Original article

http://dx.doi.org/10.4322/jms.076514

Effect of malunited fractured distal end of radius on the morphometric parameters of distal radioulnar joint

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Abstract

Introduction: Malunion is the most frequent complication of fracture distal radius. Fracture malunion has been shown to associate with altered morphometric anatomy of distal radioulnar joint. **Objective:** This study aims to identify normal radiographic morphometry reference values and variations according to age and sex of distal radioulnar joint. This study was also carried out to determine the radiological correlation between normal and malunited distal radius in patient with unilateral malunited fracture to find out the effect of malunited fractured distal end of radius on the morphometric parameters of distal radioulnar joint. **Materials and Methods**: After twelve weeks of injury x-ray of injured wrist was compared with the radiograph of the contra lateral normal wrist for the difference in radial length, radial inclination, ulnar variance and palmar tilt. **Results:** Results of this study showed that there were significant difference in distal radius parameters between genders for both groups except for the difference in palmer tilt *i.e.* since value of P< 0.0001 so there is significant difference between two group 1% level of significant suggesting that with 99% confidence, there is significant difference between mean of normal male and female right wrist parameters of both age group except for palmer tilt. Similarly there were variations in all parameter measurements for those x-ray films showing severe malunion and significant differences were noted for all parameters distal radius between normal and malunited wrist in both age groups *i.e.* since value of P< 0.0001 so there is significant difference between two group 1% level of significant suggesting that with 99% confidence, there is significant difference for all parameters between mean of normal and malunion group. **Conclusion:** These results can be used in treatment of the malunited distal radius for correction of deformity at the wrist and achieving the best possible anatomical reduction in the young active patient and at minimizing the intervention in the low demand elderly patient with multiple comorbidities. These data also can be used for clinical research in the designing of wrist implants.

Keywords: radiological parameter, distal end radius, malunion.

1 Introduction

The anatomic reduction in fracture treatment is the foremost important and considered in light of functional outcome. Fractures of the distal radius are the most common of the upper extremity and also of all orthopedic injuries, accounts about 20% of all fractures presenting to emergency. Osteoporosis is a risk factor in women above 50 year of age for distal radius fracture. The complication rate following the distal radius fracture varies from 10-80%, these may occur from the fracture itself or its treatment. The most frequent complications are impairment of joint mobility, malunion, residual pain and reflex sympathetic dystrophy (RSD). Malunion results when fracture is unable to resist displacement once it has been reduced anatomically. Malalignment of the distal radius was associated with a higher risk of poor out-come, but the impact diminished with advancing age, significant dorsal tilt may lead to diminished strength and movement. The radiological end-result of distal radius fractures does not always correlate to the functional outcome. Jupiter (1991) reported that patients may not experience any problems despite malunion. Individual outcomes are not entirely predictable because of the different functional demands, expectations, and pain tolerance for each patient. In young adults the need for an anatomic reduction has been stressed. Fernandez (2000) suggested that a maximum of 10° of dorsal tilt, 15° of radial inclination, 2 mm of radial shortening and 2 mm of intra-articular incongruity may be accepted. Elderly populations may tolerate greater degrees of residual deformity because of a more sedentary lifestyle. Lafontaine, Delince, Hardy et al. (1989) identified several risk factors associated with secondary fracture displacement despite a satisfactory initial reduction. These included the presence of dorsal tilt >20degree, comminution, intra-articular involvement, an associated fracture of the ulna, and age greater than 60 years. If three or more of these factors were present there was a high likelihood of fracture collapse. Several studies have determined that the severity of the initial radial shortening alone seems to be a reliable indicator of instability as referred by Abbaszadegan, Jonsson and Von Sivers (1989), Altissimi, Mancini, Azzarà et al. (1994) and Hove, Solheim, Skjeie et al. (1994). In patients older than 60 years of age, Leone, Bhandari, Adili et al. (2004) found that the degree of radial shortening and volar tilt and the amount of dorsal comminution were predictive of early or late failure. An unexpected finding was that in patients older than 65 years of age, one third of the initially undisplaced fractures subsequently collapsed. Nesbitt, Failla and Les (2004) proposed that age was the only statistically significant predictor of secondary displacement. After obtaining an acceptable initial closed reduction, those patients who were more than 60 years of age had four times

the risk for failure within the initial 4 weeks as compared with younger patients. It is also said that the risk for displacement increased with each subsequent decade. It is apparent that late fracture displacement is common in elderly patients, which may be related to their lower bone density. In healthy, active elderly patient if there is a loss of fracture position in the first month then adjuvant the treatment with percutaneous or external fixation. Weber (1987) agreed that the greater force is necessary to fracture the radius in younger patients because of their higher bone density, which can result in more comminution and a higher risk for subsequent fracture collapse. Internal or external fixation is indicated in younger patients for fractures with >2 mm of radial shortening and >15 degree of dorsal tilt following a closed reduction, especially if there is comminution of two or more cortices Trumble, Schmitt and Vedder (1994) and Trumble, Wagner, Hanel et al. (1998) in a prospective study of 61 consecutive patients presenting with distal radial fractures treated by plaster immobilization, showed that shortening of >4 mm was associated with wrist pain at a mean follow-up of 23 months. Trumble, Schmitt and Vedder (1994) also have reported that shortening was strongly associated with poor outcome. In a study by Jenkins NH1, Mintowt-Czyz WJ wrist function was assessed in patients between 1-3 years post injury of Colles' fractures. The range of wrist flexion and the strength of grip were found to be deficient. In their study the loss of power in gripping was due to mal-union affecting the coronal and sagittal inclination of the articular surface of the radius. McQueen and Caspers (1988) performed comprehensive functional assessment on 30 patients with extra-articular fractures after a mean of five years. They showed that malunion (dorsal tilt>20 degree and >2mm of radial shift) was clearly associated with significant functional limitation. In contrast, the limit of palmar tilt has not been well defined in the literature. The overall goal of the orthopaedic surgeon should be the optimal restoration of anatomy and function of the wrist.

2 Aims and Objective

1. To identify normal radiographic morphometric reference values of distal radioulnar joint according to age and sex in north Indian population.
2. To compare the normal and malunited distal radius morphometric parameters in patients with unilateral right side fracture distal radius.

3 Materials and Methods

For this prospective cross sectional study plain radiograph (PA and Lateral x-ray) was used and only right hand with wrist was included. Equal number of men and women of different age group (middle age group below 50 years and old age groups above 50 years) were included for normal reference values according to age and sex of distal radioulnar joint in north Indian. Similar study was carried out to determine the radiological correlation between normal and malunited distal radius in patient with unilateral malunited fracture. For this unilateral distal radial fracture (fracture belonging to universal classification type-II *i.e.* extra articular displaced/stable distal radial fracture) were included. Clinical eligibility criteria includes a history of a unilateral distal radius fracture, without fracture of the sigmoid notch, treated by closed reduction and casting. After twelve weeks of injury x-ray of injured wrist compared with the radiograph of the contra lateral normal wrist for the difference in radial length, radial inclination, ulnar variance and palmar tilt to know the effect of malunited fractured distal end of radius on the morphometric parameters of distal radioulnar joint. Angle of inclination and palmar tilt were measured using a long armed goniometer and all other parameters were measured using sliding vernier calipers.

4 Results

PA and lateral radiograph of normal right side distal radioulnar joint were analyzed for reference values according to age group and sex in north Indian. The final fracture union radiographs were analyzed for difference in morphometric parameters of normal and mal-aligned distal radius in patients with unilateral fracture distal radius. There were variations in all parameter measurements for those x-ray films showing severe malunion as shown in Figure 1 and 2 and Table 1-4.

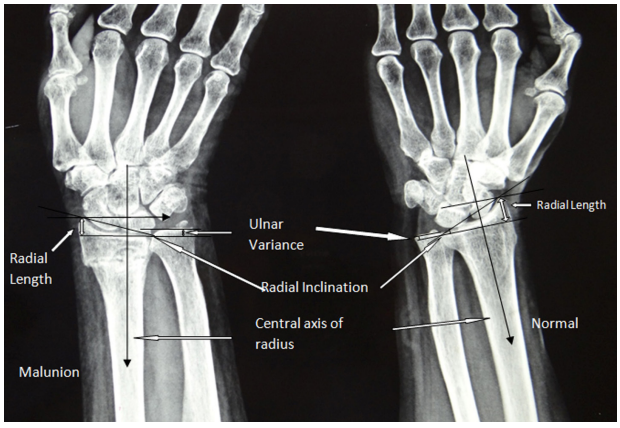

Figure 1. Radiograph of patient hands with wrist (PA view of normal and malunited distal radius).

Figure 2. Radiograph of patient hands with wrist (Lateral view of normal and malunited distal radius).

Table 1. Measured morphometric parameters of distal radius in normal male and female right wrist of middle age group and old age group.

S. No	Age group	Parameters	Males			Females			P Value*
			Min.	Max	Mean±SD	Min.	Max	Mean±SD	
1.	Middle age group (30-40 years)	Radial length (mm)	9.8	16.8	12.6294±1.62241	8.8	13.6	10.5941±1.75338	P<0.0013
		Radial inclination (°)	22°	26°	23.7647±1.03256	20°	22°	21.00±.70711	P<0.0001
		Ulnar Variance (mm)	0.38	0.42	.3976±.01147	0.34	0.40	.3682±.01944	P<0.0001
		Palmar or Volar tilt of Radius (°)	9°	12°	10.4706±.8747	9°	11°	9.9412±.65865	P<0.0548
2	Old age group (41-70 years)	Radial length (mm)	9.8	16.8	13.6588±2.0051	8.8	13.6	11.1176±1.46297	P<0.0002
		Radial inclination (°)	22°	26°	24.0588±1.14404	20°	22°	20.8235±.72761	P<0.0001
		Ulnar Variance (mm)	0.38	0.42	.3994±.01298	0.34	0.40	.3782±.01912	P<0.0006
		Palmar or Volar tilt of Radius (°)	9°	12°	10.4118±.87026	9°	11°	10.0000±.70711	P<0.1398

*Since value of P< 0.0001 so there is significant difference between two group 1% level of significant that means we may say that with 99% confidence, there is significant difference between mean of normal male and female right wrist parameters of both age group except for palmer tilt.

Table 2. Measured parameters (Minimum, maximum and mean±SD) of normal and malunited distal radius in different age group females.

S.No	Type of Distal radius	Parameters	Middle Age Group (30-40 years)			Old Age Group (41-70 years)		
			Min.	Max	Mean±SD	Min.	Max	Mean±SD
1.	Normal	Radial length (mm)	8.0	12.8	10.2176±1.38394	8.0	12.6	9.9706±1.31661
		Radial inclination (°)	20°	22°	21.00±.707	21°	23°	21.71±.686
		Ulnar Variance (mm)	0.36	0.38	.3682±.0064	0.32	0.34	.3282±.00636
		Palmar or Volar tilt of Radius (°)	9°	10°	9.47±.514	9°	11°	10.06±.659
2.	Malunited	Radial length (mm)	6.0	8.2	7.500±.63541	6.0	9.8	7.6294±.93526
		Radial inclination (°)	11°	12°	11.65±.493	11°	14°	12.35±1.057
		Ulnar Variance (mm)	1.2	2.0	1.5765±.28838	1.8	2.6	2.1824±.26276
		Palmar or Volar tilt of Radius (°)	10°	18°	13.29±2.229	12°	20°	15.65±2.473

Table 3. Descriptive statistical data of measured parameters (Between normal & malunited DR) in middle age group (30-40 Year) females.

S.N.	Parameter	Type of distal radius	Number of patient	Mean	S.D.	MD of Normal and malunited distal radius	P Value*
1	Radial Length(mm)	Normal	17	10.218	±1.384	2.588	P<0.0001
		Malunited	17	7.629	±.935		
2	Radial Inclination(°)	Normal	17	21.00	±.707	9.3500	P<0.0001
	Malunited		17	11.65	±.493		
3	Ulnar variance(mm)	Normal	17	.368	±.0064	1.209	P<0.0001
	Malunited		17	1.577	±.288		
4	Palmar tilt(°)	Normal	17	9.47	±.514	3.8200	P<0.0001
	Malunited		17	13.29	±2.229		

*Since value of P< 0.0001 so there is significant difference between two group 1% level of significant that means we may say that with 99% confidence, there is significant difference between mean of normal group and malunion group.

Table 4. Descriptive statistical data of measured parameters (Between normal & malunited DR) in old age group (41-70 Year) females.

S.N.	Parameter	Type of distal radius	Number of patient	Mean	S.D.	MD of Normal and malunited distal radius	P Value*
1	Radial Length (mm)	Normal	17	9.971	1.317	2.47	*P<0.0001
		Malunited	17	7.500	.635		
2	Radial Inclination (°)	Normal	17	21.17		9.3600	*P<0.0001
		Malunited	17	12.35			
3	Ulnar variance (mm)	Normal	17	.3282	.0064	1.854	*P<0.0001
		Malunited	17	2.1824	.2628		
4	Palmar tilt (°)	Normal	17	10.06	.659	5.5900	*P<0.0001
		Malunited	17	15.65	2.473		

*Since value of P< 0.0001 so there is significant difference between two group 1% level of significant that means we may say that with 99% confidence, there is significant difference between mean of normal group and malunion group.

5 Discussion

First finding of our study was that the incidence of distal radius fracture appeared to be both gender and age specific but more common in females above 50 years of age Table 1. Fracture malunion has been shown to associate with altered morphometric anatomy of distal radioulnar joint resulting in higher disability among young and middle-aged adults in several studies by Gliatis, Plessas and Davis (2000), Grewal and MacDermid (2007) and Kumar, Penematsa, Sadri et al. (2008). In contrast, studies of distal radius fracture in elderly patients with comorbidities and low functional demands have shown poor correlation between radiographic and functional outcome of Beumer and McQueen (2003), Young and Rayan (2000) and Anzarut, Johnson, Rowe et al. (2004). Differing views have been expressed on the radiologic and clinical outcomes of distal radius fractures in the literature. Kelly, Warwick, Crichlow et al. (1997) felt that for patients more than 65 years old a maximum of 30° of dorsal angulation and 5 mm of radial shortening could be accepted. Jacob, Mielke, Keller et al. (1999) found that a dorsal angle of more than 20° and a radial inclination of less than 15° were associated with more complaints and patient dissatisfaction. Treatment guidelines have also been advanced for distal radius fractures based on the anatomic deformity. It is generally accepted that treatment of a distal radius fracture should aim at achieving the best possible anatomical reduction in the young active patient and at minimizing the intervention in the low demand elderly patient with multiple comorbidities.

6 Conclusion

Malunion of the distal radius is the most commonly reported complication of closed treatment for distal radius fractures. Results of this study bear out the conclusion that the common morphometric distal radioulnar joint parameters of our population are comparable to those reported in other part of India and Western society. There was significant difference in distal radius parameters between genders for both groups except for the difference in palmer tilt. This study also documents the roentgen graphic measurements, relationship and variation according to age and sex between right distal radiuses serving as reference point among north Indian. These data also can be used in clinical research, correction of deformity at the wrist *i.e.* how much to osteotomised from malunited distal radius to make it normal and in the design of wrist implants.

Acknowledgements: Authors are thankful to the Department of Anatomy, orthopaedics and radiology, Jawaharlal Nehru Medical College, Aligarh Muslim University for providing facilities to carry out this research work.

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Received July 27, 2014
Accepted November 16, 2015