. Patients were excluded if they had prior surgical treatment for hallux rigidus (27 patients) or if they underwent cheilectomy alone (32 patients), with or without BMAC. Patients with little to no motion at the first MTP joint (grade IV Coughlin classification) with advanced arthritis on plain film radiographs and underwent MTP fusion (12 patients) were not included. Twenty-two patients with insufficient baseline or follow-up functional outcome scores were excluded. In total, 137 patients were included, 71 treated with cheilectomy with Moberg osteotomy alone (CM) and 66 treated with cheilectomy with Moberg osteotomy and BMAC (CM+BMAC).

Figure 1. Preoperative example of hallux rigidus with bone spurs.

Study Population

Preoperative examination included standing anteroposterior (AP), oblique, and lateral plain radiographs as well as clinical evaluation. The severity of hallux rigidus was assessed using the Coughlin and Shurnas classification system (Figure 1). All patients between grades 1 and 3 had at least 20 degrees of first MTP joint dorsiflexion preoperatively and were indicated for the cheilectomy procedure with Moberg osteotomy. Chart review was performed to collect demographic information and to record any postoperative complications.

Survey Outcomes

Patient-reported outcomes were assessed using Patient-Reported Outcomes Measurement Information System

(PROMIS) scores, which has been validated in various foot and ankle surgeries. PROMIS is a computerized adaptive test (CAT) used to assess functional outcomes in the following domains: physical function, pain interference, pain intensity, global physical health, global mental health, and depression. Scores have a standardized mean of 50, the reference population average, with a standard deviation (*T* score) of 10. Higher scores indicate greater physical function, pain interference, pain intensity, global health, and depression. In our patient cohort, clinical outcomes were collected preoperatively and at a minimum of 1-year postoperative follow-up. All patients received PROMIS surveys at 1, 2, and 5 years postoperatively through the foot and ankle registry at our institution, and for the purposes of this study, an attempt was made to collect the most recent PROMIS scores for all patients.

Figure 2. The postoperative lateral radiograph indicates satisfactory alignment with a 7 × 9-mm staple 7 months after surgery.

Surgical Technique

At our institution, we use a surgical technique in which a combined cheilectomy with extension osteotomy of the great toe proximal phalanx (Moberg) was performed for patients with advanced first MTP arthritis. This procedure was performed with the addition of BMAC in 66 study patients.

Cheilectomy-Moberg osteotomy procedure (CM group). Patients were positioned supine. Regional anesthesia and/or a spinal block was used along a thigh or ankle tourniquet for hemostasis. A straight dorsal incision positioned over the medial aspect of the extensor hallucis longus was made to access the first MTP joint. Dorsal osteophytes were removed with a rongeur or a saw blade, with up to 30% of the dorsal metatarsal head excised. A Moberg osteotomy was then performed, removing a 2- to 3-mm wedge of dorsal bone of the proximal phalanx and secured with a 7 × 9-mm staple (Figure 2). Positioning of hardware was confirmed on fluoroscopy. The metatarsal head and the proximal phalanx were contoured using an oscillating rasp, ensuring that no sharp edges remained. A layered closure was then completed beginning with the capsule. A soft dressing with a postoperative shoe or splint was applied. Patients were limited for the first 14 days to allow the incision to heal. Sutures were removed on their first postoperative clinic visit, and patients were transitioned into regular shoewear between 4 and 6 weeks postoperatively. Patients began range-of-motion exercises at 2 weeks, and physical therapy began at 4 weeks following surgery.

Figure 3. Example of intraoperative placement of ECM-BMAC after the osteotomy.

Cheilectomy-Moberg osteotomy–BMAC procedure (CM+BMAC group). Patients were positioned supine. Approximately 60 mL of bone marrow was aspirated from the ipsilateral iliac crest and concentrated to yield approximately 3 mL of BMAC. The BMAC is set aside. Next, a straight dorsal incision positioned over the extensor hallucis longus was made to access the first MTP joint. Dorsal osteophytes were removed with a rongeur or a saw blade. Moberg osteotomy was then performed, removing a 2- to 3-mm wedge of dorsal bone of the proximal phalanx and secured with a 7 × 9-mm staple. BMAC was then applied on the proximal phalanx to allow for better application within the first MTP joint (Figure 3). Positioning of hardware was confirmed on fluoroscopy. The metatarsal head and the proximal phalanx were contoured using an oscillating rasp, ensuring that no sharp edges remained. ECM was mixed with BMAC and then applied on the proximal phalanx to allow for better application within the first MTP joint. A layered closure was then performed beginning with the capsule. The same postoperative protocol as outlined in the CM group was performed.

Table 1. Demographic Cohort Comparison.

	Cheilectomy and Moberg (n = 71)	Cheilectomy and Moberg With ECM/BMAC (n = 66)	*P* Value[a]
Age, y, mean (SD)	54.3 (10.4)	56.7 (9.5)	.16
BMI, mean (SD)	25.1 (3.9)	25.5 (4.6)	.56
Sex: female, n (%)	52 (73)	37 (56)	**.03**
Clinical FU, mo, mean (range)	21.6 (12-36.2)	27.8 (12-82.5)	**.001**

Abbreviations: BMI, body mass index; ECM/BMAC, extracellular matrix with bone marrow aspirate concentrate; FU, follow-up.
[a]Boldface type indicates statistical significance.

Table 2. Comparison of PROMIS Scores Between CM and CM+BMAC Patients.[a]

	Preoperative Score, Mean ± SD	Postoperative Score, Mean ± SD	*P* value [95% CI]	Score Change, Mean ± SD
Physical function				
CM	45.0 ± 6.4	52.6 ± 8.9	<**.01** [5.0, 10.2]	7.6 ± 8.4
CM+BMAC	45.4 ± 6.3	53.2 ± 8.9	<**.01** [5.2, 10.3]	7.8 ± 10.9
P value [95% CI]	.74 [–1.8, 2.5]	.50 [–2.5, 3.7]		.43 [–3.1, 3.5]
Pain interference				
CM	58.1 ± 6.4	48.9 ± 9.3	<**.01** [6.6, 11.8]	–9.1 ± 8.4
CM+BMAC	57.2 ± 6.3	48.1 ± 7.5	<**.01** [6.7, 11.5]	–9.1 ± 9.5
P value [95% CI]	.37 [–1.2, 3.0]	.88 [–2.1, 3.7]		.50 [–3.0, 3.0]
Pain intensity				
CM	49.9 ± 6.7	39.2 ± 8.2	<**.01** [8.2, 13.2]	–10.7 ± 8.8
CM+BMAC	48.9 ± 6.1	38.9 ± 7.6	<**.01** [7.6, 12.4]	–10.0 ± 12.4
P value [95% CI]	.35 [–1.2, 3.2]	.65 [–2.0, 2.6]		.29 [–2.9, 4.3]
Global physical health				
CM	47.3 ± 7.5	54.1 ± 7.8	<**.01** [4.2, 9.3]	6.8 ± 9.5
CM+BMAC	48.7 ± 6.2	53.7 ± 7.4	<**.01** [2.6, 7.4]	5.0 ± 9.7
P value [95% CI]	.26 [–0.9, 3.7]	.54 [–2.2, 3.0]		.78 [–1.4, 5.0]
Global mental health				
CM	54.0 ± 8.8	55.8 ± 8.4	.22 [–1.1, 4.7]	1.8 ± 10.2
CM+BMAC	54.1 ± 7.3	54.4 ± 9.4	.16 [–2.6, 3.2]	0.3 ± 11.1
P value [95% CI]	.96 [–2.6, 2.8]	.13 [–1.6, 4.4]		.32 [–2.1, 5.1]
Depression				
CM	47.5 ± 8.5	47.0 ± 7.8	.72 [–2.2, 3.2]	–0.5 ± 8.2
CM+BMAC	47.0 ± 7.3	45.0 ± 8.5	.49 [–0.7, 4.7]	–2.0 ± 9.4
P value [95% CI]	.68 [–2.2, 3.2]	.47 [–0.8, 4.8]		.71 [–1.5, 4.5]

Abbreviations: BMAC, bone marrow aspirate concentrate; CM, cheilectomy and Moberg without BMAC; CM+BMAC, cheilectomy and Moberg with BMAC; PROMIS, Patient-Reported Outcomes Measurement Information.
[a]Boldface type indicates statistical significance. Postoperative scores represent the latest available survey follow-up scores.

Statistical Analysis

Descriptive statistics were reported as means and standard deviations for continuous variables and counts and percentages for categorical variables. An a priori power analysis demonstrated a minimum of 24 patients required for each preoperative and postoperative cohort to achieve 80% power.[26] Paired *t* tests were used to compare preoperative and postoperative PROMIS scores after normality was assessed and confirmed using the Shapiro Wilk test. Listwise deletion was conducted for patients with missing data. Statistical significance was determined with an alpha of .05. Analysis was conducted on R: A Language and Environment for Statistical Computing (R Core Team 2021, Vienna, Austria).

Results

Demographic Data

Chart review was performed to collect demographic information and to record any postoperative complications.

Table 3. Revision and Complication Data.

	Cheilectomy and Moberg, n (%)	Cheilectomy and Moberg with ECM/BMAC, n (%)	P Value
Subsequent procedures	1 (1.4)	0 (0)	.78
Revisions	1 (1.4)	0 (0)	.78
Arthrodesis	1 (1.4)	0 (0)	.92
Infections	0 (0)	0 (0)	N/A
Progression to arthritis	4 (5.6)	0 (0)	.46
Persistent pain	8 (11.3)	4 (6.1)	.28

Abbreviation: ECM/BMAC, extracellular matrix with bone marrow aspirate concentrate.

Demographics are presented in Table 1. The average age for all patients was 55 (range, 24-76) years, with an average of 54 (range, 24-72) years for the CM group and an average of 57 (range, 33-76) years for the CM+BMAC group (P = .16). The average body mass index (BMI) for all patients was 25.3 (range, 17.3-38.5), with an average of 25.1 (range, 17.3-37.9) for the CM group and an average of 25.5 (range, 18.3-38.5) for the CM+BMAC group (P = .56). Eighty-nine of 138 total patients (64.5%) were female, with 52 of 71 patients (73.2%) in the CM group and 37 of 66 patients (56.1%) in the CM+BMAC group (P = .03). The average time of patient-reported onset of pain for all patients was 5.0 (range, 1-10) years, with an average of 4.5 (range, 1-10) for the CM group and an average of 5.2 (range 1-9.6) years for the CM+BMAC group (P = .79).

Clinical Outcomes

In total, 71 CM patients and 66 CM+BMAC patients had both preoperative and minimum 1-year postoperative PROMIS scores. The average time from surgery to survey follow-up was 21.6 (range, 12-36.2) months for CM patients and 27.8 (range, 12-82.5) months for CM+BMAC patients (P = .001). Both CM and CM+BMAC cohorts demonstrated significant improvement in physical function, pain interference, pain intensity, and global physical health (Table 2). However, there were no significant differences in preoperative or postoperative PROMIS domains between the 2 cohorts.

Complications

Complication and revision data are presented in Table 3. There were no significant differences in the incidence of subsequent procedures on the ipsilateral first ray, revisions, conversions to first MTP arthrodesis, infections, progression to arthritis, and persistent pain.

The rate of revision between the CM and CM+BMAC groups was not significantly different (P = .78). One of 71 CM patients required a revision surgery at 21 months following the index surgery. This patient was diagnosed with a metabolic bone disorder concurrently managed by a metabolic bone specialist and rheumatologist. She underwent revision cheilectomy with PVA implantation at 21 months following the index procedure. The patient subsequently developed persistent pain with a magnetic resonance imaging (MRI) scan showing a stable PVA implant with significant edema 8 months following the revision procedure. She underwent 2 rounds of shockwave therapy as well as ultrasonography-guided injection of the first MTP joint that resolved issues.

A total of 8 CM and 4 CM+BMAC patients reported persistent pain postoperatively. These patients were subsequently treated with a combination of steroid injections, orthotics, physical therapy, and/or shockwave therapy that resolved issues. The rates of persistent pain requiring additional intervention were not significantly different between groups (P = .63). No patient who underwent CM or CM+BMAC had a documented postoperative infection. No other major postoperative events were reported in either group.

Discussion

This study sought to evaluate the potential benefit of adding ECM/BMAC to the cheilectomy and Moberg procedure to address cartilage lesions of the first MTP joint. To our knowledge, this study represents the first summary of outcomes for patients who underwent cheilectomy and Moberg osteotomy with ECM/BMAC as well as the first comparison of outcomes between patients who underwent cheilectomy and Moberg osteotomy with and without BMAC. Both CM and CM+BMAC cohorts demonstrated significant improvement in PROMIS physical function, pain interference, pain intensity, and global physical health domains ($P < .01$). Demographic variables were generally similar between groups, and although sex was found to be statistically different (P = .03), we do not believe that this difference affected our results from a clinical standpoint. Contrary to our hypothesis, which predicted that patients who underwent cheilectomy and Moberg osteotomy with ECM/BMAC would experience improved clinical outcomes, the 2 groups demonstrated similar outcomes in both postoperative PROMIS scores and revision rates. Although our results did not indicate whether ECM/BMAC improved outcomes compared with the CM group, the insights conferred by the clinical and functional outcomes reported here contribute to a greater understanding of hallux rigidus treatment and pose new questions for future research in cartilage repair of the first MTP joint.

Historically, cartilage damage of the first metatarsal head in the setting of hallux rigidus has been addressed through arthrodesis. Although arthrodesis is a viable option for advanced stages of hallux rigidus in regard to pain relief, the expense of the first MTP range of motion remains a limitation, especially for younger or more active populations. Isolated cheilectomy in the management of advanced hallux rigidus has been associated with failure rates as high as 37.5%, with failure defined as persistent pain or limitations in daily activities.[21] These complications coincide with recent gait analysis studies, which have suggested that cheilectomy alone does not address the pathologic biomechanics of advanced hallux rigidus (such as a long first ray) and thus renders the first MTP joint vulnerable to further degeneration and progression to arthritis.[6,10] The addition of Moberg osteotomy to the cheilectomy procedure has been shown to clinically and biomechanically improve outcomes.[24] O'Malley et al previously demonstrated improved dorsiflexion and American Orthopaedic Foot & Ankle Society (AOFAS) scores and an 85% satisfaction rate in their cohort of 81 patients with a minimum 2-year follow-up after cheilectomy and Moberg osteotomy for grade III hallux rigidus.[31] Maes et al[29] demonstrated a significant positive effect on range of motion, visual analog scale (VAS) pain score, AOFAS score, and 36-Item Short Form Health Survey (SF-36) score in their cohort of 105 patients with 12 months' minimum follow-up. Kim et al[26] compared patient-reported outcomes via PROMIS scores between isolated cheilectomy and cheilectomy with Moberg osteotomy in a cohort of 129 patients with a minimum 2-year follow-up and reported significantly improved 1-year postoperative pain intensity outcomes for the cheilectomy with Moberg osteotomy group.

As mentioned earlier, this study represents the first case series reporting outcomes of the treatment of hallux rigidus with cheilectomy and Moberg osteotomy with ECM/BMAC. The strategy behind ECM/BMAC application stems from the notion that the CM procedure fails to address cartilage defects in the plantar 50% of the metatarsal head and the proximal phalanx articulation, which may be a reason for persistent pain and further complications.[9] The use of BMAC either as a postoperative injection or surgical adjunct has been previously reviewed in the treatment of knee and ankle osteoarthritis and has demonstrated good to excellent short-term clinical and functional outcomes.[4,8,14-16,20,22,27,37] Hannon et al[20] compared patients who underwent arthroscopic bone marrow stimulation supplemented with BMAC to patients who underwent bone marrow stimulation alone for osteochondral lesions of the talus (OLT) and reported improved radiographic outcomes via Magnetic Resonance Observation of Cartilage Repair Tissue (MOCART) scores for the BMAC at 2-year follow-up. Giannini et al[18] prospectively reviewed outcomes for 48 patients who underwent arthroscopic debridement with BMAC placement for an OLT with 2-year follow-up and reported that all patients demonstrated evidence of restored cartilage layer at the defect site on postoperative MRI.

The literature concerning the application of BMAC on first MTP arthritis is sparse, more so investigating the efficacy of BMAC as postoperative injections in the treatment of hallux rigidus with promising outcomes. Shimozono et al[33] conducted a retrospective review of 13 patients who received postoperative BMAC injections for hallux sesamoid disorders and reported significant improvements in FAOS, VAS, and 12-Item Short From Health Survey (SF-12) scores as well as a high rate of return to play. One case report of a 50-year-old gentleman presenting with grade II hallux rigidus resistant to conservative measures demonstrated improved symptoms and function at 9-month follow-up after receiving a first MTP injection of autologous adipose-derived mesenchymal stem cells.[5]

Other techniques to address articular cartilage damage in the setting of hallux rigidus such as microfracture and cartilage implants have been described in the literature. The microfracture technique has traditionally been used to stimulate fibrocartilage regeneration by microfracturing the subchondral bone to open the zone of vascularization, thus theoretically inducing healing.[35] Becher et al[3] reported significant improvement in range of motion and AOFAS scores in a patient cohort of 28 patients with an average follow-up of 23 months treated with microfracture in conjunction with cheilectomy. However, more advanced cases of hallux rigidus demonstrated poorer results than less severe cases.[3] More recently, synthetic cartilage implants such as a polyvinyl alcohol (PVA) hydrogel implant have been used in the treatment of advanced cases of hallux rigidus, representing an alternative to fusion that allows for the treatment of symptomatic first MTP arthritis with preservation of motion at the joint. Baumhauer et al[2] presented the first study comparing the PVA hydrogel implant with first MTP arthrodesis and reported significant but similar improvements in Foot and Ankle Ability Measure sports and activities of daily living scores, as well as VAS scores between the 2 groups at 1- and 2-year follow-up. However, recent studies have reported less promising results with regard to the PVA implant at short-term follow-up, and the surgeons in this study have transitioned away from using this technique.[1,7,9]

Our findings have direct implications for both clinical care and future research. Our results demonstrate similarly positive results for both procedures, suggesting that external considerations should be made when deciding on an appropriate course of treatment. For example, patient-specific concerns like recovery time, comfort level, costs of surgery, and overall goals with surgery might need to be discussed and considered. Of note, the increased financial cost of ECM/BMAC warrants discussion as to whether the additional procedure is worth pursuing. Future research is essential to elucidate the effect of BMAC on cartilage repair of the first MTP joint as well as explore outcome differences between the two groups. Most importantly, future studies with greater sample sizes and longer-term outcomes are necessary to validate any potential findings in this study. Additionally, studies observing radiographic outcomes of the CM+BMAC procedure may offer insight into the effect of BMAC on repairing cartilage damage for hallux rigidus.

There are several limitations to the study. First, we did not stratify our patient cohorts based on preoperative hallux rigidus grade, though the indication for a joint-preserving procedure at our institution typically includes grade I or IIA hallux rigidus based on the Coughlin scale.[10] Furthermore, Baumhauer et al[2] have demonstrated that preoperative dorsiflexion range of motion and VAS pain scores did not correlate with the Coughlin grading scale and did not predict the success or failure of first MTP arthrodesis or PVA implantation. Their results therefore suggest that clinical symptoms as opposed to grading systems may be better guides for treatment. Second, we did not stratify our patient cohorts based on articular cartilage damage severity. The severity of cartilage lesions were not routinely reported nor were arthroscopic images routinely available, preventing the authors of this study from collecting cartilage lesion data. This may be observed as a major confounding factor, as patients who received BMAC may have presented with more severe cartilage damage compared to patients who did not receive BMAC. Third, other possible factors that can affect the development of hallux rigidus or surgical outcome, such as instability or hypermobility of the first ray, radiographic arch parameters, or foot shape, were not including the generalizability of the study results.

Conclusion

In conclusion, this study compares short- to medium-term patient-reported clinical outcomes and complications of cheilectomy and Moberg osteotomy against cheilectomy and Moberg osteotomy with ECM and BMAC for hallux rigidus. The addition of ECM and BMAC did not increase the incidence of postoperative complications nor lower the reoperation rate when compared to cheilectomy and Moberg osteotomy, while producing similar PROMIS scores at 1-year minimum follow-up. This study suggests that any potential differences in outcomes between groups are not large enough to be clinically meaningful in the short term and that other factors may be more relevant in determining the best course of treatment. A longer follow-up is required to evaluate long-term functional and clinical outcomes.

Ethical Approval

Ethical approval to pursue this study was granted by our institution's Foot and Ankle steering committee.

Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: Mark Drakos, MD, reports general disclosures from Arthrex, extremity consultant. Disclosure forms for all authors are available online.

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