

## Original Article

# "Nonunion of Adult Humerus Fracture" - Management Using the Ilizarov External Fixator.

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### Abstract :

Humeral shaft fractures occur about three percent of all fractures in adults. A very high union rate is achieved with non-operative treatment, however when nonunion occurs conservative approach or after operative management they are often very difficult to treat, and often requires multiple procedures to achieve union. Even with multiple procedures, true pseudoarthrosis have only a 59% union rate. The aim of this study was to find out the results of such complicated cases treating with Ilizarov's external fixator. We conducted a prospective study of eleven patients with nonunion humeral shaft fracture in adult wherein the outcome of the treatment was analyzed. In our series we achieved union in all of the cases with a mean of 29.1 weeks with negligible complications like pin tract infections and in one case refracture occur due to forceful manipulation. So it can be concluded that Ilizarov's method is an excellent option for the treatment of nonunion of diaphyseal fracture of the humerus.

**Key words :** Non-union, Humerus, Healing, union, Ilizarov's method.

### Introduction :

Humeral shaft fractures in adults have a high rate of union whether they are treated either operatively or by conservative method. About 90-95% cases have union with good return of functions<sup>1-3</sup>. However, up to a 13% nonunion rate has been reported following open reduction and internal fixation or closed intramedullary nailing and up to an 8% nonunion rate has been reported for fractures treated non operatively<sup>2,4-7</sup>. In Bangladesh this proportion will be a bit higher because of the practice of malhandling of fractures by quacks and local kabiraj. The nonunion presents a difficult proposition to both the patient and the surgeon.

The common modalities of treatment of aseptic nonunion are plating with bone grafting, intramedullary nailing and Ilizarov's method. In case of infected nonunion the usual protocol is to eliminate infection, removal of hardware if any, debridement and a second surgery which is a lengthy and disabling procedure and obviously with a doubtful outcome<sup>7,8</sup>.

The advantage of Ilizarov's method is that it can be done in infected condition, no need for bone grafting and deformity if present and in any plane can be corrected simultaneously because of its versatile and modular construct<sup>3,4,7-13</sup>.

### Materials and Methods :

We treated eleven patients with diaphyseal shaft fractures of the humerus in between year 2009 to 2013 with an age range of 24 to 65 years. There were seven male and four female patients. Two patients with initial type-II open fractures. The primary management was plate and screws in four cases which subsequently failed due to infection and faulty fixation (mechanical failure), one case was initially treated in the form of intramedullary Rush nail fixation, and conservative were five cases of which one case was treated by Kabiraj (traditional bone setter). Open cases were initially treated by uni-axial external fixators. All the cases of nonunion were atrophic type except one (With R-nail) where some form of callus at fracture site was present. All the cases were assessed thoroughly and examined, the causes of nonunion explained and associated problems like

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infection, deformity, shortening and joint stiffness were documented. Nonunion was seen in middle shaft (n=6), at the junction of upper and middle third (n=3) and in lower third (n=2).

**Operative Procedures :**

All patients and their attendants were explained about the problem and the treatment procedure, the post operative protocol in the hospital and home so that they can make themselves familiar with the device. The apparatus was assembled pre-operatively with a plan to correct all the composite deformities and to achieve union. Two levels of fixation done in each segment [Fig-2,3]. The most proximal fixation near the shoulder was done by an omega arch and the distal one is a 5/8th ring near the elbow to allow elbow flexion. In one case where the fracture was near to elbow, the 5/8th ring was replaced by drop wires. The middle wires are attached with full ring. In post surgical infected nonunion (n=4) the implants were removed, thorough debridement done, the bone ends were acutely docked and the ring fixator applied. In post surgical aseptic nonunion ( R-nail), the ring fixator was applied closed method before removing the nail, distraction prior to compression was done at the rate of 1mm/day for one week to break the fibrous tissue present at the nonunion site. Compression was done at the rate of 1mm/day till the patient fill pain at the docking site and radiological evidence of acute docking. Then the rush nail was removed and compression was given at a rate of 0.25mm/3 days. In aseptic nonunion, following conservative treatment, initial distraction for two weeks followed by compression was given as per rule. In one case the fracture was at a proximal level with acutely tapered bone ends, one intramedullary 2mm k-wire was given because of the chance of translation on docking and excision of tapered end will cause unacceptable shortening of the bone [Fig-1,3]. In no cases bone grafting was applied. I/V antibiotic, analgesic was given for five days and switching to oral one for three weeks according to culture and sensitivity guide. Shoulder and elbow exercises were encouraged just day after surgery. All patients were instructed about post operative protocol and slowly progressed to daily activities, frequently cleansing the pin site and discharged with follow up every month until radiological signs of union. Apparatus was removed on outdoor basis. Before complete removal, abnormal mobility was assessed by disconnecting the ring between the fracture and twisting and angulatory forces added to elicit any deformation.

The final outcome of treatment was judged by bony union (Bridging of fracture on A/P and lateral radiographs) and functional status of the limb<sup>18</sup>. Paley categorized bone healing as excellent when union achieved in absence of infection, deformity <7° and LLD <2.5 cm. It was graded as good when union occurred with any two of other three criteria and fair when only one of the three criteria was fulfilled along with union. Poor result was graded when fracture failed to unite with persistent or recurrent infection.



**Figure 1 :** Antero-posterior radiograph of a 65 years old female patient with 10 month old nonunion fracture shaft humerus with tapering of fracture ends.

Functional result was graded as excellent when there was shoulder abduction >150°, no loss of movement >10° in any direction, full strength at elbow and shoulder joint and absence of pain at union site and adjacent joints. It was graded as good when shoulder abduction >120°, no loss of >15° of motion in any direction, full strength at adjacent joints and absence of pain. A fair results was shoulder abduction 90- 120°, no loss of movement >20° in any direction, less than full strength in elbow and shoulder with mild manageable pain. Shoulder abduction <90°, loss of motion >20°, gross decrease in power in shoulder and elbow with pain hampering activities of daily living was considered a poor result. Follow up was done for a period of 9 to 22 months (mean=15.5m).



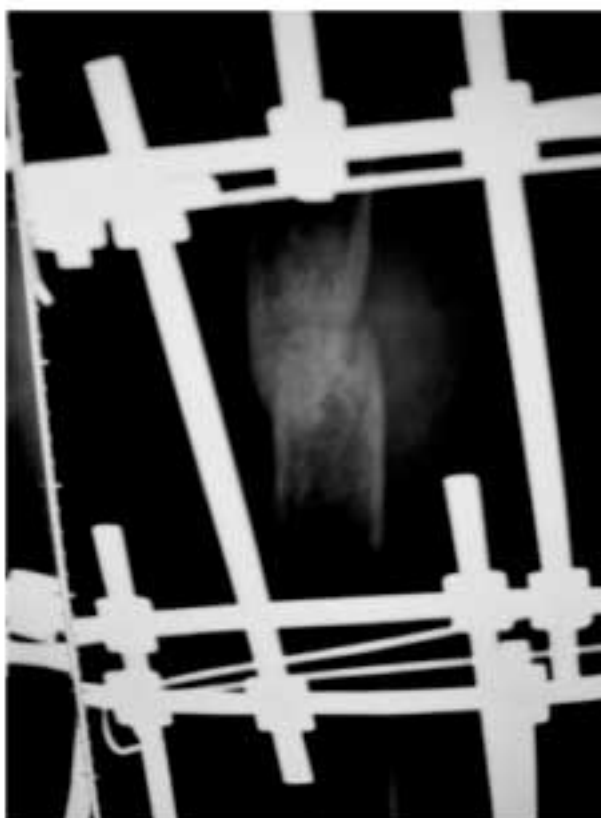
**Figure 2 :** Same patient after application of Ilizarov's apparatus.



**Figure 3** : Immediate post operative x-ray with a 2 mm k-wire placed intramedullary to prevent translation.



**Figure 5** : 28 weeks after application, the apparatus removed with 90° abduction of shoulder.



**Figure 4** : 24 weeks after application showing thickening of bone ends with signs of union (k-wire removed on acute docking).



**Figure 6** : 8 weeks after removal of the apparatus, the patient is able to fully abduct her shoulder and flexes elbow without pain.

**Table I : Clinical details of the patient (n=11)**

| No | Age    | Sex | Duration(m) | Fracture type                   | Previous Rx                             | Co-morbidity             | Type of Non- union              |
|----|--------|-----|-------------|---------------------------------|---|--------------------------|---------------------------------|
| 1  | 65 yrs | F   | 10          | Closed,proximal shaft           | conservative                            | Nil                      | Atrophic                        |
| 2  | 60 yrs | M   | 11          | Open,midshaft (Type-ii)         | Ex-fix                                  | Nil                      | Atrophic                        |
| 3  | 25 yrs | M   | 15          | Closed<br>comminuted,midshaft   | I/m nailing<br>by R-nail                | Nil                      | Hypertrophic                    |
| 4  | 35 yrs | M   | 12          | Closed,distal shaft             | Plating,BG                              | Nil                      | Infected Non-union              |
| 5  | 38 yrs | M   | 8           | Open comminuted,mid<br>shaft    | Ex-fix                                  | Nil                      | Infected nonunion               |
| 6  | 25 yrs | M   | 11          | Closed,proximal shaft           | Conservative                            | Ipsilateral<br>#clavicle | Atrophic                        |
| 7  | 40 yrs | F   | 12          | Closed midshaft                 | Plating                                 | Nil                      | Infected nonunion               |
| 8  | 32 yrs | F   | 15          | Closed comminuted, mid<br>shaft | Plating                                 | Nil                      | Nonunion(mechanical<br>failure) |
| 9  | 23 yrs | M   | 9           | Closed, distal shaft            | Conservative                            | HBV<br>infected          | Atrophic                        |
| 10 | 38 yrs | M   | 24          | Closed, midshaft                | Plating,<br>removal due<br>to infection | Diabetic                 | Infected nonunion               |
| 11 | 50 yrs | F   | 9           | Closed, proximal shaft          | Conservative                            | Diabetic                 | Atrophic                        |

M= male, F= female, I/M= Intramedullary nailing, HBV= Hepatitis B virus, BG= Bone grafting

**Results :**

Union was achieved in all the cases treated within a mean period of 29.1 weeks (24 to 36 weeks) [Fig-5]. Pin tract infection was seen in three cases (27.27%), which were superficial and controlled successfully by antiseptic cleansing and antibiotics. In one case refracture occur after 2 weeks of removal during forceful extension of elbow for achieving elbow movement. Shortening, angulation, shoulder abduction and pain persistence was carefully assessed after removal of

apparatus and at last follow up and no significant abnormality found. Three patients dropped from regular follow up so that their outcome cannot measured. The bone healing was excellent in 10 cases (90.9%), good in 1 case (9.09%). Functional results were scored excellent in 7 cases (63.63%) [Fig-6], fair in one case (9.09%). Eight patients participated in regular follow up for a period of 9 to 22 months.

**Table II : Results of 11 patients treated for nonunion of humerus**

| No. | operation   | Time of union(wks) | LLD   | Angulation | Shoulder abduction | Pain | Complication        | Follow-up (months) |
|-----|---|--------------------|-------|------------|--------------------|------|---------------------|--------------------|
| 1   | Ring fixation with I/M k-wire, compression                    | 28                 | 1.5cm | 5°         | 160°               | Nil  | Nil                 | 22                 |
| 2   | Ring fixation, distraction/compression                        | 36                 | 1cm   | 6°         | 140°               | Nil  | Nil                 | 18                 |
| 3   | Ring fixation, distraction/compression over nail              | 24                 | Nil   | 0°         | 155°               | Nil  | Nil                 | 15                 |
| 4   | Plate removal, debridement, ring fixation and compression     | 26                 | 1cm   | 0°         | 155°               | Nil  | Pin tract infection | 12                 |
| 5   | Removal of ex-fix, ring fixation, distraction and compression | 30                 | Nil   | 0°         | 165°               | Nil  | Do                  | 10                 |
| 6   | Ring fixation, distraction and compression                    | 25                 | Nil   | 5°         | 160°               | Nil  | Nil                 | 9                  |
| 7   | Removal of plate, debridement, ring fixation and compression  | 32                 | 1.5cm | 6°         | 140°               | Nil  | Pin tract infection | –                  |
| 8   | Removal of plate, debridement ring fixation and compression   | 36                 | Nil   | 0°         | 155°               | Nil  | Nil                 | 10                 |
| 9   | Ring fixation, distraction and compression                    | 28                 | 1cm   | 5°         | 135°               | Nil  | Nil                 | –                  |
| 10  | Ring fixation and compression                                 | 32                 | 2cm   | 6°         | 110°               | Nil  | Pin tract infection | –                  |
| 11  | Ring fixation, distraction and compression                    | 24                 | 2cm   | 12°        | 165°               | Nil  | Pin tract infection | 10                 |

**Discussion:**

Diaphyseal fractures of the humerus can be treated both operative and non operative method with a nonunion rate of about 10%. Non union may be atrophic or hypertrophic with or without infection<sup>11,15</sup>. In both the situation further operation, selection of a particulate

implants, osteopenia with poor quality of bone and soft tissue condition makes it very difficult to achieve union. Ilizarov's external fixator is the only device which can apply effectively even without opening the fracture site. Its biological properties of neohistogenesis helps in bone and soft tissue regeneration and infection control. Again it helps to

correct the composite deformities either intra operatively or gradually postoperatively due to its versatility and modular construct<sup>13</sup>. Time taken for union in our series (29.1wks) is comparable with other series in the literature like Manish kiran et al<sup>17</sup> (25.6 wks), Cattaneo et al<sup>18</sup> (29.6 wks), Lammens et al<sup>11</sup> (18wks) and Bari et al<sup>19</sup> (32 wks). Success rate of our series (100%) is also good in comparison to other series like Manish kiran et al<sup>17</sup> (100%), cattaneo et al<sup>18</sup> (86%), lemmens et al<sup>11</sup> (93%) and Maini et al<sup>8</sup> (90%). Pin tract infection in three cases (27.27%) and refracture in one (9.09%) case is seen in our series which are also presents in other series. Functional results are also comparable to other series.

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