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Use of Autologous Non-Vascularized Fibular Graft as a Biological Intramedullary Nail for the Management of Bone Loss in Compound Distal Tibia Fractures

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Abstract: ***Compound fracture resulting in segmental bone loss is a challenge to orthopaedic surgeons. Choosing a correct surgical modality for gap non union is controversial, In our study non-vascularized fibular graft was taken from contralateral leg as a biological intramedullary nail in the management of compound distal third both bones fracture right leg, which has shown good results at the end of 18months of followup.***

Keywords: Gap non-union, Fibular graft, Biological intramedullary nail

1. Introduction

Compound distal tibia fractures are more prone for non-union, there are many factors which contribute to the development of non-union [1,2] The subcutaneous nature of tibia results in a greater incidence of open fractures and provides less soft-tissue coverage, the middle third-lower third junction is a watershed area, these result in higher incidence of nonunion and infected nonunion.

Treatment of distal third tibial fractures is still controversial. Distal third tibial fractures differ from proximal third fractures by their difference in anatomy and difference in healing potential.[3,4]

Intramedullary nailing is used in cases with sufficient distal fragment to offer rigid fixation. [5,6] Compression plates can be used for angulated distal fractures; and ring fixators are preferred in cases with bone loss. [7]

In certain cases, specially with poor local skin condition, distal fibula can be used to bridge the nonunion tibia site and provide advantage of both bone grafting and internal fixation. Such use was first described in 2005 by James and Santrock in an abstract presented at foot and ankle surgery course 2008. [8] We describe successful use of similar technique in non infected tibia nonunion in 20 year old male.

A fibula either the ipsilateral or the contralateral can be used as a bridging graft of non-union tibia, either a vascularized or non-vascularized fibula can be used, studies shows vascularized fibular graft has good healing.

In this paper, we present the case of a patient who suffered a grade 3b comminuted distal third fracture both bones right leg according to gustilo and Anderson classification. The surgical technique is described in which a nonvascularized autologous fibular strut graft was used as an augmentation technique.

2. Case

A 13 year old boy presented to the casuality with grade 3b compound comminuted fracture of right lower third leg, he sustained injury due to sudden fall of a current pole directly on to his right leg, immediately after trauma he was brought to the hospital (image a).

All the blood investigations were within normal limit, xrays shows comminuted fracture of both bone lower third right leg (image b), then the patient was immediately shifted to operation theatre where through debridement of the wound was done, their was significant bone loss at the fracture site, later the fracture was stabilized with external fixator (image d).

After about 1month the soft tissue healing was poor and bone at the fracture site was very osteoporotic, we planned for second stage procedure using nonvascularized fibular strut graft bridging the gap at the fracture site, and single frame external fixator was converted to a delta frame(image e,f).

For about 2weeks intravenous antibiotics were given and daily dressing of the wound was done using EUSOL solution, later after achieving good granulation tissue we planned for soft tissue coverage.Patient was advised for wound dressing and regular follow up.

At 3rd month follow up their was only minimal callus at the fracture site with severe disuse osteopenia, the calcaneal pin was removed from the delta frame and bone marrow injection was given at the fracture site.

Patient was adviced for active ankle and knee joint movements with tibial external fixator frame insitu, as patient was not on regular follow up, he visited to hospital after 5month of surgery, i.e; at 8th month followuptheir was only minimal callus at the fracture site (image g), for which

externlfixator was removed and later patellar tendon bearing cast was applied and patient was adviced to walk with the help of walker.

Later patient was followed at 12months (image h) and then at 18months image (i). There is restriction of inversion and eversion of right ankle when compaired to left ankle (image n,o), ankle dorsiflexion is also restricted (image l).

3. Images

(a)

(b)

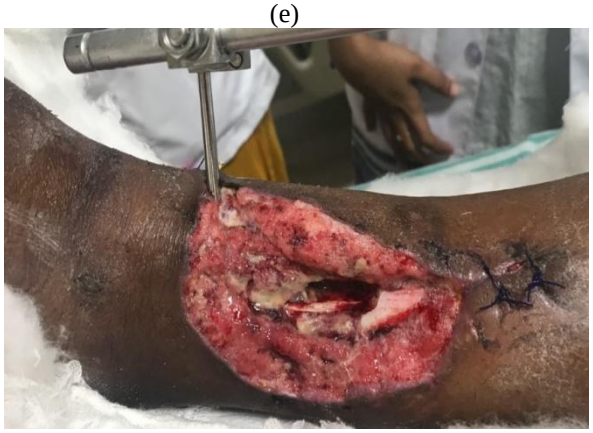
(a) Clinical image showing grade 3 b compound fracture of right leg.
(b) Xray showing both anterio-posterior and lateral view of right leg with ankle joint.

(c)

(d)

(c) (d) Post-operative(1st stage procedure) radiographs showing external fixator divice in situ.

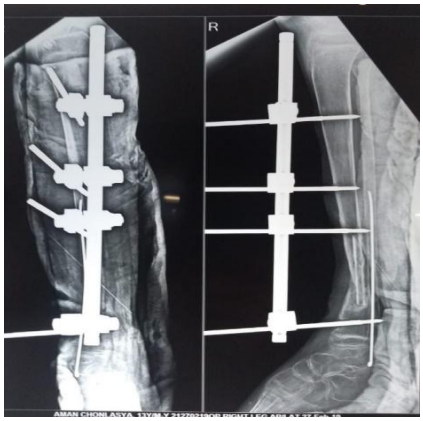
(e)



(f)

(e) Post-operative(2nd stage procedure) radiographs showing fibular rush pin, contralateral fibular strut graft and the gap site with delta frame in-situ.

(f) Clinical image showing soft tissue diffect at the fracture sit, which was managed by soft tissue reconstruction (3rd stage procedure).



(g)

(h)

(i)

(g) Xray showing anterio-posterior view of right leg at 8 months of follow up.

(h) Xray showing anterio-posterior views of right leg at 12 months of follow up.

(i) Xray showing anterio-posterior views of right leg at 18months of follow up.

Range of movements of right ankle at 18 months of follow up:

(j)

(k)

(j) Clinical image showing squatting position.
(k) Clinical image showing sitting cross-legged position.

(l)

(m)

(l)(m) Clinical images showing active dorsiflexion and plantarflexion of both the ankle joints.

(n)

(o)

(n)(o) Clinical images showing active inversion and eversion of both the ankle joints.

4. Discussion

In case of fractures affecting the leg, tibia is more prone to injury when compaired to fibula as it is subcutaneously located, leading to bone loss, or in the process of treating the fracture surgically the nectrotic segments of bone are trimmed of, on the other side fibula has adequate cover with muscles all around it and it regains its continuity by its own with bridging callus.

Nonunion of the long bones is a difficult condition to treat and is fraught with complications.[9] After repeated implant failures, nonunions are resistant to treatment.[10,11] In such cases, the bone is often osteoporotic, with a large gap between the bone segments, and fixation is usually difficult to achieve. [12-18]

Gap nonunion presents a major challenge to the orthopedic surgeon, especially when associated with infection, old or active osteomyelitis, and multiple previous surgeries. [19]

Gap non-union of tibia following traumatic bone loss or infection dramatically emphasizes the limitation of conventional reconstructive techniques. With presence of significant skin loss or poorly vascularised recepient bed, complications and failure rate increase and solution often lies in amputation.

Management of the gap nonunion is technically difficult, time-consuming, physically and psychologically demanding for the patient with unpredictable clinical outcome. The problem involves bridging or regenerating areas of bone loss while maintaining limb length and alignment.[20] Open fractures with bone loss are most common in the tibia due to its subcutaneous anatomical site, and a number of patients have secondary bone loss after surgical debridement of the necrotic bone or osteomyelitis.[20] Nonunion with infection, bone loss, or both, represents a more complex problem and is better managed with a vascularized fibular graft, free fibular graft, bone transport, or sometimes even amputation. [21,22] The nonunion may persist despite a series of reconstructive procedures, with external fixation, internal fixation (plate or intramedullary rods), bone grafting, plastic surgery, and Ilizarov frame application.

Treatment of such gap nonunions include non-vascularized fibula graft from contralateral leg, Huntington's procedure, Papineau type of cancellous bone, microvascular fibular transfer and Ilizarov technique.

The illizarove technique is a well known technique for gap non-union, infected non-union, LLD etc.; it gives good union at the fracture site, it has its own complications and obstacles.[23] Although early weight bearing is possible, it is very difficult for the patient to carry on this for long duration.

Free fibular graft from the opposite side leg, in the presence of sepsis, may necrose and even if it survives, it will take a very long time to heal, with a poor functional outcome.[24]

In our case the non union had abnormal mobility and thus stabilization was required. With these options and problems with them, we tried the concept of bridge grafting as described by James and Shr. [25]A similar concept was utilized by Weinberg et al to fill up defect in war injuries. [26] They however osteotomised the fibula at one end. In our case the fibula was united in slight angulation towards the tibia thus we could utilized the fibula as an internal fixation device without osteotomy, which acted as the working length and stabilizing the non union site.

5. Conclusion

The use of non-vascularized fibular graft in the management of gap non-union has resulted in good clinical outcome, This procedure is effective, but for optimal results the treatment needs to be individualized by the treating surgeon, with due consideration of soft tissue coverage, socioeconomic factors, and the available expertise.

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