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Surgical management of large talar osteochondral defects using autologous chondrocyte implantation

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ABSTRACT

Background: Talar osteochondral lesions (OLT) occur frequently in ankle sprains and fractures. We hypothesize that matrix-induced autologous chondrocyte implantation (MACI) will have a low reoperation rate and high patient satisfaction rate in treating OLT less than 2.5 cm^2.
Methods: A systematic review was registered with PROSPERO and performed with PRISMA guidelines using three publicly available free databases. Clinical outcome investigations reporting OLT outcomes with levels of evidence I–IV were eligible for inclusion. All study, subject, and surgical technique demographics were analyzed and compared. Statistics were calculated using Student's t-tests, one-way ANOVA, chi-squared, and two-proportion Z-tests.
Results: Nineteen articles met our inclusion criteria, which resulted in a total of 343 patients. Six studies pertained to arthroscopic MACI, 8 to open MACI, and 5 studies to open periosteal ACI (PACI). All studies were Level IV evidence. Due to study quality, imprecise and sparse data, and potential for reporting bias, the quality of evidence is low. In comparison of open and arthroscopic MACI, we found both advantages favoring open MACI. However, open MACI had higher complication rates.
Conclusions: No procedure demonstrates superiority or inferiority between the combination of open or arthroscopic MACI and PACI in the management of OLT less than 2.5 cm^2. Ultimately, well-designed randomized trials are needed to address the limitation of the available literature and further our understanding of the optimal treatment options.

1. Introduction

Studies have shown that osteochondral lesion of the talus (OLT) are frequent occurrences when patients sustain both traumatic and atraumatic ankle injuries [1] with a report rate of up to 70% OLT in patients who sustain an ankle sprain or fracture [2]. When a patient is found to have an OLT, studies have shown the a medial OLT has a traumatic etiology 70% of the time, while lateral lesions have a traumatic etiology in 98% of cases [1]. These lesions are seldom treated non-operatively as results of non-operative treatment have shown a success rate of less than 50% [3].

Surgical treatment options for OLT can be broken down into reparative (marrow stimulation) and replacement (transplant of tissue) options, and are frequently dictated by characteristics of the lesion, including size and presence or absence of cysts [4,5]. Patient preference also plays an important role in treatment options, as some techniques can be done arthroscopically while other require a more extensive surgical approach. Reparative options include microfracture while replacement options include osteochondral autograft or allograft transplantation (OAT), autologous chondrocyte implantation (ACI), matrix induced autologous chondrocyte implantation (MACI), periosteal autologous chondrocyte implantation (PACI), and metallic implantation. In these techniques, a patient's cartilage cells are cultured in the initial procedure. In PACI, a periosteal flap harvested from the patients distal tibia is sutured over the transplanted cells in a second stage procedure. In MACI, a chondrocyte-loaded scaffold is implanted. While microfracture has been classically used for defects less than 1.5 cm^2, the optimal treatment for larger lesions has yet to be identified [5].

The purpose of this study was to perform a systematic review [6] of the literature to determine which surgical treatment option for OLT less than 2.5 cm^2 excluding microfracture provided the

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lowest complication rate, best clinic outcomes, and highest patients satisfaction rate. A secondary goal was to determine which treatment provided the best functional outcomes scores in patients for treatment of OLT. The authors' hypothesis was that MACI would have the lowest complications rate and the highest patient satisfaction rate of the treatments examined.

2. Methods

A systematic review was conducted according to PRISMA guidelines (Preferred Reporting Items for Systematic reviews and Meta-Analyses) using a PRISMA checklist [7]. Systematic review registration was performed using the PROSPERO International prospective register of systematic reviews (registration number CRD42015016494) [8]. Two reviewers independently conducted the search on May 1, 2016 using the following databases: Medline, Cochrane Central Register of Controlled Trials, SportDiscus, and CINAHL. The electronic search citation algorithm utilized was: (talus OR talar) AND (osteochondral OR cartilage OR lesions) AND (chondrocyte OR autologous OR implantation OR chondrogenesis). English language Level I–IV evidence (2011 update by the Oxford Centre for Evidence-Based Medicine [9]) clinical studies were eligible. Medical conference abstracts were ineligible for inclusion. All references within included studies were cross-referenced for inclusion if missed by the initial search. If duplicate subject populations were encountered, the study with the longer follow-up was included. Level V evidence, reviews, letters to the editor, basic science, biomechanical studies, imaging, surgical technique, and classification studies were excluded.

A total of 218 studies were located, and, after implementation of the inclusion criteria, 19 studies were included in the final analysis (Table 1). Study subjects of interest in this systematic review underwent either matrix induced autologous chondrocyte implantation (MACI) or periosteal autologous chondrocyte implantation (PACI) for treatment of osteochondral lesions of the talus less than 2.5 cm^2. No minimum requirement was set for follow-up. Study and subject demographic parameters analyzed included year of publication, years of subject enrollment, level of evidence, number of subjects, gender, age, body mass index (BMI), diagnoses treated, lesion size, and surgical technique. Clinical outcome scores sought were the VAS (visual analog scale), AOFAS (American orthopaedic foot and ankle society) Hindfoot Score, Hanover, Lower Limb Outcome Assessment, AAOS (American Academy of Orthopaedic Surgeons), FFI (Foot Function Index), Mazur, Tegner, and Finsen scores. Time to return to sport, patient satisfaction, complications, and reoperations were recorded. When applicable, radiographic follow up with plain radiographs or magnetic resonance imaging (MRI) was recorded. Study methodological quality was evaluated using the MCMS (Modified Coleman Methodology Score) [10].

2.1. Statistical analysis

Study data was aggregated based on each treatment method (open MACI, arthroscopic MACI, open PACI), and weighted outcomes and complication rates were calculated. A heterogeneity and publication bias analysis was performed on all included studies. Due to significant heterogeneity between studies, a random effects model was used for all statistical methods. An Inverse Variance statistical method was used to compare all continuous data outcomes, and was reported using means and standard mean differences. A Mantel–Haenzel statistical method was used to compare all dichotomous data outcomes and complications, and was reported using odds ratios and 95% confidence intervals. The reported p values refer to a one-sided (likelihood ratio) test for difference in outcomes and complication rates between each group. Probability values of <0.05 were considered significant. All statistical tests were performed using Review Manager (RevMan, Version 5.3; Copenhagen, Denmark: The Nordic Cochrane Centre, The Cochrane Collaboration; 2011).

3. Results

A total of 219 articles were identified on the initial literature search. Among the initial studies, 196 of 219 were excluded in the primary screening leaving at total of 25 for review of the abstract or full article. After the 25 were reviewed for eligibility based on the inclusion and exclusion criteria, a total of 19 were included in the systematic review [11–29]. Four of the 25 studies represented an analysis of patients at earlier times points [30–33]. Of the 19 studies, none of the studies included randomized or prospective studies. All studies were retrospective case series published between 2003 and 2014. Within the 19 studies, the treatment options presented were 6 studies of arthroscopic MACI, 8 studies of open MACI, and 5 studies of open PACI. The average number of subjects in each study was 18 patients (range, 6–45) with mean ages between 24 and 42 years and mean follow-up between 12 and 119.5 months. Of the collective 343 study subjects, 117 subjects

Table 1
Demographics.

Author	Year	# pts enrolled/time period	Mean age	ACI or MACI	Open (O)/arthroscopic (A)	Mean defect surface area (cm^2)
Anders	2012	22	23.9	MACI	O	1.94
Apprich	2012	10	32.4	MACI	O	1.21
Aurich	2011	16	29.2	MACI	A	1.5
Battaglia	2011	20	35	MACI	A	2.7
Caumo	2007	14	35.2	MACI	n/a	n/a
Dixon	2011	28	41	MACI	O	1.31
Giannini	2005	16	30.5	MACI	A	n/a
Giannini	2014	46	31.4	MACI	A	1.6
Giza	2010	10	40.2	MACI	A	1.3
Lee	2011	21	39	MACI	O	n/a
Magnan	2012	30	28.9	MACI	A	2.4
Quirbach	2009	12	32.8	MACI	O	n/a
Ronga	2005	6	28.6	MACI	O	3.4
Schneider	2009	20	36	MACI	O	2.33
Baums	2006	12	29.7	PACI	O	2.3
Giannini	2009	10	25.8	PACI	O	3.1
Kwak	2014	32	34	PACI	O	1.98
Petersen	2003	14	28	PACI	O	1.7
Whittaker	2005	10	42	PACI	O	1.95

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