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Ulnar Collateral Ligament Reconstruction: Graft Selection and Harvest Technique

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Introduction

Ulnar collateral ligament (UCL) reconstruction has proven effective in correcting elbow valgus instability in overhead athletes. Return to the same or higher level of sport has been reported as high as 73–90 % in the recent literature [1–3]. Reconstruction of the UCL has been described using several well-described methods, including the classic Jobe technique and the docking procedure [4–8].

The goal of reconstruction is to reproduce the anatomy, tension, and stability of the anterior bundle of the UCL which is the primary stabilizer of valgus stress to the elbow [2, 4, 9]. Reconstructive options must attempt to resist the tremendous forces generated across the elbow joint during the overhead throwing motion. At end of the late-cocking phase and initiation of the acceleration phase of the throwing cycle, the elbow extends at speeds over 2300° per second generating medial shear forces of nearly 290 N. The valgus load to the elbow at this phase has been documented at 64 N m. This force exceeds the ultimate tensile strength of the native ligament, particularly in the setting of repetitive overhead throwing [10, 11]. The applied load-to-failure moment of the native UCL has been reported by Ahmad et al., Prud'homme et al., and Paletta et al. as 18.8 N m, 20.9 N m, and 30.4 N m, respectively, based on the cyclic loading testing models utilized [12–14].

The selection of an appropriate graft for UCL reconstruction, therefore, focuses on obtaining the strongest available graft with the lowest donor site morbidity. The chapter discusses the available graft selection options and harvest techniques utilizing the most current literature.

Graft Selection Options

Ipsilateral or contralateral palmaris longus tendon autograft is the most commonly utilized graft in UCL reconstruction [1–8, 15, 16]. The gracilis tendon is the second most frequently utilized. In a series of 100 consecutive overhead throwing athletes, Dodson et al. reported use of 70 palmaris (59 ipsilateral, 11 contralateral) and 30 gracilis tendons for reconstruction [2]. In the original description of the UCL reconstruction procedure by Jobe et al., the donor tendon was the palmaris longus (12 patients), the plantaris (3 patients), and a 3-mm wide and 15-cm long strip of Achilles tendon (one patient) [4]. Cain et al. reported the largest published series of UCL reconstructions to date with the results of 743 patients [1]. Autograft distribution consisted of 552 palmaris (512 ipsilateral, 40 contralateral), 175 gracilis, and 16 palmaris tendons. Additional autograft sources in the literature include toe extensor tendons and patellar tendon [3].

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The author primarily utilizes ipsilateral palmaris tendon autograft in most cases due to ease of harvest in the same surgical field. An exception is in the case of female overhead athletes, such as a javelin thrower, wherein the authors experience the tendon may be smaller than the desired 3 mm. All patients are given the option to utilize palmaris or gracilis tendon autograft based on their desired preference after the procedure has been explained. Allograft tissue is utilized only in the revision setting when a reasonable autograft option is not available.

A small percentage of the population has demonstrated an absence of a palmaris tendon. Troha et al. randomly evaluated 200 Caucasian patients for the presence or absence of the palmaris longus tendon [17]. It was absent unilaterally in 3 % of patients and bilaterally in 2.5 % for a 5.5 % total overall absence. Soltani et al. prospectively evaluated 516 patients for the absence of the palmaris tendon based on ethnicity [18]. There was no difference between white (non-Hispanic) and white (Hispanic) patients, with a prevalence of 14.9 and 13.1 %, respectively. However, African-American (4.5 %) and Asian (2.9 %) patients had significantly fewer absences of the palmaris.

Biomechanical studies have been performed to evaluate the ideal graft choice for UCL reconstruction. In a cadaveric model with a uniaxial load applied to catastrophic failure, Regan et al. reported the palmaris tendon had a load to failure of 358 N compared to 261 N in the native UCL [19]. Paletta et al. reported no difference in load to failure between the intact UCL and a four-strand palmaris reconstruction using the docking technique in a single load-to-failure model without cyclic loading [14].

More recent studies have reported a different result. Armstrong et al. performed cyclic testing of the elbow with incremental increases in load until failure defined as 5 mm elongation [20]. The authors reported the native ligament failed at 142.5 N, and the palmaris reconstruction failed at 53 N. The mean number of cycles to failure was 2536 for the intact UCL and 701 for the reconstruction. Using a slightly different loading protocol, Prud'homme et al. reported the native UCL failed at 193.3 N, and the palmaris reconstruction failed at 102.7 N [12]. The mean number of cycles to failure was 367 for the intact UCL and 185 for the reconstruction. Larger gracilis and patellar tendon grafts showed no statistical difference in load to failure or number of cycles to failure. The authors concluded there was no biomechanical advantage to a larger graft; therefore, the palmaris is the ideal graft source secondary to its ease of harvest with low morbidity.

Graft Harvesting Techniques

Palmaris Longus Tendon

The harvesting techniques for the palmaris tendon have been published in recent clinical studies with several small variations [1–5, 7, 8, 21]. It is important in the office and again in the preoperative area to confirm the presence of a palmaris tendon prior to entering the operative suite. The clinical examination to identify the palmaris longus consists of asking the patient to actively oppose the thumb and small finger while slightly flexing the wrist. If the tendon is present, it can be easily visualized and palpated in the forearm just proximal to the wrist crease (Fig. 12.1). Signing both the surgical site and the

Fig. 12.1 Clinical photograph demonstrating the technique for examining the presence of a palmaris longus tendon. The patient is asked to actively oppose the thumb and small finger while slightly flexion the wrist. If present, the tendon is visualized and palpated just proximal to the wrist crease

Fig. 12.2 The surgical site and the palmaris tendon harvest site are signed individually in the preoperative holding area to confirm the clinical presence of the tendon

palmaris tendon at the level of the wrist is routinely performed by the author (Fig. 12.2). The surgical extremity is positioned using a hand table extension.

A 1-cm incision is made in the volar crease of the wrist. Superficial exposure is performed with a dissecting scissor to expose the tendon. Caution is exercised to avoid deep dissection to avoid iatrogenic injury to the underlying median nerve. The tendon is delivered from the incision using a right-angle hemostat and tagged with a braided No. 1 or No. 2 suture in a Krackow fashion (Fig. 12.3). The distal end of the tendon is then cut in preparation for harvest. A tendon stripper is then utilized to harvest the tendon (Fig. 12.4). Complete harvest of the tendon is confirmed by visualizing the proximal muscular attachment (Fig. 12.5). Azar et al. have described using two additional small incisions at 7–9-cm intervals along the palmaris to further confirm the ligament has been appropriately identified at the musculotendinous junction before harvest [3] (Fig. 12.6). This step may further decrease the risk of iatrogenic median nerve injury.

After harvest, the tendon is prepared by removing any muscle tissue proximally. The tendon diameter is confirmed using a tendon sizer and is typically 3–3.5 mm in diameter in most cases (Fig. 12.7). The tendon should be at least

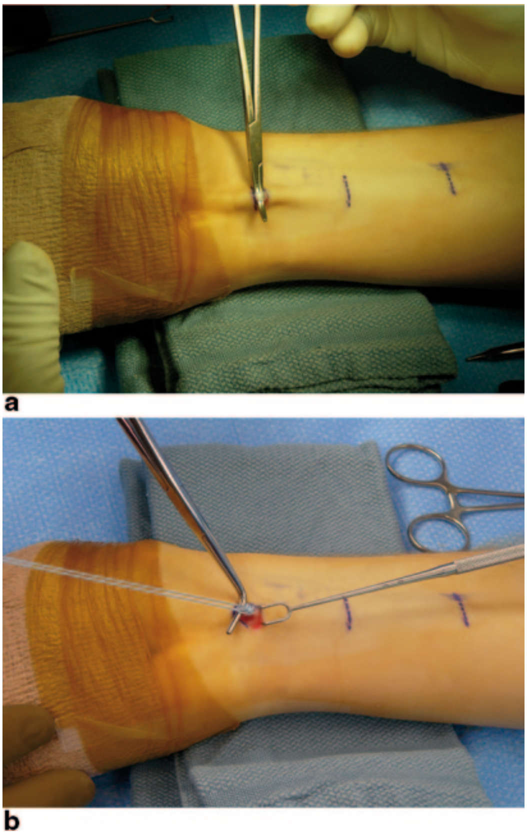

Fig. 12.3 **a** The intraoperative image of a right wrist demonstrates delivery of the palmaris tendon through a 1-cm incision in the wrist flexion crease using a curved hemostat. **b** The tendon is tagged in a Krackow fashion using a braided suture and its distal attachment is released

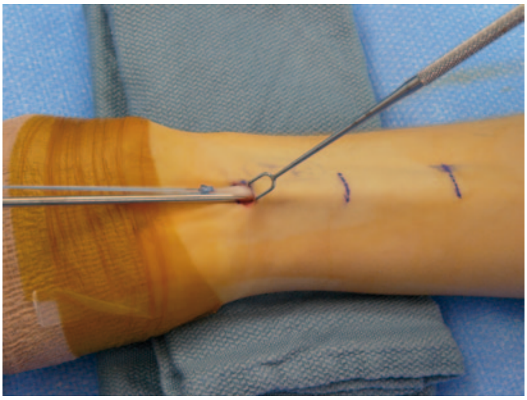

Fig. 12.4 The intraoperative image of a right wrist demonstrates passage of the tendon harvester over the palmaris tendon through a 1-cm incision in the wrist flexion crease

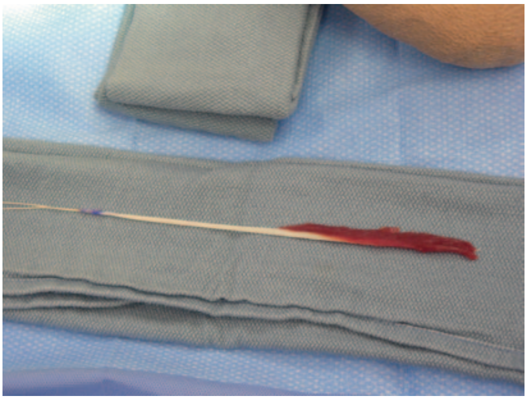

Fig. 12.5 The intraoperative image demonstrates a harvested palmaris tendon with proximal muscle attachments. The tendon is gently debrided of any residual muscle tissue during graft preparation

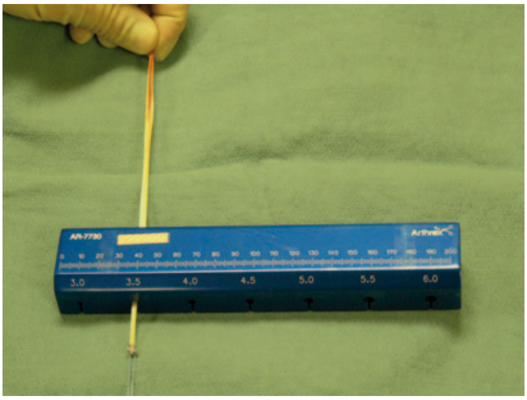

Fig. 12.7 The intraoperative image demonstrates use of a tendon sizer to confirm the palmaris tendon diameter. The tendon is typically 3–3.5 mm in diameter

Fig. 12.6 The intraoperative image of a left wrist demonstrates delivery of the palmaris tendon through a 1-cm incision in the wrist flexion crease and a second incision proximal incision confirming identification of the tendon to avoid iatrogenic median nerve injury. (The wrist crease and hand are to the *left* of the image)

10 cm in length and can range up to 20 cm. Most surgical descriptions of UCL reconstruction describe drilling 3–3.5-mm bone tunnels on the ulna; therefore, the graft should accommodate this [1–3, 5, 8]. The graft is then placed in a moist sponge and protected on the back table.

Gracilis Tendon

The gracilis tendon may be utilized as the primary autograft source for UCL reconstruction when the palmaris tendon is absent or in the revision setting when the palamris has been previously harvested. In some cases, overhead athletes have elected to use the gracilis as the primary source of autograft secondary to concerns of forearm pain with pitching, although the occurrence of this is quite rare [1, 3]. Harvest of the gracilis from the contralateral or the plant leg of the thrower has been reported by Dugas et al. [22]. Contralateral harvest avoids the potential for residual weakness at deep knee flexion angles reported after hamstring harvest that may affect the power generated when pushing off the back leg (ipsilateral) during the throwing cycle [23–25]. The surgeon must consider this when positioning the patient and operative table during the procedure for ease of access to the extremity.

Gracilis tendon harvest is employed most commonly in the setting of anterior cruciate ligament (ACL) reconstruction [23, 26, 27]. The technique for harvest of the tendon for UCL reconstruction is quite similar. Often the harvest can be performed through a slightly smaller incision due to preservation of the more distal semitendinosus. The gracilis tendon is often larger than the palmaris and may require careful trimming of the graft to a diameter of 3–3.5 mm.

Harvest of the gracilis is performed using a 2–4-cm incision in the anteromedial tibia. The Sartorius fascia identified and incised in line with the fibers taking care to protect the saphenous nerve. Adhesions between the gracilis and semitendinosus tendon or gracilis and gastrocnemius are carefully removed to circumferentially free the tendon (Figs. 12.8 and 12.9). A tendon stripper is then used to harvest the tendon. The knee is flexed during harvest to decrease the risk of saphenous nerve injury and iatrogenic truncation of the tendon [23, 24, 28]. Then tendon is often much longer than 10 cm. The proximal muscle is removed from the tendon in a similar fashion as discussed for the palmaris. An alternative "posterior" method of hamstring harvest has been proposed by Prodromos et al. that may allow for easier distinction of the hamstring tendons and improved cosmesis [27, 29].

Fig. 12.8 The intraoperative image of a left knee demonstrates the isolated gracilis tendon prior to harvest. The gracilis tendon is then inspected for adhesions to the gastrocnemius as shown in this image. Adhesions must be freed prior to gracilis harvest to prevent truncation of the tendon

Fig. 12.9 The intraoperative image of a left knee demonstrates the isolated gracilis tendon prior to harvest. Gastrocnemius adhesions have been freed and the tendon is adequately mobilized for harvest

Complications

Complications of palmaris and gracilis tendon harvest are fortunately infrequent. It is important to discuss the potential complications during preoperative planning in order for the patient to make the most informed decision about autograft selection.

A rare, but potentially devastating complication of palmaris tendon harvest is inadvertent transection or harvest of the median nerve [29]. Deep dissection during palmaris tendon harvest should be avoided. The author recommends using an additional proximal incision to confirm the palmaris musculotendinous junction. If the palmaris cannot be clearly identified, an alternative graft choice should be considered.

In the series of UCL reconstructions reported by Azar et al. 4 (4.4 %) patients reported complications related to palmaris harvest. Two reported superficial wound infections that resolved with oral antibiotics, and two reported tightness or tenderness at the harvest site.

Gracilis tendon harvest complications have primarily been reported in the setting of ACL reconstructions [23–28]. Superficial wound infection, saphenous nerve injury, and loss of knee flexion strength are the most commonly reported complications. The risk of knee flexion weakness may be less when harvesting the gracilis tendon alone [25]. Postoperative sensory disturbance in the saphenous distribution has been reported as high as 73 % [28]. Sanders et al. reported the saphenous nerve was intimately associated with the gracilis for 4.6 cm in the distal thigh over a segment of the tendon spanning 7.2–11.8 cm proximal to the insertion [28]. This places the nerve at risk when passing the tendon stripper for harvest.

Conclusion

Surgical reconstruction of symptomatic UCL injuries in the overhead athlete has demonstrated high levels of return to play. Graft selection and safe harvest technique are critical steps in UCL reconstruction for a successful outcome. The palmaris longus and gracilis tendon autografts are the most commonly used and accessible options for reconstruction. Complications can be minimized with attention to surgical technique and knowledge of the surrounding neurovascular anatomy.

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