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RESEARCH ARTICLE

RECONSTRUCTION OF THE RADIO-ULNAR LIGAMENTS USING FREE PALMARIS TENDON AUTOGRAFT GRAFT.

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Abstract

Introduction: The radio-ulnar ligaments of the triangular fibrocartilagenous complex are the primary intrinsic stabilizers of the DRUJ. In this study, isolated DRUJ instability was managed by reconstruction of the Radio-ulnar ligaments using free palmaris longus tendon autograft.

Patient and Methods: Reconstruction of the Radioulnar ligaments was performed in fourteen patients complaining of post-traumatic radio-ulnar instability using free palmaris longus tendon autograft passing through drill holes in the distal radius and ulna.

Results: Mayo wrist score improved from average 38.2points (poor) to be 90 points (excellent) with 9 patients excellent and 5 patients good. The average PRWE changed from 71.28 points to be 14.6 points. The average DASH score changed from 57.8 points to be 8.13 points. Changes in Mayo score, PRWE score and DASH score were significant at $p < 0.05$.

Conclusion: Reconstruction of the radio-ulnar ligaments using free palmaris longus tendon autograft for management of isolated distal radio-ulnar instability can restore DRUJ stability, improve complex wrist motion and grip strength.

Introduction:-

The Articular geometry of the distal radioulnar joint [DRUJ] provides an extensive pronation supination range of motion (almost 180º). However, this extreme range of motion risks the inherent intrinsic stability of the joint. The main intrinsic stabilizer of the DRUJ is the triangular fibro-cartilaginous complex [TFCC] predominantly the volar and dorsal radio-ulnar ligaments [RUL].[1, 2]

Both RUL act in a concert pattern to provide stability in both volar and dorsal direction. In patients with DRUJ instability, both ligaments are likely to be injured and reconstruction of both ligaments is mandatory to restore normal DRUJ stability and kinematics.[3, 4]

Although DRUJ instability often accompanies distal radial fractures, solitary injuries to the DRUJ are common and needs a high index of suspicion.

In this study, reconstruction of the DRUJ was done using free palmaris longus autograft passed through drill holes in the distal radius and ulna.

Patient and Methods:-

Our local ethical review board approved this study.

In the period between February 2012 to January 2015, 14 patients 10 males and 4 females with chronic isolated dorsal DRUJ instability were included in this study. Patients with distal radial malunion, arthritis of the DRUJ were excluded from this study.

The patients' average age was 31.7 years (ranging from 22 years to 41 years). Right side was affected in 8 patients and left side in 6 patients with the dominant wrist affected in 10 patients.All the patients had a traumatic insult to wrist with fall down on outstretched hands (forced hyperpronation and extension of the wrist).9 patients got their injury during sport activity, 2 patients during work related injury, 2 patients with domestic injury, and one patient got his injury via fall from a motor bike.

Patients were initially treated by splinting, NSAIDs, activity modifications for at least 6 months with no marked improvement. The average period between the initial trauma and surgical interference was 16.2 months (ranging from 12 to 24 months). (Table 1)

Table 1	
	Studied Group (N=14)
Age (years)	
Mean ± SD	31.7 ± 5.53
Median (Range)	31.5(22 – 41)
Duration between trauma and surgical interference /month	
Mean ± SD	16.2± 3.5
Median (Range)	15.2 (12-24)

Patients were clinically evaluated using antero-posterior stress test. The radius was grasped using one hand and the ulna was held with the other hand and an antero-posterior force was applied. The results of the test were classified to four grades; whereas grade 0: is for normal stability, grade I: for asymptomatic ligamentous laxity with firm end point, grade II: for dynamic instability, and grade III: for spontaneous subluxation and reduction with forearm rotation. Only grades II and III patients were included in this study (9 patients were grade II and 5 patients were grade III).

Radiological evaluation includes an antero-posterior [AP] and true lateral radiographs of both wrists, widening of the radio-ulnar space on AP radiograph in relative to the contralateral side, and a radio-ulnar distance of 6 mm or more between the most dorsal cortices on the true lateral radiographs indicate DRUJ instability.

Range of motion was recorded, preoperative average wrist flexion/extension was 62.8º/58.5º, average wrist radial/ulnar deviation was 17.7º/27.7º, while the average forearm pronation/supination was 62.1º/70.7º.

Preoperative grip strength was recorded using CAMRY® electronic hand dynamometer (figure 1). The average preoperative grip strength was 8.4 kgs (ranging from 6.4 kg to 11.4 kg).

The preoperative Mayo score was 38.2 (poor) preoperative Patient Rated Wrist Evaluation (PRWE) score was 71.28, while the preoperative Disabilities Arm, Shoulder, and Hand (DASH) score was 57.8.

Surgical technique:-

All cases were performed under general anaethesia with tourniquet inflated around the upper arm 100 mmHg above systolic pressure.

Prophylactic third generation cephalosporin was administrated prior to tourniquet elevation.

The bony landmarks of the distal radius and ulna was identified (figure 2) followed by harvesting the palmaris longus tendon through three to four 1 cm incisions in the forearm along the course of palmaris longus tendon (figures 3 and 4).

Figure 1: CAMRY® electronic hand dynamometer for grip strength evaluation.

Figure 2: Identification of bony landmarks.

Figure 3: Identification of the palmaris longus tendon through 3-4 volar incisions.

A 5-cm dorsal incision was done between the 5th and 6th extensor compartments exposing the dorsal surface of the distal radius (figure 5). An L-shaped DRUJ capsulotomy was done with the horizontal limb just proximal to the sigmoid notch.

Figure 4: Harvesting Palmaris longus tendon.

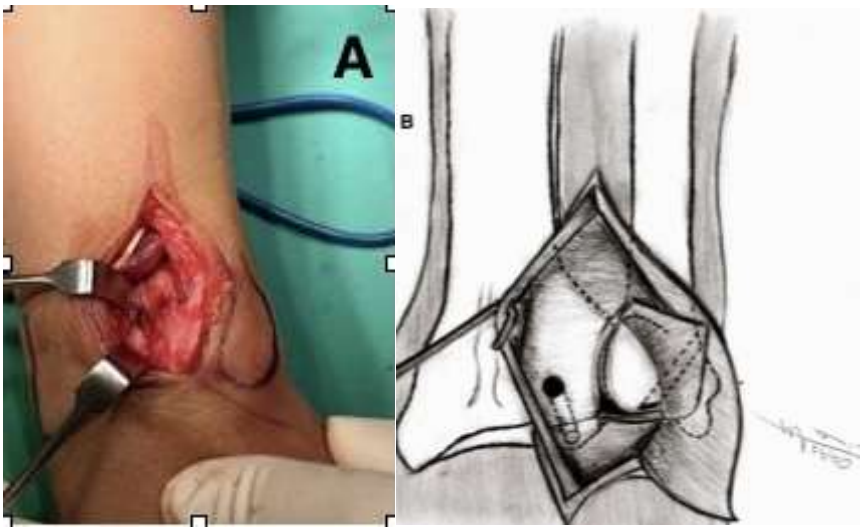

Figure 5 A, B: Through dorsal incision exposure of the dorsal surface of the distal radius.

Under fluoroscopy, a guide wire is used to create a hole in the distal radius 5 mm. Proximal to the lunate fossa and 5 mm. radial to the sigmoid notch, a 3.5 mm cannulated drill is used to create a tunnel in the distal radius (figure 6).The guide wire is used to create a tunnel in the distal ulna between the fovea and base of styloid process to exit on ulnar side of the ulnar neck. Then a 3.5 cannulated drill is then used to create a tunnel (figure 7).

A 3 to 4 cm volar incision is used to expose the volar radial hole and a suture retriever is passed from dorsal to volar and is used to pull one end of the harvested palmaris through the radial tunnel.

A straight haemostat is pushed through the volar DRUJ capsule and is used to get the other end of the graft through this tract (figure 8).

Figure 8: Through a volar incision one end of the graft is passed from volar to dorsal.

Figure 9: The 2 ends of the graft appearing on the dorsal wound.

Figure 10: The 2 end of the graft exit at the ulnar neck, and are passed on opposite direction around the ulnar neck to be tied .

Through the dorsal incision both limbs of the graft, (one dorsal and one volar) are passed through the ulnar tunnel to exit at the ulnar neck (figure 9). The 2 limbs are passed on opposite direction around the ulnar neck to be tied and sutured together with the forearm in neutral rotation and the DRUJ reduced and compressed (figures 10, 11).

Figure 6: A guide wire is used to create a hole in the distal radius 5 mm. proximal to the lunate fossa and 5 mm. radial to the sigmoid notch.

Figure 7: The guide wire is used to create a tunnel in the distal ulna between the fovea and base of styloid process to exit on ulnar side of the ulnar neck.

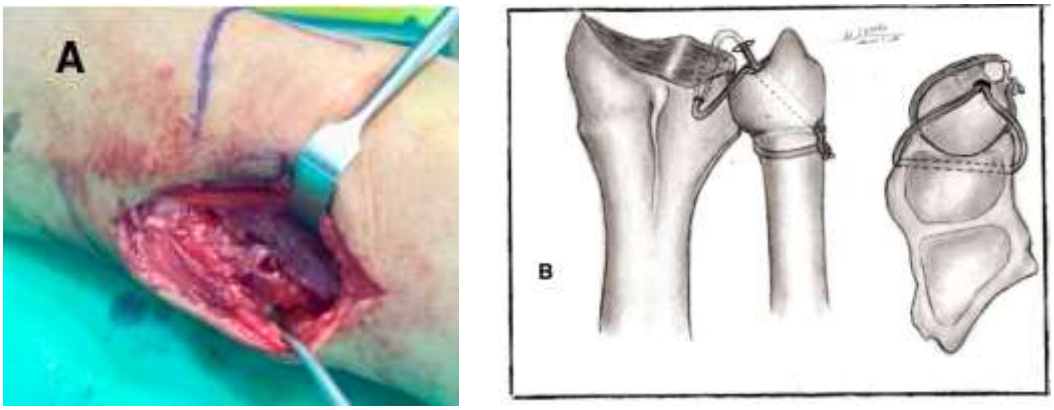

Figure 11 A,B: The 2 ends of the graft are tied together with the joint reduced and compressed.

Post-operative care:-

Post-operatively, an above elbow splint was applied with the forearm in neutral rotation. After 2 weeks, sutures were removed and the splint was converted to above elbow cast in neutral rotation for 2 weeks more. Then a well moulded below elbow cast was applied for another 3-4 weeks.

Two months post-operatively, a removable splint was applied with a rehabilitation program aiming to regain full wrist and forearm motion and strength for 2 months more.

Results:-

Patients were evaluated 12 months post-operatively for stability, range of motion, grip strength, Mayo score, PRWE, and DASH were recorded.

Anteroposterior stress test was performed in the last follow up; results showed no instability detected in 9 patients [Grade 0] while 5 patients showed ligamentous laxity with firm end point [Grade I].

	Pre-operative (N=14)	**Post-operative (N=14)**	**Value of t**	***p***
Flexion				
Mean ± SD	62.8 ± 4.6	63.5 ± 3.63	0.6938892004	0.499964
Median (Range)	65 (55-70)	65 (60 – 70)		
Extension				
Mean ± SD	58.5± 4.5	60 ± 3.9	1.471960	0.164823
Median (Range)	60 (50-65)	60 (55-65)		
Pronation				
Mean ± SD	62.14 ± 4.2	63.5 ± 4.12	1.748949	0.103855
Median (Range)	62.5 (55-70)	62.5 (60-70)		
Supination				
Mean ± SD	70.7 ± 5.13	71.8 ± 3.25	1.069780	0.30418
Median (Range)	75(65-80)	70 (65 –76)		
Radial deviation				
Mean ± SD	17.7 ± 1.3	18.14 ± 1.2	1.748949	0.103855
Median (Range)	18 (16-20)	18 (16 – 20)		
Ulnar Deviation				

Mean ± SD	27.7 ± 2.43	28.5± 2.06	1.196544	0.252851
Median (Range)	28(25 – 32)	30 (25– 30)		
Paired t-test. ***The result is significant at p ≤ 0.05***				
Table 2 : Pre and post operative range of motion				

Post-operative average wrist flexion/extension was 63.5º/60º, average wrist radial/ulnar deviation 18.1º/28.5º, while the average forearm pronation/supination 63.5º/71.8º. Changes in the post-operative range of motion were not significant at $p < 0.05$. (Table 2)

Post-operative average grip strength was 15.3 kg, changes in the grip strength was significant at $p < 0.05$. (Table 3)

	Pre-operative (N=13)	**Post-operative (N=13)**	**Value of t**	***p***
Grip Strength				
Mean ± SD	8.48 ± 1.4	15.3 ± 1.27	18.064018	< 0.00001
Median (Range)	8.4 (6.8– 11.4)	15.2 (13.6-17.5)		
Paired t-test. ***The result is significant at p ≤ 0.05***				
Table 3 : Pre and post operative grip strength				

Mayo wrist score changed from average 38.2points *poor* (range from 20 to 50) to be 90 points *excellent* (range from 80 to 95), with 9 patient excellent and 5 patients good. The average PRWE changed from 71.28 points (range from 65.5 to 77) to be 14.6 points (range 11.5 from to 18). While the average DASH score changed from 57.8 points (range from 49.1to 69.4) to be 8.13 points (range from 6.6 to 11.1). Changes in Mayo wrist score, PRWE score and DASH score were significant at $p < 0.05$. (Table 4).

All patients showed an improvement of the overall pain with regaining the ability to perform complex wrist movement patterns, and all patients returned to their pre-injury work and sport activity.

Aside from one patient complained of persistent parathesia along the distribution of dorsal ulnar cutaneous nerve no other significant complications were encountered.

Discussion:-

The volar and dorsal radio-ulnar ligaments [RUL] are the corner stone structures providing stability to the DRUJ.[1, 2] These ligaments [RUL] run from the dorsal and volar margins of the radial segmoid notch, respectively blending together in a triangular configuration to be attached to the distal ulna. Near its ulnar attachment the RUL divide in the coronal plane into deep or proximal limb which attaches to the fovea and superficial or distal limb attaches to the radial surface of the base and middle of ulnar styloid process.[3,4]

Traumatic instability to the DRUJ can be isolated or more commonly associated with other fractures “distal radial articular fracture or Galeazzi fracture dislocation”.

Isolated DRUJ traumatic instability is usually caused by fall down on outstretched hands and can be isolated volar instability with the forearm in a supination rotational moment, or the more common isolated dorsal instability with the forearm in hyperpronation rotational moment.[5,6] All the cases of this study were isolated dorsal instability.

	Pre-operative (N=14)	**Post-operative (N=14)**	**Value of t**	***p***
Mayo wrist score				
Mean ± SD	32.2 ± 10.6	90 ± 5.88	29.0000002005	< 0.00001
Median (Range)	45 (20-50)	92.5 (80 –95)		
PRWE score				
Mean ± SD	71.28± 2.92	14.64 ± 2.04	-73.972375	< 0.00001
Median (Range)	71.25 (65.5-77)	15 (11.5-18)		

DASH score				
Mean ± SD	57.8 ± 6.17	8.13 ± 1.24	-34.135724	< 0.00001
Median (Range)	56.2 (49.69.4)	7.8(6.6-11.1)		
Paired t- Test. T***he result is significant at p ≤ 0.05***				
Table 4 : pre and post operative Mayo, PRWE, DASH scores				

Diagnosis of DRUJ instability is difficult and often presents with indistinct symptoms, in this study the anteroposterior stress test was used as a diagnostic criterion, patients with grades II and III were included in this study.

Although conservative management of acute DRUJ instability is usually successful, chronic persistent DRUJ instability leads to chronic ulnar side wrist pain, decreased grip strength, inability to perform complex wrist motion and arthritis of the DRUJ. [7, 8, 9]

Several procedures have been attempted for management of DRUJ instability, most of these techniques fall into 4 categories; 1) Extrinsic radio-ulnar tethering [10], 2) Extensor retinaculum capsulloraphy. [11] 3) Ulno-carpal sling. [12] 4) Reconstruction of the dorsal and ulnar radio-carpal ligaments.

The first 3 categories provide non-anatomic restoration of DRUJ stability and may lead to restriction of wrist motion.[13] Reconstruction of the dorsal and volar ligaments specially when attached to the radial and ulnar near anatomical sites provide an optimal restoration of stability without restriction of wrist motion.[8]

Several tendons were used for reconstruction of the RUL, Palmaris longus (PL), Extensor indicis proprius (EIP), slip of flexor carpi-ulnaris (FCU), slip of extensor carpi-ulnaris (ECU),[14] in this study harvesting of palmaris longus tendon was done. PL provides a sufficient length (average 13cm +2cm) for performing reconstruction without any donor site morbidity.

Anatomical or near anatomical reconstruction of the RUL provides the optimum results, in this study placement of the radial and ulnar tunnels was done according Adams and Lawler[15] recommendations. The radial tunnel was placed 5 mm proximal to the lunate fossa and 5 mm radial to the segmoid notch. While the ulnar tunnel was placed in the distal ulna between the fovea and the ulnar styloid process distally to subcutaneous border of the ulna proximally. No implant was used for graft fixation in this procedure and hazards of pin fracture or migration was eliminated.

Results of this study is comparable to similar studies; Mark Henry [16] performed anatomic arthroscopic assisted reconstruction of the RUL using palmaris tendon graft passed through 3 tunnels in the distal radius and ulna in 25 patients, postoperatively there was no significant difference in the change of range of motion nor grip strength while the DASH score improved from 62 (+ 16) to 7 (+ 3).

Seo et al.[8] In 16 patients performed anatomic RUL reconstruction using palmaris tendon graft, however in 10 patient they did distal radius osteotomy to correct distal radius malunion prior to RUL reconstruction. Results of their study showed no range of motion significant improvement, while grip strength was significally improved. PRWE improved from 62.3 preoperatively to 20.3 postoperatively, Mayo wrist score improved from 72.5 to 92.8, while DASH score improved from 34.5 to 10.5.

Conclusion:-

In Absence of distal radius malunion anatomic reconstruction of the dorsal and volar radioulnar ligaments using palmaris longus autograft is thought to be an effective procedure for restoring distal radio-ulnar instability without any limitation of wrist and forearm range of motion.

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