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Research Article

Assessment of the Incidence of Carpal Instability and Morbidity in Distal Radius Fractures

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Abstract

Aims & Objectives

Investigation of the incidence of concomitant distal radius fractures and carpal instability and demonstration of its contribution to morbidity in this study will introduce a novel approach to the treatment of distal radius fractures.

Materials & Methods

The functional outcomes of 34 wrists of 33 adult patients with distal radius fractures presenting to our clinic in 1994-97 under emergency conditions who were treated conservatively except those who underwent primary surgical treatment primer were scored using Bruijn criteria.

All fractures were assessed using Mayo classification and divided into four groups. 10 of the patients were Type-I, 3 were Type-II, 18 were Type-III and 3 were Type-IV. 9 patients were found to have carpal instability. The incidence of carpal instability in patients with distal radius fracture was 26.4%. Except one patient, the radius fractures of the other patients with carpal instability involved the joint. The incidence of instability of the joint-associated fractures was observed to increase.

Results

The assessment of the functional outcomes revealed that distal radius fractures concomitant with carpal instability radius distal were observed to also increase the De Bruijn scores and morbidity. Impaired angular values of the radius were associated with impaired carpal connection, which restricted the wrist mobility, resulted in declined grip strength and increased distal radius fracture morbidity.

Conclusion

Therefore, distal radius fractures that particularly involves the joint should be assessed for concomitant carpal instability and the treatment of distal radius fractures should be managed considering the recovery of the soft tissue structures of the wrist.

Introduction

Background/rationale: Distal radius fractures concomitant with carpal instability have been studied and treatment options have been suggested by several authors in previous and recent years. Widespread use of motor vehicles, regular exercise habits and increased interest in alternative sports have increased the risk of trauma and thus the incidence of fracture. Given the fact that 47% of the limb fractures occur in upper limbs while 22% of upper limb fractures occur in the distal radius [1] radius distal, the extent of labor loss and national wealth can be understood. Failure to treat these fractures in the right way will result in additional morbidity while concomitant soft tissue pathologies will further increase morbidity [2,3]. While the incidence of carpal instability concomitant with distal radius fractures was formerly around 7% [4-7], it was then demonstrated to rise up to 36% according to the multi-centre studies using arthroscopy [4,5,7-13].

Objective

We believe that investigation of the incidence of concomitant distal radius fractures and carpal instability and demonstration of its contribution to morbidity in this study will introduce a novel approach to the treatment of distal radius fractures. Distal radius fractures are important as they are common fractures of upper limbs. Initial studies were published by Pouteau (1783). Colles (1814) defined the fracture with his name and described its pathogenesis and treatment principles. Other definitions were also suggested by Barton (1838), Smith (1854) and Dupuyren (1847) [14,15].

The complications that were formerly concomitant with radius fracture can be summarized as carpal tunnel syndrome, tendon ruptures and reflex sympathetic dystrophy, which would not change the treatment approaches much, though [16,17]. However, particularly increased wrist kinematic examination since 1970s, better understanding of the concept of carpal instability and the role of distal radioulnar and ulnacarpal joint (Triquetral fibrocartilage complex) have raised the issue of late complications [18-26]. Carpal instability, radioulnar incongruity and ulnar impaction syndrome are among such late complications. These complications revealed that other wrist structures should also be assessed along with radius fracture in addition to its treatment [25,26].

Therefore, the purpose of this study was to investigate the association between the scapholunate angle and radial tilt, radiocapitate displacement, radial shortening and radial angulation, and to demonstrate the scapholunate angle-de Bruijn score relation, scapholunate interval-de Bruijn score [27] relation due to the impact of carpal incongruity on morbidity with a view to demonstrating that soft tissue structures were also injured in addition to orthopedic pathology in distal radius fractures and the resulting carpal instability influenced post-treatment morbidity, the incidence of carpal instability concomitant with distal radius fracture, the impact of radiological angular changes after radius fracture on intercarpal incongruity, repair and morbidity [28-33].

Methods

Study Design

Patients with unilateral distal radius fractures presenting to our clinic for emergency from 1994 to 1997 were included in the study. The type of the radius fracture in 34 wrists (28 left, 6 right) of 33 patients aged 20 to 69 (mean age=44) of whom 22 were female and 11 were male was identified according to the Mayo classification (Table V). Out of 34 patients, 10 were in Type-I, three were in Type-II, eighteen were in Type-III, and three were in Type-IV. After the fractures were classified, radiocarpal and carpal alignment was assessed and compared with the contralateral wrists. The presence of malalignment following closed reduction was investigated. Patients who had radial shortness greater than 5 mm, dorsal angulation greater than 100, developed neurovascular deficit, had multiple fractures, who were old and had primary instable fractures associated with the joint despite closed reduction according to the Garthland's secondary surgery criteria were operated for early mobilization and excluded from the study.

All patients were followed up conservatively. Following the closed reduction, fixation with short arm circular casts was applied to patients older than 45 for 4-6 weeks, with long arm circular casts for 3 weeks and short arm circular casts for 3 weeks to younger patients depending on the fracture stability. Following minimum fifteen-day rehabilitation after the treatment ended, malalignment was assessed through clinical examination, static and dynamic scans. The patients were scored according to de Bruijn criteria based on their complaints and clinical examination results (Figure-1). All findings of the patients were recorded in the wrist follow-up form. The patients were admitted to ther rehabilitation program after their treatment and asked to visit for control following their rehabilitation. During the control, their complaints were questioned according to the Bruijn criteria [28]. Their wrist movements were measured with standard gonyometer and the score in the Bruijn chart corresponding to the extent of movement in the intact wrist was determined.

The motor functions of the hand were proportioned to the intact wrist using dynamometer (Figure 2) and the corresponding score was found in the chart. The functions related to the use of fractured wrist in daily life contained in the chart were asked and the relevant scores were recorded. In the presence of signs and findings during the physical examination, their corresponding scores were found. The total score was calculated by adding up the scores of all parameters. The radiological assessment of the wrist was made by comparing it with the intact wrist. The patients' wrists were assessed using standard anterior-posteriora and lateral scans. Each wrist was measured on the scans at admission, after reduction and following the treatment, which was recorded in the form. The radiological criteria were assessed in two groups.

Complaints	Score
a. Pain while resting	10
a. Pain while moving	8
a. Pain during heavy work/excessive motion (if b=0)	4
a. Numbness of paresthesia in the fingers	3
a. Restricted Daily basic life activities	10
a. Pain while weinging out clothes (if b + c = 0)	3
a. Loss of power	3
a. Subjective judgment of the end result	5 or 10
a. Open question for any other complaints (if a + b + c = 0)	1,2 or 3

Motion in the wrist region	0-40%	40-60%	60-80%	80-90%
• Dorsal flexion	5	4	3	2
• Volar flexion	5	4	3	2
• Radial deviation	2	1	1	0
• Ulnar deviation	2	1	1	0
• Pronation	5	4	3	2
• Supination	5	4	3	2

	Abnormal	Impossible
• Opening a door	5	8
• Weight lifting	5	8
• Picking uo a pen	5	8
• Crumpling a piece of paper	5	8
• Lifting a cup and saucer	5	8

Signs and symptoms	
• Swelling of hand/fingers	5
• Abnormal color	2
• Skin atrophy /hyperesthesia /hyperhidrosis	4
• Ulnar compression pain	2

Cosmesis	
• Cosmetic apperance	2,3, or 5

Figure 1: *De Brujin Scoring system of the final clinical assessment.*

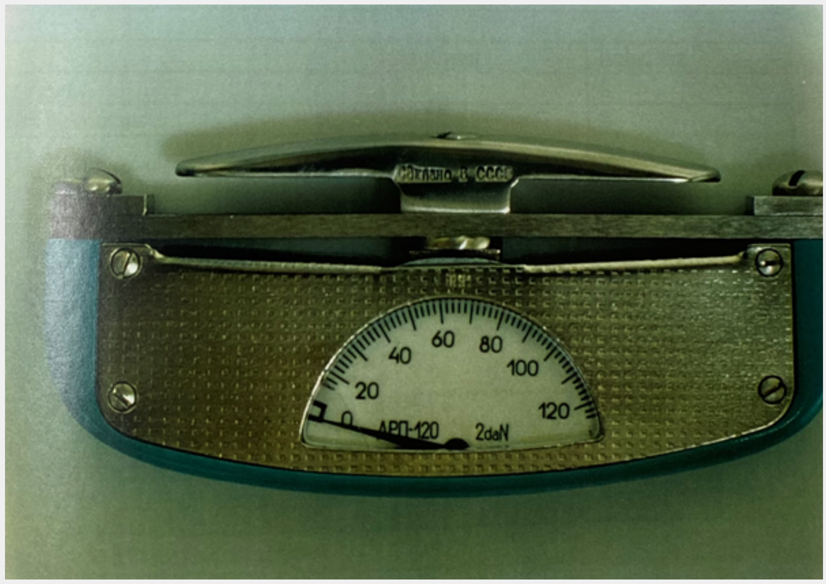

Figure 2: *Hand Grasping Manometer*

1. Radiological findings of the radius

• Radial angulation (RA): measured on anterior-posterior scans. Normal range is 12-30 degrees, mean is 22 degrees.

• Radial tilt (RT): Measured on lateral scans. Tilted 110 degrees on average towards the volar. May range from -7 and 28 degrees.

• Radial length: Measured on anterior-posterior scan. Mean is 9mm. May range from 8 to 14mm.

2.Radiological findings of intercarpal and radiocarpal alignment:

Scapholunate interval: 1-2mm is normal. Pathological if larger than 2mm.

Radiolunate angle: Measured on lateral scans. Normal value is 0 degree. But it may range from 12 to (-9) depending on the flexion of hand. (Dorsiflexion is considered negative)

• Lunacapitate angle: Measured on lateral scan. Pathological if it is greater than 15°.

• Scapholunate angle: It is the angle between the scaphoid and lunate axis on the lateral scan. It may range from 30 to 60 degrees. The mean value is 46°.

• Radio-capitate displacement: Measured on anterior-posterior scan.

The radiological criteria of the patients with total De Bruijn scores were assessed as follows:

A. functional outcomes were shown.

1. The distribution of the mean de Bruijn scores according to the types of fracture,

2. Comparison between the mean "de Bruijn" scores of the patients with and without carpal -radiocarpal instability distribution by the types of fracture,

3. Distribution of the mean de Bruijn scores of the elderly patients according to the types of fracture.

B. Significant association was explored by analysis of variance of the presence of the radiological criteria indicating carpal malalignment an the "de Bruijn" scores. Accordingly;

• Scapholunate interval- de Bruijn score

• Scapholunate angle -de Bruijn score

• Radiolunate angle- de Bruijn score

• Capitolunate angle- de Bruijn score

C. Radial measurements were compared with carpal angles for the radiological parameters and the lineer relationship of the radial angulation was explored for carpal instability.

• Radial tilt- radiolunate angle

• Radial tilt- skafolunat angle

• Radial tilt- kapitolunat angle

• Radial angulation-radiocapitate displacement

D. Significant difference between the mean de Bruijn scores of the patients with and without instability was analyzed with "student-t test".

E. In radius fractures, the incidence of carpal instability and its distribution by the types of fracture were demonstrated.

Setting

TIP: -Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection

- Mention the details of the Supplier/manufacturer of the equipment/ materials (E.g. Chemicals) used in the study

- Mention the details of the drugs (manufacturer, dosage, dilution, frequency and route of administration, monitoring equipment) used in the study

- Mention the details about the cell lines (names and where it was obtained from)

- Mention the details of plant sample collection (Location, time period, validation of the specimen, Institution where the specimen is submitted and the voucher specimen number)

Participants

The distribution of 34 wrists of 33 patients according to the Mayo classification was as follows:

Type-I: 10 Wrists

Type-II: 3 Wrists

Type-III: 18 Wrists

Type- IV: 3 Wrists

Total: 34 Wrist

In our case series, 9 patients were found to have carpal malalignment (26.47%). The distribution of the patients with instability according to the fracture types was as follows:

Type-I: 1 patient

Type-II: 1 patient

Type-III: 6 patients

Type-IV: 1 patient

According to the breakdown of carpal instability by fracture types in our series; Type-l accounted for 2.94%, Type II accounted for 2.94%, Type III accounted for 17.65%, Type IV accounted for 2.94% while the percentage of the patients with Type III fracture was markedly higher. However, when proportioned to the number of patients separately according to fracture types; the incidence of carpal instability was 10% in Type I patients while it was 33% in fractures that involved the joint.

Data Sources/Management

After scoring our patients according to de Bruijn criteria, scores ranging from 0 to 80 were obtained (mean=34.5). The distribution histogram of the mean de Bruijn scores according to fracture types revealed the incidence of morbidity as the severity of the fracture increased. The de Bruijn scores according to the fracture types were 45,5 in Type III and 57,3 in Type-IV. The histogram showing the distribution of the mean de Bruijn scores according to fracture types among elderly patients and young patients separately demonstrates the degree of impact of the age factor on morbidity (Figure-3). This figure shows that as the severity of the fracture increased in both age groups de Bruijn scores also increased; while elderly patients had worse functional outcomes. We didn't have any patient younger than 45 with Type-II fracture.

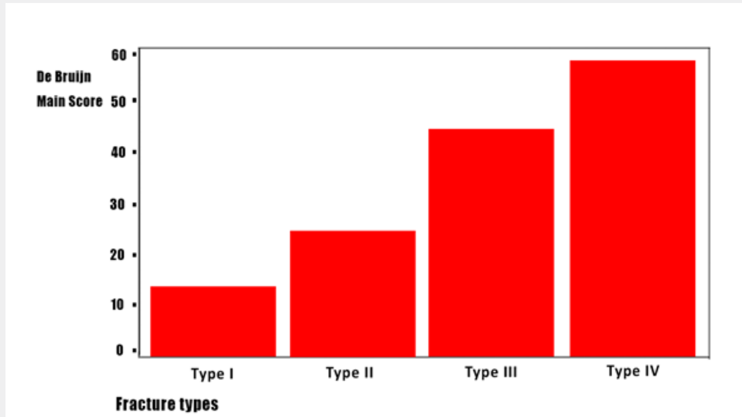

Figure 3: *Fracture types and De Brujin Scores distributions*

Statistical Method

Cross-sectional study-

1.Parameters were compared with Pearson's one-way analysis of variance in order to demonstrate the impact of carpal malalignment on functional outcomes and draw a statistical conclusion

2.Multi-way analysis of variance was performed for the relation between sqapholunate interval and sqapholunate angle and the total de Bruijn score to analyze the effect of both variables together on functional outcome.

3.The regression analyses between the radial angles and intercarpal angles revealed that there was a correlation between the radiolunate angle and radial tilt,

4.The comparison between the mean de Bruijn scores of the groups with and without instability through student-t test revealed a significant difference between the two groups (p=0.38 >0.05).

Main Results

The values found in this study were analyzed according to patient profile, functional outcomes, impact of carpal malalignment on functional outcomes, comparison of radiological parameters of the radius and carpal bones, comparison between the patients with and without instability (student-t test analysis of the patients with and without instability and comparison between their mean de Bruijn scores).

A patient profile:

The distribution of 34 wrists of 33 patients according to the Mayo classification was as follows:

Type-I: 10 Wrists

Type-II: 3 Wrists

Type-III: 18 Wrists

Type- IV: 3 Wrists

Total: 34 Wrist

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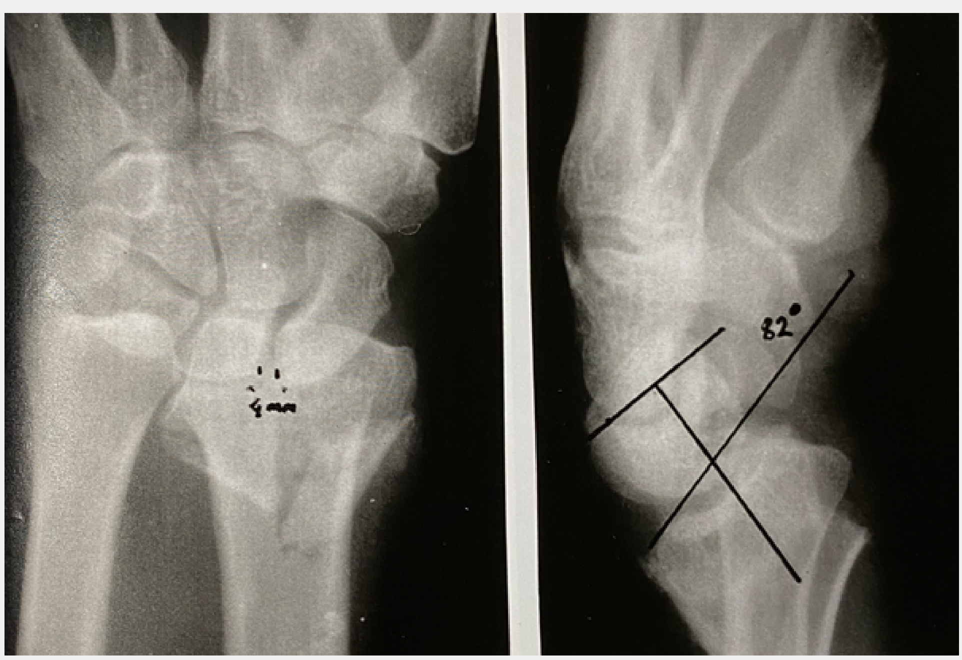

Figure 4: *53 Y Patient with Carpal Instability*

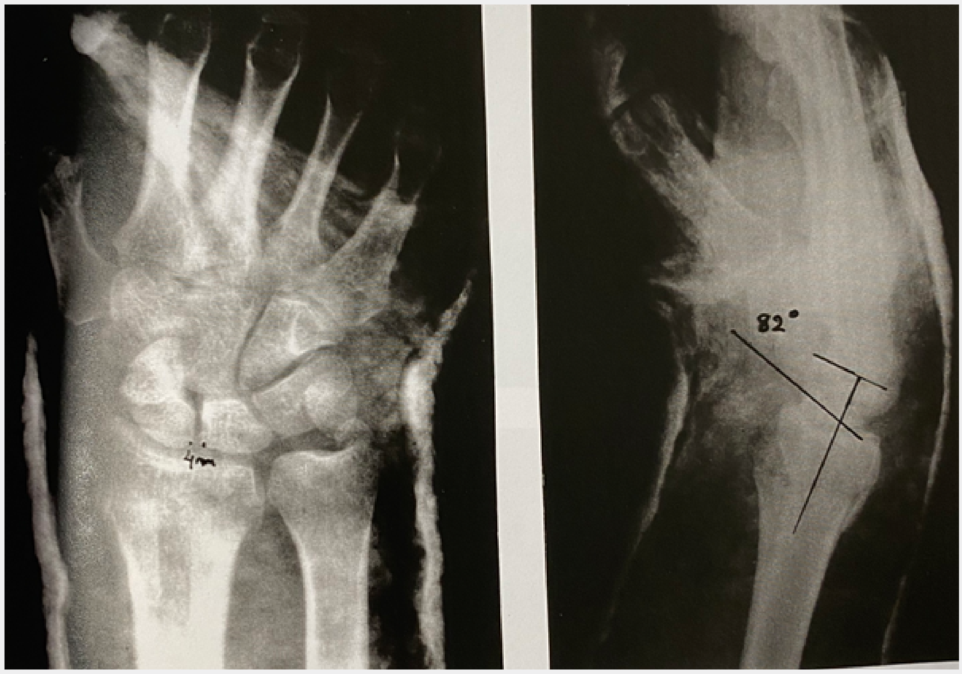

Figure 5: *Patient Radiologic Evaluation After Conservative Treatment*

Figure 6: *52 y old patient before and after conservative tretament carpal relations*

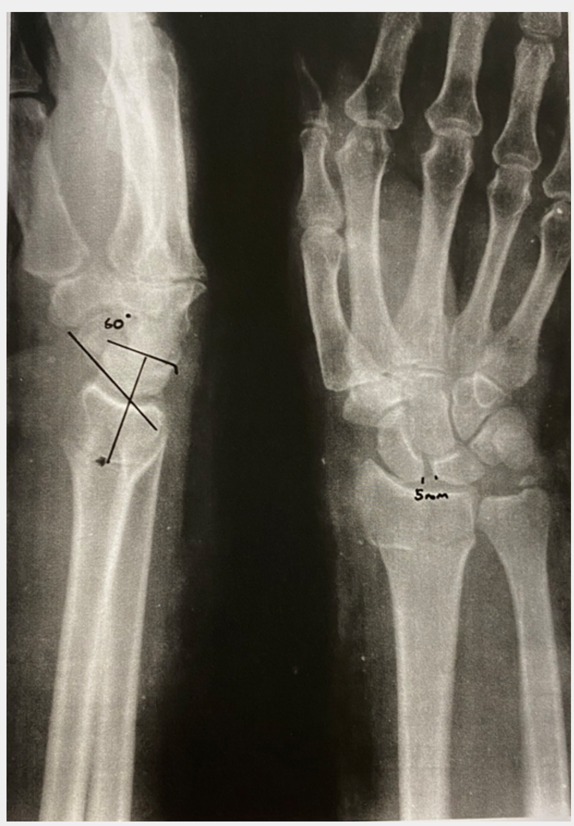

Figure 7: *46 Y Patient with Sl Distance instade of Lateral SL angle limit*

Figure 8: *66 year old Patient PREOP and POSTOP radiologic assesment*

B. functional outcomes

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Figure-III shows that the functional outcomes of the young patients were lower than 40 according to the "de Bruijn" scores. The functional outcomes of the elderly patients with fractures involving the joint were worse that those of the young patients while the mean de Bruijn score for Type-II fractures was 24. This difference can be neglected considering that Type-III and Type-IV fractures had a score of 55,4 and 71, respectively in the same population. However, there was a patient with Type-II fracture in elderly population whose fracture involving lunate facet was non-displaced and stable, which was reason why the functional outcome was that good.

The histogram on the distribution of the mean de Bruijn scores of the patients with and without instability according to the fracture types shows the degree of impact of the instability on the incidence of morbidity (Figure-9).

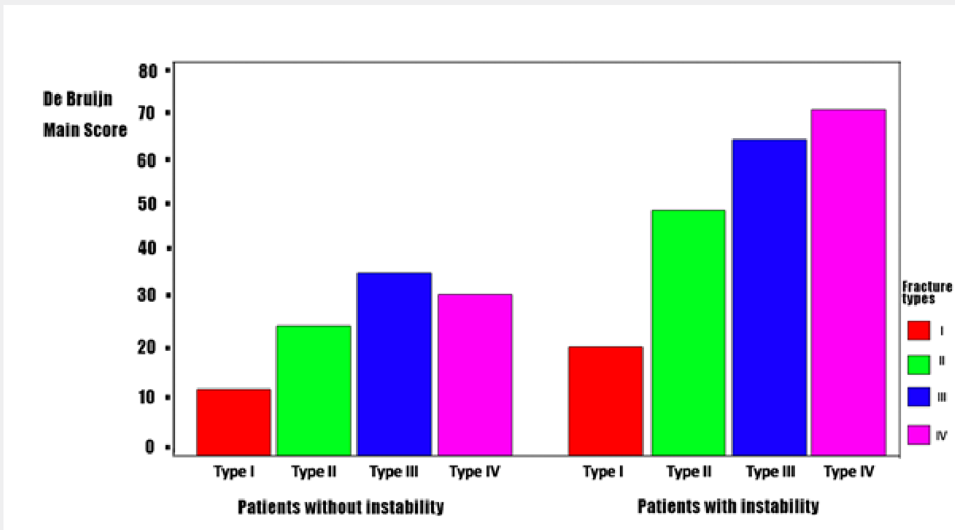

Figure 9: *De Brujin Scores Distrubitions on groups with and without and Instability*

According to the Figure-10; the mean de Bruijn score of Type-IV patients in the patient group without instability was 30, while it was 38,9 in Type-III patients. However, the mean age of Type-IV patients was 34 whereas it was 51 in Type-III patients. This indicates the impact of age on morbidity and functional outcome in addition to the fracture type. One of the striking findings in the same graph was that the de Bruijn score in the Type-I column of the group with instability was as high as that of the patient group without instability who had fractures involving the joint. The difference between the mean de Bruijn scores of the fractures involving the joint in the groups with and without instability indicates the impact of carpal instability on the functional outcome.

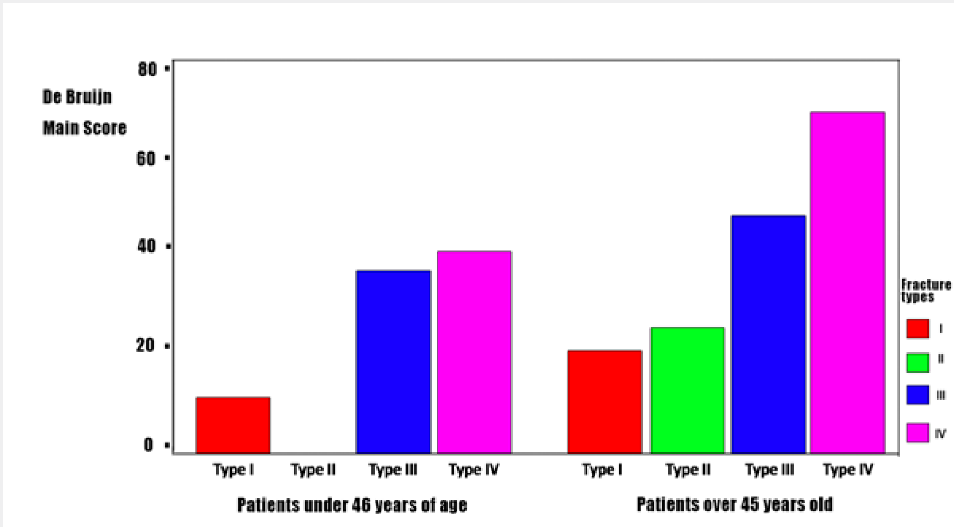

Figure 10: *Fracture type and age distributions*

C. Impact of carpal malalignment on functional outcomes:

Parameters were compared with Pearson's one-way analysis of variance in order to demonstrate the impact of carpal malalignment on functional outcomes and draw a statistical conclusion.

When the effect of the widening of scapholunate interval on functional outcomes was analyzed statistically, it was found have a link with the de Bruijn scores ($P=0.021<0.05$) and widened interval had a negative impact on the functional outcome. It had a stronger correlation with scapholunate angle ($p= 0.012< 0.05$). A greater scapholunate angle has a substantially negative impact on functional outcome. Multi-way analysis of variance was performed for the relation between sqapholunate interval and sqapholunate angle and the total de Bruijn score to analyze the effect of both variables together on functional outcome. The correlation was found to be stronger ($p<0.01$).

Scapholunate angle and interval are assessed together in the clinic and support the diagnosis of scapholunate instability; thus, p value lower than 0.01 in the paired correlation of both parameters supported the clinical finding.

Similar results were obtained from the analysis of variance of the radiolunate and capitolunate angles. Increased radiolunate angle affected functional outcomes negatively ($P=0.014<0.05$)

Capitolunate angle had a weaker correlation. ($P-0.28<0.05$)

According to the regression analysis performed to show if the relationship between the sqapholunate angle and total de b<ruijn score was statistically significant, it was possible to formulate the points obtained with a linear line. This linear line indicates the importance of sqapholunate angle since it affects functional outcome as it increases and carpal malalignment increases morbidity (Figure- V). Morbidity worsens as the de Bruijn score increases in proportion to the increased sqapholunate angle.

D. Comparison between the radiological parameters of the radius and carpal bones:

The regression analyses between the radial angles and intercarpal angles revealed that there was a correlation between the radiolunate angle and radial tilt ($p<0.05$) while the points on the graph produced could be formulized with a lineer line (Figure-11). The same relationship was observed between the radial tilt and sqapholunate angle ($p<0.05$).

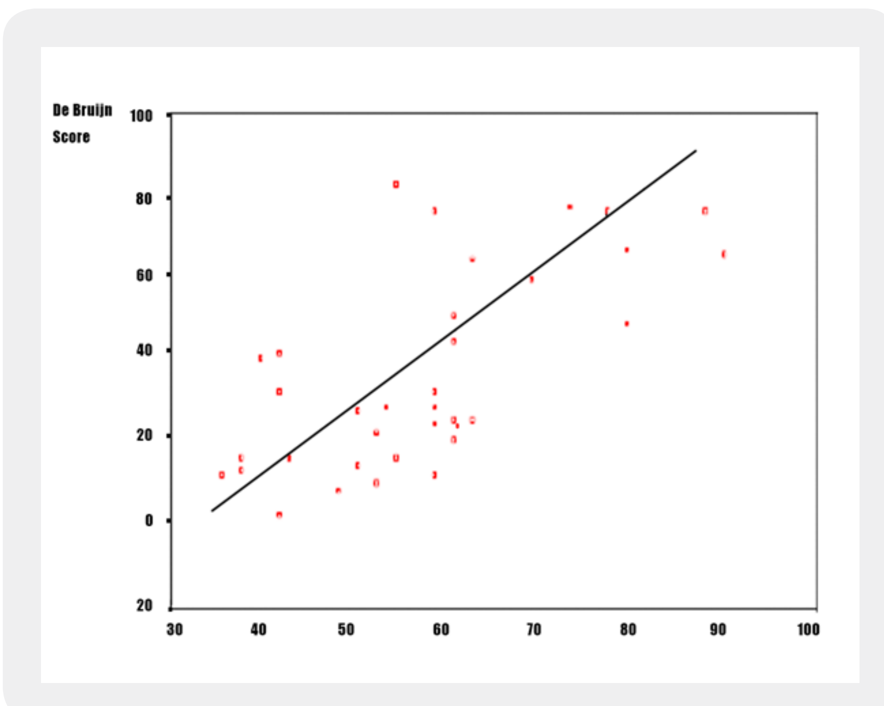

Figure 11: *Lineer Relationship between De Brujin Scores and ScafoLunate Angles*

The regression analysis between the radial tilt and capitolunate angle and between the radial angulation and radiocapitate displacement did not reveal any significant association.

E. Comparison between the patients with and without instability:

The comparison between the mean de Bruijn scores of the groups with and without instability through student-t test revealed a significant difference between the two groups ($p=0.38 >0.05$). The histogram showing the mean de Bruijn scores of both groups is striking as it demonstrates the effect of carpal instability on functional outcomes. (Figure-V).

Discussion

The concept of carpal instability was proposed by Gilford, Bolton and Lanbrunidi in their publications in 1943. The authors described the carpal ring system deprived of scaphoid stopping mechanism resulting in the potential collapse during compression. In 1972, Linscheid classified instabilities according to the rotation of the proximal row that he named as intercalated segment. The dorsiflexion instability of the intercalated segment refers to the dorsiflexion of the lunatum against the radius (DISI) [7,30,32].

Although DISI instability developing after radius fracture was first reported in 1919 by Jeanne and Mouchet at the 28th French surgery congress with the title "dorsal dislocation of the capitate due to malunited distal radius fracture" [5,31], there were not so many publications since then till until the reports of Dobyns, Linscheid and Cooney in 1972. Linscheid published his two cases of DISI that developed after distal radius fracture in 1972 [1,5,33].

In 1984, in a series of 13 cases, Taleisnik found carpal instability due to malunion that developed as a result of angular changes of the radius and distal radius fracture [14,15]. The instability was corrected in these cases after corrective osteotomy. That study demonstrated that pain and decreased grip strength in the wrist due to increased radial tilt developed due to the tilt greater than 250 and shortness greater than 6 mm as described by Fernandez and recommended corrective osteotomy [14,15]. Carpal instability due to increased or impaired radial tilt decreases teh grip strength of the hand and causes pain (extrinsic carpal instability) should reflect and elucidate how the results correspond to the study presented and provide a concise explanation of the allegation of the findings.

In 1983, in a series of 190 cases, Rosenthal *et al.* published the first study on the incidence of carpal instability due to radius fractures which they reported as 7.4%. Rosenthal inculpated displacement and degree of angulation for the presence of instability rather than the severity of fracture. He explained the higher incidence of carpal instability in elderly patients with the dysfunction caused by cortical weakness of the ligament attachment regions as a result of osteoporosis [34].

In 1989, Brown reported a case with VISI in addition to the publications on radius fractures with DISI. Brown associated carpal instability with the rupture of RSL in fractures involving the joint [29].

After the morbidity and functional treatment of distal radius fractures were described by Casebaum, Garthland, Mason, Lindström and Villar, de Bruijn proposed the morbidity criteria in his series where he compared three basic conservative treatments and developed a scoring system. In 1981, De Bruijn grouped conservatively treated patients according to the Sarmiento classification and demonstrated the radiological and functional outcomes. In this study, in addition to the fracture types of the patients, the angles of the radius were measured during radiological examination and their distribution analysis was performed. In the study of De Bruijn, the morbidity criteria were considered in five groups while assessing the functional outcomes and their effect on outcomes were analyzed. These groups are:

1.Complaints

2.Wrist movements

3.Motor functions of hand

4.Signs and Findings (Physical Examination)

5.Cosmetic changes.

When the parameters of each group were scored from 1 to 10 according to their effect on functional outcomes, the total score and the functional treatment outcome of patients were expressed as ''functional treatment score'' in numerical terms. De Bruijn divided the patients treated with different treatment approaches into three groups, compared their functional treatment outcomes and demonstrated the differences between the treatment groups (Sarmiento, Conventional and Functional Treatment) as regards their statistical impact on treatment outcome, thus their morbidity [27].

In 1989, Bickerstaff and Bell compared this score and the radius angles and carpal radiological findings statistically. This study found a significant correlation between radial tilt, scapholunate angle, radiolunate angle, lunacapitate angle and de Bruıjn score and demonstrated the effect of concomitant carpal instability and radius fracture on functional outcomes Therefore Bickerstaff *et al.* demonstrated the statistical association between the numerical values of de Bruıjn scoring system and the angular findings of carpal instability. This study showed that carpal instability criteria affected "de Bruijn" score. Bickerstaff explained extrinsic carpal instability through regression analysis showing the variation in radial tilt ant carpal angle (1) De Bruijn criteria that indicate the effect of distal radius fractures on functional outcomes is the largest study of case series in the literature with the most significant statistical results. Bickerstaffin published similar rsults in his study where he applied these criteria to his patients with carpal instability. Therefore, we also used de Bruijn scoring system in our study and had the opportunity to compare Bickerstaff 's statistical models [28].

In series of 120 cases, Mc Queen *et al.* ark. performed a statistical analyses for the concomitant carpal instability and distal radius fractures and demonstrated the negative impact. This study found that radius malunion with a dorsal angle greater than 100, volar angulation greater than 150 and radial shortness greater than 3mm resulted in canal malalignment [35].

In a series of 10 cases, Mudgal and Jones argued that scapholunate dissociation concomitant with distal radius fracture occurred because lunatum displaced into the the cleft of the radius fracture due to axial overloading [35]. Arguing that resulting ligament injury would not heal in fractures treated with distraction ligamentotaxis and increase instability, Mudgal suggested that canal alignment should be assessed thoroughly especially in four-part fractures involving lunate facet [36].

Mayo classification sheds light on the functional treatment of fracture and also contains instability criteria; on the other hand, it helps us identify the fracture type according to facet involvement especially in fractures involving the joint In the series of Mudgal and Jones, they used Melone classification based on Mayo classification and showing the facet involvement and demonstrated the incidence of sqapholunate dissociation in lunate facet involvement [36].

In two separate studies, Tang *et al.* [35] and Fok *et al*. Reported that concomitant distal radius fracture and soft tissue injury had a negative impact on prognosis [37].

In a series of Cooney where he used external fixator guided by arthroscopy for the treatment of distal radius fractures, he suggested open reduction in case of concomitant carpal instability. Similarly, Fernandez also referred to the challenges of treatment with external fixator for distal radius fractures concomitant with carpal instability [30].

If treatment is not performed well when carpal instability is present, it may still persist after surgery. Fixing the fracture only with a plate without carefully assessing the carpal structures of a patient following Barton fracture, Doig found that DISI deformity that developed five weeks later was a residual outcome when he examined the pre-operative scans; nonetheless, he published it as late carpal instability concomitant with dorsal radial fracture [38,39].

In a series of 132 cases with distal radius fracture, Tang Jin-Bo found that the incidence of carpal instability was 30.6%. In this study, he tried to explain the pathomechanics by demonstrating the relationship between radial tilt and radiolunate angle in some fracture types in elderly patients (instability develops due to cortical insufficiency at the beginning of dorsal ligament due to osteoporosis), especially in dorsal and medioaterally displaced fractures. He argued that DISI developed when radial tilt was greater than 150 while scapholunate dissociation might developed in a range of 50-200 [40].

In cadaver studies, Gilula, Mayfield and Totty examined the carpal ligament injuries in radius fractures they created by forced extension with axial overloading and demonstrated the reasons of residual carpal instability that many surgeons observe after radius fractures [33] When fractures were classified according to Frykman classification to examine the resulting ligament injury; they found

• Radial collateral ligament tear in radial styloid fracture (type-III)

• Volar radiocapitate, radiotriquetral ligament injury in radial styloid and ulna styloid fracture (type-IV)

• Rare TFCC injury in Frykman type-II

• Distal radioulnar capsule, ulnatriquetral ligament injury in Frykman type-VI

• Radiocapitate, radiotriquetral ligament injury in volar, TFCC injury in ulnar in Frykman type-VIII,

• Reverse Barton Frykman type-III volar radioscaphocapitate, radiolunotriquetral lig. radyocarpal lig. injury,

• Frykman type- VIII, Melone type-IV volar radioscaphocapitate, radiolunolriquetral, radiscarocapitate, radial and ulnar kollateral lig. injury.

Therefore, they demonstrated the concomitant soft tissue injury (ffl).

In a multi-center study conducted in 1996, Geissler found 68% of the cases with distal radius fractures suspected to have carpal instability had soft tissue injury after arthroscopic examination and demonstrated that the incidence of carpal ligament injury went up to 46% [32].

Key Results

Parameters were compared with Pearson's one-way analysis of variance in order to demonstrate the impact of carpal malalignment on functional outcomes and draw a statistical conclusion.

When the effect of the widening of scapholunate interval on functional outcomes was analyzed statistically, it was found have a link with the de Bruijn scores (P=0.021<0.05) and widened interval had a negative impact on the functional outcome. It had a stronger correlation with scapholunate angle (p= 0.012< 0.05). A greater scapholunate angle has a substantially negative impact on functional outcome. Multi-way analysis of variance was performed for the relation between sqapholunate interval and sqapholunate angle and the total de Bruijn score to analyze the effect of both variables together on functional outcome. The correlation was found to be stronger (p<0.01).

Scapholunate angle and interval are assessed together in the clinic and support the diagnosis of scapholunate instability; thus, p value lower than 0.01 in the paired correlation of both parameters supported the clinical finding.

Similar results were obtained from the analysis of variance of the radiolunate and capitolunate angles. Increased radiolunate angle affected functional outcomes negatively (P=0.014<0.05) Capitolunate angle had a weaker correlation. (P-0.28<0.05).

According to the regression analysis performed to show if the relationship between the sqapholunate angle and total de b<ruijn score was statistically significant, it was possible to formulate the points obtained with a linear line. This linear line indicates the importance of sqapholunate angle since it affects functional outcome as it increases and carpal malalignment increases morbidity (Figure- V). Morbidity worsens as the de Bruijn score increases in proportion to the increased sqapholunate angle.

D. Comparison between the radiological parameters of the radius and carpal bones:

The regression analyses between the radial angles and intercarpal angles revealed that there was a correlation between the radiolunate angle and radial tilt (p<0.05) while the points on the graph produced could be formulized with a lineer line (Figure-VI). The same relationship was observed between the radial tilt and sqapholunate angle (p<0.05)

The regression analysis between the radial tilt and capitolunate angle and between the radial angulation and radiocapitate displacement did not reveal any significant association.

E. Comparison between the patients with and without instability:

The comparison between the mean de Bruijn scores of the groups with and without instability through student-t test revealed a significant difference between the two groups (p=0.38 >0.05). The histogram showing the mean de Bruijn scores of both groups is striking as it demonstrates the effect of carpal instability on functional outcomes. (Figure-12).

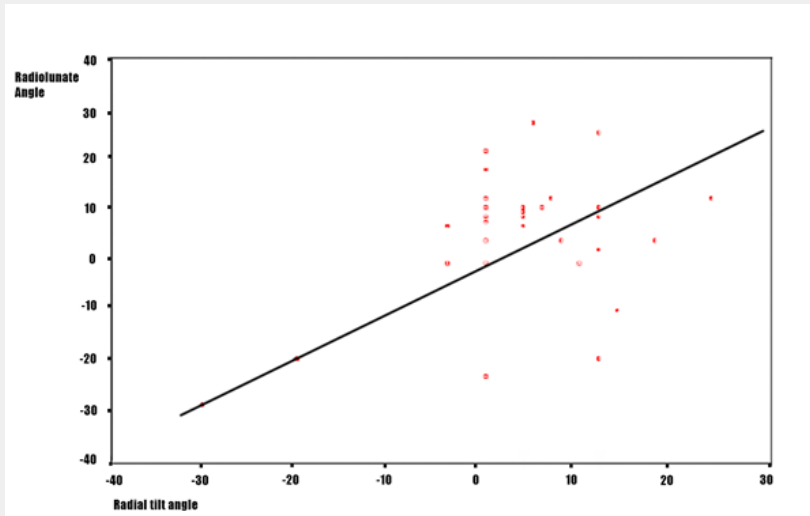

Figure 12: *Radiolunat Angles instead of Radial Tilt angles Student T test Analyses*

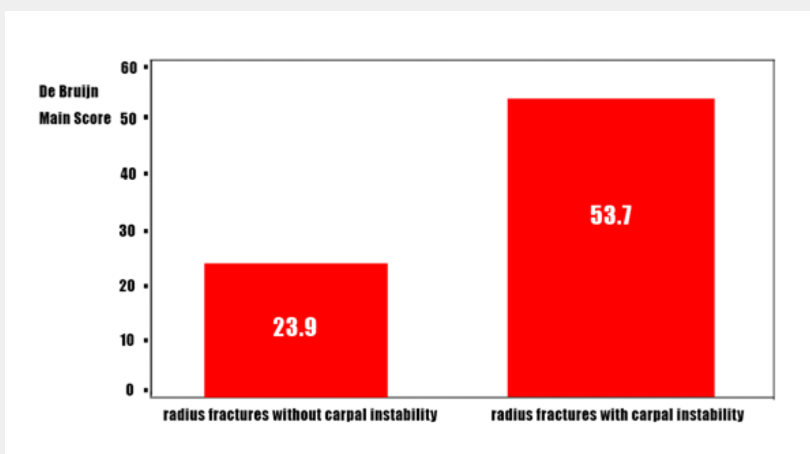

Figure 13: *De Brujin Main Scores with or withoout Instability*

Conclusion

This study showed that carpal instability was considerably concomitant with fractures involving the lunate facet of the radius. In this study of Geissler, it was also demonstrated that early ligament repair was more advantageous than late repair and it would be wrong to choose treatment options based on ligamentotaxis for the treatment of patients considered to have ligament injury [32,41].

In the light of the abovementioned information, in our series of 34 cases where we performed radiological measurements, the incidence of 29.4% we found which went up to 33% in fractures involving the joint was consistent with the findings reported by Tan Jin Bo, Mudgal and Geisler [32,36,40].

When the functional outcomes are assessed, it is clear that carpal instability increases morbidity irrespective of the radius fracture. The de Bruijn score of distal radius fracture concomitant with carpal instability was found to be twice higher than that of distal radius fracture alone.

When the factors affecting the functional outcomes of radius fracture are analyzed ultimately, the functional outcomes of the group with carpal instability were worse in the breakdown of age and fracture types [37,40-43]. According to student-l analysis between the groups, $p>0.05$ referred to a significant difference.

As regards the association between the angular values of carpal alignment and functional outcomes, a significant association of $p<0.05$ demonstrated the contribution of carpal instability to morbidity in distal radius fracture.

When the angles are compared and subjected to regression analysis to determine the effect of angular variations of the radius on carpal alignment, radial tilt angle is found to impair the radiolunate and scapholunate angles [44-47]. In addition to this extrinsic instability, it also explains the pathogenesis of intrinsic instability that occurs due to dorsal flexion-ulnar deviation and axial overloading.

In conclusion, while assessing distal radius fractures; wrist should be assessed as a whole and absolute carpal alignment should be reviewed. The same procedure should be repeated after the treatment. Planning should be made on the basis of such data. Radial tilt and carpal alignment should be carefully examined for post-treatment residual deformities Increased radial tilt and decreased radial angulation leads to carpal malalignment and arthritis [44]. Carpal malalignment that develops in addition to the impaired angle of the radius restricts hand movements and decreases grip strength.

Considering the contribution of carpal instability in distal radius fractures to morbidity, treatments that would delay ligament healing should be avoided and ligament repair should be performed if needed in addition to the open reduction of the fracture or arthroscopic assisted closed reduction fracture treatment.

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