

## Outcome of Management of Humerus Diaphysis Non-union

F.C Sitati, J. Kingori,  
CEA Kikuyu Hospital, Kikuyu, Kenya.

*Correspondence to:* Dr. Sitati Fred Chuma Email: [fredsitati@yahoo.com](mailto:fredsitati@yahoo.com)

**Background:** The majority of diaphyseal humerus fractures heal uneventfully when treated non-operatively, however, nonunion is not a rare event. Nonunion after conservative treatment can be successfully treated by open reduction and internal fixation. A nonunion of a diaphyseal fracture of the humerus can present a major functional problem. The main of our study was to document the outcome of management of non united diaphyseal humerus fractures with plate or plate and rush pin fixation.

**Methods:** A 4 year retrospective study was undertaken at Presbyterian Church of East Africa (PCEA) Kikuyu Hospital, Orthopedic Unit in Kenya from April 2004 to April 2008. Records of consecutive patients with nonunion of the humeral diaphysis were reviewed. Four cases were lost to follow up. The rest were treated with a single posterior, anterior or anterolateral plate while four with a plate and rush pin construct. Autogenous iliac crest bone graft was utilised in most of the cases. A clinical evaluation for union, range of motion and complications. Radiological assessment for union was also done.

**Results:** A total of 46 patients with humerus diaphysis non union met the inclusion criteria. Their ages ranged from 23 to 95 years with a mean of 43.6 years. The overall healing rate was 92.8 % (39/42 cases) at 6 months follow up. 3 failures occurred of whom one was a smoker and diabetic, another had a loose plate and screws following replating. The third case went to nonunion. Three cases of postoperative radial nerve palsy all of which resolved within six weeks were documented. All four treated with a plate and rush pin construct healed uneventfully.

**Conclusion:** The results of this study indicate that our standard surgical procedure for treatment of nonunion of the humeral shaft is reliable with a 92.8% union rate in our study with few complications. The plate and rush pin construct is useful in dealing with nonunion involving osteoporotic bone.

### Introduction

Although the majority of diaphyseal humeral fractures heal uneventful when treated nonoperatively, nonunion is not a rare event<sup>1,2</sup>. The prevalence of nonunion as a complication of both nonoperative and operative treatment has been reported to be as high as 13%<sup>3</sup>. When nonunion does occur, it is likely to be related to the severity of the initial injury, the transverse pattern of the fracture, distraction of the fracture, soft tissue interposition or inadequate immobilization<sup>2</sup>. Obesity, alcoholism and the method of treatment may also be contributory factors<sup>3</sup>. Nonunion after conservative treatment can be successfully treated by open reduction and internal fixation with plate and screws<sup>4,5</sup>, reamed intramedullary nailing<sup>6</sup> and external fixation<sup>7</sup>. Supplementing fixation with bone graft reliably achieves union<sup>3,8</sup>. A nonunion of a diaphyseal fracture of the humerus can present a major functional problem even in the elderly population.

Numerous studies have been done outlining the various methods of treating humeral shaft nonunions<sup>4,5,6,7,8,9</sup>. However, in our setup, no studies have focused specifically on the management of humeral diaphysis nonunions after failure of conservative or surgical interventions. The objective of this study was to document an audit of fixation of humerus diaphysis nonunion using a 4.5mm dynamic compression plate with at least eight cortices of fixation, and utilization of autologous bone grafting.

### Patients and Methods

This retrospective study was conducted at PCEA (Presbyterian Church of East Africa) Kikuyu Hospital, Orthopedic Unit from April 2004 to April 2008. Records of consecutive patients with nonunion of the humeral diaphysis treated by compression plating with or without a rushrod were reviewed and evaluated. Autogenous bone grafts was utilised in most cases. The tool for data collection was a predesigned data sheet to collect information on the cases. The questionnaire contained information on age, sex, residence, side involved, co-morbid conditions, mechanism of injury, fracture location, initial treatment of the fracture, time from injury to definitive treatment, definitive treatment, time taken to unite, function and complications. In this

study, nonunion was defined as absence of radiographic signs of union and persistent pain on clinical examination 6 months after injury<sup>10</sup>. A fracture between the superior border of the pectoralis major insertion and 2cm above the olecranon fossa was defined as a diaphyseal humerus fracture<sup>11</sup>. Records of patients were reviewed for history, physical examination, operative reports, and all radiographs. Laboratory studies included a hemoglobin level, urinalysis and random blood sugar where indicated. A Microsoft Excel spreadsheet package was used for statistical analysis.

### *Surgical Technique*

Surgery was done under general anesthesia and prophylactic antibiotics were administered in all cases. Treatment consisted of a standard posterior triceps-splitting approach to the humerus in a primary procedure or based on prior skin incisions in a secondary procedure. The radial nerve was identified and protected for the duration of the procedure. The intramedullary canal was reconstituted with a drill and bone ends were contoured to provide adequate diaphyseal contact. A dorsal 4.5mm DCP plate was utilized and autogenous cancellous bone graft was placed at the nonunion site. A minimum of eight cortices of fixation above and below the fracture site were obtained. In cases where the bone was very porotic, a rushrod inserted antegrade through the greater tuberosity together with a plate and screws was utilised.

Postoperatively, anteroposterior and lateral radiographs were done to assess alignment, loosening of devices, and later presence of bridging callus across the nonunion site. Patients were placed in an arm sling primarily for comfort for two weeks. Gentle pendulum and active assisted shoulder and elbow range of motion were started at 2 weeks post surgery followed by strengthening and passive range of motion exercises<sup>12, 13</sup>. Patients were reviewed at 2, 6, 12 and 16 weeks. The primary outcomes measured were time to union, function and complications. Union was determined by radiographic evidence of cortical bone bridging at the nonunion site, stable hardware position on radiographs, as well as absence of pain with manual palpation of the nonunion site. Function was assessed using the American Shoulder and Elbow Surgeons (ASES) Score for 13 activities of daily living<sup>9</sup> requiring full shoulder and elbow movement. The maximum possible score is 52 points.

### **Results**

Records of forty six consecutive patients between the ages of twenty three and ninety five years (mean 43.6 years) with nonunion of the humeral diaphysis treated by compression plating with or without a rushrod were reviewed and evaluated. Autogenous bone grafts was utilised in 35 cases. 4 patients were lost to follow-up and therefore were excluded from the study. Therefore 42 patients fulfilled criteria to be entered in the study group. The series included 15 females and 27 males (Tables 1) who were followed for an average of 24 months (Range 12months – 4 years). The left side was involved in 24 cases while the right in 18 cases. The average time interval between the injury and surgical procedure was 8 months (range 4 months-6 years). Fracture types included ten transverse, twelve spiral and twenty short oblique. Thirty fractures were atrophic while twelve were hypertrophic.

In 36 cases, the fractures were closed while in 6 were open. The mechanism of injury was motor vehicle crush in thirty one patients, falls in four patients, gun shot injury in three, assault in two, explosion one and falling tree in one (Table 2). Initial fracture treatment was non-operative in 36 patients (u-slab - 35 and long arm cast - 1) while 6 patients (Plate - 4 and External fixator – 2) had operative interventions. A total of 38 patients were treated with plating while 4 had a plate and rushrod construct. In 39 (92.8 %) out of 42 cases there was evidence of complete healing as defined by radiographic evidence of at least three out of four bridging cortices within 6 months of surgery (Figure 1). All four patients treated with a plate and rush pin construct healed uneventfully.

At final follow-up, the ASES<sup>9</sup> score (Max 52) on average was 46(Good); 6 patients had elbow stiffness which resolved within 8 weeks post surgery following physiotherapy, while 2 patients had persistent extension deficit of more than 40° and one had elbow stuck at 90° flexion. Complications experienced include iatrogenic injury to the radial nerve occurred in 3 patients. These patients had neuropraxia: one recovered fully in 2 weeks while the other two at 6 weeks. One case of non-union occurred in a heavy

smoker who declined to stop smoking despite medical advice. Failure of fixation characterized by loosening of a plate which occurred 1 day postoperatively was treated by addition of an antirotation plate in one case. In the 3rd failure, the patient returned to heavy work two weeks postoperatively and the fixation loosened. One case of deep infection was reported four weeks postoperatively in a patient with an open fracture.

**Table 1.** Age Distribution

Age groups	No.	%
0 -15	0	0
16 – 30	9	21.5
31 – 45	13	31.0
46 – 60	14	33.3
Over 60	6	14.2
<b>Total</b>	<b>42</b>	<b>100.0</b>

MOI	No.	%
Fall	4	9.5
MVA	31	73.8
Assault	2	4.75
Gunshot	3	7.2
Others: explosion, falling tree	2	4.75
<b>Total</b>	<b>42</b>	<b>100.0</b>

**Table 2.** Mechanism of injury



**Figure 1.** Non-union Humeral Shaft. Plated Humeral Shaft.

## Discussion

The treatment of nonunions differs from that of acute fractures. Various techniques and devices have been used in the treatment of nonunion of the humeral diaphysis including open reduction and internal fixation with a dynamic compression plate and autogenous bone graft<sup>12, 14, 15</sup>. Exchange nailing following failed primary intramedullary nailing<sup>16</sup>. Rush rods in isolation and ring external fixators<sup>17</sup> have also been used. Compression plating with a 4.5mm plate and autogenous bone grafting has been considered the gold standard with a reported success rate greater than 90 percent<sup>12, 15, 18, 19, 20</sup>. This was to ensure the screws did not pull out, hence the plate. The rush rod was therefore meant to augment the fixation by reducing angular motion at the fracture site. In this study, the double fixation was done specifically in patients with markedly porous bone. However there were no studies found documenting the use of plate combined with a rush rod.

Healy et al<sup>18</sup> concluded that a stable plate fixation was the most reliable treatment for humeral non unions. Foster et al. reported a 96% rate of union in their study of fixation of both fractures and

nonunions<sup>14</sup>. They used both single and dual-plate constructs with or without lag screws. The most commonly reported cause of failure of operative treatment of primary humeral shaft fractures is inadequate internal fixation<sup>21,22</sup>. Generally, the recommendations for optimal fixation in both the primary fracture and nonunion settings are varied, ranging from six to ten cortices<sup>14, 18, 19, 22</sup>. In our setup, no studies have focused specifically on the salvage of humeral diaphysis nonunions after failure of conservative interventions. In this study, the average age was 43.6 years. This compares well with studies published elsewhere. Rubel, Ivan et al reported an average age of 48 years. In this study, the high union rate of 92.8 % reported compares well with other studies. Foster et al. in their study involving fixation of both fractures and nonunions reported a 96% union rate. They recommended the use of a dual plate construct for long standing nonunions but stated that one plate construct provided the same stability<sup>14</sup>. After four months follow up, Marti et al<sup>12</sup> reported union in 50(98%) of 51 patients. Our functional results were good on average. This was similar in other studies<sup>12,14</sup>. Physiotherapy has major role in achieving good shoulder and elbow range of movement.

There were some complications. We had three failures of fixation related to porotic nature of the bone and poor patient compliance. The incidence of radial nerve palsy was 7.1 % (3 cases). In other studies, an incidence of up to 14% has been quoted. Chronic alcoholism which is associated with a high non-union rate as high as 50%<sup>23</sup> in some studies accounts for the case of nonunion reported in this study. The patient continued to take alcohol in spite of being counseled about its negative effects on bone healing. The single case of deep infection occurred in a patient who had an open fracture. The infection settled with use of antibiotics. Generally, the complications were related to the severity of injury, co-morbid conditions and poor patient compliance.

### Conclusion

The results of this study indicate that our standard surgical procedure for treatment of nonunion of the humeral shaft is reliable and achieves high union rates in one procedure with few complications. The plate and rush pin construct is useful in dealing with nonunion involving osteoporotic bone.

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