

Huntington's procedure revisited

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ABSTRACT

Background: Management of gap nonunion of tibia is difficult for the surgeons, and time consuming for patients with unpredictable results. There are various methods to treat gap nonunion, but each one has its own limitations. We report the outcomes of ipsilateral fibular transposition (Huntington's procedure) for reconstruction of major tibial defects.

Methods: It is a retrospective study including 4 patients who underwent ipsilateral vascularized transposition of fibula for gap nonunion of tibia. Fibula was transferred to tibia as vascularized pedicle graft in one-staged procedure.

Results: Single stage fibular transposition was performed in four patients. The transferred fibula united in all patients. Mean follow-up after fibular transposition was 1.2 years. Partial weight bearing started after an average of 5.25 months till hypertrophy of fibula is seen on radiographs than full weight bearing started. The mean time to healing was 7.5 months (range: 5–10 months). Tibialization of fibula occurred in all patients as evident on radiographs.

Conclusions: Huntington procedure is a simple and technically easy for large tibial defects. It does not require microsurgical skill and implants. The union of transferred fibula is faster than conventional graft as it is a vascularized graft. It is a rational choice for the treatment of large tibial defects in selected cases.

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1. Introduction

Segmental tibial loss due to trauma, tumor, congenital deficiency or infection is a considerable surgical challenge.^{1,2} Limb salvage in the presence of significant segmental loss of tibia is real challenge for a surgeon and leads to the prolonged treatment which imposes great physical, psychosocial and economic burden on the patient. None of the conventional methods promise a satisfactory outcome. Amputation often is considered in these cases, which is not always acceptable to the patients. Major tibial defects required the help of modern techniques of fracture stabilization and soft-tissue/bone reconstruction. However, providing the viable bone to bridge skeletal loss to maintain limb length and satisfactory bone union/function remain a considerable challenge. This article describes the role of Huntington's procedure for limb salvage in major tibial loss.

2. Material and methods

It is a retrospective study including four patients with massive bone loss of tibial shaft was treated by Huntington's procedure between January 2016 to December 2017. There were 2 male and 2 female patients. The mean age of the patients at the time of the fibular transposition was 24.5 years (range: 12–40 years). The tibial lesion was caused by high energy vehicular trauma with loss of tibia in 2 patients, Ewing's Sarcoma in 1 patient and Pseudoarthrosis in 1 patient. Treatments used before ipsilateral fibula transfer (Huntington procedure) included debridement and external fixator in both trauma patients and preoperative chemotherapy in Ewing's Sarcoma. Devascularized tibia debrided at the nonunion site in cases of trauma, wide surgical excision of the tumor in Ewing's Sarcoma (Figs. 1,2) and excision of pseudoarthrotic tibia was done. The mean size of the bony defect was 16.25 cm (range: 14–18 cm). The demographic, operative and outcome details of patients are shown in Table 1. We did not exclude patients with a single level fractured fibula. Preoperative affected lower limbs CT angiogram was done in all cases to ascertain the vascular anatomy of leg and fibula; in addition to routine clinical and radiological examinations.

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Fig. 1. Ewing's sarcoma of tibia.



Fig. 2. Resected specimen of tibia.

2.1. Operative technique

External fixator was applied in the affected leg and 'diseased' tibia was excised. The length of defect was maintained by external fixator and then ipsilateral fibula was harvested. The head of the fibula and lateral malleolus were marked and a line was drawn along the posterior border of the fibula along the posterior crural inter-muscular septum. Distal osteotomy site was at least 5 cm above the projection of the lateral malleolus (to maintain ankle stability) and proximal osteotomy site at 2 cm below the neck of fibula was marked. Next the flap was raised with standard technique of free micro vascular flap; except peroneal vessels were not divided. The fibula was then osteotomized at both ends with preservation of the peroneal vessels (Fig. 3) and was shifted in the tibial defect and placed in intramedullary space and fixed with screws (Fig. 4, 5, 6). Additional fixation was provided with the help of external fixator in cases of trauma and Ewing's sarcoma while in Pseudoarthrosis tibia the internal fixation with plate was done.

2.2. Postoperatively

Patient's leg immobilized by external fixator for 3 months followed by above knee cast for 6 weeks and then PTB cast for another 6 weeks. Partial weight bearing was allowed by PTB brace. Healing of the transferred fibula was evaluated radiographically using anterior–posterior (AP), lateral and oblique views of the affected leg. Apart from healing process complications such as a fatigue fracture/angulation of the fibula was also monitored. Immobilization in the external fixator/cast continues until radiographic union is evident, usually by 14 weeks post-surgery.

3. Results

Single stage fibular transposition was performed in four patients. The transferred fibula united well in all patients, without major complications. Mean follow-up after fibular transposition was 1.2 years (range: 1–3 years). Guarded partial weight bearing started using the PTB brace after an average of 5.25 months (range 3.5–7 months) until enough consolidation of fibula is evident on radiographs (Fig. 7). Full weight bearing started after mean of 6.75 months (range 5–8.5 months) Healing was achieved in all patients. The mean time to healing was 7.5 months (range: 5–10 months). (Table 1) The mean range of knee flexion was 115° (range: 0–130°). The mean leg length discrepancy was 2.5 cm (range: 0–3.5 cm). The mean range of motion of the ankle joint was 10° for dorsiflexion (range: –5 to 35°) and 25° for plantar flexion (range: 0–44). There were no complications except the patient with Pseudoarthrosis had varus deformity. Transferred fibula got thickened and matched the size of opposite tibia in all patients. Majority of the patients were satisfied with the procedure.

4. Discussion

Treatment of major bone gap is demanding and if patient is not willing for prolonged treatment than amputation remains the only options. Modern methods of bone replacement enables one to reconstruct any degree of bone loss³ but the severity of the soft-tissue loss and the insensate foot are the most important reason for considering the amputation. The initial cost for amputation is considerably less compared to limb salvage, but in long run the costs of maintenance of prostheses is considerably more than for a successful reconstruction.^{4,5}

Significant segmental defects of tibial defects can be treated by conventional bone grafting/Papineau technique, allograft reconstruction, bone transport using the Ilizarov frame, contralateral free

Table 1
Demographic, operative and outcome details of the patients.

S No	Age/Sex	Side	Initial lesion	Previous treatment	Bone defect(cm)	Weight bearing		Time before union (months)	Hospitalization time (months)	Functional results	Complications
						Partial months	full months				
1	12Yrs/F	Left	Ewing's SA	Preop chemo	14	4.5	6	6	1	Normal Walking	No
2	16yrs/F	Right	Pseudoarthrosis tibia	None	16	3.5	5	5	1	Normal Walking	Varus foot deformity
3	30yrs/M	Right	Open tibial fracture with bone loss	Debridement Ex fix	18	6	7.5	9	2	Normal Walking	No
4	40yrs/M	Left	Open tibial fracture with bone loss	Debridement Ex fix	17	7	8.5	10	2	Normal walking	No



Fig. 3. Vascularized fibula raised on peroneal pedicle.



Fig. 4. Defect in tibia.



Fig. 5. fibula placed in the tibial defect.

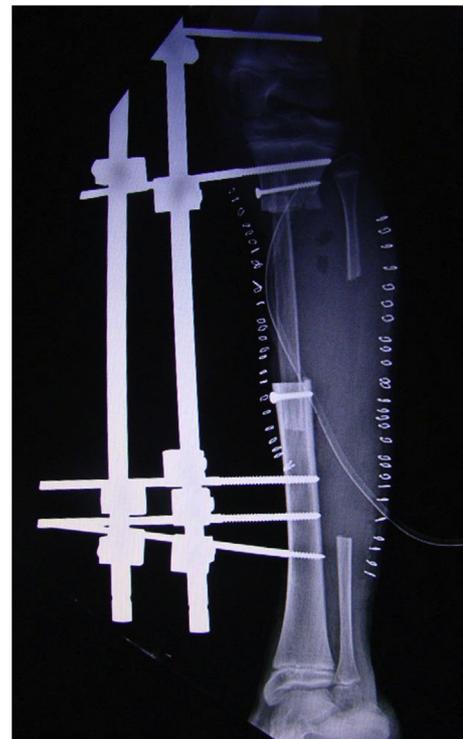


Fig. 6. Immediate post op X-Ray showing fibula in tibial defect.

vascularized fibular and transport of the ipsilateral fibula (Huntington procedure). All of these techniques have their pros and cons. Conventional bone grafting/Papineau technique is useful for smaller defects with good vascularity and absence of infection. However, bone graft has limited mechanical strength and takes a long time for union and weight bearing.⁶ Reconstruction with bone allograft is not feasible due to absence of bone bank. Moreover, bone allograft may be associated with high risk of failure, infection, rejection, fracture, and nonunion.⁷ The most surgeons prefer bone transport with Ilizarov technique for large tibial defects; but in many cases the tibial remnant is inadequate for lengthening. Additionally longer healing time with a significant pin track infection and bulky ring frame which may not be tolerated by some patients.⁸ Contralateral vascularized fibula requires micro vascular expertise and may lead to ankle pain/instability, peroneal nerve injury, and progressive valgus deformity.⁹

Transposition of the ipsilateral fibula to the tibial gap was first proposed by Hahn in 1884 and later used successfully by Huntington in 1903.^{10,11} Huntington and Catagni transferred fibula in two stages while Tuli described single stage end to end apposition of fibula.^{12,13}

The length of fibular available for transfer is 20–24 cm; sparing 2 cm at the upper end to prevent injury to the common peritibial nerve and 6 cm at lower end for the stability of the ankle joint. In leg tibia is main weight bearing bone and fibula act as strut for muscle attachment and provide stability to the ankle joint. Fibula transmits only 15% of body weight and almost 70% of the fibula shaft can be used for transfer.^{14,15}

We transferred the fibula in one stage and placed it intra-medullary. It reduces the risk of fracture as the graft falls in the line of the mechanical and anatomical axis of the tibia. This is in contrast from the technique by Huntington which places the graft posterior or medial to the tibia.^{16,17} The vascularized fibula heals by primary bone healing and does not require creeping substitution as occurred in non vascularized grafts. It has all the advantages of vascularized fibular graft without the need for micro vascular expertise.¹⁸

The fibula has abundant blood supply from the nutrient branch of peroneal artery and surrounding muscle attachments which lead to early union and good vascularity wash out the infection. This is also the basis behind Huntington procedure for gap non-union.¹⁹



Fig. 7. Tibialization of fibula after 6 months.

Therefore fibula is a good choice to reconstruct tibial defects as it has a good mechanical properties and its ability to get hypertrophied.¹¹ Fibula when subjected to continuous mechanical load; has immense potential to undergo remodeling and hypertrophy (Wolfe's Law).²⁰

The indications for Huntington's procedure are gap non union of tibia (due to trauma, tumor, Pseudoarthrosis and osteomyelitis) with scarring, presence of infection, severe soft tissue injury, malalignment of the limb and failure of conventional techniques. The management of gap nonunion of tibia in above mentioned scenario is difficult by conventional methods like bone transport, auto/allografting, distraction osteogenesis and micro vascular surgery. The contraindication of Huntington's procedure includes fracture of fibula at multiple level and loss of peroneal vessels by trauma.

Huntington procedure has the advantages of using fibula as biological implant for internal fixation implants at a site vulnerable to infection and non union. The fibula firmly secured to the tibia maintaining the length of limb, and restores its alignment. Fracture of tibialized fibula and valgus deformity of the ankle is uncommon.²¹ It is a single stage surgery, independent of recipient bed, faster union, and good stability with no contralateral limb donor site morbidity. The limitations of the procedure include primary applicability in young patients because rate of union is faster and the hypertrophy is maximum in younger patients.¹⁹

5. Conclusions

Huntington procedure is a simple, cost effective, and technically easy for large tibial defects. It does not require microsurgical skill and implants. There is no donor site morbidity and it can be performed in modest settings. It is a strong cortical vascularized bone which can be used to replace tibia with fast union rate as compared to other techniques. It is a rational choice for the treatment of large tibial defects in selected cases.

Author's contribution

Prof. Pawan Agarwal- Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Roles/Writing - original draft; Writing - review & editing.

Dr Rajiv Savant- Data curation; Formal analysis; Investigation; Methodology; review & editing.

Prof. Dhananjaya Sharma- Formal analysis; Investigation; Methodology; review & editing.

Conflicts of interest

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jcot.2019.06.011>.

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