Research Article

Outcome after Interlocking intramedullary nailing of humeral shaft fractures

Ummat A[1], Kochhar S[2], Bansal K[3], Bhardwaj R[4], Sharma C[5]

[1]Dr. Ashwani Ummat, Associate Professor, Department of Orthopaedics, [2]Dr. Sonia Kochhar, Professor, Department of Physiology, [3]Dr. Kunal Bansal, PG Resident, Department Of Orthopaedics, [4]Dr. Rahul Bhardwaj, PG Resident, Department of Orthopaedics, [5]Dr. Chetan Sharma, PG Resident, Department of Orthopaedics. All are affiliated with Maharishi Markandeshwar Institute of Medical Sciences and Research, Mullana, Haryana, India.

Address for Correspondence: Dr. Ashwani Ummat, Associate Professor, Department of Orthopaedics, Maharishi Markandeshwar Institute of Medical Sciences and Research, Mullana (Haryana) India. E-mail: kochhar.sonia.dr@gmail.com

……..

Abstract

Introduction: Management of fractures of humeral shaft is always a challenging problem to deal with as they are very frequently associated with multiple injuries, leading to complications. Interlocking intramedullary nails have gained popularity now a days for stabilization of humeral shaft fractures due to load sharing nature of implant, preservation of fracture haematoma, minimal exposure and rigid fixation with early mobilization. **Material & Methods:** A prospective clinical study on fifty patients of humeral shaft fractures was performed using antegrade locked intramedullary nailing in our hospital setting to evaluate the incidence of complications associated with this method of humeral shaft fracture fixation. **Results:** Superficial wound infection occurred in four cases (8%). Shortening of one cm was observed in one case (2%) and troublesome shoulder pain remained in two patients (4%). Persistent restriction of shoulder movements remained in twelve patients (24%) at 6 months, non-union occurred in two patients (4%), iatrogenic transient radial nerve palsy occurred in four patients (8%). Two patients (8%) developed myositis ossificans of shoulder joint and two patient (8%) developed hypertrophy of scar. **Conclusion:** A number of technical errors and complications, which we consider technique specific, were registered. The analysis and avoidance of these complications, related to intramedullary nailing of the humerus, will allow intramedullary nails to successfully bridge the gap between bracing and plating**.**

Key words: Complications, Humeral fractures, Intramedullary Interlocking Nailing.

…….

Introduction

Acute fractures of the humerus have a good healing tendency with non operative methods thanks to the excellent blood supply of the surrounding muscles. Thus functional bracing is still the treatment of choice in many trauma centres [1,2]. When operative treatment is needed plate and screws osteosynthesis has been the treatment of choice in many places [3,4]. Although dynamic compression plating has traditionally been considered the "gold standard" in humeral surgery, intramedullary fixation has certain advantages like being closer to the normal mechanical axis of the bone and acting as a load sharing device. Bending forces and consequent fatigue failure are less. Since the fracture is not exposed directly (fracture haematoma is preserved) and soft tissue dissection is much less, the fixation is more biological and with less stress shielding and chances of iatrogenic nerve injury are also reduced. Intramedullary nail (IM) fixation is an established method of treatment of high-energy long bone fractures especially in polytrauma setting, as well as osteoporotic, impending and pathological fractures. Locked intramedullary nails usually can be inserted using closed techniques avoiding the extensive soft tissue dissection required for plating. Interlocking nails give rotational stability, decrease the need for post operative bracing and allowing early mobilization of the extremity while preserving fracture haematoma [5,6]. However the procedure is not without its pitfalls. Failed closed reduction, failed locking, iatrogenic fractures and

Manuscript received 11th April 2016
Reviewed: 24th April 2016
Author Corrected: 6th May 2016
Accepted for Publication 19th May 2016

nerve injuries in the intraoperative period and adhesive capsulitis, non union, nail protrusion and impingement in post-operative have been reported.

So in this prospective study we will evaluate the incidence of complications associated with locked antegrade intramedullary nailing of humeral shaft fractures in 50 patients in our setup.

Material and Methods

This is a prospective study of humeral shaft fractures in fifty patients aged between 20-65 years (average 39.64 years) treated with antegrade unreamed intramedullary interlocking nail based on Russel- Taylor Model(made of 316L stainless steel) for humeral shaft fractures (n=50) at our hospital. Humeral nail used in this study has 2 proximal screws directed lateral to medial and 2 distal holes for anteroposterior locking. It has 5° lateral bend, 4 cm from its proximal end. Patient demographics and baseline characteristics were prospectively recorded: gender, age, accident type, localization palsies, length of hospital stay, and delayed union and non-union. Non-union was defined as no evidence of radiological progression of fracture union for more than 3 months. The inclusion criteria included skeletally mature patients and all fracture shaft humerus including Grade I, II, III A and III B compound fractures. The exclusion criteria included patients with open epiphysis, compound Grade III C fracture, patients unfit for surgery and associated ipsilateral proximal humerus fractures.

There were 44 males and 6 female patients. Mode of injury included 34 road traffic accidents, 8 accidental falls, 4 pathological fractures (2 cases had humeral metastasis from Ca breast and another2 cases of severe osteoporosis with failed dynamic compression plating) and 4 due to assault. Associated injuries were present in 28 acute fractures: 12 had fractured both bone forearms, 6 had associated radial nerve injury, 3 had fracture shaft femur and 2 each had fracture patella, multiple rib fracture and head injury and 1 patient had associated spinal cord injury. Compound fractures were initially given thorough wash in casualty department with appropriate pain relief. Plaster of Paris U-slab was initially applied to immobilize the limb in all humerus fractures.

Technique

Fixation with intramedullary interlocking humerus nail is appropriate for humeral fractures between 3-cm proximal to the olecranon fossa and 2-cm distal to the surgical neck. Patients are positioned supine on a fluoroscopy operating table. The ipsilateral shoulder is pulled to the edge of the table, and the head is turned to face the contralateral side.

All open fractures are treated with immediate debridement and irrigation and exploration of the fracture site to ensure that the radial nerve is not entrapped. In patients with preoperative radial nerve palsy, nerve exploration was done at the time of primary surgery using Henry's approach at appropriate level. The entry portal for the nail is made using the anterolateral approach described by Riemeret al [7]. A 4-cm incision is made anterior to the midpoint of the acromion and deltoid muscle is split longitudinally. A 1- cm incision is made in the rotator cuff in line with its fibers. An awl is used to create the entry portal just medial to the greater tuberosity in the sulcus between the greater tuberosity and the articular margin. Humeral opening was enlarged with hand reamers in order to avoid iatrogenic fractures at the time of nail insertion. Fracture was reduced by closed method and guide wire passed under fluoroscopic control to measure length of the nail. (The guide wire tip was kept 2-3 cm proximal to proximal end of olecranon fossa). Then appropriate size nail was passed after removing guide wire, under fluoroscopic control. The proximal end of the nail is seated approximately 5-mm beneath the bone to prevent impingement. The nail should be inserted with the fracture well aligned to avoid intraoperative comminution. Proximal interlocking screw is placed with the use of a proximal drill guide. The screw should be directed so that it exits medially, distal to the articular margin of the humerus. A drill sleeve is inserted through a stab incision after soft tissues have been dissected bluntly down to bone. A hole is made with a 2.7-mm drill bit, and a 4 mm bicortical screw is inserted. Distal locking was performed using a freehand technique. Before the distal screw was inserted, the fracture site is compressed by placing an axial load on the elbow. Correct rotation is obtained by pointing the forearm and hand perpendicular to the ceiling.

The patient's arm was supported simply in a neck sling for the first few days after surgery. Range of motion exercise was encouraged as early as tolerable. Anteroposterior and lateral radiographs were taken postoperatively and on every follow up until union was achieved. Patient was followed up every 6 weeks till satisfactory union was achieved. Radiological union was defined as presence of bridging callus in both

anteroposterior and lateral x-rays bridging at least three cortices without gap. Non-union was defined as no evidence of radiological progression of fracture union for more than three months. Malunion was defined as greater than 10°angulation in either A.P or lateral views. The time to union, shoulder functional score based on Modified American Shoulder and Elbow Society score(activites like pull, throw were excluded), shoulder and elbow range of motion, the visual analogue pain score were recorded. The follow up time was 6 months.

Statistical Analysis: Mean values of time to union, shoulder functional score, shoulder and elbow range of motion and visual analogue pain scores given with their own ranges.

Results

Forty eight of 50(96%) fractures eventually united. Out of fifty cases, in six patients (12%) radiological union was evident in less than 12 weeks, in twenty four patients (48%) it took 12-15 weeks. In sixteen patients (32%) signs of radiological union were seen at 15-20 weeks and in two patients (4%) it took 23 weeks. Two patients (4%) went for non-union in the present study.

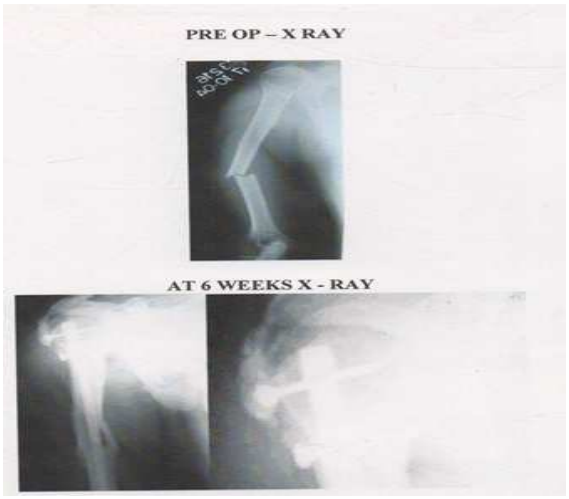

Figure-1: Myositis Ossificans.

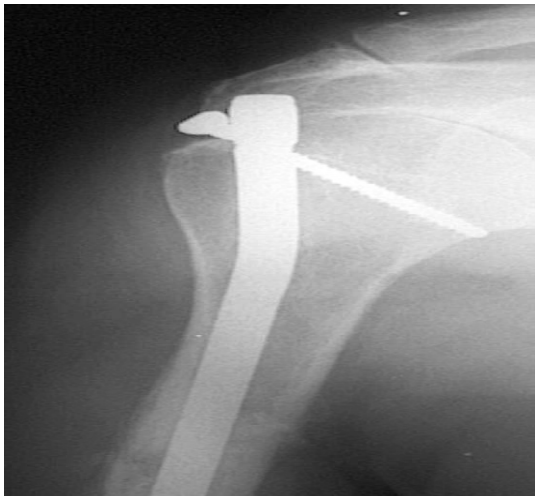

Figure-2: Protrusion of a nail and a proximal screw.

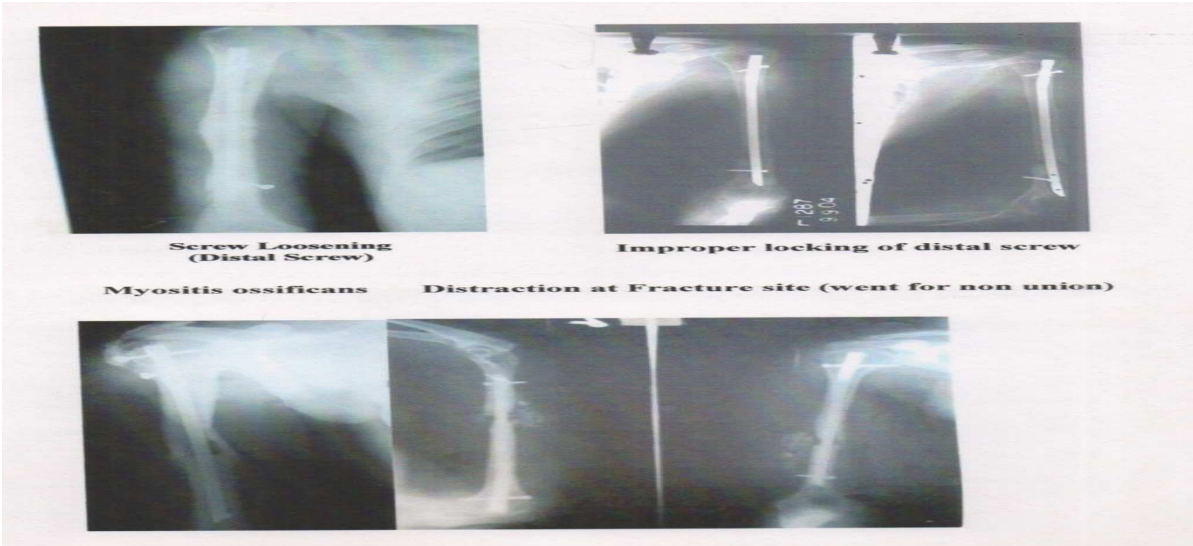

Figure 3: Myositis ossificans & other complication

Shoulder and elbow range of motion were recorded [Table-1(a)]. At first follow up (6weeks) forty six patients had restriction of abduction and flexion of shoulder joint of more than 20° and remaining 4 patients had restriction of <20°. However this improved by continuous physiotherapy. At 6 months, thirty eight (76%) patients had full range of shoulder movements and only six (12%) had restriction of flexion and abduction greater than 20° and another six (12%) <20°[Table-1 (b)]. All patients had full range of movements at elbow, wrist and fingers.

Table-1(a): Shoulder and elbow movements at 1st follow-up (6 weeks).

Range of motion	No. of Cases / Percentage	
	Shoulder	Elbow
Full movement	0	50(100%)
Restriction of movement		
<20°	4(8%)	0
>20°	46(92%)	0

Table-1 (b): Shoulder and elbow movements at 6 months follow-up.

Range of motion	No. of Cases / Percentage	
	Shoulder	Elbow
Full movement	38(76%)	50(100%)
Restriction of movement		
<20°	6(12%)	0
>20°	6(12%)	0

Table-2: Visual Analogue Scale.

	0	1-5	5	5-9	10
At 10 days	18	18	12	2	
At 6 weeks	28	20	2		
At 6 months	48	0	2		

Table-3: Complications of humeral shaft fractures treated with interlocking nailing in present study.

S.No.	Complications	No. of cases	Percentage
1	Persistent restriction of shoulder movements	12	24%
2	Non union	2	4%
3	Myositis ossificans of shoulder joint	2	4%
4	Persistent shoulder pain	2	4%
5	Residual deformity (shortening of one cm)	1	2%
6	Hypertrophy of scar	2	4%
7	Impingement caused by protruding proximal nail	2	4%
8	Prominent protruding screws	2	4%
9	Failed closed reduction	2	4%
10	Failed distal locking	2	4%
11	Iatrogenic communication of fracture	1	2%
12	Radial nerve palsy(transient)	4	8%
13	Infection(superficial)	4	8%

To assess function, we used the criteria given by American Shoulder and Elbow Society (ASES) score [Appendix I] which was modified according to Indian conditions (activities like pull, throw were excluded) for 10 activities of daily living requiring full shoulder and elbow movement with maximum of 40 points. Results were graded according to following criteria:

Good -if patients modified ASES score was between 30-40.
Fair - if patients modified ASES score was between 20-29.
Poor - if patients modified ASES score was <19.

Forty two (84%) of patients had good functional outcome whereas four (8%) had fair results and four (8%) had poor result [Figure-5]. Out of 4 poor results two patients developed Myositis Ossificans of shoulder joint and the other two developed non-union.

We quantified pain using visual analogue scale [Table-2], with zero being no pain and 10 extreme pain. At 6 months shoulder pain remained in only two patients. These patients developed Myositis Ossificans of shoulder joint and needed frequent analgesics for pain relief. Superficial wound infection occurred in four (8%) cases which was evident by local signs of redness, erythema of skin and serous discharge. No patient developed deep infection in present study. Superficial wound infection was controlled by local wound care and appropriate antibiotics. No valgus or varus angulation was found clinically. Neither was there any anterior or posterior angulation. Rotational alignment was satisfactory in all cases. Shortening of one cm was observed in one case which was due to impaction of comminuted fracture fragments.

Troublesome shoulder pain remained in two patients (4%) which needed frequent analgesics. Persistent restriction of shoulder movements remained in 12 (24%) patients at 6 months, non-union occurred in two patients (4%), iatrogenic transient radial nerve palsy occurred in four (8%). However this recovered within three months of post operative period. Two patients (4%) developed myositis ossificans of shoulder joint and two patients (4%) developed hypertrophy of scar. In the intraoperative period, one patient (2%) had iatrogenic comminution of the fracture, two (4%) had failed closed reduction which necessitated open reduction of the fracture, two (4%) had failed distal locking in whom an above elbow POP back slab was applied for 6 weeks. Fracture gap due to distraction at the fracture site occurred in one case due to improper assessment of nail length (too long) and was associated with subsequent nonunion in the patient which was managed by autogenous bone grafting. Distal locking in two cases (4%) could not be done since multiple attempts at locking ended in multiple holes, none of which were properly located and to avoid iatrogenic fracture at the site, the locking was abandoned. Protruding proximal nail causing impingement was observed in two cases (4%) due to improper countersinking of the nail end into the humeral head. This case was managed by early nail removal at 12 weeks. In two cases (4%), prominent protruding screws due to backout following vigorous physiotherapy were removed at 8 weeks with no adverse effects [Table 3].

Discussion

Isolated humeral shaft fractures can be treated satisfactorily with non-operative methods[8,9] but operative stabilization of it is necessary for multiple injured patients, patients with acute, high energy humeral fractures to improve chances of healing, fracture alignment and functional results [10,11]. With recent interest in biological fixation of fracture and because of biomechanical advantage of intramedullary nailing over dynamic compression plating, intramedullary nailing for fracture shaft humerus has gained a lot of popularity these days. Antegrade nailing is giving good results as it saves vital blood clot at fracture site, checks rotation, axial alignment and telescoping along with early mobilization of patient. Moreover, it is very useful in pathological and impending fractures.

A 96 % rate of union was achieved in present study. Union occurred in less than 15 weeks in 60 % of our cases. Ikpeme [12] reported 100% union rate in twenty fractures treated with Russell-Taylor nail using antegrade route. Heim's [13] reported 85% union rate in forty-seven humeral shaft fractures treated by antegrade route using Russell-Taylor nail. Linn et al [14] reported 96% union rate where as Rommens [15] reported 97% union rate. John [5] and Crolla [16] reported union rate of 97%. Riemer [7] reported 100% union rate in forty fractures treated by Seidel nail using antegrade route. Union rates of present study correlates well with Linn et al[14], Rommens [15] and Crolla[16] studies but were inferior to Ikpeme [12] and Riemer [7] result but superior to Heim's and Cox [17] study. A high union rate with intramedullary interlocking nailing can be explained due to absolute rotational control of fracture fragments, minimum damage to fracture site soft tissue, intact periosteal blood supply preservation of fracture haematoma and less chances of infection. In the present study there was a restriction of more than 20 degree of shoulder movements in six (12%) cases and restriction

of less than 20° in another six cases (12%). Robinson et al [18] (1992) reported restriction of shoulder movements in 48% cases treated with Seidel nails. Ikpeme [12] (1994) reported shoulder pain and decreased shoulder abduction in three patients (15%). In our series, the restriction in shoulder movements occurred in overall twelve (24%) cases. In two (4%) case it was due to myositis ossificans of shoulder joint and in other eight (16%) it was probably due to delayed initiation of shoulder movements and in adequate cooperation of patients with the physiotherapy regimen. Two patients (4%) had nail impingement which caused severe shoulder stiffness. Elbow movements were not restricted in any of our cases. John [5] reported elbow restriction in three patients.

Functionally good results were achieved in 84% cases, fair in 8% and poor in 8% of our cases using modified American Shoulder and Elbow Society (ASES) score. John Crates et al [5] (1998) reported 90.4% good results, fair in 5.5% and 4.1% poor functional results using antegrade intramedullary interlocking nail.

Superficial infection occurred in four (8%) of our patients which was controlled by local wound care and appropriate antibiotics. However no deep infection was seen in the present study. Rommens et al (1995), Heim and Linn reported no infection. Brumback et al (1986) reported an infection rate of 1.7% and Henley et al (1992) reported deep sepsis in 3.3% cases.

Iatrogenic radial nerve palsy occurred in four (8%) of our cases. However all were transient and recovered within 12 weeks of post operative period. Debezies et al (1992) reported secondary radial nerve involvement of 5.5% and 2.7% rate was reported by John Crates et al (1998).

Shortening of 1 cm was observed in one (2%) case in our study which was due to severe comminution at fracture site.

Two cases (4%) developed non-union. In one patient it was due to unrecognized distraction at fracture site at the time of surgery. In post-operative period the problem was discussed with patient but he was not ready for another procedure immediately. Later on, non-union was treated by exchange nailing and bone grafting at fracture site. In second patient it was probably due to iatrogenic comminution at fracture site (due to wrong assessment of width of nail) and gap at fracture site (due to wrong selection of length of nail)which was treated by bone grafting Heim's[13], Linn [14], Cox [17], Crolla[16], Robinson [18] and John et al [5] reported different non-union rates in their respective studies.

Two patients (4%) in our study developed myositis ossificans of shoulder joint. One patient had ipsilateral supracondylar fracture femur with intercondylar extension and fracture both bone forearm (compound) of opposite forearm along with head injury. Second patient had associated spinal cord injury with fracture tibia. Probable cause for myositis ossificans could be due to the associated head injury, spinal cord injury and initial trauma to shoulder joint soft tissues. In a nutshell, we conclude that intramedullary interlocking nailing of humerus, using antegrade route under image intensifier guidance, is an excellent method of management of fracture shaft of humerus. We recommend intramedullary nailing in most of the cases of fracture shaft of humerus selected for surgical management. However more specifically, we would emphasize it's use in cases of severe osteoporotic fractures, pathological fractures due to metastasis, impending fractures and in patient with multiple fractures. Also, the importance of proper preoperative planning and using the proper sized implant cannot be over emphasized. Shoulder stiffness seems inimical to antegrade nailing and this maybe obviated by accurate portal entry, countersinking the nail tip in the humeral head and wad capping the proximal hollow of the nail along with early initiation of physiotherapy.

Conclusion

Specific technical errors and complications related only to intramedullary nails were registered in this case series. From our findings we conclude that strict adherence to proven indications like polytrauma, impending fractures, pathological fractures due to osteoporosis and metastasis and good surgical technique like proper attention during nail insertion, proximal end of nail should be well seated inside bone will allow the interlocking IM nailing to bridge the gap between functional bracing and the plating and to achieve better results compared to both of them. Our experience from this study makes us wiser by the thought that post operatively the shoulder and elbow should be mobilized as soon as the patient becomes comfortable. Aggressive post operative physiotherapy is the best way to prevent shoulder stiffness.

Funding: Nil, **Conflict of interest:** None.
Permission of IRB: Yes

References

1. Bleeker WA, Nijsten MW, ten Duis HJ (1991) Treatment of humeral shaft fractures related to associated injuries. A retrospective study of 237 patients. Acta Orthop Scand 62(2): 148–53.

2. Wallny T, Westermann K, Sagebiel C, Reimer M, Wagner UA. Functional treatment of humeral shaft fractures: Indications and results. J Orthop Trauma. 1997 May;11(4):283-7.

3. Vander Griend R, Tomasin J, Ward EF. Open reduction and internal fixation of humeral shaft fractures. Results using AO plating techniques. J Bone Joint Surg Am 1986; 68(3):430-3.

4. Heim D, Herkert F, Hess P, Regazzoni P. Surgical treatment of humeral shaft fractures - the Basel experience. J Trauma. 1993; 35(2):226–232.

5. Crates J, Whittle AP. Antegrade interlocking nailing of acute humeral shaft fractures. Clin Orthop Relat Res. 1998;(350):40–50.

6. Scheerlinck T, Handelberg F. Functional outcome after intramedullary nailing of humeral shaft fractures: Comparison between retrograde Marchetti-Vicenzi and unreamed AO antegrade nailing. J Trauma 2002; 52:60-71. http://journals.lww.com/jtrauma/Abstract/2002/01000 /Functional_Outcome_after_Intramedullary_Nailing_of.12.aspx

7. Riemer BL, Butterfield SL, D'Ambrosia R, Kellam J. Seidel intramedullary nailing of humeral diaphyseal fractures: a preliminary report. Orthopedics. 1991 Mar;14(3):239–246.

8. Balfour GW, Mooney V, Ashby ME. Diaphyseal fractures of the humerus treated with a ready-made fracture brace. J Bone Joint Surg 1982;64A:11-3.

9. Sarmiento A, Kinman PB, Galvin EG, Schmitt RH, Phillips JG.Functional bracing of fractures of the shaft of the humerus.JBoneJointSurgAm1977;59(5):596-601.

10. Brumback R.J., Gosse M.J., Poka A., Burgess A.R. Intramedullary stabilization of humeral shaft fractures in patients with multiple trauma. J Bone Jt Surg. 1986;68A:960–970.

11. Henley M.B., Chapman J.R., Claudi B.F. Closed retrograde Hackethal nail stabilization of humeral shaft fractures. J Orthop Trauma. 1992; 6:18–24.

12. Ikpeme JO. Intramedullary interlocking nailing for humeral fractures. Experiences with Russell-Taylor humeral nail. Injury 1994; 25:447-455.

13. Hems TE, Bhullar TP. Interlocking nailing of humeral shaft fractures; the Oxford Experience 1991 to 1994. Injury 1996; 27:485-489. http://www. Scien-cedirect.com/science/article/pii/0020138396000563

14. Lin J, Hou SM. Antegrade locked nailing for humeral shaft fractures. Clin Orthop Relat Res. 1999;(365):201–210.

15. Rommens PM, Verbruggen J, Broos PL. Retrograde locked nailing of humeral shaft fractures. A review of 39 patients. J Bone Joint Surg Br. 1995;77(1):84–89.

16. Crolla RMPH, de Vries LS, Clevere GJ. Locked intramedullary nailing of humeral fractures.Injury 1993; 24:403-406.

17. Cox M, Dolan M, Synnott K, McElwain JP. Closed interlocking nailing of humeral shaft fractures with Russell-Taylor nail. Journal of Orthopaedic Trauma 2000; 14(5): 349-353. http://journals.lww.com/jorthotrauma/Abstract/2000/06000/Closed_Interlocking_Nailing_of_Humeral_Shaft.8.aspx

18. Robinson CM, Bell KM, Court-Brown CM, McQueen MM (1992) Locked nailing of humeral shaft fractures: Experience in Edinburgh over a two year period. J Bone Joint Surg [Br] 74:558–562.

……...

How to cite this article?

Ummat A, Kochhar S, Bansal K, Bhardwaj R, Sharma C. Outcome after Interlocking intramedullary nailing of humeral shaft fractures. *Int J Med Res Rev* 2016;4(5):803-809.doi: 10.17511/ijmrr.2016.i05.25.

…….