

Original Research Article

Management of Arbeitsgemeinschaft fur osteosynthesfragen type C fractures of distal humerus in adults with two column fixation

Manjit S. Daroch, Sanjeev Sreen, Deepak Vashisht*, Parveen Puri

Department of Orthopaedics, Government Medical College and Hospital, Patiala, Punjab, India

Received: 10 September 2016

Revised: 12 October 2016

Accepted: 24 October 2016

*Correspondence:

Dr. Deepak Vashisht,

E-mail: d.vshst@yahoo.in

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: Accurate reconstruction of articular surface of distal humerus by closed manipulation is not possible. The recent trend for displaced intra-articular fractures of the distal humerus is open reduction and stable osteosynthesis with early rehabilitation. The best exposure of both columns of the distal part of the humerus and articular surface is achieved through trans-olecranon approach. Objective of the study was to evaluate the management and outcome of two column fixation of intra-articular fracture of distal humerus in adults by posterior approach via olecranon osteotomy and to restore early elbow joint function.

Methods: Twenty-five cases of intra-articular fractures of distal humerus were treated by open reduction and internal fixation. All the patients were of adult age group. Chevron type olecranon osteotomy was performed and fixed with tension band wiring in all cases and follow-up period was upto 36 months. Regular clinical examination and periodical radiological evaluation were done.

Results: All fractures united within average duration of 3 months. Results were evaluated as per Mayo Elbow Performance Score. According to this criteria, excellent result was achieved in 8 patients (32%), good in 13 (52%), fair in 3 (12%) and poor in 1 (4%) patients. Thus satisfactory result was obtained in 96% cases.

Conclusions: The critical factors for a successful outcome of intra-articular fractures of the distal humerus depend upon severity of fracture, meticulous surgical technique, stable internal fixation, surgical experimentation and early controlled postoperative mobilization.

Keywords: Adults, Distal humerus, Olecranon, Posterior approach, Type C fractures

INTRODUCTION

In this modern era of industrialization, increased vehicular traffic and more use of mechanized agricultural methods, trauma of different kinds including fractures, are increasing in frequency and severity. At the same time because of busy and competitive life and advent of modern techniques in orthopaedics, one wants to be treated by a method which will allow on going back to duties as early as possible. Incidence of distal humeral fractures is increasing. Distal humerus fractures comprise

2-6% of all fractures. There is a bimodal distribution with respect to age and gender with peak incidence in young male and in older female patients. Most fractures in elderly patients are intra-articular with bi-columnar involvement. Distal humerus fractures remain one of the most difficult injuries to manage. They are commonly multifragmental, occur in osteopenic bone, and have complex anatomy with limited options for internal fixation. Treatment outcomes are often associated with elbow stiffness, weakness and pain. A painless, stable and mobile elbow joint is desired as it allows the hand to

conduct the activities of daily living, most notably personal hygiene and feeding. Therefore, starting with a highly traumatized distal humerus and finishing with a stable, mobile, and pain free joint is challenging and requires a systematic approach. Meticulous planning is required in determining the operative indications, managing the soft tissues, selecting a surgical approach, obtaining an anatomic intra-articular reduction, and creating a fixation construct that is rigid enough to tolerate early mobilisation.¹ In 1913, Albin Lambotte challenged the leading opinions of conservative management for distal humerus fractures and advocated an aggressive approach of open reduction and internal fixation. He described the principles of osteosynthesis and believed restoration of anatomy correlated with a better return to function. Unfortunately, surgical outcomes in that era were plagued with a high risk of infection and hardware failure. Evans in 1953 advised 'bag of bones' treatment and believed that although it may be appropriate for the elderly patient, it was not ideal for the young active patient.² Radin, in 1969 reported that operative treatment was unpredictable and often associated with poor outcomes; therefore, he recommended nonsurgical management.

In the last quarter of century improved outcomes have been reported with surgery for distal humerus fractures. The principles set out by the Arbeitsgemeinschaft für Osteosynthesefragen (Association for the Study of Internal Fixation, AO-ASIF) group, including anatomic articular reduction and rigid internal fixation, allow for rapid healing and early postoperative range of motion. The last decade has seen advances in the understanding of elbow anatomy, improvements in surgical approaches, new innovative fixation devices and an evolution of post-operative rehabilitation protocols. Precontoured locking plates for posterior column, medial column and for fixation of olecranon osteotomy by AO group is new and effective method of fixation in distal humeral fractures and more effective in osteoporotic bone.¹ In younger patients, open reduction and internal fixation of distal humerus fractures using modern fixation principles is considered the gold standard. In elderly patients, restoration of the anatomy and obtaining rigid internal fixation may be difficult because of poor bone quality and comminution of the articular surface and metaphysis. In cases in which rigid internal fixation cannot be achieved to allow early range of motion, resultant prolonged immobilization often leads to poor outcomes. Other complications associated with potentially poor outcomes included malunion, non-union, contracture, avascular necrosis, heterotopic ossification, hardware failure, and symptomatic prominent hardware. Other procedure for severely comminuted intra-articular fracture is total elbow arthroplasty but disadvantages of this procedure notably are inevitable failure of prosthesis and potential devastating complications like deep infection and osteolysis. For these reasons TEA is currently no good treatment option, especially where OR and IF can be done. Hence, the present study is

undertaken to evaluate the management and outcome of two column fixation of intra-articular fracture of distal humerus in adults by posterior approach via olecranon osteotomy and to restore early elbow joint function.

METHODS

This was a prospective interventional study which included 25 consecutively admitted cases of intra-articular fractures of distal humerus in adults {more than 15 years of age (15-70 years)} carried out in Department of Orthopaedics, Government Medical College, Patiala after getting the approval from ethical committee and complete informed written consent from all patients participated in our study. Fractures were classified as per AO fracture classification system.

Criteria for exclusion from the study were anterior coronal fracture of capitulum or trochlea and open fractures which are badly contaminated. Primary treatment in the form of splintage of limb, analgesics and anti-inflammatory drugs, immunization against tetanus in open fracture and intravenous fluids in multiple injuries was given. All patients were taken for elective surgery as soon as possible after necessary blood, urine and radiographic pre-operative work-up. General anesthesia or regional anesthesia was used after proper pre-medication as per the anesthetist recommendation. Trans olecranon posterior approach was used as it gives visualization of the articular surface for reduction and fixation. Disadvantages are non-union and hardware prominence related to osteotomy and linked visualization of anterior articular surfaces.³ In present study we used 3.5 mm reconstruction plates of appropriate size mostly which will be contoured according to the need and appropriate size cortical screws along with Kirschner wires and stainless steel wires for tension band wiring of osteotomised olecranon. Patient was placed in a lateral decubitus. A midline posterior incision was made over the distal humerus, with or without curving around the tip of olecranon. The Ulnar Nerve was identified and protected. An olecranon chevron osteotomy was used for adequate exposure of the joint surface with the osteotomy being placed at the lowest point of the trochlear notch. Later on osteotomy was fixed with tension band wiring in all cases. The Anconeus Muscle was elevated as a flap to preserve its innervation and olecranon Osteotomy was done in most of cases. The articular fragments were reduced and held with a partially threaded cancellous screw or cortical screws. They were then secured to the columns. In most cases two reconstructive plates (3.5mm) were contoured to the distal humerus. One plate was placed on medial column and one on the posterior aspect of the lateral column (90° to each other). Plates applied on distal humerus at right angle to each other create 'Girdler like effect' which strengthen fixation construct. Plates should end at different levels on humeral shaft to minimize the 'stress riser' effect. Each plate should have at least 3 bicortical screws proximal to metaphyseal comminution (Table 1).²

Table 1: Technical objectives for fixation of distal humeral fractures.

Technical objectives for fixation of distal humeral fractures
Every screw should pass through a plate.
Each screw should engage a fragment on the opposite side that is also fixed to a plate.
As many screws as possible should be placed in the distal fragments.
Each screw should be as long as possible.
Each screw should engage as many articular fragments as possible.
Plates should be applied such that compression is achieved at the supracondylar level for both columns.
Plates used must be strong enough and stiff enough to resist breaking or bending before union occurs at the supracondylar level.

From Sanchez-Sotelo J, Torchia ME, O'Driscoll SW: Principle-based internal fixation of distal humerus fractures, Tech Hand Upper Extremity Surg 5:179, 2001.²

Light posterior plaster splint was given for 3 days which was replaced by hinge brace and gentle active or active-assisted exercises were carried out as soon as possible as pain permits. Parenteral broad-spectrum antibiotics were given for 4 days then Oral antibiotics till suture removal. Post operatively dressings are done on 3rd, 7th and 11th day under aseptic conditions. Stitches were removed from 11th - 14th postoperative day as per the condition of the wound.

Analgesics and anti-inflammatory drugs were given as required. All patients were followed up at monthly intervals for 6 months.

During this period patient was motivated for physiotherapy and gradual normal use of the affected limb, fracture union was assessed clinically and radiologically and elbow function on the operated side was evaluated and compared with the normal side as per Mayo elbow score by the same observer.²

Table 2: Mayo elbow performance score.

Function	Mean score (Points)			
PAIN (Maximum 45 points)				
None (45)	Mild (30)	Moderate (15)	Severe (0)	
ROM (Maximum 20 points)				
>1000 (20)	500 to 1000 (15)	<500 (5)		
Stability (Maximum 10 points)				
Stable (10)	Moderately Stable (5)	Unstable (0)		
Function (Maximum 25 points)				
Comb (5)	Feed (5)	Personal (5)	Shirt (5)	Shoes (5)
Mean Total (maximum 100 points)				

Interpreting the Mayo Elbow Performance Score: Excellent 90; Good 75-89; Fair 60-74; Poor below 60.

Mayo elbow performance score

It is based on 100 point scale with maximum of 45 points for Pain, 25 points for Function, 20 points for Range of Motion and 10 points for stability (Table 2).

RESULTS

In the present study, 25 cases of supracondylar intra articular fracture of humerus in adults, treated with two column fixation via olecranon osteotomy. Intra-articular fractures of the distal humerus occurred in all age groups but were more common in younger age from 16-35 years. There was more number of males than females with a male female ratio of 3:2. Most of the fractures are the result of Road side accidents. Left humerus was found to be more commonly involved. 88% of patients had closed fractures and among those with open fractures, Grade III (12%) fractures were the more common. There were

associated injuries in 28% of cases like fracture ulna, fracture BB leg or nerve injuries. 5 out of 25 cases had associated medical illness. 1 had diabetes mellitus type-2, 3 had hypertension and 1 had both DM-2 and HTN. Most of the patients were operated within 24 hours of injury. Most of the fractures are of C1 type as per AO system of classification. At the average follow up of 20 months, the flexion at the elbow joint ranged from 70 degrees to 140 degrees with an average of 120.2 degrees. 21 patients had a flexion beyond 110 degrees (84%). And average loss of extension ranged from 0 degrees to 30 degrees with an average of 14.2 degrees. All the patients have extension loss less than 30 degrees. More than 100 degree of range of movement is obtained in 56% of cases. In most the cases functional arc of motion (300 to 1100) is preserved. Scoring of range of motion is done as per Mayo Elbow Performance Score. Most of the fixations are stable. 5 (20%) patients suffered transient Ulnar N Neuropraxia in the early post-operative period. No patient suffered from iatrogenic vascular injury. Hardware failure in 3, painful

hardware in 4, superficial infection in 3, non-union of olecranon osteotomy in 1, elbow stiffness in 6 and 3 had cubitus varus deformity. In this study, results were evaluated according to Mayo Elbow Performance Score.⁴ According to this criteria, excellent result was achieved

in 8 patients (32%), good in 13 (52%), fair in 3 (12%) and poor in 1 (4%) patients (Figure 1). Thus satisfactory result was obtained in 96% cases, and the Mean Mayo Elbow Performance Score is 83.4 (Table 3).

Table 3: Final functional outcome.

Function		No. of patients	Percentage (%)	Mean score (Points)
PAIN (Maximum 45 points)	None (45)	7	28	33.6
	Mild (30)	17	68	
	Moderate (15)	1	4	
	Severe (0)			
ROM (Maximum 20 points)	>100 (20)	14	56	17
	50 -100 (15)	9	36	
	<50 (5)	2	8	
Stability (Maximum 10 points)	Stable (10)	23	92	9.6
	Moderately (5)	2	8	
	Unstable (0)			
Function (Maximum 25 points)	Comb (5)	20	80	23.2
	Feed (5)	25	100	
	Personal (5)	25	100	
	Shirt (5)	25	100	
	Shoes (5)	21	84	
Mean Total (max. 100 points)				83.4

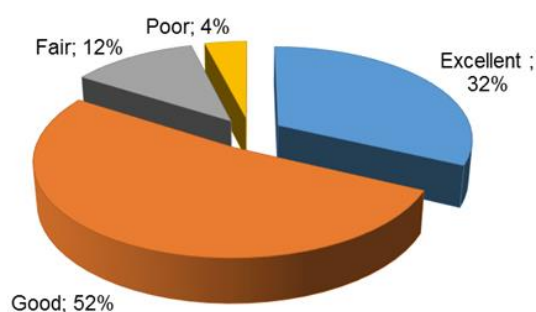


Figure 1: Results.

DISCUSSION

In the present study most of the fractures (64%) occurred in the younger age group i.e. 16 to 35 years. Males constituted the largest group (60%) in the study with a male-female ratio of 3:2. The low incidence of females in our study was probably because of fewer incidences of road traffic accidents in females due to less outdoor activities in females. Sixteen (64%) of the patients had injury of left side and rest nine (36%) had injury of right humerus. 88% of patients had closed fractures and among those with open fractures, grade III (12%) fractures were the more common. Road side accident was the most common mode of injury in 68% patients followed by those sustaining the fracture due to falls (20%). Since most of the fractures were the result of high velocity

trauma, there was high incidence of associated injuries (28%).



Figure 2: (A) Initial injury anteroposterior and lateral radiograph of a 80 Year female with displaced AO Type C3 distal humerus fracture; (B) Anteroposterior and Lateral radiographs six months after the fracture fixation; (C) Clinical picture with full supination and pronation fifteen months after fixation of fracture.

In the present study, 13 patients had C1 (52%), 8 had C2 (32%), 3 had C3 (12%) and 1 had type B1 (4%) fracture configurations according to AO classification. There was

more number of C type fracture (96%) and out of them C1 type is more common (52%). Time elapsed between injury and surgery ranged from 12-24 hours with most patients (72%) being operated between 12-24 hours of injury.



Figure 3: (A) Initial injury anteroposterior and lateral radiograph of 60 years female with displaced AO Type C3 distal humerus fracture; (B) Anteroposterior and Lateral radiographs five months after the fracture fixation; (C) Clinical picture with full supination, flexion and extension twelve months after fixation of fracture.

18 out of 25 patients (72%) were managed within 24 hours of presentation. 4 patients (18%) were given definitive treatment within a few days but a few (8%) had to wait for more than a week for definitive management either because they were managed initially at other centres or because of associated problems which were either an associated injuries or systemic problems. All patients were treated by open reduction and internal fixation with two column fixation with orthogonal plates followed by early physiotherapy. In this study, results were evaluated according to Mayo Elbow Performance Score.⁴ According to this criteria, excellent result was achieved in 8 patients (32%), good in 13 (52%), fair in 3 (12%) and poor in 1 (4%) patients. Thus satisfactory result was obtained in 96% cases.

Rigid fixation and early rehabilitation are the most important goals in treatment of type C elbow fracture. In our study, posterior approach with olecranon osteotomy was used in distal humerus fracture. The advantages of this approach are exposure of the intra-articular fragments which aids in good reduction and the implementation of early functional exercises is possible. Articular restoration is the most essential step followed by stabilization of the largest columnar fragment. The aim is to facilitate biomechanical reconstruction of the two-column structure which was carried out in all 25 cases in

our study. In each case, fracture reduction was satisfactory, fixation was strong and durable, fracture site stable and early post-surgical functional exercise was possible.



Figure 4: (A) Initial injury anteroposterior radiograph of a 40 years female with displaced AO Type C3 distal humerus fracture; (B) Anteroposterior and Lateral radiographs three months after the fracture fixation; (C) Clinical picture with functional movements ten months after fixation of fracture.

In present series, at the time of injury 1 patient had ulnar nerve palsy and 1 patient had radial nerve which completely recovered over a period 10 months. Post-operatively, 3 patients had transient ulnar nerve Neuropraxia (which was completely recovered after 3 months), 3 patients had superficial infection which got better with antibiotics and dressings. Some degree of loss of extension is seen in most of the cases, more than 20 degree of stiffness is seen in 6 patients. Other complications encountered in our series were varus deformity in 3 patients, hardware failure in 3 patients, non-union of olecranon osteotomy in 1 patient, 17 patients had mild pain and 7 patients had no pain at all. Pain at final follow up was not related to the type of fracture. Henley in their series of 33 patients observed fixation failure in 5 patients, infection in 2 patients, one superficial and one deep and heterotopic ossification in 2 patients.⁵ Sodegard et al in his series of 96 patients encountered 6 post-operative infections.⁶ 12 neural injuries and 16 fixation failures. Thus the complications in our study were comparable to other studies.

It is important to realize that final outcome of painless, functional range of motion at elbow causing no disability is more important than a sound radiographic and anatomic union. At the average follow up of 20 months, the average flexion achieved was 120.2 degrees ranged from 70 degrees to 140 degrees. 21 patients had a flexion beyond 110 degrees (84%). The average loss of extension was 14.2 degrees ranged from 0 degrees to 30 degrees. In most the cases functional arc of motion (30° to 110°) is preserved. 17 patients had a mild pain not limiting their

activities of daily living. 1 patient had a moderate disability so that he could not work in the same job which they used to do before sustaining the fracture. The results were graded according to Mayo Elbow Performance Score and good results was achieved in 13 (52%) patients and 8 (32%) have Excellent outcome. 3 (12%) had fair results and 1 (4%) had poor outcome. The Mean Mayo Elbow Performance Score is 83.4. Dasheng Tian et al in compared the clinical outcomes of the perpendicular and Y-shaped double-plating with olecranon osteotomy methods when applied to type C distal humerus fractures in young adults and found Mayo Elbow Performance Scores, 84.6% of patients in group I and 83.3% in group II had excellent or good scores.⁷ Kilicarlan K et al conducted study on 27 patients and observed the Mayo Elbow Performance Scores to be excellent results in 20 patients (74%), good in 4 (14.8%), fair in 2 (7.4%) and poor in 1 patient (3.7%).⁸ Thus the results of our study were comparable to other studies. General limitations observed in present study were small sample size for comparative study, inadequate follow-up in some cases and there is limited literature regarding objective extensor mechanism strength assessment in our study.

CONCLUSION

From the study we concluded that, the AO classification is most comprehensive classification for clinico-radiological assessment of fractures of distal humerus as it is very thorough and allows better documentation and specific comparison of fracture types. Supracondylar intra-articular fractures of humerus are more common in males than females due to more outdoor activity in males. The mode of injury for supracondylar intra-articular fractures of humerus is road side accidents mostly, which is results of increased vehicular traffic. The most important factor in determining outcome of these fractures is the displacement of the intra articular components. The quality of elbow function after fractures of distal humerus is related to degree to which anatomic relationships are maintained. The reliable method to restore the normal alignment and contours of distal humerus is operative exposure by Trans-olecranon approach (with Chevron osteotomy) which gives best view to intra articular distal humeral fractures and direct manipulation of fracture fragments. It is imperative to maintain the width of distal humerus and the two columns with orthogonal plates, so that the fixation is stable enough for early post-operative rehabilitation. The

method is safer than other posterior approaches, effective than other means of internal fixation, and economical as K-wires and Reconstructional plates are used. By this method, we have achieved early mobilisation of the elbow with good range of elbow movement (300-1100) with fewer complications.

Funding: No funding sources

Conflict of interest: None declared

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

REFERENCES

1. Athwal GS. Distal Humerus Fractures. In: Rockwood and Green's fractures in adults. 7th ed. Philadelphia: Lippincott Williams and Wilkins. 2010;1:945-72.
2. Crenshaw AH, Perez EA. Fractures of the shoulder, arm and forearm In: Cambell's Operative Orthopaedics. 11th ed. USA: Mosby. 2008;3:3405.
3. Brown RF, Morgan RG. Intercondylar T-shaped fractures of Humerus. *J Bone Joint Surg.* 1971;53B(3):425-8.
4. Dawson J, Fitzpatrick R, Car A, Murray D. Cambridge Shoulder Group Revised. *British Journal of Bone and Joint Surgery.* 1996;78-B(2):185-90.
5. Henley MB. Intraarticular distal Humeral fractures in adults. *Orthop. Clin North Am.* 1987;18(1):11-23.
6. Sodergard J, Sandelin J, Bostman D. Mechanical failures of internal fixation in T & Y fractures of the distal Humerus. *J Trauma.* 1992;33(5):687-90.
7. Tian D, Jing J, Qian J, Jianming Li. Comparison of two different double-plate fixation methods with olecranon osteotomy for intercondylar fractures of the distal humeri of young adults In: *Exp Ther Med.* 2013;6(1):147-51.
8. Kilicarlan K, Bektaser B, Ucguder A, Dogan M, Ugurlu M, Yildirim H. Results of early surgical treatment of intra-articular complex fractures of the humerus in adults In: *Bratisl Lek Listy* 2011;112(9):501-5.

Cite this article as: Daroch MS, Sreen S, Vashisht D, Puri P. Management of Arbeitsgemeinschaft fur Osteosynthesefragen type C fractures of distal humerus in adults with two column fixation. *Int J Res Med Sci* 2016;4:5440-6.

Annexure

MASTER CHART

Name	CR. No.	Sex	Age (Yrs)	Mode of Injury	S I D E	OPE N/C LOS E	Asso. Injuries	Medical illness	Post-Op Follow up(m)	Interval b/w inj. & op.(days)	Injury type (AO)	Range of Movement (degrees)		Pain (Mayo 45 pts)	ROM (Mayo 20 pts)	Stability (mayo 10 pts)	Function (mayo 25 pts)	mayo score (0 to 100)	Complications	Result
												Loss of Extension	Flexion							
MS	30957	M	30	Fall	L			HTN	30	1	C1	15	125	30	20	10	25	85	HF,PH	G
So D	10856	F	40	RSA	L		RNP		12	1	C2	10	115	45	20	10	25	100	TN	E
Ti	33915	M	23	Fall	L				27	1	C1	30	110	30	15	10	25	80	PH	G
KR	30885	M	35	FALL	R				19	5	C1	10	115	45	20	10	25	100		E
DS	396	M	21	RSA	L				31	1	C1	0	135	45	20	10	25	100		E
Na	41498	F	60	RSA	R			HTN	18	1	C3	25	115	30	15	10	25	80	TN	G
Na S	14804	M	28	RSA	L				30	1	C2	10	100	30	15	10	25	80		G
SK	772	F	60	RSA	R				27	5	C3	25	120	30	15	10	25	80	SLCV	G
NS	26768	M	20	RSA	R		#BB Leg R		29	5	C1	10	120	30	20	10	25	85		G
AK	26759	M	30	MI	L		#Ulna L, U NP		31	5	C2	15	130	30	20	5	25	80	SLHF, CV	G
RKH	5724	F	80	Fall	R			HTN, DM	19	1	C3	30	125	30	15	10	25	80	SLCV	G
MK	10357	F	30	RSA	L	O	#radius L		19	8	C1	25	120	30	15	10	15	70	PH	G
JK	10656	F	55	RSA	R	O	#HORR	HTN	17	1	C2	0	130	30	20	10	25	85		G
Ta	30950	M	22	RSA	L				24	1	C1	10	125	45	20	10	25	100		E
Su D	29495	F	45	RSA	L				18	1	C1	10	135	45	20	10	25	100		E
RK	26052	F	60	ASLT	L			DM	18	1	C1	10	120	30	20	10	25	100		E
J	21280	M	25	RSA	R		#Olecranon R		12	12	C1	30	125	30	15	10	15	70		F
LS	37887	M	56	RSA	R				12	1	C1	20	115	30	15	10	25	85		G
N	29795	F	25	RSA	L		#Olecranon L		6	30	C2	10	70	15	5	5	20	50	TN, NO O, ES, HF	P
Ma S	149180	M	28	RSA	L				24	1	C1	0	135	30	20	10	25	85		G
KS	8250	M	45	RSA	L				24	1	C2	10	125	30	20	10	25	85	TN	G
P	36225	F	23	Fall	L				12	1	C1	0	135	45	20	10	25	100		E
HN	32045	M	28	RA	L	O			12	20	C1	20	140	45	20	10	25	100		E
TS	40029	M	24	RSA	R				17	1	C3	10	130	30	5	10	15	60	ES, PH	F
JS	21041	M	21	RSA	L				12	1	C2	20	90	30	15	10	15	70		F

HOR: Head of Radius; HTN: Hypertension; DM: Diabetes mellitus; TN: Transient Neuropraxia; BB: Both bone; HF: Hardware Failure; PH: Painful Hardware; RNP: Radial Nerve Palsy; SI: Superficial Infection; CV: Cubitus Varus; NOO: Non union of osteotomy; ES: Elbow Stiffness