



Study for the Management and Functional Outcome of the Diaphyseal Humeral Non-Union With Compression Plating on Medial Surface and Cancellous Bone Grafting

KEYWORDS

humeral diaphysis, medial plate osteosynthesis, radial nerve palsy.

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ABSTRACT *Background: In humeral diaphyseal fractures, nonunion is not a rare event. It occurs upto 8% in conservative and upto 13% in operative management. Plate osteosynthesis in case of diaphyseal humeral fracture is done either on posterior or lateral surface. Aim of our study is to study the management and functional outcome of diaphyseal humeral nonunion with compression plating on medial surface and cancellous bone grafting. Methodology: This prospective study includes 22 patients conducted at the department of orthopaedics at Maharaja Agrasen Medical College, Agroha, Hisar (Haryana) from June 2013 to June 2015. Results: There were 16 males and 06 females. Average age was 45.6 years. Average time of nonunion was 22.4 months. Average time of union was 14.4 weeks. Medial plate osteosynthesis with cancellous bone grafting was done in all. 100% union was achieved in all. No case of infection and iatrogenic radial nerve palsy. Conclusions: We found medial plate osteosynthesis with bone grafting has achieved 100% union rates in less time. It is relatively simple, with less need of soft tissue dissection, no need of radial nerve exploration and that's why it leads to decrease (in our study nil) iatrogenic radial nerve palsy.*

INTRODUCTION

Fracture shaft of humerus comprises upto 3% of all fractures. Nonsurgical management is preferred in humeral diaphyseal fractures but the operative treatment with plate osteosynthesis has been appeared to be a gold standard. Although majority of diaphyseal fractures of humerus heal uneventful but nonunion is not a rare event.¹ The incidence of nonunion in case of conservative treatment is upto 8% and in operative treatment, it is upto 13%. Nonunion in case of diaphyseal fracture of humerus can present a major functional problem even in elderly population. Multiple factors contribute for nonunion like:- severity of the initial injury, transverse pattern of the fracture, distraction of the fracture, soft tissue interposition or inadequate immobilization. Obesity, alcoholism and method of treatment may also be contributory factors.¹ Failure to unite after the operative treatment may be due to poor contact between the bone ends, inadequate stabilization, devitalization of the fracture fragments, infection, osteopenia and bone defects.²

Nonunion of long bone fracture is a major therapeutic challenge for the trauma surgeons, being a debilitating unacceptable condition. Advances in fracture care and modern implant designs have led to a marked reduction of the diaphyseal non union rates in the past decades.³

There are multiple treatment options available for nonun-

ions of diaphyseal fractures of humerus. Treatment options include intramedullary nailing, illizarov external fixation and compression plating with bone grafting and onlay bone plate augmentation. The intramedullary nail are associated with shoulder pain and stiffness of antegrade insertion. Excessive reaming of the canal can cause heat necrosis and iatrogenic fractures. Ilizarov external fixation has yielded a union rate of 94% but it requires long fixation time, risk of pin tract infection and patient's discomfort because of the large size of the frame.⁴

Plate fixation with bone grafting achieves a union rate of more than 90% but it requires a wide dissection which is having a high risk of radial nerve damage (around 5%).⁴

In this study we have done autologous cortico-cancellous bone grafting and plate osteosynthesis on the medial surface of the humerus, which does not require the exploration of radial nerve.

METHODOLOGY

This study was conducted at the department of orthopaedics, Maharaja Agrasen Medical College, Agroha, Hisar, Haryana. 22 patients fulfilling the inclusion criteria, with nonunion fracture shaft of humerus, were included. In all cases, standard anterolateral approach was used. After skin incision, biceps was exposed and retracted medially. Then brachialis was split longitudinally at fracture site. Fracture

ends exposed and fracture ends freshened & recanalization of marrow was done. Fracture reduced and fixed with plate osteosynthesis on medial surface of the humeral diaphysis. For bone grafting, cancellous bone was harvested from patient's iliac crest. In none of the cases radial nerve was exposed during surgery. Plaster of paris slab was applied for two days for relief of pain due to soft tissue injury, after that PVC brace was given for 4 weeks. Gentle shoulder and elbow physiotherapy was started postoperatively, as per patient's pain tolerability. Patients were regularly followed up at 6, 12, 18, 24 weeks. Patients were assessed both clinically and radiologically. Functional outcome was evaluated as per Rodriguez-merchan criteria.

RESULTS

There were 16 males and 06 females. 14 patients were right sided and 08 were left sided. Mean age was 45.46 years (20-60 years). 15 patients were having atrophic type and 07 were having hypertrophic non-union. Mostly (15 cases) were due to failure of conservative treatment (mainly by quacks). 01 patient was having infected nonunion after an open fracture which was managed earlier with external fixator and skin grafting. 03 patients were with intramedullary interlocking nails with hypertrophic nonunion out of which one was with broken nail. 01 patient was previously operated with intramedullary rush nail with hypertrophic nonunion. 02 patients were with compression plates. Out of 22 patients, 08 were chronic alcoholics and 12 patients were smokers. Average duration of nonunion was 22.4 months with earliest being 10 months and latest was 34 months. All conservatively managed patients were having shoulder and elbow stiffness. 03 patients with intramedullary interlocking nails were also having shoulder stiffness. In both the plating cases lateral surfaced plate was present. 08 patients were having severe osteoporosis. With PVC brace, preoperative physiotherapy was started to correct the elbow and shoulder stiffness for few days.

In all patients standard anterolateral approach was used. Plate osteosynthesis was done on medial surface in all cases. Autologous cancellous bone grafting was done in all cases. Soft tissue interposition was found in 11 out of 15 conservatively managed cases and 04 were due to improper immobilization. Loosening of intramedullary nail was found in one nailing case. In none of the cases, radial nerve exploration was done. In 10 cases locking compression plates, in 07 cases dynamic compression plates and in 05 cases LC-DCP were used. Union was achieved in all cases within 24 weeks. Average time for union was 14.4 weeks. No implant was loosened or broken. There were no iatrogenic radial nerve palsy cases. Functional outcomes according to Rodriguez- Merchan criteria were excellent in 16 (72.7%), good in 03 (13.7%), fair in 02 (9%) and poor in 01 (4.6%) cases. There was no case with superficial/ deep infection.



Figure 1, 2, 3:- 14 months diaphyseal humeral non-union with pre-op, post-op and union x-rays.



Figure 4, 5, 6, 7, 8:- 36 months old infected non-union with pre-op, post-op, union x-rays. Figure 8 showing scarred skin due to multiple surgeries (external fixator, skin grafting) with healthy surgical scar line at 18 months follow up.



Figure 9, 10, 11:- 18 months old case of humeral diaphyseal non-union with pre-op, post-op and follow up.

DISCUSSION

The reasons for nonunion in diaphyseal fractures of humerus are multifactorial. Nonunion can be a complication of both conservative and operative interventions of humeral shaft fractures. However, if it happens after surgical stabilization, it is notoriously difficult to treat. The possible reasons of nonunion could be:- distraction or inadequate reduction at the fracture site, possible devitalisation due to wide exposure of bone fragments for plate fixation, Rigid fixation without achieving compression, infection, improper immobilization, diabetes, smoking and alcohol consumption etc. Persistent nonunion of long duration results in osteopenia, fatigue failure of implants, increased gap across the fracture zone, progressive osteolysis around the backed out screws and cortical resorption of the foot print of the plate. Humeral shaft fractures resulting in a nonunion, pose major therapeutic challenges. Various methods have been introduced for the management of humeral shaft fractures with good results. The available implant options for re-fixation are interlocking nail, single plate, dual plates, plate and antegrade rush rod combination and Ilizarov frame.⁵

Locked intramedullary nailing is suggested by some in nonunion diaphyseal cases. It has been used for primary fixation for diaphyseal fractures of humerus. Exchange nailing in case of diaphyseal nonunion in humerus has not been as successful as for the femur or tibial shaft fracture nonunions. High failure rates of exchange nailing in humeral diaphyseal fracture nonunions may be due to absence of the cyclic loading by weight bearing and higher amount of distractive and torsional loads.⁶ Difficulty in achieving compression at the nonunion site is a potential drawback that can result in significant failure rate. Additional problems are rotator cuff damage, shoulder pain and stiffness when inserted antegrade and the risk of iatrogenic fracture at the insertion site when placed in a retrograde fashion. Understanding the limitations, such as the narrow medullary canal, significant bone defect and difficulty to achieve compression, a locked intramedullary implant as a fixation device is not considered in the present situation.⁷

It may be possible to achieve stable fixation with the

Ilizarov frame, even in the presence of osteopenia or bone defects⁸. In presence of infection, ilizarov fixation has distinct advantage over internal fixation modalities⁹. However in aseptic nonunions, it is associated with the potential complications such as bulkiness, pin-site infections, nerve injuries, and frame impingement over the chest wall resulting in constant discomfort with sleep disturbances⁹. It was also suggested by Singh HP et al¹⁰ in their study of 14 cases with humeral nonunion in adults managed with removal of previously fixed dynamic compression plates and ilizarov fixation. They achieved union in 13 out of 14 cases. One patient required an additional surgery with bone grafting. The reported healing rate in management with ilizarov fixator is 86-93%. But the incidence of infected cases was also high (10.425%). So, management of aseptic nonunions using internal fixation is likely to be associated with higher degree of patient comfort and compliance.

Rush roads in isolation and ring external fixators have also been used¹¹. But, compression plating and with autologous bone grafting has been considered gold standard with a reported success rate more than 90%.

Ring *et al.* used locking compression plate for management of nonunion of humeral diaphyseal fractures with osteoporosis. They reported successful union in all the 24 patients they had treated using LCP. The average duration of nonunion was 22.4 months in our series which was 28 months in that of Ring *et al.* The mean age of our patients was 45.46 years in comparison with the mean age of 72 years in the study by Ring *et al.* Another difference from the series by Ring *et al.* is that 9 out of 24 patients in their series had delayed union and 15 had nonunion, whereas in our series, all patients had established nonunion.¹²

Jupiter JB treated four obese patients with atrophic nonunion of humeral shaft with medial approach, anterior plating, a vascularized fibular bone graft and cancellous grafts from the iliac crest. Average age was 40 years which is comparable with our study, average duration of nonunion was 33.5 months. Each patient was having history of multiple surgeries. He found 100% union which is comparable with our study.¹³

In a study done by Collie et al at Mayo Clinic, nine patients with persistent nonunions and having had multiple previous procedures were treated with a lone compression plate and a tibial onlay bone graft with screw fixation applied at 90 degrees to the plate. Cancellous bone grafts were also used. There was 100% union rate.¹⁴

Sitati FC et al in their retrospective study of 46 patients with humeral diaphyseal nonunion, found mean age 43.6 years, which is comparable with ours. Overall healing rate was 92.8%. there were three cases of postoperative radial nerve palsy.¹

Hsu Liang Tsu et al, in their study of 105 patients of nonunion shaft of humerus found average time of union 16 weeks which is 14.2 weeks in our study. There were 04 patients with temporary radial nerve palsy. 04 patients with wound infections. They found DCP with cancellous bone grafting as an effective and reliable treatment for nonunions for diaphyseal fractures of humerus.⁸

Marti RK et al in their study of 51 humeral diaphyseal nonunion cases managed with compression plating and bone grafting, achieved union in all with two patients having

transient neuropathy of radial nerve. They found this management reliable.¹⁵

Ayotunde olasinde Anthony et al found union in all cases with average time being 16 weeks(which is 14.4weeks in our study). They found management of humeral diaphyseal nonunions with dynamic compression plate and cancellous bone grafting, as an effective method.¹⁶

Martinez antonio angel et al did two plate fixation with bone grafting. Average time of union was 18 weeks. One patient was having iatrogenic radial nerve palsy, though it recovered within 3 months.⁴

In posterior approach, we have to explore the radial nerve and much soft dissection has to be done for this. Because of this there is risk of radial nerve damage. In lateral surface plate osteosynthesis we have to lift the deltoid insertion proximally. But in medial placed plate osteosynthesis, there is no need for radial nerve exploration or deltoid dissection and soft tissue dissection is also very less. There is also very less periosteum stripping. That is beneficial for the union.

CONCLUSIONS

We concluded that proper preoperative planning, minimal soft tissue dissection, strict asepsis, proper postoperative rehabilitation and patient education are more important to achieve excellent results. Early postoperative mobilization improves shoulder and elbow motions. We found anterolateral approach to be easier than others. It has avoided secondary radial nerve palsies. Medial plate osteosynthesis requires lesser soft tissue dissection and also it has given early union. Also there is no need for plate moulding in the middle 2/3rd of the humeral diaphysis. We recommend medial plate osteosynthesis through anterolateral approach for routine use in humeral diaphyseal fractures.

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