

# Non-union Treatment Outcomes in South-East Nigeria

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## Abstract

**Introduction:** Management of non union of long bones can be challenging and frustrating for the orthopaedic surgeon. In sub Saharan Africa, the bulk of surgeries done by the orthopaedic surgeon may include a significant number of non union of long bones. This is largely because of the strong affinity for seeking treatment from the traditional bone setter as the first on call following fractures in most cases. The orthopaedic surgeon frequently gets to manage the complications arising from such treatment. In managing such cases, adjunctive therapies targeted at increasing union rates which are available to surgeons elsewhere are frequently lacking. **Methodology:** The study was aimed at determining the outcome of surgeries done for non union of long bones in our institution. It was a retrospective study spanning a 3 year period, from April 2013 to March 2016, involving 80 patients who presented with non union of any of the 3 long bones which had not previously been surgically managed. The patients had surgery with plate / screw construct or a solid intramedullary nail. Outcome measures analysed included occurrence of union, time to union and occurrence of complications with each treatment method for the 3 long bones. **Results:** We recorded a union rate of 79.2% for all 3 long bones. Majority of the femoral non unions were nailed while the humerus was more commonly plated. The humerus did better with plating than it did when nailed, though nailed non unions were observed to unite faster. Femoral non unions united better when nailed than when plated, though the difference was not statistically significant. Complications rates were higher following plating for femoral non unions. Complications following humeral non union plating were also higher than observed for nailing, with radial nerve palsy occurring in 23.5% of platings. Tibial non unions demonstrated high union rates irrespective of treatment method used. **Conclusion:** In conclusion, management of non union of long bones is still a challenge with a recurrence rate of 10.8%. Humeral non unions do better when plated as opposed to the femur. Tibial non unions do well with either plating or nailing.

**Keywords:** Long bones, nailing, non-union, outcome, plating

## INTRODUCTION

Successful management of non-union of long bones can be very challenging for an orthopaedic surgeon without any guarantee of a positive outcome. Surgery for non-union of diaphyseal bones usually entails extensive dissection, complications, morbidity and a higher risk of recurrence than fixation of fresh fractures, which are usually done closed where facilities exist. In Nigeria, a good percentage of patients will present first to the traditional bone setter.<sup>[1]</sup> Presentation to the orthopaedic surgeon is frequently when the fracture has failed to unite.<sup>[2]</sup> In our environment, adjunctive strategies to the management of non-unions such as the use of bone marrow products may not be readily available, except autologous bone grafts.

The outcome of treatment of these non-unions thus depends on a range of factors, including the expertise and devices available to the surgeon. The nature of the non-union may also play a role in the outcome depending on whether the non-union is atrophic or hypertrophic. Soft tissue interposition

between the fracture ends of the bones and interference with periosteal blood supply from disruption of the soft tissue envelope in high-energy injuries is an important factor.<sup>[3]</sup>

In the UK, with approximately 850,000 new fractures per year, non-union rates of 5%–10% have been suggested and is said to remain at <20 per 100,000 population.<sup>[4]</sup> Non-union rates in the US average 4%–9% with males more prone to non-unions.<sup>[5]</sup> Data on non-union rates in Nigeria, as a whole, are difficult to find, but anecdotal experience suggests that non-union rates in Enugu, Nigeria, are far higher than rates in the developed world as a result of the ubiquitous nature of traditional bone setter intervention, poverty and other factors. Outcome studies for non-union treatment in our institution, being one of the major orthopaedic centres in

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the country, are non-existent. This study sought to evaluate the occurrence of union and time to union following surgery for long-bone non-union using intramedullary nails or plate/screws with adjunct autologous bone grafting.

## MATERIALS AND METHODS

This was a retrospective study done from April 2013 to March 2016, at the National Orthopaedic Hospital, Enugu, South-East Nigeria. The study involved 80 consecutive patients, with 81 non-unions of the long bones, who had surgery using intramedullary nails or plates/screw constructs. Intramedullary nails used were of the Surgical Implant Generation Network (SIGN) variety.

Inclusion criteria included all long-bone non-unions, patients who had no previous surgeries and patients who had a minimum follow-up of 12 months. The diagnosis of the non-union was made by the managing unit using standard definitions.

Outcome measures were the occurrence of union and time to union. All surgeries were done by qualified surgeons or senior registers who had acquired an acceptable level of training.

Demographic details such as age, sex, duration of non-union, site of non-union, type of non-union, prior visit to traditional bone setter and complications following treatment were recorded.

The records of postoperative clinical and radiological progression of the patients, as documented by the managing units, were retrieved and studied by the authors. Pre- and post-operative radiographs were also retrieved by the authors and analysed.

A successful union was defined by bridging callus across three or more cortices in two orthogonal X-ray views. Union rates for each long bone were determined as a proportion of recurrence compared to successful cases following surgery. The data obtained were analysed using SPSS 17 (IBM Corp, New York, USA). The association between categorical variables was done using the Chi-Square test while the Student's *t*-test was used to investigate the difference in the meantime to union. The level of significance was chosen as a  $P < 0.05$ .

## RESULTS

There were a total of 80 patients in this study with 81 non-unions with a male-to-female ratio of 1.9:1. Forty-eight patients had nailing, 26 males (54.2%) and 22 females (45.8%) with a male: female ratio of 1.2:1. Thirty-two patients had plating, 26 males (81.3%) and 6 females (18.7%), for their non-unions (ratio of 4.3:1). The mean age for the nailing group was  $40 \pm 13$  years while that of plating was  $43 \pm 14$  years.

The femur was the most common bone involved in the nailing group while the humerus was most commonly involved in the plating group. Atrophic non-union was more common than hypertrophic non-union in both the nailing and plating groups. Seventy-five per cent (75%) of the patients in the nailing group had patronised traditional bone setters while 79% in the plating group had visited traditional bone setters before treatment.

Patients in the plating group had a mean duration to union of 6 months, for all three long bones, compared to 8 months for those in the nailing group, and this was significant ( $P = 0.000$ ) [Figure 1].

There was a greater incidence of complications in the plating group compared to the nailing group as shown in Figure 2 (32.4 vs. 6.2%) which was significant ( $P = 0.002$ ).

The humerus had the greatest recurrence rate (37%), regardless of the method of fixation. Table 1 shows the rate of complications among the bones.

There was no statistically significant relationship between the occurrence of union and the type of non-union ( $P = 0.214$ ) or the fixation type ( $P = 0.978$ ). Furthermore, age ( $P = 0.145$ ) and duration of non-union ( $P = 0.226$ ) failed to demonstrate any significant effect on the occurrence of bone union.

## DISCUSSION

The incidence of non-union following long bone diaphyseal fractures is reported to be 5-10% in the developed world.<sup>[6]</sup> Bone fixation options for non-union treatment are variable. In weight-bearing bones, intramedullary nails are often preferred. Intramedullary nailing provides stable osteosynthesis, thus permitting early joint movement and weight bearing. It acts as a load-sharing device as opposed to a load-bearing device, thus promoting callus formation. The central location of the nail within the medullary canal also shortens the lever arm thus imparting less bending stress to the nail. The nails could be hollow or solid. Solid, stainless steel nails allow for stable, rigid, interlocking intramedullary fixation. Varieties such as the SIGN have jigs that remove the need for a fracture table, power reaming or image intensifier. This implant and its instrumentation are obtainable free of charge in public health institutions in Nigeria and has reduced the burden of the provision of care in the hospital.

Before the advent of locked intramedullary nails, plates and screw constructs were the favoured option for the management of non-unions. Advancement in plate design was also progressive to address peculiar problems noted in non-union surgery. This gave rise to the development of locking plates to address the issue of osteoporosis associated with non-union surgery. Regular plate and screw constructs have fallen out of

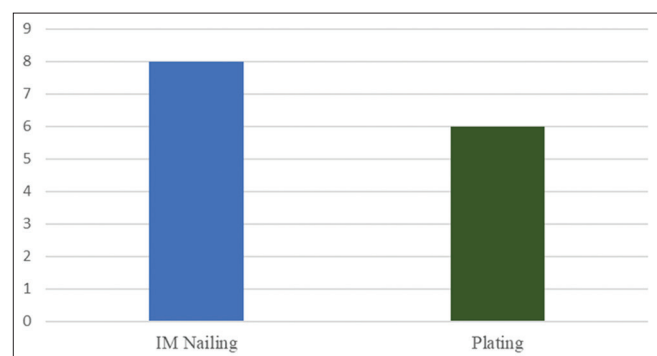
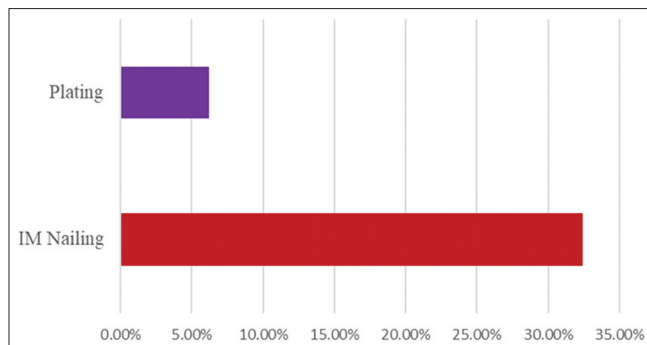


Figure 1: The mean time to union (months)



**Figure 2:** The complication rate in the two groups

favour over the years, with the exception of non-union surgery on the humerus. In Sub-Saharan Africa, use of the regular plate and screw or locked nail construct remains a viable option.

Various authors have evaluated the outcome of fixation of humeral non-unions using a plate/screw construct or an intramedullary locking nail. Chapman *et al.* reported a 93% union rate by 16 weeks compared to an 87% union rate in the nail group for humeral non-union fixation.<sup>[7]</sup> Shoulder pain and a decrement in shoulder range of motion were the significant associations with nailing. Ayotunde *et al.* reported a 100% union rate following plating for humeral non-union with a union time of 16 weeks on the average.<sup>[8]</sup>

Crolla *et al.* also reported a union rate of 67% within 6 months for humeral non-unions.<sup>[9]</sup> The remaining 33% united after additional bone grafting. In our study, the humerus had a far better union rate (76.5%) if plated when compared to a union rate of 23.5% when nailed and this was statistically significant. One must note, however, that majority of the humeral non-unions were plated. There was a statistically significant difference in union time between humeral non-unions managed by nailing or plating. Nailed non-unions were observed to unite faster. The SIGN nail differs in design compared to nails used for humeral fracture fixation elsewhere. The SIGN nail has two slots at either end for dynamic and only one slot for static locking. Nails used elsewhere have multiple static locking slots proximally enhancing stability and union. This may explain why plating did better than nailing in this series. Complications, apart from the recurrence of the non-union, were seen more in the plating group. Radial nerve palsy followed humeral plating in a significant number of patients in our series.

Femoral non-unions united better with nailing than plating though this was not statistically significant. Nailing is the gold standard treatment for femoral non-union though plating has reached a near equivocal rate of success.<sup>[10]</sup> Nailing allows for load sharing and weight bearing. Cove *et al.*<sup>[10]</sup> suggested that wave plate fixation of femoral diaphyseal non-unions may have advantages over reamed exchange nailing and recommend this technique if there is an intercalary defect >5 cm, a history of sepsis, or occlusion of the intramedullary canal by bone or fibrous tissue. In a study of exchange nailing for aseptic non-union of the femoral shaft, Yu *et al.*<sup>[11]</sup> reported a union

**Table 1: The rate of recurrence among the bones**

Bone	Recurrence rate (%)
Humerus	37.0
Tibia	15.0
Femur	11.9

rate of 91.7% and a union period of 4 months on the average. Shroeder *et al.*<sup>[12]</sup> reported a union rate of 86% with an average duration of 16 weeks.

We found that complications were significantly higher when femoral non-unions were plated. Plating for femoral non-union often requires extensive dissection and soft tissue trauma. Surprisingly, plating was observed to give faster union than nailing and this was statistically significant.

Tibial non-unions demonstrated a high union rate irrespective of the technique used to treat it. The incidence of complications was also not different between the two techniques used in this study. There was no statistically significant difference in union time between the two techniques. Various modalities have been recommended for treatment of tibial non-unions with studies documenting variable outcome measures. Ong *et al.*<sup>[13]</sup> reported the results of external fixation in 29 patients treated for tibial fractures and tibial non-union using a novel multi-axial external fixator followed prospectively until bony union. Shah *et al.*,<sup>[14]</sup> in Nepal, studied 25 tibial non-unions managed by intramedullary nailing with autogenous bone grafting. They reported a mean time for healing of 8.08 months. Satisfactory results (excellent and good) were achieved in 88% cases and unsatisfactory (fair and poor) results in 12% cases.

Our study recorded an acceptable union rate of 79.2% for all long bones. A similar study involving SIGN nail fixation of non-union of long bones from Pakistan<sup>[15]</sup> reported a union rate of 92%. The duration of non-union in that study was 16.16 months which was similar to our own findings. The tibia was the bone most involved in the study from Pakistan while the femur was the bone most involved in our own study.

## CONCLUSION

The management of non-union of long bones is still a challenge to all orthopaedic surgeons, especially those practising in resource-challenged areas such as Sub-Saharan Africa. Intramedullary nailing or plating usually constitutes the two means of non-union management available to such surgeons. Our study shows that acceptable union rates were achieved for long-bone non-unions in our environment. We found that humeral non-unions were more prone to recurrence but that the humerus fared better when plated for non-unions. Femoral non-unions fared better when nailed and had the lowest recurrence rates of the three long bones. Tibial non-unions fared well with either of the two methods in this study.

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## Conflicts of interest

There are no conflicts of interest.

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