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Original Research Article

# A Prospective Study of Antegrade intramedullary interlocking nailing versus DCP for humeral diaphyseal fractures

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**Abstract:** Humeral shaft fractures account for 5% of all fractures. Rigid immobilization of the humeral shaft is difficult in view of the gleno humeral articulation. Non surgical management of humeral shaft fractures are falling out of vogue. Among the surgical options available for closed and open humeral shaft fractures are DCP and Antegrade Intramedullary Interlocking Nailing. The present prospective study conducted at SBMCH, Chennai, between August 2013 to July 2016, compared two groups of patients (n=19, n=21, total n=40) with either DCP or AIIN. The results were compared both radiologically and clinically. The functional outcome was assessed using the American Shoulder and Elbow Surgeons (ASES) scores. Our results failed to establish convincingly that either technique is superior to other. Hence the study concludes that both techniques are equally useful in the management of humeral diaphyseal fractures.
**Keywords:** Humeral shaft fractures, DCP, AIIN, ASES score, closed fractures, open fractures

## INTRODUCTION:

Fractures of the humeral shaft are common skeletal injuries in the adult. Its unique anatomy and the fracture geometry influence treatment options. Humeral shaft fractures account for approximately 3 to 5% of all fractures [1]. Function of the upper extremity is not affected even when there is upto $20^0$ of anterior angulation, $30^0$ of varus angulation and 3 cm of shortening of the humeral shaft. Rigid immobilization of the humeral shaft is difficult in view of its articulation with scapula. Other disadvantages of conservative treatment include joint stiffness, edema, muscle wasting and disuse osteoporosis. Inadequate immobilization leads to delayed or non-union. Nonsurgical management of humeral shaft fractures are falling out of vogue. Surgical management is indicated in most situations; including polytraumatic injuries, open fractures, vascular injury, ipsilateral articular fractures, floating elbow injuries, and non-unions. Surgical options include external fixation, ORIF, MIPPO, and antegrade or retrograde intramedullary nailing. Each of these techniques has its own advantages and disadvantages, and the rate of fracture union varies based on the technique used. A relatively high incidence of radial nerve injury has been associated with surgical management of humeral shaft fractures [2]. However, good surgical outcomes can be achieved with proper patient selection and strict adherence to surgical principles.

The sleeve of muscles surrounding the humeral shaft and the rich vascularity provided by them helps in fracture healing. The mobility of the shoulder and the elbow joint accommodates for a reasonable degree of angulation and shortening. As the upper limb does not take part in weight bearing or ambulation; some amount of shortening is functionally acceptable. Because of all these inherent anatomical and functional advantages of the region, conservative treatment results in very gratifying outcome [2].

Open reduction and internal fixation with plate osteosynthesis supplemented with bone grafting has been the gold standard for treatment of fractures of the humeral diaphysis [3]. Though plate fixation has given high rates of union, it involves long incisions extensive soft tissue and periosteal stripping, potential injury to radial nerve and poor fixation in osteoporotic bone. Delayed mobilization of shoulder and elbow can cause stiffness. Further there is stress shielding of the bones by the plate and reduced strength of union, owing to primary osteal healing as opposed to callus healing.

Here in lies the advantages of intramedullary nailing that include minimal surgical exposure, better biological fixation, and minimal disturbances of soft

tissues and early mobilization of neighboring joints [4]. Intramedullary nailing is a load sharing device and is biomechanically stronger than DCP. The technique of interlocking nailing represents a novel approach of the treatment of humeral fractures. Interlocking nailing also avoids complications like lack of rotational control, migration of nail and requirement of supplementary bracing [5].

## MATERIALS AND METHODS:

This prospective study was conducted at the Department of Orthopaedics, SBMCH, chromepet, Chennai from August 2013 to July 2016. We compared 40 patients with humeral diaphyseal fractures treated with plating and intramedullary nailing which were allocated randomly.

### Inclusion Criterion

1. Diaphyseal humeral fractures in men and women aged 18 and above.
2. All closed fractures and open Gustilo Anderson [6] type I to IIIA with or without radial nerve injury.
3. Fracture line lying 3cm beyond the surgical neck of the humerus and 4 cm proximal to the tip of olecranon fossa.
4. All diaphyseal fractures of humerus were included in the study even when associated with other fractures.

### Exclusion criteria

1. Age less than 18 years, because of open physis.
2. Pathological fractures, non-unions and malunited fractures.
3. Grade IIIB and IIIC Open fractures.
4. Fractures in grossly osteoporotic bones.

The 40 patients with diaphyseal fractures of humerus were allocated randomly to two groups one underwent DCP {n=19(m=9, w=10)} and AIIN {n=21(m=12, w=9)}.

All patients were investigated for anaesthetic fitness and x-rays were taken to analyse the fracture pattern and to classify them according to the AO classification [7]. Patients who had closed injuries and open type I and type II were taken up for surgery immediately. Patients with type IIIA were assessed after debridement if feasible, definitive operative procedure was done immediately or else daily dressing were done and taken up for definitive surgery once the wound was deemed fit. Intravenous antibiotics, T.T and Tetgolb500 IU were given routinely.

### Operative procedure and follow up for plating:

For the DCP ORIF groups, patient was placed in prone position if the posterior triceps splitting approach was adopted or in the supine position if the anterolateral approach was adopted. The arm was supported on the side board. Soft tissue handling and periosteal stripping was kept at the bare minimum in order not to compromise on the vascularity to the bone[8]. Fracture hematoma was curetted and the medullary canal opened up. Anatomic reduction was achieved. The DC plate was held with bone reduction clamps and fixed with four cortical screws on either side of the fracture line. In the presence of any fracture site comminution and in all open fractures prophylactic cancellous bone grafting, taken from the ipsilateral iliac crest was done. Wounds were closed over DT and sterile dressings applied with compression bandage. Arm sling support was given. Intravenous antibiotics started preoperatively were continued for 5 more days. At 48 hours the DT was removed and SR done on day 12 to 14. From the 3rd post op day, active assisted physiotherapy was initiated to mobilize elbow, wrist, hand and shoulder.

### Operative procedure and follow up for antegrade intramedullary nailing:

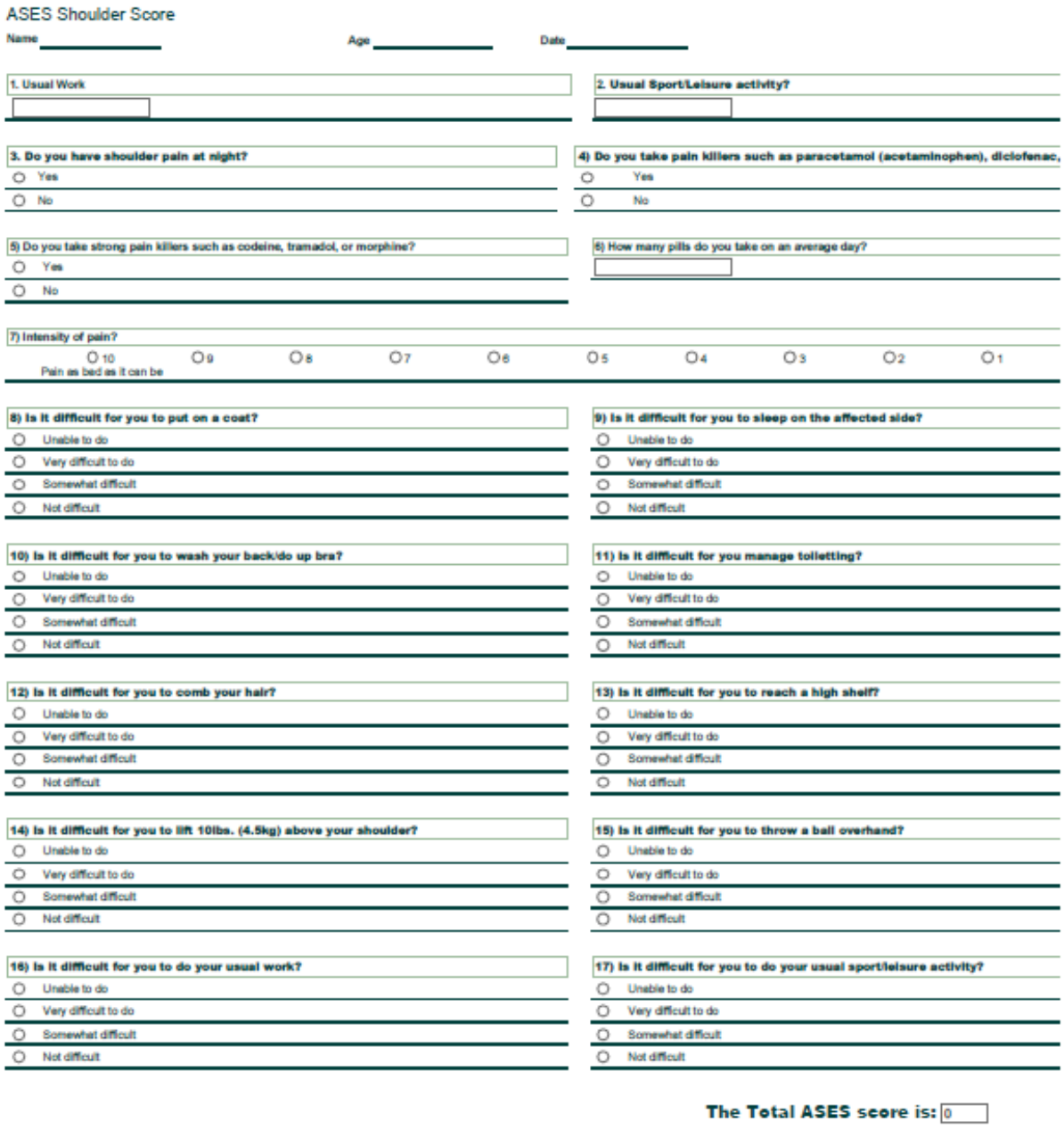
For the nailing group, a longitudinal skin incision was made extending from the most lateral point of the acromion centering over the tip of humeral greater tuberosity using the small curved bone awl, entry portal [9] was made just medial to the tip of the humeral greater tuberosity. About 1 cm posterior to the bicipital groove, c-arm image was used to confirm the entry point and the awls' position in the medullary canal. The nail was then introduced over the guide wire after serial reaming. The proximal locking was done with a jig and distal locking was done using the free hand technique under c-arm guidance. The wounds were closed, sterile dressings applied. IV antibiotics were continued for three more days post operatively. Arm sling was used for 3 weeks. Shoulder, elbow and wrist and hand mobilization was done from 2nd post op day. Stitches were removed on the 12th post op day.

Patients who were above 50 years were started on inj. Teriparatide 20 mcg s/c for a period of 3 months along with Salmon Calcitonin nasal spray 200 IU per day. Inj. Decadurabolin 50mg IM given once in 3 weeks for a total of 5 doses. Protein, Calcium and VitD3 supplementation was given for all the patients.

Patients were followed up every fortnightly from 4 weeks to 16 weeks and thereafter on a monthly basis for upto 6 months or until bone union, whichever was later. Lifting of weights and two wheeler riding was not allowed until clinical and radiological evidence of bone union. Functional outcome in the 2 groups was assessed using American shoulder and elbow surgeons (ASES) scores.

The ASES questionnaire [8] is composed of both a physician rated component and a patient reported component. The patient questions focus on joint pain, instability and ADL. The pain VAS is used to tabulate scores. The final pain score is calculated by an

independent formula. The pain and functional portions are then summed to obtain the final ASES score, with higher scores indicating better outcomes. The ASES has been found to be comparable to the shoulder pain and disability index (SPADI) and constant Murely scores in terms of responsiveness.



ASES Shoulder Score

Name _____ Age _____ Date _____

1. Usual Work

2. Usual Sport/Leisure activity?

3. Do you have shoulder pain at night?
- Yes
- No

4) Do you take pain killers such as paracetamol (acetaminophen), diclofenac,
- Yes
- No

5) Do you take strong pain killers such as codeine, tramadol, or morphine?
- Yes
- No

6) How many pills do you take on an average day?

7) Intensity of pain?

10 9 8 7 6 5 4 3 2 1

Pain as bad as it can be

8) Is it difficult for you to put on a coat?
- Unable to do
- Very difficult to do
- Somewhat difficult
- Not difficult

9) Is it difficult for you to sleep on the affected side?
- Unable to do
- Very difficult to do
- Somewhat difficult
- Not difficult

10) Is it difficult for you to wash your back/do up bra?
- Unable to do
- Very difficult to do
- Somewhat difficult
- Not difficult

11) Is it difficult for you manage toiletting?
- Unable to do
- Very difficult to do
- Somewhat difficult
- Not difficult

12) Is it difficult for you to comb your hair?
- Unable to do
- Very difficult to do
- Somewhat difficult
- Not difficult

13) Is it difficult for you to reach a high shelf?
- Unable to do
- Very difficult to do
- Somewhat difficult
- Not difficult

14) Is it difficult for you to lift 10lbs. (4.5kg) above your shoulder?
- Unable to do
- Very difficult to do
- Somewhat difficult
- Not difficult

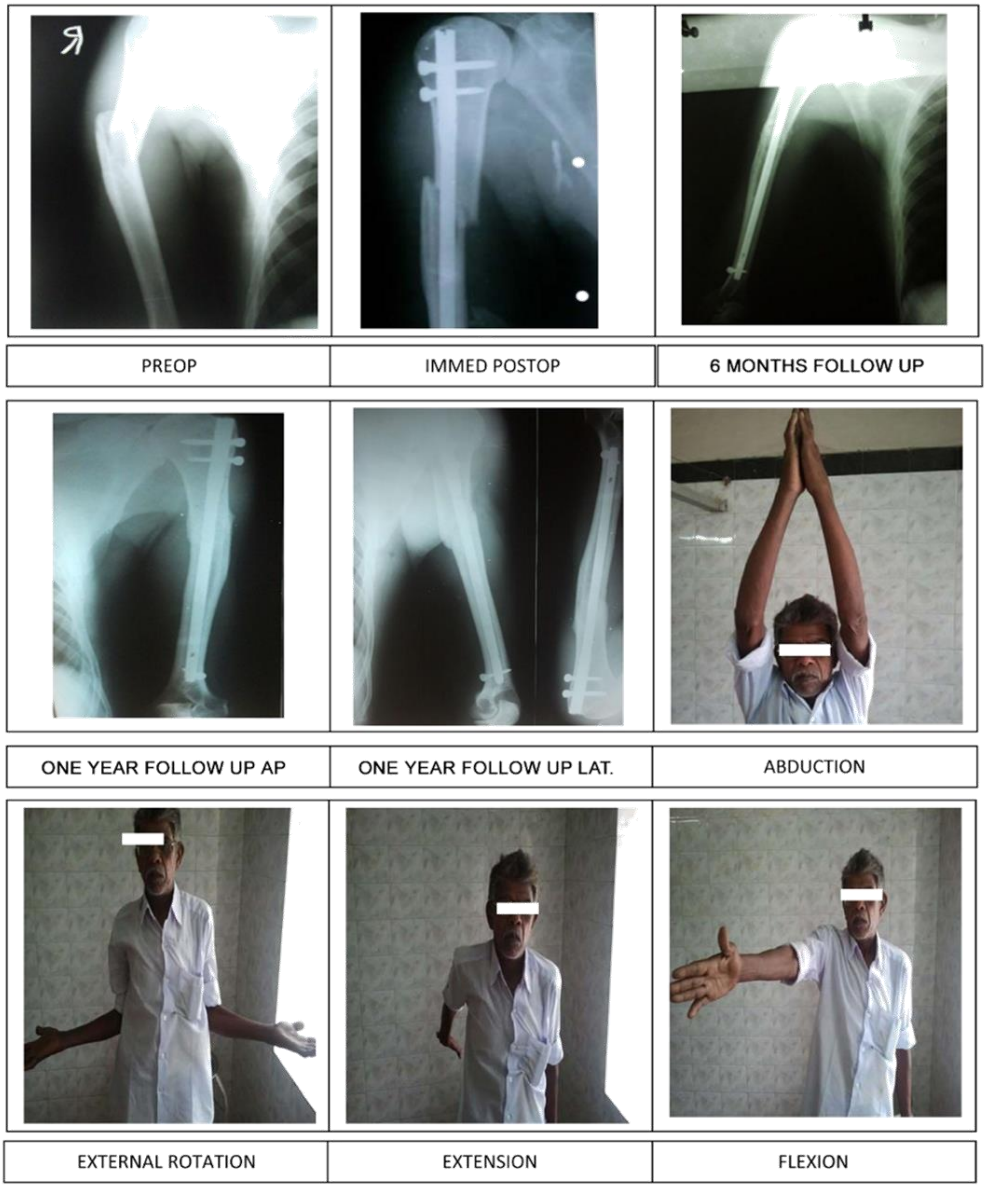
15) Is it difficult for you to throw a ball overhand?
- Unable to do
- Very difficult to do
- Somewhat difficult
- Not difficult

16) Is it difficult for you to do your usual work?
- Unable to do
- Very difficult to do
- Somewhat difficult
- Not difficult

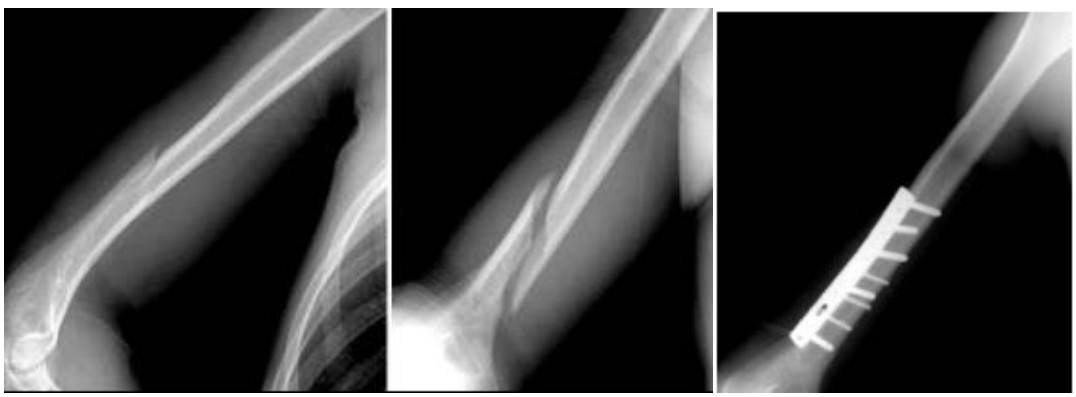
17) Is it difficult for you to do your usual sport/leisure activity?
- Unable to do
- Very difficult to do
- Somewhat difficult
- Not difficult

**The Total ASES score is:** 0

CASE 1


PREOP
IMMED POSTOP
6 MONTHS FOLLOW UP
ONE YEAR FOLLOW UP AP
ONE YEAR FOLLOW UP LAT.
ABDUCTION
EXTERNAL ROTATION
EXTENSION
FLEXION

**CASE 2**




**RESULTS:**

Of the 9 men and 10 women who underwent DCP, the causes of injury were H/O fall (n=5), RTA (n=9) and assault (n=5). The most common fracture was type A3 (n=9) followed by C1 (n=5) and B3 (n=2). Of the 19 cases the fractures were closed in 13 cases and open in 6 cases (grade I- 3, grade II- 2, grade IIIA- 1) 5 patients had radial nerve palsy.

Of the 12 men and 9 women who underwent AIIN fixation, the causes of injury were H/O falls (n=7), RTA (n=10) and assault (n=2). The most common fracture was type A2 (n=8) followed by B2 (n=6) and A3 (n=4). The fractures were closed in 18 patients and open in 3 patients (grade II-2, grade IIIA-1). 4 patients had radial nerve palsy. For the nailing group 7 to 8 mm diameter nails were used with an apex medial bend with length ranging 16-30 cms.

In the DCP group and AIIN group the mean patient age was 41 years (range 18- 80 years) and 36 (range 18-70 years). The mean follow up period was 18 and 16 months. The mean time for union was 15 and 18 weeks. The mean operative time was 100 mins and 75 mins respectively. The mean blood loss volumes were 220ml and 50 ml. Mean ASES scores were 30.94 and 32.62 respectively. Complication rates were 5/19(26.32%) and 3/21(14.29%), non union rates were 3/19(15.79%) and 2/21(9.52%), delayed union rates were 4/19(21.05%) and 2/21(9.52%) in the DCP and AIIN groups respectively. The cause of non-union (3/19) in the DCP group was because of loss of fixation and infection. The 2/21 cases of non union in the AIIN group were due to distraction at the fracture site.

**Table 1: Sex distribution table in the two groups**

| Sex | DCP group | AIIN group | Total |
|---|---|---|---|
| Male | 9 | 12 | 21 |
| Female | 10 | 9 | 19 |
| Total | 19 | 21 | 40 |

**Table 2: Mode of injury distribution in the two groups**

| Mode of injury | DCP group | | AIIN group | |
|---|---|---|---|---|
| | Male | Female | Male | Female |
| Fall | 2 | 3 | 4 | 3 |
| RTA | 5 | 4 | 6 | 6 |
| Assault | 2 | 3 | 2 | 0 |
| Total | 9 | 10 | 12 | 9 |

**Table 3: Age distribution of the patients in the two groups**

| Age in years | DCP group | | AIIN group | |
|---|---|---|---|---|
| | Male | Female | Male | Female |
| 10-20 | 0 | 1 | 1 | 1 |
| 21-30 | 2 | 2 | 1 | 1 |
| 31-40 | 2 | 3 | 4 | 5 |
| 41-50 | 2 | 2 | 2 | 0 |
| 51-60 | 1 | 0 | 2 | 1 |
| 61-70 | 1 | 1 | 2 | 1 |
| 71-80 | 1 | 1 | 0 | 0 |
| Total | 9 | 10 | 12 | 9 |

**Table 4: Fracture type distribution according to AO classification**

| AO fracture type | No. (%) of patients in DCP group | No (%) of patients in the AIIN group |
|---|---|---|
| A1 (simple wedge) | 0(0) | 0(0) |
| A2 (simple oblique) | 1(5.3) | 8(38.1) |
| A3 (simple transverse) | 9(47.4) | 4(19) |
| B1 (spiral wedge) | 1(5.3) | 1(4.8) |
| B2 (spiral oblique) | 0(0) | 6(28.5) |
| B3 (fragmented wedge) | 2(10.5) | 1(4.8) |
| C1 (complex spiral) | 5(26.2) | 0(0) |
| C2 (complex segmental) | 1(5.3) | 1(4.8) |
| C3 (complex irregular) | 0(0) | 0(0) |
| Total | 19(100) | 21(100) |

**Table 5: Open fracture distribution of cases as per Gustillo Anderson classification**

| Gustillo Anderson classification | DCP group | | AIIN group | |
|---|---|---|---|---|
| | Male | Female | Male | Female |
| Grade 1 | 1 | 2 | 0 | 0 |
| Grade 2 | 1 | 1 | 1 | 1 |
| Grade 3A | 0 | 1 | 1 | 0 |
| Grade 3B | 0 | 0 | 0 | 0 |
| Grade 3C | 0 | 0 | 0 | 0 |
| Total | 2 | 4 | 2 | 1 |

**Table 6: Distribution of ASES scores**

| ASES score | No of patients in DCP group | No of patients in AIIN group |
|---|---|---|
| 40-52 | 3 | 4 |
| 27-39 | 12 | 14 |
| 14-26 | 2 | 2 |
| 1-13 | 2 | 1 |
| Mean | 30.94 | 32.62 |

## DISCUSSION:

The time tested DCP plating for humeral diaphyseal fracture has been praised as a gold standard with respect to achieving high rate of bone union and good functional outcome. Its disadvantages are longer incision, soft tissue handling, disturbing the vascularity at the fracture site, greater blood loss, hematoma evacuation and stress shielding. It is not by far the best option while dealing with an osteoporotic bone. On the other hand, intramedullary nailing involves a simpler technique with minimal surgical exposure, minimal blood loss and a shorter operating time. Higher union rates are achieved due to the fact that fracture site is left undisturbed. Locked nails further provide for rotational stability. The only disadvantage with the medullary anatomy of the humerus is that it can at times lead to residual fracture site distraction leading to delayed or non union. The comparison of the functional outcomes and ASES scores does not convincingly prove that for humeral diaphyseal fractures the AIIN is a better option than the DCP. The promise a locking nail holds out in the instance of tibial and femoral fractures are due to their tubular nature. In the humerus however the sagittal diameter of the distal humerus is small and hence contributory towards fracture site distraction and a resultant delayed union or non union. We conclude that it should be left to the operating surgeon to choose either method of fixation based on his surgical skills and training. Our findings are in similarity with the study done by Sunil G. Kulkarni *et al.;* [9] in Maharashtra.

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