

# Isolated fractures of the greater tuberosity in proximal humerus: does the direction of displacement influence functional outcome?

## An analysis of displacement in greater tuberosity fractures

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**Abstract.** *Background and aim of the work:* The treatment of isolated fractures of the greater tuberosity of the proximal humerus is still debated, especially in the case of minimally displaced fractures. Differently from other proximal humerus fractures this kind of injury frequently affects young patients with high functional request. The aim of this study is to assess the outcome of patients treated conservatively for greater tuberosity isolated fractures, comparing the clinical results in patients with different direction of fracture displacement. *Methods:* 38 patients with isolated fracture of greater tuberosity participated to the study and were evaluated at 17 months (10-26) of follow up using Constant Murley Score and DASH Score. Patients were divided in groups with different direction of displacement (10 no displacement, 13 postero-superior, 6 antero-superior and 9 antero-inferior displacement). *Results:* Patients with no displaced fractures had a mean Constant Murley Score of 82 and a mean DASH Score of 15; those with postero-superior displacement had a mean a Constant Murley Score of 61 and a mean DASH Score of 43; for antero-superior displacement the mean Constant Murley Score was 76 and the mean DASH Score of 18; for the antero-inferiorly displaced the mean Constant Murley Score was 83 and the DASH Score 16. *Conclusion:* Data suggest that postero-superior displacement leads to poorer outcomes than undisplaced or displaced in other directions fractures treated conservatively. ([www.actabiomedica.it](http://www.actabiomedica.it))

**Key words:** Shoulder, fracture, greater tuberosity, displacement, treatment

### Background and aim of the work

Proximal humerus fractures represent 5% of skeletal fractures; 20% of them are isolated tuberosity fractures (1). Nowadays is still debated its inclusion in modern shoulder fractures classifications (2), since there are important epidemiological differences: they mostly affect young men without important comorbidities (3). This implies an important difference of functional demand. They can be caused by different mechanisms of injury like avulsion of rotator cuff (Fig

1), impaction toward the acromion, direct blow to the lateral aspect of the shoulder or shearing against the glenoid rim in anterior dislocation of the glenohumeral joint (4) (Fig 2). About 13-33% of joint dislocations are accompanied by greater tuberosity fracture (5).

The treatment is controversial: for undisplaced fractures it's quite universally accepted the properness of conservative treatment with immobilization in Gilchrist bending or shoulder sling with 85° degrees of intrarotation for 25 days (6,7); the treatment of dis-



**Figure 1.** Isolated greater tuberosity fracture caused by avulsion of the rotator cuff.



**Figure 2.** Isolated greater tuberosity fracture associated with gleno-humeral anterior dislocation.

placed fractures is more discussed, also for minimally displaced fractures.

The aim of this study is comparing functional outcomes of minimally displaced fractures with different direction of displacement.

### Material and methods

38 patients treated for isolated fractures of greater tuberosity since January 2006 till June 2010 (22 male, 16 female) in our Institute, with a mean age of 56 (31-79) were re-examined retrospectively with a mean follow-up of 17 months (10-26). Were included all the fractures with a displacement less than 5 mm treated conservatively. Were excluded patients who had had other surgical interventions to the same limb, patients treated more than 4 weeks after the trauma, patients affected by neurological illnesses such as Alzheimer or Multiple Sclerosis and neoplastic.

16 individuals got injured falling from a height or from stairs, 11 were sport traumas (3 skiing, 2 mountain-biking, 1 playing basket-ball), 10 road accidents (6 motor-bikers) and 1 after seizures. No cases of bilateral fractures were reported, neither exposed fractures.

17 fractures were associated with anterior gleno-humeral dislocation. All the patients had been immobilized in intra-rotation ( $85^\circ$ ) with a sling for 4 weeks and then, after a clinical and radiographical check, they started rehabilitation.

Patients were divided in 4 groups depending on the direction of the displacement of the fragment: 10 of them were undisplaced (mean age: 60), 13 had postero-superior displacement (mean age: 52), 6 had antero-superior displacement (mean age: 57) and 9 of them were displaced antero-inferiorly (mean age: 51). The amount and the direction of the displacement were evaluated and classified in according with Bahrs studies (4,6).

At the time of follow up all the patients underwent clinical examination using Constant Murley (CM) Score (8) and Disability of the Arm, Shoulder and Hand (DASH) Score (9). Results were classified according to Literature in excellent, good, average and poor results.

Statistical analysis was performed using IBM SPSS v.20 statistical package. Descriptive analysis has included mean, median, standard deviation, variance, standard error, asymmetry and kurtosis. Inferences among different variables have been performed using Analysis of variance (ANOVA) and Kruskal-Wallis test. The results were considered statistically significant when  $p < 0.05$ .

## Results

The mean CM Score of all the patients treated was  $74.8 \pm 6.8$ , indicating a good outcome; mean DASH Score was  $24.9 \pm 11.4$ , indicating an excellent outcome.

The 10 subjects that had no displacement of the fragment had 2 excellent CM Score and 8 good CM Score. The mean CM Score in this group was  $82.1 \pm 2.1$ , indicating a good functionality of the affected shoulder. All of them had an excellent outcome at the DASH Score; the mean DASH Score was  $15.4 \pm 4.2$ , indicating an excellent retrieval of the quality of life.

The 12 patients with postero-superior displacement had 1 excellent CM Score, 1 good, 6 average and 4 poor CM Score. The mean CM Score was  $61.6 \pm 4.4$  (average). 2 of them had an excellent DASH Score, 5 good and 5 average DASH Score and the mean DASH Score was  $43.3 \pm 13.2$  (good).

The 7 patients with antero-superior displacement had 1 excellent CM Score, 5 good and 1 average CM Score; the mean outcome of CM Score for this subjects was  $76.1 \pm 2.8$ , indicating good functionality of the joint. 5 of them had excellent DASH Score and 2 had good results; the mean outcome was  $18.1 \pm 12.7$ , indicating an excellent quality of life.

The 9 patients that had antero-inferior displacement of the fracture had 6 excellent and 3 good CM Score and the mean outcome was  $83.4 \pm 2.2$  (good). 6 of them had excellent outcome of the DASH Score, for 3 of them it was good and the mean score was  $16.4 \pm 13.2$  (excellent) (Fig 3-4).

Data in detail are illustrated in Table 1.

Using ANOVA to compare CM Score and DASH Score resulted in significant p-values ( $p = 5.1 \times 10^{-5}$ ;  $8.1 \times 10^{-5}$ ). Descriptive analysis is described

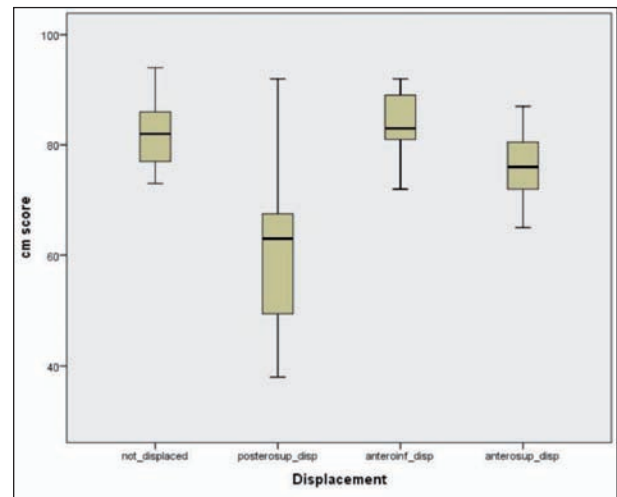


Figure 3. Boxplot histogram of descriptive analysis.

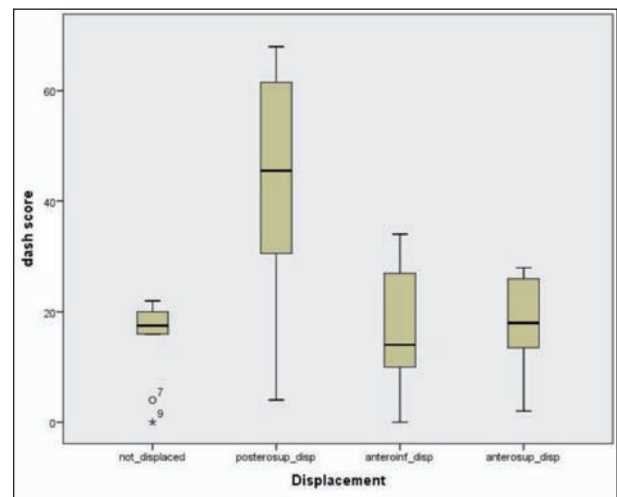


Figure 4. Boxplot histogram of descriptive analysis.

in Table 2. Kruskal-Wallis test produced similar results.

## Discussion

The treatment of isolated fractures of greater tuberosity is still controversial in Literature and the proximal humerus fractures classifications don't help the surgeon in the choice between conservative and surgical treatment.

**Table 1.** Patients' data.

Gender	Age	Dislocation	Cm Score		Dash Score		Displacement
F	67		77	Good	17	Excellent	Absent
F	58		73	Good	22	Excellent	Absent
F	60	Y	81	Good	16	Excellent	Absent
F	62	Y	83	Good	20	Excellent	Absent
F	62		86	Excellent	19	Excellent	Absent
M	51	Y	84	Good	18	Excellent	Absent
M	71	Y	74	Good	4	Excellent	Absent
M	39	Y	94	Excellent	16	Excellent	Absent
M	64	Y	90	Good	0	Excellent	Absent
M	70		79	Good	22	Excellent	Absent
F	79		61	Everage	39	Good	Postero-Superior
F	74		43	Poor	68	Everage	Postero-Superior
F	75		60	Everage	12	Excellent	Postero-Superior
M	46		38	Poor	60	Everage	Postero-Superior
M	67		49	Poor	64	Everage	Postero-Superior
F	55		66	Everage	32	Good	Postero-Superior
F	40		68	Everage	47	Good	Postero-Superior
F	64		65	Everage	57	Everage	Postero-Superior
F	53		80	Good	29	Good	Postero-Superior
M	31		92	Excellent	4	Excellent	Postero-Superior
M	51	Y	50	Poor	63	Everage	Postero-Superior
M	41		67	Everage	44	Good	Postero-Superior
F	54	Y	72	Good	28	Good	Antero-Superior
F	73	Y	65	Everage	13	Excellent	Antero-Superior
M	61	Y	79	Good	14	Excellent	Antero-Superior
M	58	Y	76	Good	24	Excellent	Antero-Superior
F	48		82	Good	18	Excellent	Antero-Superior
M	34		87	Excellent	2	Excellent	Antero-Superior
M	68		72	Good	28	Good	Antero-Superior
M	61		83	Good	6	Excellent	Antero-Inferior
M	38	Y	82	Good	13	Excellent	Antero-Inferior
M	69	Y	72	Good	28	Good	Antero-Inferior
M	55	Y	92	Excellent	27	Good	Antero-Inferior
F	50	Y	83	Good	16	Excellent	Antero-Inferior
M	37	Y	90	Excellent	0	Excellent	Antero-Inferior
M	59		79	Good	34	Good	Antero-Inferior
M	52	Y	81	Good	14	Excellent	Antero-Inferior
M	42		89	Excellent	10	Excellent	Antero-Inferior

**Table 2.** Descriptive analysis.

<b>Displacement</b>		<b>Statistic</b>	<b>Std. Error</b>		
<b>cm score</b>	not_displaced	Mean	82,10	2,132	
		95% Confidence Interval for Mean	Lower Bound	77,28	
			Upper Bound	86,92	
		5% Trimmed Mean	81,94		
		Median	82,00		
		Variance	45,433		
		Std. Deviation	6,740		
		Minimum	73		
		Maximum	94		
		Range	21		
		Interquartile Range	11		
		Skewness	,361	,687	
		Kurtosis	-,520	1,334	
		posterosup_disp	Mean	61,58	4,406
	95% Confidence Interval for Mean		Lower Bound	51,88	
			Upper Bound	71,28	
	5% Trimmed Mean		61,20		
	Median		63,00		
	Variance		232,992		
	Std. Deviation		15,264		
	Minimum		38		
	Maximum		92		
	Range		54		
	Interquartile Range		19		
	Skewness		,364	,637	
	Kurtosis		,163	1,232	
	anteroinf_disp		Mean	83,44	2,062
		95% Confidence Interval for Mean	Lower Bound	78,69	
			Upper Bound	88,20	
		5% Trimmed Mean	83,60		
		Median	83,00		
		Variance	38,278		
		Std. Deviation	6,187		
		Minimum	72		
		Maximum	92		
Range		20			

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Displacement		Statistic	Std. Error		
		Interquartile Range	10		
		Skewness	,717		
		Kurtosis	1,400		
anterosup_disp		Mean	76,14		
	95% Confidence Interval for Mean	Lower Bound	69,40		
		Upper Bound	82,88		
	5% Trimmed Mean	76,16			
	Median	76,00			
	Variance	53,143			
	Std. Deviation	7,290			
	Minimum	65			
	Maximum	87			
	Range	22			
	Interquartile Range	10			
	Skewness	-,013	,794		
	Kurtosis	-,254	1,587		
	dash score	not_displaced	Mean	15,40	
			95% Confidence Interval for Mean	Lower Bound	10,08
Upper Bound				20,72	
5% Trimmed Mean			15,89		
Median			17,50		
Variance			55,378		
Std. Deviation			7,442		
Minimum			0		
Maximum			22		
Range			22		
Interquartile Range			8		
Skewness			-1,480	,687	
Kurtosis			1,183	1,334	
posterosup_disp				Mean	43,25
			95% Confidence Interval for Mean	Lower Bound	30,00
	Upper Bound	56,50			
	5% Trimmed Mean	44,06			
	Median	45,50			
	Variance	434,750			
	Std. Deviation	20,851			
	Minimum	4			

Displacement		Statistic	Std. Error
	Maximum	68	
	Range	64	
	Interquartile Range	33	
	Skewness	-,677	,637
	Kurtosis	-,522	1,232
anteroinf_disp	Mean	16,44	3,712
	95% Confidence Interval for Mean	Lower Bound	7,88
		Upper Bound	25,00
	5% Trimmed Mean	16,38	
	Median	14,00	
	Variance	124,028	
	Std. Deviation	11,137	
	Minimum	0	
	Maximum	34	
	Range	34	
	Interquartile Range	20	
	Skewness	,258	,717
	Kurtosis	-,877	1,400
	anterosup_disp	Mean	18,14
95% Confidence Interval for Mean		Lower Bound	9,43
		Upper Bound	26,86
5% Trimmed Mean		18,49	
Median		18,00	
Variance		88,810	
Std. Deviation		9,424	
Minimum		2	
Maximum		28	
Range		26	
Interquartile Range		15	
Skewness		-,641	,794
Kurtosis		-,136	1,587

Kim described that there are important demographic differences between isolated greater tuberosity fractures and other proximal humerus fractures. The former ones are more common in relatively younger population, whereas the latter ones are more common in the elderly female population who often has associated medical problems, first of all osteo-

porosis. He asserted that it would be more reasonable and practical to classify the isolated greater tuberosity fractures of the humerus separately from the others (5), since there is a very important difference of functional demand between these two populations.

Fractures of the greater tuberosity occur in 13-33% of dislocations, many more than other fractures

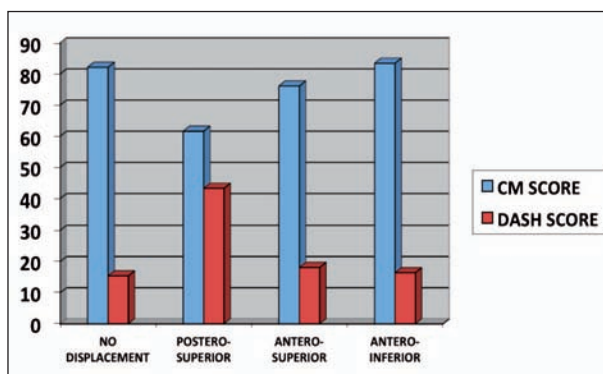
(5). Zanetti observed a significant association of greater tuberosity fractures with cuff tears in patients younger than 40 years old (10).

These aspects imply that isolated tuberosity fractures should be clinically distinct from other proximal humerus fractures and also the management must be enlightened for a good functional outcome. We retrospectively re-evaluated our patients to analyze if the direction of the displacement may influence the clinical outcome in conservatively treated fractures.

In our experience, fractures with displacement lesser than 5 mm treated conservatively lead to satisfactory clinical results in 34 cases (89.5%). An acceptable quality of life was recovered by the 100% of our patients. These data agree with Literature, since Authors assert that surgery is not necessary for this size of displacement (11-14).

Comparing results in relationship to the direction of the displacement, we find good and excellent results for undisplaced fractures; good results were observed for those fractures whose displacement was antero-superior or antero-inferior. Those subjects with postero-superior displacement of the fracture fragment had lower outcomes if compared with the previous ones (Fig 5), since the CM mean Score obtained was 61.5 and the mean DASH Score was 51.9, classified as average results, differently for outcomes of other displacements or undisplaced fractures. 4 of them had not satisfactory results in terms of shoulder functionality.

As reported by previous Authors, the postero-superior displacement can lead to a lack of abduction



**Figure 5.** Graphic showing a comparison of the results of the groups.

and cause chronic pain, since it can create acromion impingement and direct mechanical block, or harm the rotator cuff function for a loss of tension or a direct lesion of the tendon (15). This agrees with the high incidence of cuff diseases associated with these fractures (10).

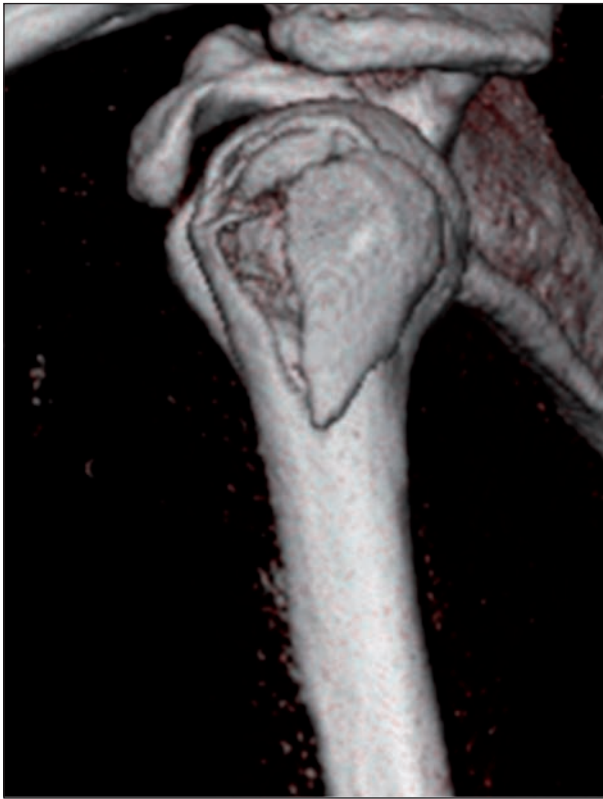
Even if in 1970 Neer recommended treating surgically fractures with more than 1 cm of displacement (16,17), during the following years the cut-off above whom surgery is the proper treatment got lower and lower: in 1995 Craig described satisfactory results performing surgery on fractures displaced more than 5 mm (12), supported in 1998 by Iannotti (14) and Bigliani (11) and reported by Green in 2003 (13). In 1993 Resch put the edge at 3 mm, only if the displacement is in more than one direction (18). In 1997 Park diversified the indication for surgery basing on the patient's function demand: in sport players and hard labourers the cut-off sinks from 5 mm to 3 mm (19); theory that was confirmed by George in 2007 (20).

Recently has been observed that even minimally displaced fractures can give complications if not correctly treated: in 2000 Kim described partial-thickness rotator cuff tears with chronic pain in patients previously affected by greater tuberosity fractures (21). Furthermore many surgical techniques are described as successful for the treatment of this injury, even in the case of minimally displaced fractures (21); the effectiveness of conservative treatment is more controversial (15), particularly in high-demanding patients (6).

The variability of the direction of the fragment's displacement has been described by Bahrs (4) since different mechanisms of injury are accompanied by different displacements. This is the first paper that directly compares the position of the displaced fragment related with clinical result. The direction of displacement may have the same importance of the amount of displacement for the choice of the good treatment and its prognosis, since even minimally displaced fractures of the greater tuberosity have different consequences over the joint function. An adequate planning should include a CT study of the fracture (Fig 6) to get a better assessment of direction and amount of displacement when X-ray exams are not exhaustive.

Our study shows that the postero-superior dis-





**Figure 6.** 3D CT reconstruction of an isolated greater tuberosity fracture.

placement of the fragment in greater tuberosity humeral fracture treated conservatively lead to poor clinical outcome.

## Conclusion

Our results suggest that minimally displaced isolated fractures of the greater tuberosity with postero-superior displacement have worse outcome with conservative management; further studies will investigate possible benefit from surgical intervention.

## Conflict of interest

The authors declare that they have no conflict of interest.

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