Long-term follow-up of osteochondral autologous transplantation in the metacarpophalangeal joints

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Background and Purpose

Adult articular cartilage lacks the inherent ability to heal [9]. Left untreated, isolated defects may progress to diffuse osteoarthritis [1]. Cartilage-defect reconstruction has been described using an autologous bone cartilage plug that can be harvested from the non-weight bearing portion of the knee. Osteochondral autograft transplantation (OAT) has been used extensively in knee and other large joints [3, 10, 32]. While few reports exist for this procedure in small joints of the hand [5, 18, 21, 24, 25, 33], objective long-term results are lacking. The purpose of this study was to report the long-term results in four patients who underwent osteochondral autologous transplantation (OAT) for isolated chondral defects of the metacarpal head.

Materials and Methods

Institutional review board approval was obtained. The charts of four patients were reviewed. One patient died of unrelated causes. The three surviving patients returned for follow-up clinical evaluation with minimum of 10-year follow-up. Baseline patient demographic data are shown in Table 1. All patients presented with metacarpophalangeal (MP) joint pain. One patient complained of catching and crepitus of the MP joint. The accidents reported were heavy box falling on the

hand, hand caught between a cart and a metal frame, fall on outstretched hand, and sports injury. One patient had an ulnar collateral ligament repair two years prior to presenting for the index procedure. Another patient underwent synovectomy and chondroplasty without benefit prior to the index procedure. Three of the four patients had preoperative intraarticular cortisone injections. Two patients received two injections preoperatively. Traumatic cartilage defects ranged in size from 5 to 10 mm involving the thumb metacarpal head in two cases and the metacarpal head of the index finger in two cases. The opposing joint surface of the proximal phalanx was fibrillated and was treated with drilling in two cases and intact in two cases. Two of the procedures were performed in the dominant hand. A single graft was used to restore the cartilage defect in all cases. All grafts were harvested from the non-weight bearing portion of the knee.

Measurements obtained by an occupational hand therapist included Numeric Rating Scale (NRS) pain scores (0=no pain; 10=worst pain imaginable) [6], standard goniometer ranges of motion (degrees), and hand dynamometer grip strength (kg) (JAMAR Sammons Preston, Inc., Bolingbrook, IL) [2]. Disabilities of Arm, Shoulder, and Hand (DASH) scores were obtained at final follow-up in the three surviving patients.

Surgical Procedures

Metacarpophalangeal arthroscopy was performed for diagnostic purposes (Fig. 1). The indication for OAT was an isolated cartilage defect without a full thickness cartilage lesion on the opposing joint surface (Fig. 2). Patients were offered the OAT procedure as a potential method to preserve range of motion and potentially avoid MP joint fusion. A commercially-designed surgical system, the Osteochondral Autograft Transfer System (OATS®: Arthrex, Naples, Florida) was utilized.

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Table 1 Baseline demographic data for patients who underwent Osteochondral autologous transplantation (OAT) of the MP joint

Baseline data	Patient ID			
	1	2	3	4 ^b
Gender	Female	Male	Male	Male
Age ^a (years)	35	31	35	47
Worker's compensation claim	Yes	Yes	No	Yes
Length of preoperative symptoms (months)	5	7	24	180
Graft-size (mm)	8	6	8	6

^a Age at time of operation^b Long-term follow-up for patient 4 was 4 years (deceased) versus 10 years for other patients

Once the patient was established as a candidate for the OAT procedure, an open longitudinal dorsal exposure was made. After exposing the joint surface, the size of the cartilage lesion was estimated. The graft was secured by press-fit in two cases (Figs. 3 and 4). Additional fixation was obtained with a transverse K-wire in one case and a transverse absorbable pin in one case. Range of motion was started on the first postoperative week.

Results

There were no revision surgeries. The three worker's compensation patients returned to full duty at 2.5 months, 3 months, and 3 months, respectively. One patient had increase in pain at four years postoperatively, which resolved after intraarticular cortisone injection. This same patient's postoperative course was complicated by thumb carpometacarpal degenerative joint disease treated with a splint and cortisone injection. Preoperative, 1-year, and long-term follow-up findings for pain, grip, and flexion are shown

Fig. 1 Preoperative X-ray of metacarpal lesion **Fig. 2** Intraoperative photograph showing full-thickness chondral lesion of MP joint

in Table 2. All patients had full extension at the aforementioned time periods with the exception of one patient who had a 10-degree extension lag at one year which was resolved at the ten-year visit. Postoperative radiographs showed some abnormal post-changes without progression (Figs. 5 and 6a, b, and c) when compared to earlier postoperative radiographs. One patient (patient ID #2) complained of donor-site knee pain 2 months postoperatively that resolved with an intraarticular cortisone injection.

Fig. 3 Intraoperative photograph showing graft being placed during the OAT procedure of the MP joint

Table 2 Preoperative, 1-year, and long-term follow-up findings for pain, grip, flexion, and Disabilities of Arm, Shoulder, and Hand (DASH) Questionnaire for patients who underwent osteochondral autologous transplantation (OAT) of the MP joint

Outcome	Patient ID				Average
	1	2	3	4 ^a	
Pain (0 to 10)					
Preop	7	5	nr	5	5.7
1 year	4	2	0	1	1.8
Long term follow-up	0	0	0	1	0.3
Grip (kg)					
Preop	40	30	59	27	39.0
1 year	nr	42	54	36	44.0
Long term follow-up	40	49	43	32	41.0
Flexion (degrees)					
Preop	45	35	95	85	65.0
1 year	60	40	85	80	66.3
Long term follow-up	57	40	69	64	57.5
DASH scores					
Preop	nr	nr	nr	nr	nr
1 year	nr	nr	nr	nr	nr
Long term follow-up	20	15	0	3	9.5

^a Long term follow-up for patient 4 was 4 years (deceased) with 2-year follow-up for the DASH questionnaire versus 10 years for other patients
nr not recorded

Discussion

Adult articular cartilage differs from many other body tissues because it has limited ability to repair structural damage [8], and this limitation progresses with age [9]. Therefore, structural lesions left untreated may lead to symptomatic degeneration of a joint [8].

Fig. 4 Intraoperative photograph of metacarpal head after implantation of autologous osteochondral graft

Fig. 5 Two-year postoperative MRI following OAT of the MP joint showing subchondral cystic change with partial graft resorption and intact overlying articular cartilage

Treatment options of isolated osteochondral lesions include microfracture/microabrasion/microdrilling, autologous chondrocyte implantation and OAT. Microdrilling of lesions results in disruption of the exposed subchondral bone and vessels, which result in bleeding that leads to the formation of a fibrin clot. Undifferentiated mesenchymal cells are thought to migrate into the clots and differentiate into cells resembling chondrocytes [29]. While the resulting tissue is not normal articular cartilage, the resulting fibrocartilage results in clinical improvement [7]. It is a simple arthroscopic procedure that has been used extensively in this setting with advantages including low morbidity, no donor-site morbidity, and minimal expense. However, the disadvantage is that results tend to deteriorate over time [19, 20, 22, 28].

Autologous chondrocyte implantation is frequently a two-stage surgical procedure whereby articular cartilage cells are transferred into a defect in an attempt to grow articular cartilage. Good long-term results have been reported in joints other than MP joints [23, 26, 30].

Osteochondral autologous grafts allow for the transfer of fully formed and functional articular cartilage to the defect thereby potentially allowing for reestablishment of normal contour and function [4, 11]. The concept of OAT was first introduced using blocks of osteochondral bone transferred into defects in the knee without specially designed instrumentation [31, 34]. Later, a report of standardized instrumentation for the transfer of cylindrical osteochondral autologous grafts in the knee was published in 1994 by Hangody and Karpati [13]. Other authors published similar experiences using standardized instrumentation [4].

There is some evidence to suggest that osteochondral autograft results in more rapid clinical recovery in the knee compared to autologous chondrocyte implantation [16]. However, the donor-site morbidity of this procedure, with a reported incidence of 5 %, may be a concern [12]. Only one of our patients (patient ID #2) complained of donor-site pain at 2 months postoperatively which was resolved with a cortisone injection.

Fig. 6 **a** Ten-year postoperative X-rays following OAT of the MP joint. **b** Ten-year postoperative x-rays following OAT of the MP joint. **c** Ten-year postoperative x-rays following OAT of the MP joint

According to a systematic review by Harris et al. [15], there are patient-specific and defect-specific factors that influence clinical outcome regardless of technique. The best outcomes for the knee appear to occur in young active patients with shorter duration of preoperative symptoms, fewer preoperative surgical interventions, smaller isolated defects, and no concomitant joint pathology [15].

Early animal research suggests that non-weight bearing lesions treated with OAT have better surface congruity and

bony incorporation compared to weight-bearing lesions in the knee. [14] Second-look arthroscopies have demonstrated healthy congruent cartilage surfaces at the recipient site and fibrocartilage covering of the donor site in human subjects [12]. Histological evaluations of biopsied specimens have shown normal articular cartilage at the recipient site.

Some mild degenerative changes in the knee on preoperative radiographs were demonstrated by 27% of the patients in Hangody et al.'s study [12]. The prevalence increased to 37 % postoperatively with a mean follow-up of nearly 10 years (range 2–17) [12]. Of the 221 patients with preoperative Fairbank's arthritis grade of 0, 27 progressed to a grade of I, II, or III postoperatively. Of the 82 patients with the preoperative grade of I or II, 25 progressed to a grade II or III. [12] It is not clear to what extent the radiographic changes affected outcome.

While our patients had no complications requiring reoperation, Hangody reported 8 % painful postoperative hemorrhage requiring aspiration in two cases and arthroscopic evacuation in two cases [12]. Two additional cases required arthroscopic debridement for postoperative infections. The surgeries in their series were much more extensive because of larger lesions in the knee requiring multiple plugs to fill the recipient sites (mosaicplasty). Their cases averaged 4.1 (range 3–9) grafts harvested per case.

The Disabilities of Arm, Shoulder, and Hand (DASH) outcome measure was used at long-term follow-up to measure patient reported physical function and symptoms. This is the most widely used upper extremity health measure [27], which is important in evaluating outcome and viability of OAT in small non-weight bearing joints. Within the general population, the average DASH score has been reported to be 10.1 with a standard deviation of 14.7 [17]. Although we do not have preoperative values for DASH, our postoperative values fall within one standard deviation of the general population's mean DASH score.

Long-term results in these four cases suggest that OAT may be a viable surgical option for treatment of cartilage defects of the metacarpal head. Long-term pain relief was good; however radiographic results are potentially concerning. Prospective studies comparing OAT to other treatment options would be of value to determine the role of OAT in the MP joint of the hand.

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Conflicts of Interest Louis Constantinou declares that he has no conflict of interest. Anna L. Walden declares that she has no conflict of interest. Tyson K. Cobb declares that he has a financial relationship with Integra Life Sciences.

Statement of Human and Animal Rights All procedures followed were in accordance with the ethical standards of the responsible

committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.

Statement of Informed Consent Waiver of informed consent was granted by the institutional review board as no identifying information of the four patients was used in the article.

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