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Case Report

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Comparison of two different orientations of advanced tight rope implant for distal radioulnar joint instability in same patient - efficacy, recovery and range of motion

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ABSTRACT

The distal radioulnar joint (DRUJ) is the wrist joint that allows rotation of forearm. It involves two bones-The Ulna and the Radius. The distal radioulnar joint is stabilised by ligaments, muscles and bones. The wrist or the forearm joint allows 180 degrees of pronation and supination of forearm by 4 components namely the Radio capitellar joint, the proximal radioulnar joint, interosseous membrane and DRUJ. The triangular Fibrocartilage complex (TFCC) is the primary structure for intrinsic stability of DRUJ with predominantly radioulnar ligaments. Both superficial and deep radioulnar fibres of TFCC plays role in DRUJ stability. The triangular fibrocartilage complex being an essential stabiliser biomechanically furnishes unrestricted range of motion of forearm. In the tears of radioulnar ligaments, the ulnar sided ligament tears are detected to cause DRUJ instability more common. This article discusses a case of DRUJ instability of both right and left wrists in same patient due to trauma with symptoms at varied time period. The advanced tight rope implant was placed in the wrists to regain the function. This case report compares and discusses the efficacy, recovery and range of motion of two different orientations (straight and oblique) of the advanced tight rope implant in DRUJ instability.

Keywords: DRUJ, DRUJ instability, TFCC, Triangular fibrocartilage complex, Tight rope implant, Suture button

INTRODUCTION

The distal radioulnar joint (DRUJ) is the wrist joint that allows rotation of forearm. It involves two bones-The Ulna and the Radius. Ulna being the stable part and radius rotates around it. The distal radioulnar joint is stabilised by the ligaments, muscles and bones. Various structures around this joint provides its stabilization to perform the wrist movements. The structures which form the stabilizing units are the ligaments (triangular fibrocartilage complex, the ulnocarpal ligaments complex, intraosseous ligament), tendons (extensor carpi ulnar is tendon and tendon sheath, muscle (pronator quadratus), intraosseous membrane, bone and joint capsule.[1] With this complex surrounding anatomical structures the DRUJ obtains stabilization mainly from the joint capsule, the triangular fibrocartilage complex (TFCC) and structures surrounding the capsule.[2]

Triangular fibrocartilage complex

The triangular fibrocartilage cartilage complex (TFCC) comprises of five parts namely superficial and deep radioulnar fibres and two-disc carpal ligaments.[3] The disc(fibrocartilage) proximally is stretched between ulna and radius and distally stretched between lunate and

triquetral bones distally. The base of disc is attached to sigmoid notch at its distal part (incisura ulnaris radii). The apex of disc is attached to ulnar head ((Basistyloid fovea) and continuous with ulnar collateral ligament. The disc continues with ulnocarpal ligament on the volar side and gets inserted on the lunate, triquetral and capitate bones.[4,5] The radioulnar fibres from medial of distal radius insert at ulnar fovea (deep fibres) and ulnar styloid (superficial fibres).[2]

Biomechanics of wrist

The wrist or the forearm joint allows 180 degrees of pronation and supination of forearm by 4 components namely the Radio capitellar joint, the proximal radioulnar joint, interosseous membrane and DRUJ.

Pronation and supination

In maximum pronation (90 degrees) the radius rotates around fixed ulna and the two forearm bones are parallel to each other and with maximum interosseous width. During rotational movement the radius results in translational movement in relation to distal ulna. During supination the ulna head is more palmer to radius and more dorsal in pronation. With combination of all these movements, it is considered that DRUJ has "Centrode of rotation" rather one centre of rotation.[6,7] Hence, this biomechanics of DRUJ gives more concern on moving radius than the fixed ulna for DRUJ instability.[2]

Centrode in kinematics: The path traced by instantaneous centre of rotation of a rigid plane figure moving in a plane. The two types of centrode rotation are- Space or fixed centrode and body or moving centrode.

DRUJ stability

The stability of DRUJ is required to resist gravity. For DRUJ the extra and intracapsular structures provide stability extrinsically and intrinsically respectively.[2] The TFCC is the primary structure for intrinsic stability of DRUJ with predominantly radioulnar ligaments. DRUJ capsule gives additional stabilization for Prono supination without anteroposterior luxation. Both superficial and deep radioulnar fibres of TFCC plays role in DRUJ stability. During pronation and supination radioulnar capsule (dorsal and volar) prevents luxation of ulna.[8,9]

Instability of DRUJ

The instability of DRUJ is common but mostly missed during diagnosis. Leaving it untreated can lead to long-term effects. The TFCC being an essential stabiliser biomechanically furnishes unrestricted range of motion of forearm. Both dorsal and palmar radioulnar ligaments are considered to be major factors of DRUJ stability. In the tears of radioulnar ligaments, the ulnar sided ligament tears are detected to cause DRUJ instability more common.[10,11] The clinical diagnosis of DRUJ instability should be correlated with trauma history, pain during supination and pronation. Some patients may experience a click on moving the forearm.[2-12]

Diagnostic aids for DRUJ instability

The DRUJ instability can be examined clinically and radiographically. The history of wrist trauma with painful or restricted pronation and supination is key to diagnosis of DRUJ instability. Various clinical tests are done to detect DRUJ instability. They are stress/Ballottement test, Radius pull test, Clunk test, ECU test and Press test. Among these tests the Radius pull test had showed 100% sensitivity and 100% specificity in cadaveric studies. For TFCC ligament issues press test shows 100% sensitivity.[11] Conventional radiographs in anteroposterior and lateral view of injured and normal wrist can be taken and compared. The anteroposterior view shows widening of distal radioulnar space and lateral view with radioulnar distance of 6mm or more between most dorsal cortices in DRUJ instability.[13] The MRI has greater soft tissue contrast and helps in diagnosing TFCC tears.[14]

CASE REPORT

A female patient of age 38 years reported with pain and swelling in medial side of the right wrist. The patient revealed a history of trauma (balancing two-wheeler during a fall) following which the patient had sharp pain in the right wrist on lifting even minimal weight. The patient also had such pain during supination. Initially the patient was advised to give rest to the right wrist using wrist immobilizer.

Figure 1: Right wrist showing swelling in medial side of wrist (pre-operative image).

Also, the patient was prescribed with anti-inflammatory drugs and enzymes. With conservative management there was no symptomatic relief until a month. Then the patient was advised MRI scan of right wrist. MRI right wrist joint report showed tear in the styloid and foveal attachment of triangular fibrocartilage and in the ulnar collateral

ligament. Also, there was a mild dorsal subluxation of distoradioulnar joint.

Figure 2: Left wrist showing swelling in medial side of wrist (pre-operative image).

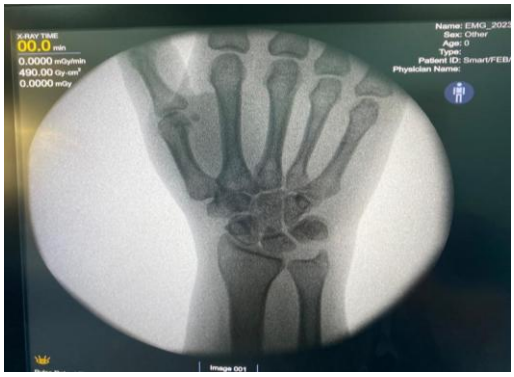

Figure 3: Pre-operative X-ray of right wrist.

Figure 4: Pre-operative X-ray of left wrist.

The patient was then advised for a minor surgical procedure for placement of advanced tight rope to hold radius and ulnar bone to aid the function of the torn ligaments.

Surgical aspects

The keyhole opening was done over ulnar bone with 11 blade and the bone was drilled with 2.5mm cannulated drill. The guiding wire was inserted and the advanced tight rope implant was introduced from ulnar to radius and it was checked under C arm and was found to be in position.

Figure 5: Right wrist post-op X-ray showing straight orientation of advanced tight rope.

Figure 6 (A and B): Left wrist post-op X-ray showing oblique orientation of advanced tight rope.

Then medial tightening was done followed by wound closure with skin stapler. Following surgery, the patient was advised physiotherapy to regain wrist movements. The patient started her activity with physiotherapy

guidance and was able to regain complete movement of right wrist in a month. In about two months after the first surgery (of right wrist), the patient had similar kind of pain and swelling in the left wrist too. Patient was advised X-ray and DRUJ disruption was found. The patient's MRI of left wrist revealed tear of styloid attachment of TFCC with grade 2 sprain of the ulnar foveal attachment. During the previous trauma both the wrists had ligament strain and since patient was a right-handed person the patient had felt the symptoms in right wrist initially.

Figure 7: Right wrist with full range following surgery in 1 and half months.

Figure 8: Left wrist in 1 week after surgery (30 degrees range of supination).

As the patient has been using the left hand more during right wrist immobilization and also after surgery of right wrist the patient eventually felt pain of left wrist. After conservative management the patient did not have symptomatic relief.

Figure 9: Left wrist after surgery in 15 days with physiotherapy.

Figure 10: Left wrist supination range of 70 degrees after surgery in 15 days.

So placement of advanced tight rope was planned as done in right wrist. This kind of ligament strain and tear usually go unnoticed and also the symptoms too depend on activity of the patient. Such ligament tear and strain show pain in the wrists especially during supination if TFCC ligaments are involved. If left untreated the patient will stop performing supination movement due to fear of pain which in turn will affect their activity and also over years it could lead to osteoarthritis of wrist with stiffness and pain.

DISCUSSION

The historic options for acute DRUJ instability were casting, radioulnar pinning and TFCC repair. With these techniques prolonged immobilization, stiffness and infection at pin site were the complications observed. Suture based stabilization augments ligamentous repairs and provides faster rehabilitation with both biomechanical and clinical success.[15]

In a study conducted by Makoa Mau et al with synthetic bone model the placement of suture buttons had restored stability. They had used Arthrex Mini tight rope repair kit in straight orientation and oblique orientation (intraosseous portion of suture button between 30mm proximal to radial styloid and 42mm proximal to the ulnar styloid). Among the orientations the straight across orientation had restored the DRUJ stability effectively than the oblique orientation. The range of motion was achieved in all configurations except for 60 degrees arm pronation.[16] In a biomechanical study conducted by Alexander R Graf et al the range of motion and total translation was analyzed in injured (DRUJ instability created) and uninjured 8 cadaveric arms. In the injured cadaveric arms, 2mm fiber tape sutures (Arthrex) were used to create DRUJ stability. The intact and suture button stabilization specimens showed average range of motion as 174 and 175 degrees respectively. Displacement was not seen with any significant difference among both groups. The translation in pronation was little lesser in suture button system group.[15] Both the above studies had shown near normal and promising results in stabilizing the DRUJ and in obtaining range of motion. They had concluded that clinical applications are required for further understanding and outcomes. Compared to other historic treatment options suture button system technique were more promising alternative according to their studies.

Yu Ning Hsiao et al conducted a first study to report In-vivo outcome of suture button system for treating acute traumatic DRUJ injury.[17] In their study they had utilized suture button system developed by De Vries et al.[18] Three patients with purely ligamentous DRUJ injuries due to trauma were treated with suture button system and the outcomes were discussed. The entry point of pin was at one third dorsal of the ulnar cortex with trajectory (45 degrees) directed towards the volar side of lateral radial cortex. Above the exiting point a 1.5cm longitudinal incision was made. Both suture buttons were engaged on the radial and ulnar cortex and then secured with four square knots. Among the three patients two developed ulnar wrist pain two months following the surgery. The irritation of the dorsal cutaneous branch of ulnar nerve and exceedingly prominent suture button system and four-square knot causing implant irritation were considered to be the causes of pain. They had concluded that knotless suture buttons system may rectify this problem.[17]

Our outlook on the pain that occurred in two patients following two months post-surgery in the In vivo study are I) Following the entry of pin, the trajectory directed on the volar side is more and this could cause tendon (Abductor Pollicis longus) irritation II) Knot causing implant irritation.

In our case study the placement of advanced tight rope holds both ulna and radius thereby holding them together during movements and both the bones work as a single unit. Thereby patient could work more efficiently without pain. In our patient the placement of advanced tight rope implant was done in a straight orientation (dead lateral to dead medial) during her first surgery (right wrist). The patient had good recovery with the placement of advanced tight rope with physiotherapy assistance but the pain experienced while obtaining supination was greater. The pain had impact over the recovery and complete range of motion (particularly supination) took a month. So during the surgery in her left wrist the advanced Mini tight rope implant was placed in an oblique orientation from dorsolateral to ventromedial. The direction of the advanced Mini tight rope was from distal of ulna to distal of radius and orientation was 5 degrees oblique from dorsolateral ulna to ventromedial radial. The range of motion immediately after left wrist surgery (Oblique Orientation-Figure 6) itself was about 10 degrees (supination) which was not seen in the straight orientation (Figure-5 of right wrist). The pain experienced by the patient during supination was also comparatively very less with oblique orientation of the implant. In about 15 days the patient was able to achieve 70 degrees of supination and 80 degrees in 20 days. Thus, the recovery was faster and also less painful with oblique orientation of the advanced tight rope implant compared to straight orientation. Such case of ligament tear in both wrist which happened at the same time but with occurrence of symptoms in different periods is usually very rare. With consideration of patient's recovery, intensity of pain and also considering the biomechanics of wrist in supination the orientation of advanced tight rope implant was done in an oblique direction and it turned out to be very effective. It improved the range of motion in a short duration and as the pain was less, the aid of physiotherapy was minimal for obtaining the movements of wrist. Also, the implant we used was advanced version (advanced mini tight rope) of suture button with small size buttons and thus the irritation was not found. In the implant we used the incision was done in the ulna side alone when compared to two incisions done in the above referred In vivo study. This makes our technique to be even more conservative and render more patient comfort.

CONCLUSION

In our case of bilateral DRUJ instability due to ligament tear following a trauma the efficacy, recovery and range of motion obtained from the two different orientations of advanced tight rope implant came up to be more successful with oblique orientation. Since this happened to be compared in the same patient the efficacy, range of motion and patient comfort (especially in terms of pain) was very

much appreciable. The oblique orientation should not be of more trajectory which was found to be causing irritation in previous In vivo case series study. Thus, the oblique orientation with appropriate direction and angulation (from distal of ulna to distal of radius and orientation was 5 degrees oblique from dorsolateral ulna to ventromedial radial) of suture buttons provides finer outcome in wrist ligament injuries.

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