

# The association between body mass index and the severity of proximal humerus fractures: effect on fracture union and soft tissue healing

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## Introduction

Obesity is becoming endemic especially in the developed world. There is now enough scientific evidence to link obesity to musculoskeletal problems. The incidence of proximal humerus fractures is rising and they are mostly linked to osteoporosis in the elderly. In general, they result from low-energy trauma following a mechanical fall, and more predominant in females. We investigated the relationship between the body mass index and these fractures in **postmenopausal females**.



## Materials and Methods

The inclusion criteria included females >45 years of age with good health status and no mental health issues, not diabetic nor suffer from neuromuscular weakness, not requiring a walking aid and no history of falls or previous fractures. 822 patients met the inclusion criteria and mechanism of injury was a mechanical fall in 92% of the cohort. Patients were classified according to their BMI into 4 categories: (1) underweight, (2) normal weight, (3) overweight and (4) obese. Fractures were classified as per the Neer classification system. 82 patients underwent surgical fixation and the rest were treated conservatively.

Radiological union required clear evidence of bridging callus and bony trabeculae traversing and obscuring the fracture line; while clinical union was a more subjective assessment of fracture stiffness. It is well known that these techniques have a number of limitations; however they continue to be the acceptable practice when assessing fracture union in the clinic. Both cohorts were followed up for a minimum period of 24 months.

## Results

Overweight and obese females are more likely to sustain 4-part proximal humerus fracture with >1cm displacement when compared to normal weight ( $p<0.001$ ) and underweight ( $p<0.001$ ) females.

	1-part fracture	2-part fracture	3-part fracture	4-part fracture
Underweight (n=6)	6	-	-	-
Normal weight (n=156)	22	78	54	2
Overweight (n=552)	6	342	68	136
Obese (n=108)	5	29	43	31

Body mass index (4 categories) of the cohort and the fractures sustained as per the Neer classification system.

The surgical fixation group (15 3-part and 67 4-part fracture) had an increase delay in fracture healing (mean 14 weeks [range 12-15]) when compared the conservatively managed group (150 3-part and 102 4-part fracture), ( $p<0.021$ ).

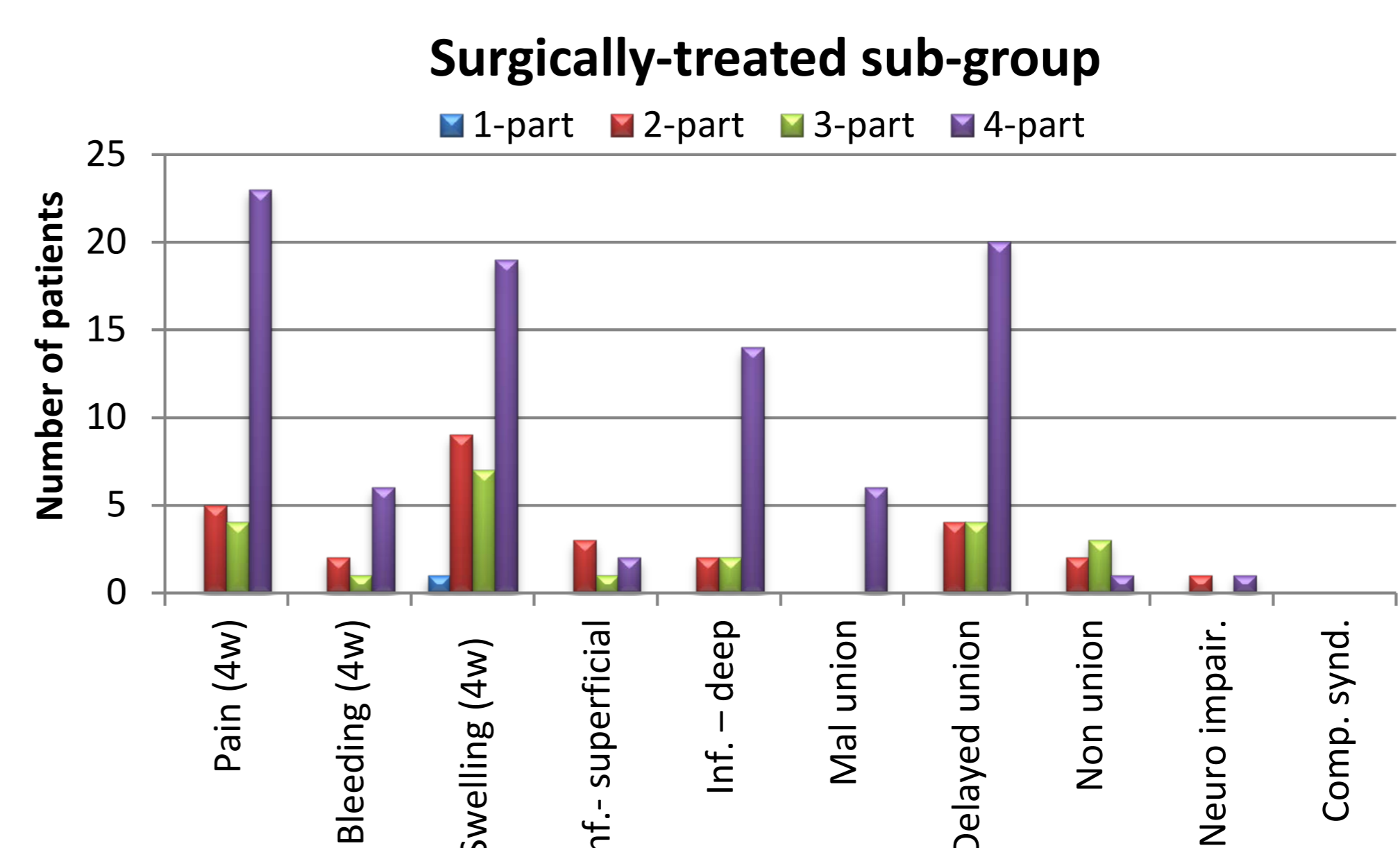
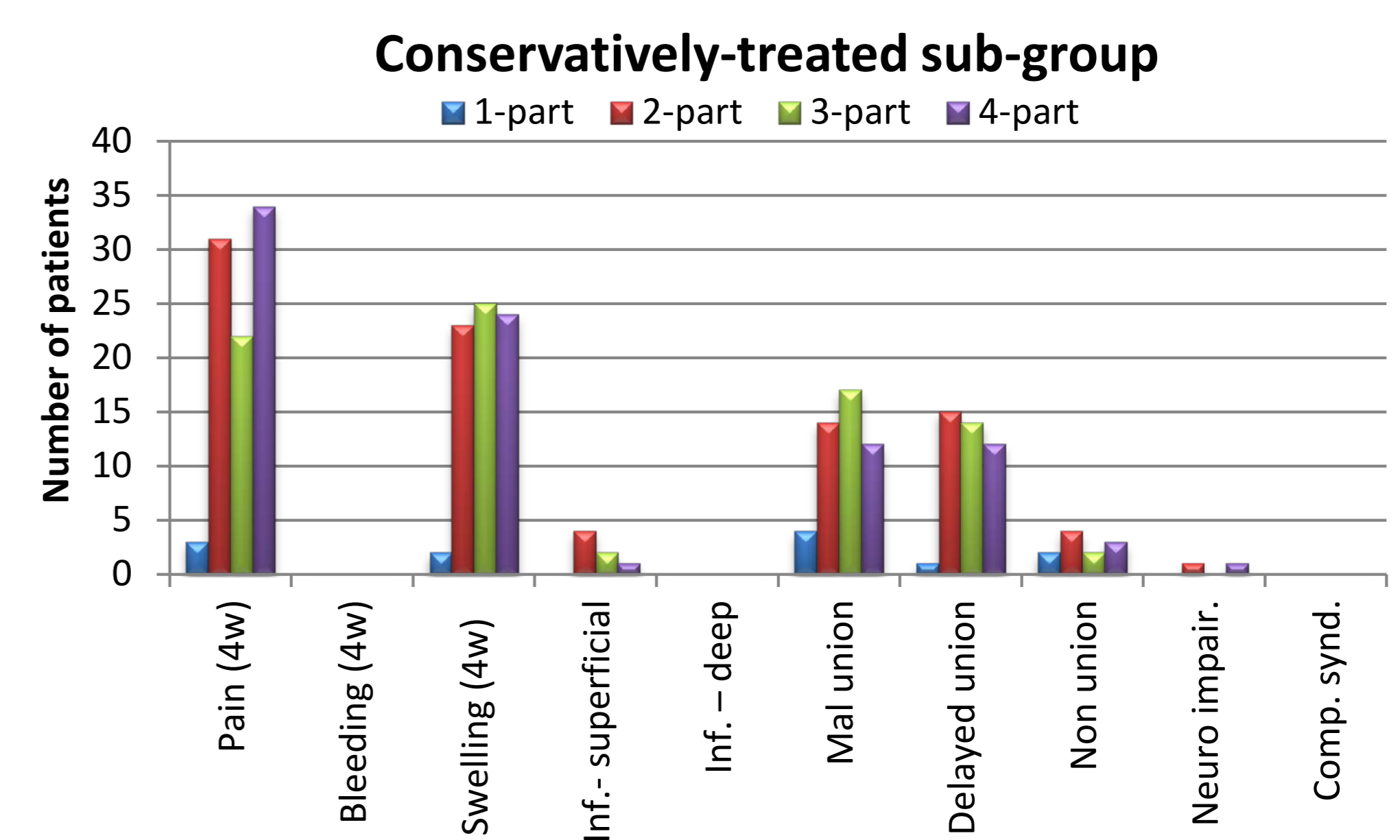
	1-part	2-part	3-part	4-part	1-part	2-part	3-part	4-part
	n = 34	n = 423	n = 150	n = 102	n = 5	n = 26	n = 15	n = 67
	Conservatively-treated				Surgically-treated			
<b>Wound healing</b>								
Mean (weeks)	3	3	3	3	3	3	4	4
Min-Max	2-3	2-4	2-4	2-3	2-4	2-4	2-5	2-5
Standard Dev.	±1	±1	±1	±1	±1	±1	±2	±2
<b>Time to union</b>								
Mean (weeks)	9	9	12	11	10	9	14	14
Min-Max	8-9	8-9	12-13	11-13	8-10	8-10	12-15	12-15
Standard Dev.	±1	±1	±1	±1	±1	±2	±1	±2

Primary outcomes in the conservatively-treated and surgically-treated sub-groups as per the Neer classification system.

Further analysis of the surgical cohort, revealed a significant correlation when it comes to postoperative delayed wound healing ( $p=0.002$ ), duration of postoperative pain ( $p=0.002$ ) and surgical site infections ( $p=0.005$ ), when compared to the conservatively managed group.

	1-part	2-part	3-part	4-part	1-part	2-part	3-part	4-part
	n = 34	n = 423	n = 150	n = 102	n = 5	n = 26	n = 15	n = 67
	Conservatively-treated				Surgically-treated			
Pain (4w)	3	31	22	34	0	5	4	23
Bleeding (4w)	0	0	0	0	0	2	1	6
Swelling (4w)	2	23	25	24	1	9	7	19
Inf.- superficial	0	4	2	1	0	3	1	2
Inf. - deep	0	0	0	0	0	2	2	14
Mal union	4	14	17	12	0	0	0	6
Delayed union	1	15	14	12	0	4	4	20
Non union	2	4	2	3	0	2	3	1
Neuro impair.	0	1	0	1	0	1	0	1
Comp. synd.	0	0	0	0	0	0	0	0

Secondary outcomes in the conservatively-treated and surgically-treated sub-groups as per the Neer classification system.



	1-part	2-part	3-part	4-part	1-part	2-part	3-part	4-part
	n = 34	n = 423	n = 150	n = 102	n = 5	n = 26	n = 15	n = 67
	Conservatively-treated				Surgically-treated			
<b>Satisfact. RoM</b>	34	412	132	62	5	18	10	44
<b>Mobility R/V</b>								
As before injury	32	400	125	55	5	16	10	38
Worse	0	6	9	18	0	4	3	8

Secondary outcomes in the conservatively-treated and surgically-treated sub-groups as per the Neer classification system.

## Discussion and Conclusion

It was traditionally thought that more weight would have a positive effect upon bone but recent findings associate it with reduced bone quality. Just as starvation increases the risk of fracture, obesity affects osteoclastic microenvironment and can have an adverse effect on bone and calcium metabolism. Adipose tissue has a direct and indirect hormonal effect and even the location of fat deposition can have varying effects upon the rate of fractures per skeletal site. The current evidence confirms that the severity of the fracture is increased in overweight and obese postmenopausal females. Furthermore, surgical fixation in 3-part and 4-part fracture tends to be associated with delay in fracture union and increase wound healing problems.