Medial Ulnar Collateral Ligament Reconstruction Using Hamstring Allograft in Overhead Throwing Athletes

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Background: Currently, several graft options have been described for reconstruction of the medial ulnar collateral ligament of the elbow. Palmaris longus, gracilis, plantaris, toe extensor, and even Achilles tendon autografts have been well documented. To our knowledge, no study has investigated the clinical outcomes following the use of allograft tendon for primary medial ulnar collateral ligament reconstruction. It is our hypothesis that medial ulnar collateral ligament reconstruction with hamstring allograft provides results similar to those reported with autograft without the potential complication or risk of donor-site morbidity.

Methods: We retrospectively reviewed the records for 123 overhead throwing athletes with medial ulnar collateral ligament injuries who had had unsuccessful nonoperative treatment. All patients were managed with reconstruction with use of a hamstring allograft and were followed for a minimum of twenty-four months. One hundred and sixteen of the 123 patients were contacted and were included in our study. Outcome measures included Conway-Jobe rating scale, the mean time to return to play, the maximum level of competition, and overall satisfaction with the reconstruction.

Results: At the time of the most recent follow-up, 110 of the 116 patients had returned to play. Thirty-three (30%) of these 110 athletes had returned to a level of play above that prior to injury, sixty-four (58%) had returned to play at the same level, and thirteen (12%) had returned to level of play lower than that that prior to the injury. The mean time to return to play was 9.9 months. One hundred and fourteen of the 116 patients who were contacted considered the reconstruction to be successful. The Conway-Jobe score was classified as excellent for 80% of the patients, good for 13%, fair for 7%, and poor for none.

Conclusions: The use of allograft tissue for the reconstruction of the medial ulnar collateral ligament in throwing athletes provides outcomes similar to that of autograft tissue after twenty-four months of follow-up.

Level of Evidence: Therapeutic Level IV. See Instructions for Authors for a complete description of levels of evidence.

Injury to the medial ulnar collateral ligament has become increasingly common[1]. Waris[2] described injuries to the medial ulnar collateral ligament of the elbow in 1946. Over the following thirty years, our understanding of medial ulnar collateral ligament anatomy and function increased dramatically. In 1974, Jobe et al. performed the first successful medial ulnar collateral ligament reconstruction, changing what was a career-ending injury into one that potentially could be overcome, allowing for return to play[3]. In 1986, Jobe et al.[3] described their technique for reconstruction of the ligament with use of ipsilateral palmaris longus tendon autograft via a flexor pronator mass detachment approach with transposition

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A commentary by Matthew V. Smith, MD, is linked to the online version of this article at jbjs.org.

of the ulnar nerve. Since the original description by Jobe et al., numerous modifications of the surgical technique have been designed to improve athletic performance and to decrease patient morbidity[4-9]. Vitale and Ahmad[8] recently published a systematic review of all published reports of medial ulnar collateral ligament reconstruction in overhead athletes. A total of eight studies were included, with graft choices that included ipsilateral and contralateral palmaris longus, Achilles, toe extensor, plantaris, and gracilis autograft tendons. A comprehensive literature review revealed no previous reports on throwing athletes who had been managed with allograft medial ulnar collateral ligament reconstruction[1-8,10-18].

Most series, including the recent extensive study by Cain et al., have documented some complications related to the donor site[11]. Cain et al. reported a 4% rate of donor-site complications in a study of 1281 athletes undergoing medial ulnar collateral ligament reconstruction. Vitale and Ahmad[8] reported an overall complication rate of 10% in the studies that they reviewed, with at least 10% of these complications (representing 1% of the 410 patients) being related to the donor site. Fortunately, most donor-site complications were relatively minor, including scarring, tenderness, superficial infection, and weakness. However, more severe injuries have resulted from graft harvest, including at least six cases[4,5,7,9] of median nerve harvest. Allograft use would eliminate these complications, but it is unknown if the functional result would be the same with allograft tissue.

The purpose of the present study was to evaluate a consecutive series of medial ulnar collateral ligament reconstructions with use of hamstring allograft in young overhead throwing athletes (with an age of less than thirty-two years) and to assess and document the mean time to return to play, the level of competition, and the rating on standard, validated outcome measures.

Materials and Methods

We performed a retrospective review of a consecutive series of patients involved in throwing sports (baseball, softball, javelin) undergoing allograft reconstruction of the medial ulnar collateral ligament from 2005 to 2009 to correct symptomatic instability, functional impairment, and an inability to return to sport despite extensive nonoperative management. All reconstructions were performed by three experienced surgeons. The indications for surgery were unsuccessful nonoperative treatment (including medication, rehabilitation, and bracing), inability to resume playing because of dysfunction of the elbow, and the desire to return to playing. In order to be included in the present study, the patient (1) had to have undergone medial ulnar collateral ligament reconstruction with use of hamstring allograft, (2) had to be an overhead throwing athlete involved in an organized sport, and (3) had to be available for subsequent follow-up at a minimum of twenty-four months postoperatively.

One hundred and twenty-three patients met the first two criteria. We were able to contact 116 (94%) of these patients more than twenty-four months after surgery; these patients form the basis of the study. Seven patients (6%) could not be contacted and were excluded. The initial examination revealed evidence of valgus instability, a positive physical examination finding of 1+ to 3+ laxity, and a positive moving valgus extension overload test in all patients. Elbow motion was normal in eighty-one patients and abnormal in thirty-five, who had flexion contractures of between 5° and 25°. Initial radiographs were normal for eighty-one patients; of the remaining thirty-five patients, fifteen had minor changes in the olecranon tip and fossa and twenty had moderate changes. Initial management for all patients included a period of medication, rest, and rehabilitation for at least six weeks. Twenty-eight patients underwent bracing after the initial visit in an attempt to allow healing of the injured medial ulnar collateral ligament. All patients had evidence of medial ulnar collateral ligament disruption on either magnetic resonance imaging (MRI) or magnetic resonance arthrography (MRA). None of the patients in the present series had an isolated humeral avulsion of a relatively normal ligament that was amenable to repair.

Our cohort included a mixture of professional (n = 23), college (n = 48), and high school (n = 45) athletes. In the present study, we included only athletes who were involved in baseball, softball, and javelin and excluded those who were involved in all other sports. The mean age at the time of medial ulnar collateral ligament reconstruction was 20.4 years (range, fourteen to thirty-two years). All reconstructions were performed through a split in the flexor-pronator mass as described by Rohrbough et al.[16] and no ulnar nerve transpositions were performed.

At the time of the latest follow-up, patients were assessed with regard to the range of elbow motion, the presence of pain, the rate of complications, and the Conway-Jobe rating score[13]. Conway-Jobe scores are classified as excellent (return to the preinjury level of competition [or higher] or performance for at least one season after medial ulnar collateral ligament reconstruction), good (return to play at a lower level of competition or performance for more than one season or, specifically for baseball players, able to throw daily batting practice), fair (able to play recreationally), or poor (unable to return to the previous sport at any level).

In addition to the one and two-year follow-up examinations, all patients were subsequently contacted via telephone and were asked follow-up questions regarding the time to return to play, the time to maximum recovery, the level of competition, and overall satisfaction with the reconstruction.

Surgical Technique

In all cases, an examination with the patient under anesthesia was performed to evaluate the degree of instability and elbow motion as compared with the contralateral elbow. Most patients had diagnostic arthroscopy in either the prone or lateral position to confirm the instability and to treat any intra-articular abnormality, followed by open ligament reconstruction.

An incision of approximately 6 cm was made from the posterior aspect of the proximal tip of the medial humeral epicondyle, extending distally past the location of the sublime tubercle. Although the location of the incision minimizes risk to the medial antebrachial cutaneous nerve, the subcutaneous tissue is dissected bluntly to identify and protect this nerve and to prevent painful neuroma formation.

An incision was then made in the flexor-pronator fascia between its middle and posterior bands, just posterior to the medial conjoined tendon, and the underlying muscle belly was divided longitudinally. The medial ulnar collateral ligament was visualized, and the damage was confirmed. A longitudinal incision was made at the anterior aspect of the ligament, and the remnants of the native medial ulnar collateral ligament were reflected posteriorly off the sublime tubercle and the medial humeral epicondyle to reveal the anatomic origin and insertion of the ligament. The initial reflection allowed for direct visual assessment of the medial joint line opening with valgus stress. Also, this split of the medial ulnar collateral ligament helped to create a bed for the allograft tissue that was bordered by native tissue. The native ligament was routinely sutured to the adjacent allograft to further support graft stability. Once the decision was made to proceed with reconstruction, the allograft was prepared. In this series, gracilis was used almost exclusively unless it was unavailable, in which case semitendinosus allograft was substituted (n = 16). In most cases, the more robust semitendinosus was thinned to allow easier passage through the bone tunnels. All physicians used grafts obtained from the Musculoskeletal Transplant Foundation (Edison, New Jersey). Graft preparation included whip stitching each end of the graft to improve graft passage. On the ulnar side, eighty-eight patients had creation of standard Jobe converging tunnels around the sublime tubercle with use of a 3.2-mm drill-bit and twenty-eight patients had creation of a single ulnar tunnel. In the latter patients, the ulnar bone tunnel was centered on the sublime tubercle and was angled toward the supinator crest of the lateral aspect of the ulna. The ulnar tunnel was reamed unicortically over a guide pin with use of either a 4.5 or 5.0-mm reamer. The graft was then attached to the screw via a suture through the screw with use of a previously described technique[3] and then was manually inserted into the ulnar

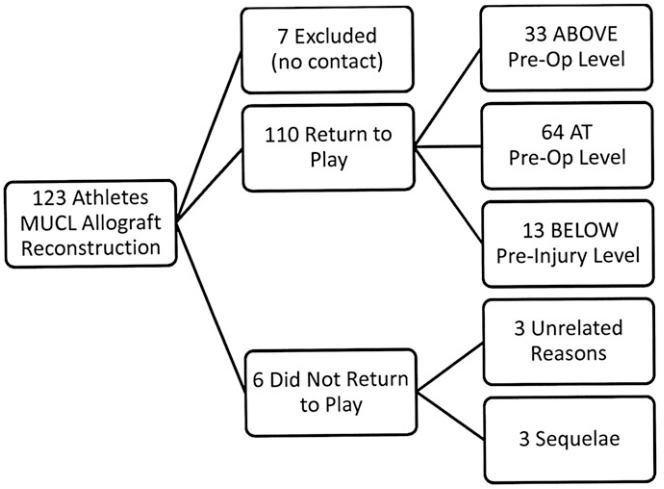

Fig. 1

Summary of the results of medial ulnar collateral ligament (MUCL) allograft reconstruction.

tunnel. A Bio-Tenodesis screw (Arthrex, Naples, Florida), usually 4.75 mm in diameter, was inserted to create an interference fit.

The proximal reconstruction was performed either with a classic Jobe technique through Y-type drill-holes (with the graft often pulled back through the central humeral tunnel to create a tripled graft) or with a docking technique. In fifteen cases, additional fixation with a proximal screw was added into the central humeral docking tunnel to increase initial fixation strength. The elbow was cycled and the graft was tensioned in 70° of flexion and forearm supination with a varus stress applied to the elbow. Any remnant of the native ligament was sutured to the allograft with #1 PDS (polydioxanone) suture (Ethicon, Cornelia, Georgia).

Prior to tourniquet release, the wound was copiously irrigated and hemostasis was achieved. The flexor pronator fascia was closed with absorbable suture. A standard closure was performed, and the arm was placed into a protective plaster splint and sling with the elbow in 70° of flexion.

The patient was managed with a removable hinged brace at the time of the first postoperative visit and was started on scapular retraction exercises. Gentle, pain-free range of motion was allowed out of the brace, which was initially set to restrict motion to 60° to 90° of flexion. Grip strengthening and forearm stretching exercises were encouraged at that time. The patient was allowed to add 10° to both flexion and extension on a weekly basis as the pain-free arc improved. Six weeks postoperatively, range of motion was expected to be equal to the preoperative arc of motion. Physical therapy at the six-week mark was performed with the arm in the brace and emphasized hip strength and flexibility, core strengthening, scapular retraction, and shoulder rehabilitation, including posterior capsule and rotator cuff stretching and strengthening. The twelve-week visit was considered to be a key landmark in postoperative rehabilitation. If there was no swelling, range of motion was equal to or better than that at the preoperative visit, and posture and core strength were satisfactory, then a throwing program was initiated with the brace in place. If any of these milestones were not achieved, the throwing program was delayed. The most common reason for delay was persistent scapular dyskinesis, which usually was treated with a combination of bracing, taping, and continued rehabilitation. The return-to-throwing program was continued with the arm in the hinged elbow brace for at least the next six to eight weeks. Barring any setbacks in terms of pain or swelling in the elbow or recurrence of shoulder, core, or posture issues, the throwing program was restarted at four and one-half to five months without the brace and progressed according to normal return-to-throwing protocols[6].

Source of Funding

There was no outside funding for this study.

Results

One hundred and sixteen (94%) of the original 123 athletes had one and two-year follow-up records and were contacted for the study. Seven (6%) patients had two years of follow-up but could not be contacted and were eliminated from the study (Fig. 1). The mean duration of follow-up was thirty-nine months (range, twenty-four to seventy-two months). Six of the 116 patients did not return to play. Three of these patients stated that their failure to return to overhead sports was unrelated to elbow symptoms but did not give specific reasons for not returning to sport. Three others did not return to sport because of sequelae of a medial humeral epicondylar fracture[1], a new flexor-pronator tear[1], and an inability to recover velocity with ongoing pain when throwing[1]. The average time until the patients began throwing in a structured "return to pitch" program was 5.5 months (range, three to eight months), and the average time to return to competition was 9.5 months (range, 4.5 to eighteen months). Seventy patients had reached the point of maximum recovery less than ten months postoperatively; twenty-nine, between ten and twelve months postoperatively; and seventeen, more than one year postoperatively (Table I). Of the 110 patients who had resumed competition, thirty-three (30%) were competing at a level of competition above the preinjury level, sixty-four (58%) were competing at the same level, and thirteen (12%) were competing at a level below the preinjury level.

The preoperative and postoperative elbow ranges of motion were evaluated for all patients in our cohort (Fig. 2). In the group with normal preoperative motion, (range, 0° to >140°) (n = 81), seventy-eight regained normal range of motion and three did not. Of the three patients who did not regain a normal range of motion, one had a loss of motion of 5° and two had a loss of motion of 10°. Interestingly, two of these three athletes reported playing below the preoperative level. The third athlete reported playing at the previous level of competition. None of these patients considered the postoperative loss of elbow motion to be

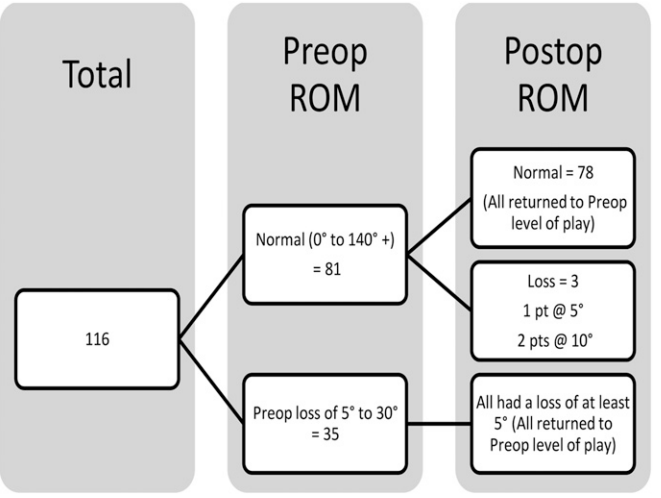

Fig. 2

Summary of preoperative and postoperative elbow range of motion (ROM). Pt = patient.

TABLE I Postoperative Data

Duration of follow-up* *(mo)*	39 (24 to 72)
Structured return to pitch* *(mo)*	5.5 (3 to 8)
Return to competition* *(mo)*	9.5 (4.5 to 18)
Maximum recovery reached *(no. of patients)*	
<10 mo. postop.	70 (60%)
10 to 12 mo. postop.	29 (25%)
>12 mo. postop.	17 (15%)

*The values are given as the mean, with the range in parentheses.

affecting their level of play. In the group with a preoperative loss of motion (range, 5° to 30° loss of extension) (n = 35), all patients continued to have a loss of at least 5° of extension. None of these patients reported playing below the preoperative level.

Conway-Jobe scores were classified as excellent for ninety-three patients (80%), good for fifteen patients (13%), and fair for eight patients (7%). No patient was rated as poor. One hundred and fourteen (98%) of the 116 patients reported being satisfied with the results of the reconstruction and reported it as being successful. Two patients were not satisfied with the result, one because of persistent pain and one because of complications of a medial humeral epicondylar fracture.

There were no intraoperative complications. Postoperative complications occurred in seven patients (6%). One patient had postoperative motor and sensory ulnar neuropathy that resolved over time and did not affect the ultimate satisfactory result. Two patients developed late sensory neuropathy (more than two years postoperatively); one of these patients required ulnar nerve release. Both patients returned to play. Two patients had postoperative wound issues; one required local debridement of a hematoma, and one was managed with an oral antibiotic because of a stitch abscess. Both of these patients returned to play. One patient sustained a medial humeral epicondylar fracture after return to sport and did not resume throwing after this injury. One patient sustained a flexor-pronator muscle and tendon tear fourteen months postoperatively and returned at a lower level of play once the tear had healed.

Of the 116 patients who were evaluated, none had clinical failure of the medial ulnar collateral ligament allograft reconstruction and none had revision reconstruction.

Discussion

The large majority of medial ulnar collateral ligament injuries occur in overhead throwing athletes, especially baseball pitchers[8]. The present study includes only throwing athletes (those who participated in baseball, softball, and javelin) and excluded those who participated in other sports (such as football and wrestling) that also are associated with medial ulnar collateral ligament injuries. Jobe et al. described medial ulnar collateral ligament reconstruction in 1986[3], changing what had been a career-ending injury into one that potentially could be overcome and allow for return to play. The original technique described by Jobe et al.[3] involved a figure-of-eight reconstruction with use of a palmaris longus autograft. The flexor-pronator mass was elevated, and the ulnar nerve was routinely transposed. Many modifications of the "classic" Jobe technique have emerged since the original description. However, all studies of which we are aware have only involved the use of autografts, with ipsilateral and contralateral palmaris longus tendon being the most common. Gracilis, plantaris, toe extensor, and Achilles tendon autografts also have been described[9].

We describe a modification of medial ulnar collateral ligament reconstruction involving the use of hamstring allograft instead of tendon autograft. The normal advantages of allograft over autograft are the lack of donor-site morbidity and a decrease in the risk of complications, both of which were noted in the present study. The overall complication rate of 6% compares favorably with those that have been reported in the literature (range, 3% to 25%)[8,19]. Complications resulting from autograft harvest include superficial infections, scarring, and occasional cutaneous tenderness. Much more substantial injuries, including at least six cases[4,5,7,9] of median nerve harvest, have been reported. In their outcome review study, Vitale and Ahmad reported an overall complication rate of 10% in association with medial ulnar collateral ligament reconstructions, ranging from 3% to 25% between studies, with 1% of all complications resulting from graft harvest alone[8]. Cain et al. reported an overall complication rate of 20%, with 4% of all complications being due to donor-site problems. The elimination of this risk is a reasonable motive to evaluate the results of allograft[11].

One concern with the substitution of allograft for autograft is the potential delay in healing, prolonging the rehabilitative process and delaying the timing of return to play. All but six patients in our study returned to play, with the majority (ninety-nine of 116) returning in twelve months or less. This finding compares favorably with those in most studies that have cited a return to sport at around twelve months postoperatively or "when ready"[6,9,11,19-24]. In the studies by LaPrade et al. involving reconstruction on the lateral side of the knee (representing an extra-articular environment similar to that of the elbow), there was no difference in the rate of recovery between patients managed with allograft and those managed with autograft[19-21].

Another concern is that allograft tissue might be unable to withstand the stress of high-level competition. However, 110 of our 116 athletes were able to return to play, and ninety-seven (88%) of these 110 athletes returned to the same level or a higher level of play, a result that compares favorably with reports in the current literature, which have cited return-to-play rates of 68% to 95%.

An advantage of allograft use is the reduction in surgical time. Nagda et al.[22] showed that, with outpatient anterior cruciate ligament (ACL) reconstruction, allograft saved operating room costs secondary to decreased time expenditure. However, procedures in which allografts were used remained more costly overall when all costs were tabulated.

Another potential downside of using allograft for medial ulnar collateral ligament reconstruction includes the risk of disease transmission[23], but this risk is thought to be extremely low.

One last concern is the rate of incorporation of the allograft. Although we are not aware of any studies that have compared allograft with autograft for medial ulnar collateral ligament reconstruction, a slower rate of time to graft incorporation has been reported in association with the use of allograft in patients undergoing ACL reconstruction[24]. However, Nikolaou et al. reported that the mechanical integrity of allografts and autografts was similar at thirty-six weeks after ACL reconstruction and that revascularization approached normal by twenty-four weeks in both groups[25]. The robust blood supply and the extra-articular environment in the elbow may be more conducive to graft incorporation than the conditions encountered in ACL surgery. Therefore, one would expect the rate of graft incorporation to be more rapid after reconstruction of the medial ulnar collateral ligament than after reconstruction of the ACL.

Vitale and Ahmad[8] reported an excellent Conway-Jobe rating for 83% of patients in their literature review of 328 medial ulnar collateral ligament autograft reconstructions. In our series involving allograft, 83% of patients received a Conway-Jobe rating of excellent. The time to return to the sport in the studies reviewed by Vitale and Ahmad ranged from 9.8 to 26.4 months[8]. The earlier return to play in the current study may have been primarily due to a relatively advanced postoperative protocol. This protocol was based, at least in part, on our perception that the medial ulnar collateral ligament is an extra-articular ligament, unlike the ACL, and that rehabilitation should be closer to that of the medial collateral ligament (MCL) of the knee than to that of the ACL. Earlier postoperative rehabilitation of the hip, back, scapula, and shoulder while the reconstruction is protected by a brace allows an earlier and safer return to play.

The weaknesses of the current study include the fact that the cohort of patients was relatively small compared with that reported by Cain et al.[11]. The present study was not a randomized controlled trial of allograft versus autograft but was a retrospective review involving historical controls.

In conclusion, reconstruction of the medial ulnar collateral ligament of the elbow with use of allograft appears to be an effective alternative to autograft reconstruction after more than two years of follow-up. The time to return to overhead sports, the return to competition, and postoperative levels of competition were comparable, if not better, than those in previous cohort studies[8] while eliminating the potential complications stemming from autograft harvest. ■

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