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Original Research Article

The association of late carpal tunnel syndrome with carpal misalignment following distal radius fracture in old Jordanian women

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ABSTRACT

Background: Late carpal tunnel syndrome following distal radius fracture is a frequent hazard especially after conservative management. Objective was to assess the association of radiological carpal alignment with the intensity of late carpal tunnel syndrome in old Jordanian women during 1 year of distal radius fracture.
Methods: Our retrospective investigation recruited 100 women, aged more than 50 years with unilateral distal radius fracture managed conservatively during one year of the fracture at Royal Jordanian Rehabilitation center, Jordan, between January 2021 to April 2023. Participants were split into 2 groups. Group I comprised of 50 patients with clinical features of late carpal tunnel syndrome (nocturnal or diurnal) and group II comprised of 50 women without clinical features. CTS-6 assessment tool score (1-6) was recorded to evaluate the intensity of the condition. Electrophysiological and radiological evaluation were performed to record carpal alignment. Student t-test was used to assess the variables.
Results: There was a remarkable discrepancy between groups in terms of the radiological variables of carpal alignment (The average of radio-capitate distance, volar tilt and volar prominence height were: -10.69 mm, -19.89 D angle and 1.45 mm, respectively in group I). There was a positive association between reduction in the variables of carpal alignment and the intensity of late CTS. Volar tilt was positively engaged in the late CTS. The threshold of the volar tilt was -19.41 D angle ($p<0.005$).
Conclusions: Modification of the carpal tunnel following distal radius fracture with carpal dorsal misalignment leads to late CTS. Reducing volar tilt and volar prominence height and radio-capitate distance are the main remarkable independent anticipators of late CTS in non-surgically treated distal radius fracture.

Keywords: Distal radius fracture, Carpal tunnel syndrome, Late, Carpal misalignment

INTRODUCTION

Carpal tunnel syndrome is frequent following distal radius fracture.[1] Carpal tunnel syndrome could happen at insult (acute) or following days to weeks (late).[2] Acute form begins hours days of distal radius fracture and is due to the rapid increase in the compartment pressure within the carpal tunnel. This rapid increase of the pressure within the compartment is due to hematoma formation, wrist immobility, soft tissue swelling, or malalignment of the fracture. Risk factors of this form are high-energy insult, fracture comminution, repeated trials of closed reduction, radiocarpal dislocations, fracture malalignment, multi-trauma and females aged less than 48 years. Late form starts weeks after distal radius fracture and is induced by anatomical modifications in the carpal tunnel anatomy following healing of the fracture. Late Carpal tunnel syndrome (weeks following distal radius fracture) is induced by modifying the anatomy of the carpal tunnel following fracture healing. The frequency ranges between

0.5 and 22%.[3] In 4%, the clinical features are temporary and will resolve spontaneously.[4] Mechanisms of late CTS occurring after distal radius fracture include fracture mal-union, chronically inflamed teno-synovium, volar callus, scar with increase in carpal tunnel pressure.[5] Distal radius mal-union and extension of the distal radius were correlated with late Carpal tunnel syndrome in patients managed conservatively. Dorsal angulation and distal radius dorsal shift might lead to distal carpal row dorsal shift and carpal misalignment.[6] The frequency of carpal tunnel syndrome after open reduction internal fixation for a distal radius fracture was 1%- 22%.[4] Preventive carpal tunnel release must be done for patients scheduled for operative management of distal radius fracture. Current investigation objective was to assess the association between modifications in carpal alignment and median nerve entrapment in patients managed conservatively for distal radius fractures during investigation of the location of the capitate to the radius and electrophysiological study of median nerve within one year following distal radius fracture.

METHODS

This retrospective investigation enrolled 100 old women, aged more than 50 years with unilateral distal radius fracture, managed conservatively during one year of the fracture, at Royal Jordanian Rehabilitation center, King Hussein medical city, Amman, JORDAN, during the period January 2021 to April 2023, after obtaining approval from our local ethical and research board review committee of the Jordanian Royal medical services.

Inclusion and exclusion criteria

Inclusion criteria were: women aged more than 50 years and with conservatively managed unilateral distal radius fracture. Exclusion criteria were: Exclusion criteria were: symptomatology of carpal tunnel syndrome before the fracture, peripheral neuropathy, upper limb direct nerve insult and diabetes mellitus.

Subjects were divided into two groups. Group I included 50 women with clinical features of late carpal tunnel syndrome (nocturnal or diurnal) with paresthesia in the median nerve distribution and positive Tinel and Phalen tests. Group II included 50 women without clinical features. CTS-6 assessment tool score was recorded to evaluate the intensity of the condition (Table 1).[7] The Radiological variables: the radio-capitate distance (the distance between the center of the head of the capitate and the volar cortical line of the radial diaphysis), volar prominence height(the distance between the vertex of the volar prominence of the distal radial epiphysis and the volar cortical line of the radial diaphysis) and volar tilt (the angle between the line connecting the dorsal and volar margins of the lunate facet of the distal radius and the line perpendicular to the volar cortical line of the radial diaphysis) were recorded with lateral image of the wrist at late carpal tunnel syndrome onset in group I and at one year following insult in group II.

Table 1: CTS-6 assessment tool.[7]

Variable	Score
Symptoms and history	
Numbness mostly or totally in the median nerve region (Sensory symptoms are mainly in the thumb, index, middle and/or ring fingers)	3.5
Night numbness (Symptoms are mostly when the patient is asleep; numbness wakes patient from sleep)	4
Physical examination	
Thenar atrophy and/or weakness (The bulk of the thenar area is minimized or where manual motor testing demonstrates strength of grade 4 or less)	5
Positive Phalen's test (Flexion of the wrist mimics worsened symptoms of numbness in the median nerve region)	5
Loss of 2 point differentiation (Failure to differentiate 2 points 5 mm or less apart from one another, in the median innervated digits)	4.5
Positive Tinel sign (Light tapping over the median nerve at the level of the carpal tunnel produces radiating paresthesia)	4
Overall	26

>12=0.80 probably of carpal tunnel syndrome, >5=0.25 probably of carpal tunnel syndrome

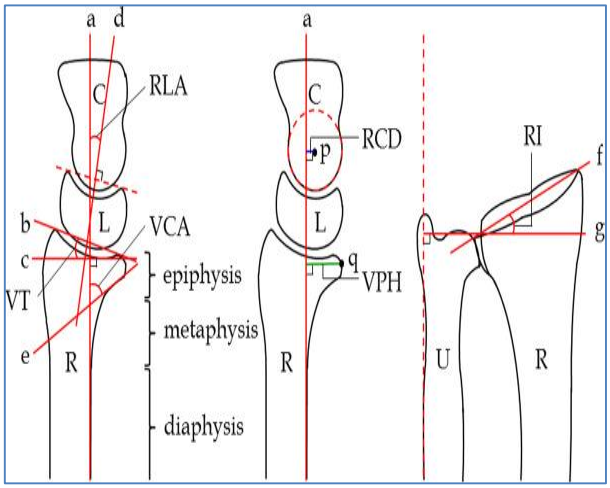

Figure 1: Radiological evaluation- Volar tilt (VT): the angle between lines b and c. Radiolunate angle (RLA): angle between lines a and d. Volar cortical angle (VCA): angle between lines a and e. Radiocapitate distance (RCD): distance between point p and line a. Volar prominence height (VPH): distance between point q and line a. Radial inclination (RI): angle between lines f and 'g'. C, capitate; L, lunate; R, radius, U, ulna.[10]

The (Figure 1). Carpal alignment is demonstrated by the radiocarpal and intercarpal angles. A negative volar tilt suggests dorsal angulation of the distal radial articular surface. The positive radio-capitate distance suggests that the center of the capitate's head is on the volar side from the volar cortical line of the radial diaphysis and negative when it is on the dorsal side.[8]

Table 2: Padua neuro (electro) physiological classification scale.[9]

Score/class	CTS severity	mSDL/uSDL	mSDL	mMDL	Details
0/I	Negative	Normal	Normal	Normal	Normal median sensory conduction velocity with normal comparative study
1/II	Minimal	Pathological	Normal	Normal	Normal median sensory conduction velocity with abnormal comparative study
2/III	Mild	Pathological	Pathological	Normal	Slowing median sensory conduction velocity and normal median distal latency
3/IV	Moderate	Pathological	Pathological	Pathological	Slowing median sensory conduction velocity and abnormal median distal latency
4/V	Severe	Not evaluable	Absent	Pathological	Unobtainable median sensory nerve action potential and abnormal median distal latency
5/VI	extreme	Not evaluable	absent	absent	Unobtainable median sensory nerve action potential and median compound muscle action potential

The electrophysiological investigation included: median (APB) and ulnar (ADM) motor nerve conduction with median (index) and ulnar (little finger) sensory nerve conduction. Median compared to ulnar investigation was performed if there was no electrophysiological abnormality in the median sensory conduction. The scoring of neurophysiological intensity of median entrapment(neuropathy) around the wrist was based on the Padua neurophysiological scale.[9] The (Table 2) depicts the Electrophysiological and radiological evaluation were performed to record carpal alignment.

Table 3: Subjects demographics.

Parameters	G I	G II
Number	50	50
Gender F	50	50
Late CTS features	Yes	No

Statistics

Student t-test was used to assess the variables. Association between CTS-6 score, Padua neurophysiological scale and the radiological variables was performed. The threshold value of variables was evaluated using logistic regression, p value less than 0.05 was considered statistically significant.

RESULTS

There were no remarkable discrepancies in terms of age. Group I; 58.2 yrs. (3.01), Group II;58.3 yrs. (4.05), p>0.05) (Table 3) The average duration between insult and onset of late carpal tunnel syndrome in group I was 5 months (3 months to 7 months) and the average CTS- 6 score in group I was 18.5 (16-21). The average RCD, VPH and VT in group I were -10.69 mm, 1.45 mm and -19.89D angle, respectively. All these radiological variables were remarkably less in group I compared to group II (Table 4). Regarding the electrophysiological study, 46% (23 subjects) experienced mild, 23% (12 subjects) experienced moderate and 2 subjects experienced severe carpal tunnel syndrome in group I but in group II only 3 subjects experienced abnormal comparative study (minimal carpal tunnel syndrome) (Table 4). There was a remarkable negative association between the clinical assessment tool score CTS-6, the intensity of carpal tunnel syndrome based on Padua neurophysiological classification scale for carpal tunnel syndrome and the radiological variables of distal radial displacement (RCD, VT and VPH) in group I (Table 5). There was a positive association between RCT, VT and VPH in group I (Table 6). The threshold value of the RCD was -9.41 mm ($p<0.005$). The threshold value of the VT was -19.41D angle ($p< 0.005$). The threshold value of the VPH was 2.21 mm ($p<0.005$).

DISCUSSION

7.0 D angle, respectively, Volar tilt less than -20 D angle was correlated with higher risk of late carpal tunnel syndrome.[1] Distal radius fracture translation was the main important risk factor in anticipating acute CTS in patients operated for distal radius fracture. An increasing grade and Orthopaedic Trauma Association fracture type C were anticipators for demanding a CTR in open distal radius fracture. Operated DRF had more intensity of bony and soft tissue insult than distal radius fracture managed conservatively. The carpal tunnel pressure following volar plate fixation of a DRF was reduced during the first 24 hours postoperatively. Routine preventive carpal tunnel release is not indicated following volar plating of distal radius fractures.[4]

Table 4: Comparison regarding radiological and neurophysiological variables.

Variables	G I	G II	P value
Radiological, average (SD)			
Radiocapitate distance	-10.69 (1.57)	-6.66 (1.28)	<0.005
Volar tilt	-19.89 (4.78)	-7.78 (6.67)	<0.005
Volar prominence height	1.45 (0.68)	4.04 (1.08)	<0.005
Padua neurophysiological, (N, %)			
1	0	47 (94)	<0.005
2	13 (26)	3 (6)	
3	23 (46)	0	
4	12 (24)	0	
5	2 (4)	0	

Table 5. Associations between variables.

Parameters	Padua neurophysiological	CTS-6 tool
	P value	
Volar tilt		
Volar prominence height	<0.005	<0.005
Radio-capitate distance		

Table 6: Significance of the radiological variables for confirmation.

Parameters	P value	Cut off
Radio-capitate distance		<-9.41
Volar tilt	<0.005	<-19.41
Volar prominence height		<2.21

Total 3% of patients in operated and conservative managements experienced CTS in the unaffected limb. Patients with an increased energy insult or unstable fracture are more likely to have CTS and CTR. Clinical features of CTS must be searched for in patients with DRF, especially in patients with DRF recommended for operation who had other risk factors for CTS (female gender, age more than 50, diabetes and hypothyroidism. Average volar tilt was remarkably less in patients with late carpal tunnel syndrome compared to patients without (-20.5 D angle vs. -11.3 D angle, respectively) and carpal misalignment (dorsal displacement of capitate) induced by mis-union of the distal radius is an anticipator of late carpal tunnel syndrome, with radio-capitate distance as the most important factor in the onset of late carpal tunnel syndrome.[12] This investigation showed that volar tilt was more anticipative. Volar tilt and tear drop angle were remarkable independent anticipators of late carpal tunnel syndrome.[13] The neurophysiological assessment was important to confirm the clinical diagnosis of carpal tunnel syndrome. In our investigation, patients in group I experienced neurophysiological indicators of carpal tunnel syndrome plus a minority in group II. Electro-diagnosis was pathological in 52.5% of fractured hands and 50% of them had paresthesia, dysesthesia or sensory impairment.[1] In this investigation there was a remarkable negative association between the intensity of carpal tunnel syndrome and the various radiological variables of distal radial misalignment. Our investigation sample was small, recruiting only women aged more than 50 years. Other radiological variables such as ulnar variance, radial inclination, scapholunate angle, capitolunate angle, radiolunate angle and tear drop angle were not recorded in our investigation. Ultrasound assessment of median nerve and carpal tunnel anatomical elements might indicate frequent locations of median nerve insults following distal radius fracture and the changed flexor tendon causes that might lead to high pressure below the transverse carpal ligament.

CONCLUSION

Late carpal tunnel syndrome might occur weeks or months following distal radius fracture. Recognizing the risk factors of late carpal tunnel syndrome might help physicians in the management of distal radius fracture to ameliorate neurological recovery and functional result. Reduced volar tilt, volar prominence height and radio-capitate distance are independent anticipators of late carpal tunnel syndrome following distal radius fracture.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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