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Prospective Treatment of First Carpometacarpal Osteoarthritis With Autologous Fat Transfer

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Background: The purpose of this study was to analyze the effect of autologous fat transfer on outcomes in patients with basilar thumb arthritis.
Methods: Twenty-three patients with carpometacarpal (CMC) arthritis underwent autologous fat transfer under fluoroscopic guidance. Autologous fat was harvested from the abdomen and separated with nonadherent gauze (Telfa). After processing, 2 mL of fat was injected into the CMC joint. All patients were placed in a prefabricated thermoplastic splint for 2 weeks postoperatively. Patients completed the Disability of Arm-Shoulder-Hand Questionnaire (DASH) questionnaire both preoperatively and postoperatively at 1, 6, and 12 months. Paired *t* tests were used to compare pretreatment to posttreatment DASH scores. Significance was set at a *P* value less than 0.05 (95% confidence interval [CI]).
Results: The average preoperative DASH score was 51.81 (95% CI, 45.85–57.76). Average postoperative DASH score at 1-month follow-up was 26.16 (95% CI, 19.76–32.57), followed by a DASH score at 6-month follow-up of 22.49, 95% CI (15.41–29.54), and a DASH score at 12-month follow-up of 26.62 (95% CI, 17.68–35.56). Improvements in DASH score were as follows: 26.49 at 1 month postoperatively ($P < 0.01$), 30.64 at 6 months postoperatively ($P < 0.01$), and 26.89 at 12 months postoperatively ($P < 0.01$). No major adverse events were observed.
Conclusions: Autologous fat transfer for the treatment of CMC osteoarthritis significantly improved hand function in our cohort. Additional studies of fat transfer are warranted to better understand the physiologic mechanisms and therapeutic benefits.
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INTRODUCTION

The first carpometacarpal (CMC) joint is the second most common joint of the hand to develop arthritis.[1] Factors including advanced age, prior injury, female sex, and postmenopausal status confer increased risk for the development of CMC arthritis.[1,2] The innate laxity of the joint increases its vulnerability to the development of arthritis, especially after years of overuse.[2] Wear and tear of the stabilizing volar oblique ligament as well as the dorsal ligamentous system can lead to articulating shear forces across the trapezium and first metacarpal base, resulting in degenerative changes.[1,3] Such degenerative changes lead to pain that worsens by grabbing or pinching objects, severely impacting a patient's ability to perform their activities of daily living. Weakness, deformity, and decreased range of motion are also commonly reported symptoms.[4]

Imaging is useful as a proxy for disease severity; however, there is a weak correlation between degree of radiographic changes and symptoms.[4] Therefore, other factors such as patient-reported pain and loss of function must be considered alongside imaging findings to determine the most effective intervention on an individual basis. The Eaton–Littler Classification system stages basilar thumb arthritis into 4 stages (I–IV) based on radiographic severity. The stages range from stage I with minor joint space narrowing to stage IV with marked degenerative changes,

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substantial subluxation, and sclerosis.[5,6] Eaton and Littler proposed a stepwise progression of the arthritis; however, radiographic patterns may involve more than 1 stage.[6]

A range of treatment options are utilized in the treatment of CMC arthritis. Conservative efforts include activity modification, splinting, nonsteroidal anti-inflammatory drugs, and hand therapy. Intra-articular corticosteroid injections have also been trialed to help mediate the inflammation associated with osteoarthritis, but meta-anlayses and systematic reviews have shown no significant long-term improvement in patient outcomes.[7] Trapeziectomy, with and without ligament reconstruction, and denervation are the most common surgical options for treatment of CMC arthritis.[8] Although trapeziectomy-base procedures are the gold standard surgical treatment for CMC arthritis, the operation alters the anatomy of the hand and has associated complications including postoperative tendon rupture and metacarpal subsidence with scaphometacarpal impingement.[9,10] Additionally, the recovery period is multiple months with intensive hand rehabilitation, which is not acceptable to many patients.[11]

Autologous fat grafting to the CMC joint is an emerging treatment option to reduce pain and improve function in patients with varying degenerative stages of CMC arthritis. Autologous fat is injected into the joint space and serves as a buffer for the articulating trapezium and metacarpal, and may also drive regeneration of adipose stem cells.[9] Bohr et al[12] first reported the therapeutic effects of autologous fat grafting into the CMC joint as a noninvasive treatment to reduce pain levels and improve function for the patient in a 2015 case report, with Herold et al[11] reporting similar outcomes in a larger study in 2017. The purpose of our study was to prospectively assess the utility of autologous fat grafting as a minimally invasive alternative in the treatment of CMC arthritis.

METHODS

Prospectively, 23 patients with CMC arthritis underwent unilateral or bilateral autologous fat grafting to the joint space under fluoroscopic guidance for a total of 27 procedures. Selection criteria included no prior surgical intervention for CMC arthritis. Patients with stage II and higher radiographic findings, pain, and impairment of function were offered autologous fat transfer. Preceding fat grafting, patients were offered corticosteroid injection and were encouraged to trial splinting for symptom relief. Preoperative and postoperative upper extremity function scores were collected to determine the effect of fat grafting. Disability of Arm-Shoulder-Hand Questionnaire (DASH) scores were assessed at 1, 6, and 12 months postoperatively and compared with preoperative DASH scores. Paired *t* tests were used to compare pretreatment to posttreatment outcomes. Significance was set at a *P* value less than 0.05 (95% confidence interval [CI]).

Autologous fat was harvested from abdominal donor sites using a 2.5-mm Tulip cannula vacuum-assisted liposuction, and the samples were washed once and allowed to concentrate on nonadherent gauze. After processing, an 18-gauge needle was utilized to inject 2 mL of fat into the CMC joint under direct fluoroscopy. All patients were placed in a prefabricated forearm-based thumb spica thermoplastic splint for 2 weeks immediately after undergoing fat transfer, and patients were seen on follow-up at regular intervals.

All patients agreed to participate in the study, and in all cases informed consent was obtained, including Health Insurance Portability and Accessibility Act consent. The study was institutional review board approved.

Takeaways

Question: Is fat grafting an effective, minimally invasive treatment to improve symptoms and function in patients with first carpometacarpal arthritis?

Findings: Patients in this study reported a 50% improvement in DASH scores 12 months postoperatively, demonstrating the clinically relevant functional benefit and longevity of autologous fat transfer as a treatment for first carpometacarpal arthritis.

Meaning: The functional improvement after autologous fat transfer supports its role as a longer-lasting alternative to steroid injection and a less invasive alternative to trapeziectomy in the treatment of first carpometacarpal arthritis.

RESULTS

Demographics for the 23 patients included in this study are shown in Table 1. Four (17.4%) patients had bilateral intra-articular fat injections, for a total of 27 cases. Relevant osteoarthritis risk factors included 1 patient with diabetes mellitus, 1 patient with a history of smoking, and 1 patient with a history of Stickler syndrome. Nineteen (82.6%) patients had occupations requiring fine motor

Table 1. Demographic Data

Characteristic	Value
No. patients	23
No. procedures	27
Sex	
Female	17 (73.9%)
Male	6 (26.0%)
Stage	
2	8 (29.6%)
3	11 (40.7%)
4	7 (25.9%)
Unidentified	1 (3.7%)
Handedness	
Right	22 (95.7%)
Left	1 (4.3%)
Occupation	
Fine motor involvement	19 (82.6 %)
Other	4 (17.4%)
Previous treatment	
Corticosteroid injections	17 (63.0%)
Systemic therapy with oral corticosteroids	2 (8.7%)
Hand therapy	7 (30.4%)
Compression gloves	2 (8.7%)
Splinting	13 (56.5%)

Table 2. Preoperative DASH Scores and DASH Score Improvement Over Time After Autologous Intra-articular Fat Grafting for the Treatment of CMC Arthritis

	Preoperatively, n = 27	1 mo Postoperatively, n = 25	6 mo Postoperatively, n = 17	12 mo Postoperatively, n = 18
Average DASH score	51.81 (95% CI, 45.85–57.76)	26.16 (95% CI, 19.76–32.57; $P < 0.01$)	22.49 (95% CI, 15.41–29.54; $P < 0.01$)	26.62 (95% CI, 17.68–35.56; $P < 0.01$)

movements of the hand. Twenty-two (95.7%) patients were right hand dominant and 1 (4.3%) was left hand dominant. Of the 27 procedures performed, 14 (51.9%) were performed on the dominant hand and 13 (48.1%) on the nondominant hand. Multiple conservative measures were tried and failed before fat grafting. All patients were offered a single intra-articular corticosteroid injection, with 17 (63.0%) patients opting for steroid injection a minimum of 6 months before autologous fat grafting. Two (8.7%) patients were treated with courses of oral corticosteroids, 7 (30.4%) participated in hand therapy, 2 (8.7%) utilized compression gloves, and 13 (56.5%) tried immobilization therapy with a thumb spica splint. Radiographically, the cases ranged between Eaton–Littler stages II and IV: 8 stage II (29.6%), 11 stage III (40.7%), 7 stage IV (25.9%), and 1 joint space unclassified due to imaging performed at an outside facility (3.7%). The average follow-up was 7.04 months. One possible complication was reported, an exacerbation of de Quervain tenosynovitis. No reports of infection at the injection or donor sites or intra-abdominal complications from liposuction were reported. Two (7.4%) patients showed gradual progression of their CMC arthritis after treatment, as evidenced by a worsening DASH score over time.

The average preoperative pain score on a visual analogue score (VAS) was 8.00 of 10. The average postoperative pain at 4–6 weeks was reported to be 4.47 of 10 ($P < 0.01$). The average preoperative DASH score was 51.81 (95% CI, 45.85–57.76). The average postoperative DASH score at 1-month follow-up was 26.16 (95% CI, 19.76–32.57) followed by a DASH score at 6-month follow-up of 22.49 (95% CI, 15.41–29.54), and a DASH score at 12-month follow-up of 26.62 (95% CI, 17.68–35.56s). These results are depicted in Table 2 and Figure 1. Improvements in DASH score were as follows: 26.49 at 1 month postoperatively ($P < 0.01$), 30.64 at 6 months postoperatively ($P < 0.01$), and 26.89 at 12 months postoperatively ($P < 0.01$). Furthermore, radiographic imaging performed postoperatively reveals joint space widening present immediately after fat injection into the thumb CMC joint. (**See figure, Supplemental Digital Content 1**, which displays the image of the joint space widening immediately after fat injection into the thumb CMC joint on fluoroscopy, **http://links.lww.com/PRSGO/D979**.)

Additionally, DASH scores can be stratified by Eaton–Littler radiographic stage. For stage II, average preoperative DASH score (n = 8) was 57.25 (95% CI, 41.40–73.10). Average postoperative DASH score at 12-month follow-up (n = 4), was 38.12 (95% CI, 0.57–75.67), indicating a 23.88 improvement ($P < 0.01$). For stage III, preoperative DASH score (n = 11) was 45.59 (95% CI, 37.47–53.71), followed by a DASH score at 12-month follow-up (n = 7) of 27.02 (95% CI, 12.62–41.42), indicating a 17.59 improvement ($P = 0.06$). For stage IV, the preoperative DASH score (n = 7) was 55.88 (95% CI, 43.23–68.53), followed by a DASH score at 12-month follow-up (n = 6) of 22.23 (95% CI, 5.83–38.63). Stage IV patients reported a 36.85 improvement in DASH scores, ($P < 0.01$).

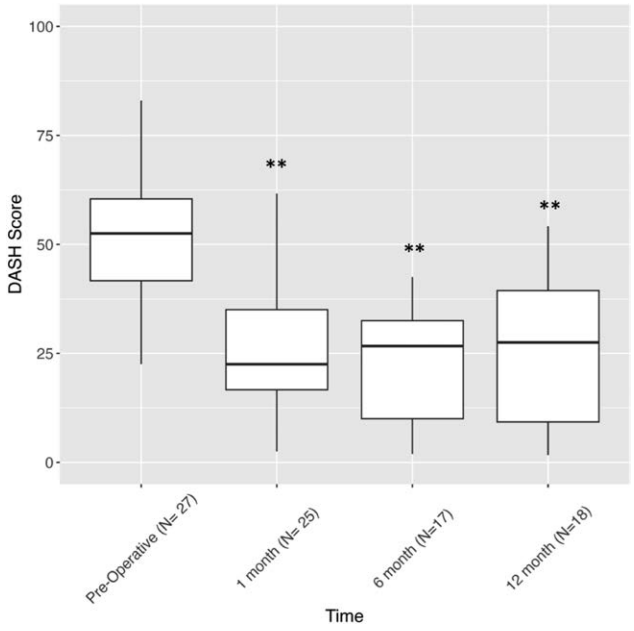

Fig. 1. DASH scores pre- and postfat injection at various intervals of follow-up. The box plot presents the mean, the 25th and the 75th percent quartiles, and the minimum and the maximum. Significance levels are indicated as follows: ** for $P < 0.01$.

DISCUSSION

In this study, we present autologous fat grafting as a minimally invasive and safe treatment modality for symptomatic and functional improvement of first carpometacarpal joint arthritis. A limited number of studies have assessed the injection of autologous fat as a treatment for CMC arthritis. Herold et al[11] proposed the therapeutic effects of fat grafting that are based on the immediate buffering effect of the transplanted fat and possibly the transplanted adipose stem cells that can regenerate chondrocytes. Similarly, Froschauer et al[13] demonstrated that fat grafting from an abdominal donor site improves function and delays the need for a more invasive surgery in patients with first CMC arthritis. Froschauer et al reported statistically significant improvement in DASH score and VAS on 2-year follow-up.[13] The study reported a 19-point reduction in DASH scores after 6 months, and a 24-point reduction in DASH scores after a 2-year follow-up. Erne et al[14] compared trapeziectomy with abductor pollicis

longus interposition to autologous fat grafting among patients with Eaton–Littler stage III–IV disease. The study reported no significant differences between trapeziectomy and fat grafting in DASH score and VAS score at 6-, 12-, and 18-month follow-up intervals. However, the time interval between surgery and symptom relief was shorter in patients who underwent fat grafting.[14] Furthermore, restoration of range of motion, and reduced pain under stress loading of the joint are also reported in the literature. In a study conducted by Haas et al,[15] patients who underwent autologous fat grafting to the first CMC joint had improved Michigan Hand Outcomes Questionnaire scores and reductions in pain at rest and under stress at 6 weeks, 3 months, 6 months, and 12 months.

In our study, 92.6% of patients reported improvement in their arthritis symptoms on interval follow-up. Average improvements in DASH score were 26.49 points at 1 month postoperatively ($P < 0.01$), 30.64 at 6 months postoperatively ($P < 0.01$), and 26.89 at 12 months postoperatively ($P < 0.01$). Not only are these reductions in DASH score statistically significant, they are clinically significant. A DASH score reduction of more than 10 points has been shown to represent clinically significant improvement in upper extremity function,[16] and improvements in DASH score in this study were durable over time.

Our practice is to offer fat grafting to patients after trialing immobilization therapy with a removal thumb spica splint as well as a single injection of corticosteroid into the joint space. These interventions were offered to all patients before fat grafting; however, only 73.9% and 56.5% of patients elected to pursue steroid injection and immobilization, respectively, before fat grafting. After immobilization and steroid injection, the next step in management traditionally includes invasive surgical options such as trapeziectomy-based procedures or denervation of the CMC joint. However, patients with CMC arthritis are often poor surgical candidates or do not desire invasive surgery. All patients in our practice are offered fat grafting as a minimally invasive option before trapeziectomy, and trapeziectomy is presented as a secondary plan for symptomatic relief if fat grafting is not successful. In this study, only 2 (7.4%) cases experienced a progression of their CMC arthritis symptoms after treatment and were offered trapeziectomy with ligament reconstruction and tendon interposition with symptomatic improvement. It is unclear why 2 (7.4%) patients experienced treatment failure in this study. Further research regarding patient-specific factors which may predispose to treatment failure as well as optimal fat treatment before grafting is ongoing. Additional studies are needed to determine if administering a corticosteroid injection into the scaphotrapeziotrapezoid ligament (STT) joint at the time of injection into the CMC joint provides additional therapeutic benefit. We evaluated for STT arthritis at the time of injection; however, this was not a data point recorded within the study, and no patients received STT joint injections in this study.

Many patients who develop CMC arthritis have comorbid conditions or demographic factors which also make surgical intervention and rehabilitation more challenging, including diabetes and smoking, occupations or hobbies requiring repetitive fine motor movement of the hand, and advancing age.[17] In this way, autologous fat grafting for symptomatic and functional improvement can be offered as an alternative option to patients for whom surgery is not optimal or desired. The large improvement in DASH scores observed in this study is comparable to DASH score changes among patients who underwent trapeziectomy-base procedures, which are considered the gold standard for first CMC arthritis treatment.[14] Komura et al[18] reported a 28.27 point reduction in DASH scores after trapeziectomy with ligament reconstruction and tendon interposition at a median 5-year follow-up. Additionally, autologous fat grafting has a short postoperative recovery. Patients undergoing autologous fat grafting in our study were immobilized for 2 weeks postoperatively compared with the traditional 6 weeks of splinting postoperatively for patients undergoing trapeziectomy, allowing patients faster return to their activities of daily living and to work with reduced stiffness and less need for hand therapy. Patients who undergo trapeziectomy-based procedures typically have a 3- to 6-month recovery period, particularly if surgery is performed on the dominant hand.[19]

Two primary mechanisms are proposed in the literature to explain the benefit of fat grafting for first CMC arthritis. First, adipose tissue, a mesenchymal cell, has regenerative effects by differentiating into chondroblasts or adipocytes. This differentiation into chondrocytes may lead to regeneration of damaged cartilage.[20] According to this theory, stem cells release anti-inflammatory factors and growth factors that modulate the inflammatory process and promote tissue repair, improving the survival of fat at the cellular level.[21] The second proposed mechanism is an immediate cushioning effect with added lubrication to decrease friction within the joint space.[13] Further research is needed to better understand the interplay between the mechanical benefits of fat grafting and the underlying biological changes that may contribute to joint space remodeling.

Limitations of this study include the lack of a control group and a relatively small sample size. Further studies will address these design limitations. As a future direction of this research, we plan to study the benefits of washing harvested fat before autologous transfer. Recent work by Liu et al[22] concluded that washing fat with Poloxamer 188 significantly improves the survival of fat cells. It is proposed that Poloxamer 188 improves adipocyte survival through stabilization of the fat membrane and by reducing the inflammation and oxidative stress induced during fat harvest and transfer.[23] We believe that higher rates of adipocyte survival during fat grafting may further boost the regenerative effects of autologous fat transfer within the joint space and should be further studied both in clinical practice and at the cellular level in animal models. Additionally, we currently perform fat grafting injections into the base of the CMC joint under fluoroscopy in a surgery center. However, with protocol optimization we believe that these injections may be done in outpatient settings under local anesthesia without the need for fluoroscopy by an experienced hand surgeon, similar to current outpatient corticosteroid injections.

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DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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