■ **D I S T A L   R A D I O U L N A R   J O I N T   S Y M P O S I U M** ■

Suture Welding for Arthroscopic Repair of Peripheral Triangular Fibrocartilage Complex Tears

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■ **ABSTRACT**

This report presents a method of arthroscopic repair of the peripheral triangular fibrocartilage tears by using ultrasonic suture welding technique, thus avoiding the need for traditional suture knots. This technique eliminates the potential causes of ulnar-sided wrist discomfort especially during the postoperative period. Twenty-three patients (9 women and 14 men; mean age, 35 years; range, 18–52 years) were operated during a 1-year period in 2001 for Palmer grade 1B triangular fibrocartilage complex tear and followed up for 17 months. At the final follow-up, the average wrist arc of motion was as follows: extension, 65 degrees; flexion, 56 degrees; supination, 80 degrees; pronation, 78 degrees; radial deviation, 12 degrees; and ulnar deviation, 25 degrees. Grip strength measured with a dynamometer (Jamar) averaged 81% of the contralateral side at the final evaluation (range, 53%–105%).
Keywords: triangular fibrocartilage complex, arthroscopy, repair, suture-welding

■ **HISTORICAL PERSPECTIVES**

Arthroscopic repair of triangular fibrocartilage complex (TFCC) tears is now a universally accepted technique that provides excellent functional outcome. The arthroscopic techniques currently in use rely on the subcutaneous suture knots on the ulnar aspect of wrist for securing the repair.[1–17] However, the tying of suture remains the main pitfall that may lead to an early failure due to breakage of suture at the knot.[18–23] Moreover, it often leads to knot-related problems especially in the early postoperative period, manifesting as ulnar-sided discomfort.[24]

The arthroscopic knots tend to be more time consuming, cumbersome, and technically more difficult

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as compared with the mini-incision technique. No matter which technique is used, the knots tend to be more bulky and often lead to foreign body tissue reaction and knot impingement that may compromise the repair.[18,19,24]

The suture welding technology uses 70 kHz of ultrasonic vibration to weld 2 limbs of monofilaments together using a low profile loop (Axya Weld; Axya Medical Inc, Beverly, Mass), thus obviating the need for knot tying. There is no thermal damage to the surrounding tissues. Moreover, the tensile properties of the welded monofilament are superior to those of knotted monofilament.[20] Our report presents the technique of suture welding in arthroscopic repair of Palmer 1B type[25] of peripheral TFCC tear, which avoids the use of suture knots, thus preventing postoperative complications related to knot slippage or subcutaneous ulnar-sided discomfort.

■ **INDICATIONS OF TFCC REPAIR**

When arthroscopic evaluation reveals a peripheral tear with loss of the trampoline effect on disk palpation, a suture repair is indicated (Fig. 1). A Palmer 1B tear is the most frequent indication, and the size of the tear determines the number of sutures to be placed. Radial-sided tears (1D) are generally not repaired because of poor blood supply in this region of the TFCC articular disk. Small tears may still require repair, if the clinical examination warrants so, because scarring about the tear may lead to a false sense of the tear size and consequent instability. This may require more aggressive debridement with mechanical shaver and/or radiofrequency to enlarge the defect and allow restoration of the disk tension.

■ **CONTRAINDICATIONS FOR TFCC REPAIR**

A grossly unstable DRUJ (distal radioulnar joint) with obvious complete loss of foveal attachment will require an open repair. This requires reattachment of the entire TFCC complex to the fovea using bone anchor or drill holes. An arthroscopically assisted technique for this is possible, but the standard repair of the sixth

FIGURE 1. Arthroscopic view demonstrating a Palmer type 1B tear of TFCC disk with synovitis. Note the concavity on the disk surface due to loss of trampoline effect.

compartment floor (as described herein) is not adequate for this profound instability. Smaller tears without loss of trampoline effect are also not indicated for arthroscopic suture repair. These minimal, but frequently painful, tears are amenable to simple debridement and perhaps radiofrequency shrinkage to further stabilize tissues and minimize redundancy.

■ TECHNIQUE

A regional block anesthesia at the elbow level is administered, with the patient in the supine position, after administering light intravenous sedation. An upper arm tourniquet is applied, and the shoulder holder is positioned. Once the arm is prepared and draped, 2 finger traps are applied to the index and middle fingers, and 10 lb of traction is applied while the arm is held down with a wide tape for countertraction at the tourniquet level.
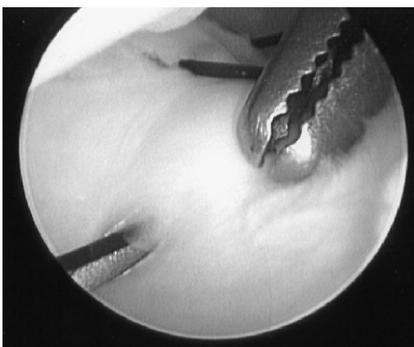
FIGURE 2. Arthroscopic view showing retrieval of the suture by a small tissue grasper, through an 18-gauge needle passed through the TFCC disk.

Diagnostic Scope

After insufflation of the joint with saline, a 2.7-mm 30-degree arthroscope is introduced into the 3–4 portal. A cursory examination is performed to inspect the entire radiocarpal joint and to confirm the peripheral TFCC tear. A 6R or 4–5 portal is created to permit the insertion of a full-radius shaver. A small joint probe is then substituted for the shaver and is used to assess the integrity of TFCC.
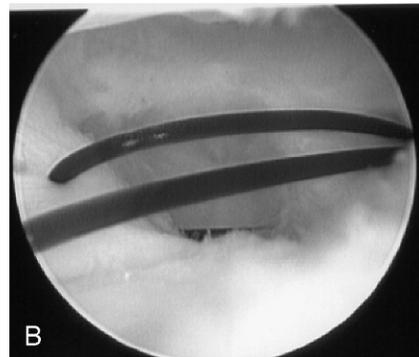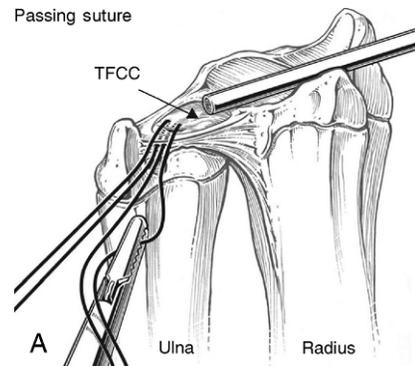
FIGURE 3. A, Illustration showing arthroscopic view of sutures spanning the TFCC tear, without tension. B, Arthroscopic view showing sutures spanning the TFCC tear, without tension. C, Arthroscopic view showing suture spanning the tear under tension. Note the loss of concavity on the disk, signifying restoration of trampoline effect.

Suture Passage

A 0.5-cm longitudinal incision is made directly over the area of TFCC detachment as determined by external palpation and arthroscopic visualization. A needle is passed through this incision, and a small joint grasper is inserted to retrieve the suture. It is important to extend longitudinally and ensure the safety of dorsal sensory branch of the ulnar nerve.
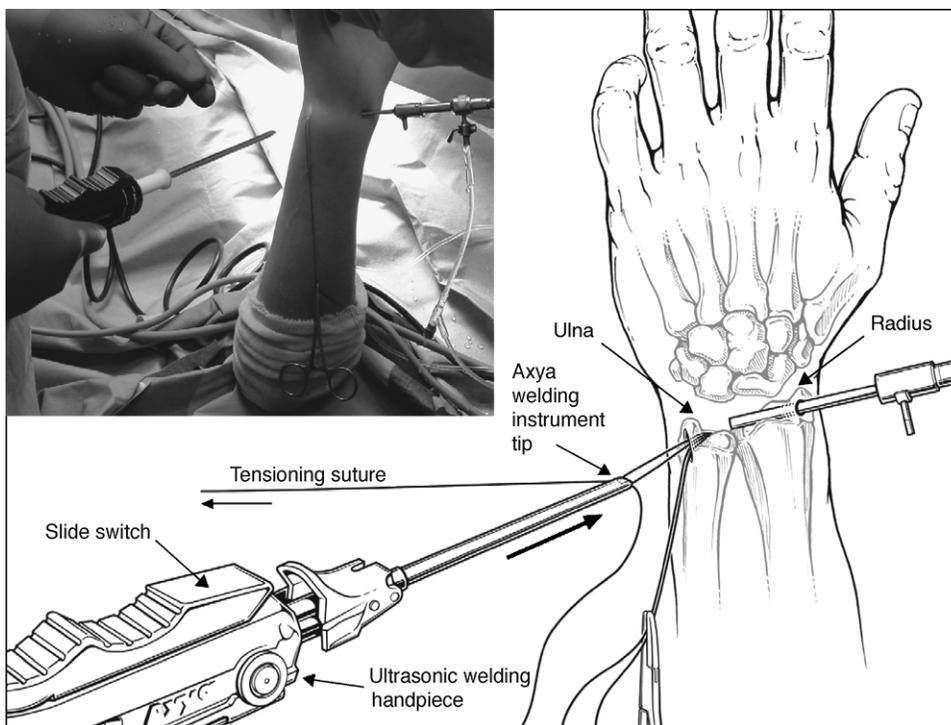
The TFCC perforation and suture passing can be performed with commercially available instruments or a simple 18-gauge needle. The needle is passed within the longitudinal incision, into the tear, and then across the edge of the visualized TFCC detachment in a proximal to distal direction. The more volar edge is first perforated, and a 2-0 nylon suture is passed through this needle and retrieved more distally above the disk with a small joint grabber or small straight clamp (Fig. 2). It is important to pull out the 18-gauge needle before retrieving the suture while grabbing the suture intra-articularly to avoid cutting it on the bevel of the needle. Once a simple suture is passed, traction is applied, and the second needle is more easily passed through the now-taut TFCC disk. This second suture is passed more dorsally, and that is usually all that is required to close the defect (Fig. 3A). Both these sutures pass just volar to the sixth compartment, and additional sutures, if required, should be passed across

FIGURE 5. Photograph showing new fixation sleeve without a J-slot, for less cumbersome welding and easy release.

the floor of the compartment by opening the sheath and retracting the extensor carpi ulnaris tendon volarly.

Two 2-0 nylon sutures are now spanning the tear (Fig. 3B), and tension should be applied to them while the wrist is held in full supination (Fig. 3C), because the ulnar head will sit more ventrally within the sigmoid notch in supination, and this allows for a tighter repair of the detached disk. This is an important maneuver because this allows the wrist to be in an advantageous position of supination during the healing process,

Ulna
Radius
Axya welding instrument tip
Tensioning suture
Slide switch
Ultrasonic welding handpiece

FIGURE 4. Illustration and photograph showing welding of the sutures under tension with wrist in supination.

FIGURE 6. Photograph showing postoperative sugar tong splint holding the wrist in supination.

whereas shoulder abduction can be used to compensate for the limited pronation during the rehabilitation period.

Welding Technique

Under arthroscopic guidance and with the wrist in supination, the sutures are now prepared for welding. The welding system (Axya Suture Welding System; Axya Inc) has 3 components: an ultrasonic generator, a resterilizable handpiece, and a per-patient disposable fixation sleeve. The disposable fixation sleeve with the crossed sutures is placed as close as possible to the TFCC tear while tension is maintained and the slot for the sutures is faced inferiorly toward the tissue. The slot for the sutures or the welding instrument tip is at the tip of the fixation sleeve, as close as possible over the repair, to transfer the ultrasonic vibrations to the sutures. It is important to keep the resterilizable hand piece at an angle below the plane of the fixation sleeve, so that the device can be easily disengaged from the suture after welding. Once the appropriate tension is applied, implying that the defect is closed and the trampoline effect is restored, the locking button or the slide switch at the top of the resterilizable hand piece is moved forward to secure the suture at the desired tension. The soft silicone or weld button underneath the switch is now pressed to weld the suture at the tip of the disposable fixation sleeve (Fig. 4). The welding occurs along the length of the J-slot tip. A green light on the ultrasonic generator confirms that welding has occurred, and the welded suture loop can be released by gently retracting the slide switch, pressing down on the repair, and sliding the disposable fixation sleeve distally off the repair site.

The disposable fixation sleeve encompasses the now-welded suture in a J-shaped slot. Once the welding occurs, one must slide the sleeve off the suture loop without disturbing the loop or stressing the repair site. This is performed by axially directing the sleeve off the welded loop and gently lifting up to disengage the suture from the welding inlet area. Recently, a modified fixation sleeve without the J-slot has been developed (Axya Suture Welding System; Axya Inc), which obviates the need of sliding from the welded suture for disengagement, thus ensuring less cumbersome disengagement (Fig. 5). A hook probe can be used to assess the integrity of the welded suture and also to confirm the restoration of TFCC disk tautness. A second suture is now usually welded in a similar fashion. The wrist is held in supination while the small incision is closed with a single absorbable skin suture and the arthroscopy portals are closed with Steri-Strips.

Immobilization and Rehabilitation

A sugar-tong plaster splint is then applied over generous cast padding while the wrist is held in supination with elbow in 90 degrees of flexion (Fig. 6). In the recovery room, immediate digital flexion/ extension is encouraged. One week after the surgery, the splint is converted to a Muenster-type fiberglass cast in supination to permit some elbow flexion/extension while restricting pronation/supination. Cast removal 5 weeks later should be followed by 4 to 8 weeks of physical therapy with active range of motion and strengthening.

■ RESULTS

During a 1-year period in 2001, the senior author (AB) used this technique in 23 patients (9 women and 14 men; mean age, 35 years; range, 18–52 years) who were diagnosed as having a type 1B TFCC tear arthroscopically. Of the 23 cases, 2 patients presented as acute cases (<4 weeks from trauma), whereas of the 19 chronic injuries, many presented well after a remote nonspecific injury. The average follow-up was 17 months. At the final follow-up, the average wrist arc of motion was as follows: extension, 65 degrees; flexion, 56 degrees; supination, 80 degrees; pronation, 78 degrees; radial deviation, 12 degrees; ulnar deviation, 25 degrees. Grip strength measured with a dynamometer (Jamar) averaged 81% of the contralateral side at final evaluation (range, 53%–105%). All the patients of the present series returned to their routine and sporting activities. Our experience with the TFCC suture welding has been excellent and affirms that it is one of the most successful wrist procedures for returning to premorbid function status.

Only 1 patient of the total 23 complained of pain over the scar at the incision site. However, we believe that this pain was a result of direct scar tenderness,

rather than the nonpalpable underlying suture. The potential complications would be failure of suture welding or loss of tension before the suture is welded, leading to incomplete closure of the tear before welding. However, no such complications were encountered in our series.

■ DISCUSSION

The term *triangular fibrocartilage complex* was first coined by Palmer and Werner.[26] It acts as a stabilizer of the distal radioulnar joint and as a focal point for force transmission along the ulnar side of the wrist.[27] Moreover, it also allows for about 6 degrees of range of motion at the wrist.[28] The TFCC is at risk in acute traumatic wrist injuries, especially in high-demand athletes such as tennis players and gymnasts.[29] This injury may actually be one of most common cause of the so-called sprained wrist. The mechanisms of injury include a fall on the pronated and hyperextended wrist, distraction forces applied to the volar forearm or wrist, and distal radial fractures.[30]

Repair of peripheral tears of the TFCC has been suggested to regain important functions related to wrist stability and load bearing.[12] Arthroscopic repair has been used universally for most of the types of TFCC tears, and very few indications remain for an open repair.[4] The inside-out technique was the first arthroscopic technique to be introduced for Palmer type 1B repair.[31,32] Both the inside-out and the outside-in techniques entail either the advancement or retrieval of the 2-0 PDS sutures to be brought out to the ulnar side of the wrist. The result is a tied knot, performed through a small incision, sitting on the ulnar aspect of the wrist capsule. In our experience, this superficial knot causes a discrete area of focal tenderness on the ulnar side of the wrist.[24]

Suture welding has been used in several surgical fields with great success.[33] Richmond[34] compared the mechanical properties of ultrasonically welded sutures and conventional tied knots. He concluded that the welding technique is a better option to repair soft tissues compared with the knot tying.

Suture welding technology simplifies the arthroscopic repair of TFCC tears and has been proven to be mechanically superior to tying knots.[24] Because the strength of traditional knot is surgeon dependent, suture welding obviates the knot strength variation, thereby producing more predictable results. Moreover, postoperative tenderness at the incision site is also avoided. This technique represents an important clinical application of ultrasonic suture welding technique in the musculoskeletal system, which may have a broader application for the future of arthroscopic surgery.

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