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Use of non-vascularized autologous fibula strut graft in the treatment of segmental bone loss

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Abstract

Background: Fractures resulting in segmental bone loss challenge the orthopedic surgeon. Orthopedic surgeons in developed countries have the option of choosing vascularized bone transfers, bone transport, allogenic bone grafts, bone graft substitutes and several other means to treat such conditions. In developing countries where such facilities or expertise may not be readily available, the surgeon has to rely on other techniques of treatment. Non-vascularized fibula strut graft and cancellous bone grafting provides a reliable means of treating such conditions in developing countries.

Materials and Methods: Over a period of six years all patients with segmental bone loss either from trauma or oncologic resection were included in the study. Data concerning the type of wound, size of gap and skin loss at tumor or fracture were obtained from clinical examination and radiographs.

Result: Ten patients satisfied the inclusion criteria for the study. The average length of the fibula strut is 7 cm, the longest being 15 cm and the shortest 3 cm long. The average defect length was 6.5 cm. Five patients had Gustillo III B open tibial fractures. One patient had recurrent giant cell tumor of the distal radius and another had a polyostotic bone cyst of the femur, which was later confirmed to be osteosarcoma. Another had non-union of distal tibial fracture with shortening. One other patient had gunshot injury to the femur and was initially managed by skeletal traction. The tenth patient had a comminuted femoral fracture. All trauma patients had measurement of missing segment, tissue envelope assessment, neurological examination, and debridement under general anesthesia with fracture stabilization with external fixators or casts. Graft incorporation was 80% in all treated patients.

Conclusion: Autologous free, non-vascularized fibula and cancellous graft is a useful addition to the armamentarium of orthopedic surgeon in developing countries attempting to manage segmental bone loss, whether created by trauma or excision of tumors.

Keywords: Bone loss, fibular allograft, segment, skeletal reconstruction

Résumé

Fond: Fractures résultant dans le défi de perte osseuse segmentaires le chirurgien orthopédiste. Les chirurgiens orthopédistes dans les pays développés ont la possibilité de choisir les transferts vascularisée os, os transport, greffes osseuses allogènes, substituts de greffe osseuse et plusieurs autres moyens pour traiter de telles conditions. Dans les pays en développement où ces installations ou l'expertise peut-être pas facilement disponible, le chirurgien doit compter sur les autres techniques de traitement. Greffe d'entretouise péroné non-vascularisé et le greffage d'os spongieux fournit un moyen fiable de traiter de telles conditions dans les pays en développement.

Méthode: Sur une période de six ans, tous les patients avec perte osseuse segmentaire de traumatisme ou de résection oncologic ont été inclus dans l'étude. Données concernant le type de blessure, taille de la perte de l'écart et de la peau à la tumeur ou fracture proviennent de l'examen clinique et radiographies.

Résultat: Dix patients satisfait les critères d'inclusion pour l'étude. La durée moyenne de la jambe du péroné est 7 cm, la plus longue étant de 15 cm et la plus courte de 3 cm de long. La longueur moyenne des défauts est 6,5 cm.

cinq patients avaient Gustillo III B ouvrir tibiales fractures. Un patient a eu tumeur récurrente géant du radius distal et un autre avait un kyste d'os polyostotic du fémur, qui a été confirmé par la suite être ostéosarcome. Un autre a non syndiqués de fracture tibiale distal avec raccourcissement. Un autre patient avait des blessures par balle le fémur et était initialement géré par traction du squelette. Le patient dixième avait une fracture fémorale broyée. Tous les patients traumatisés qui avait mesure des disparus segment, tissu enveloppe évaluation, l'examen neurologique et parage sous anesthésie générale avec la stabilisation de la fracture avec fixations externes ou de moulages. Incorporation de greffe était de 80% de tous les patients traités.

Conclusion: Autologous libre, non vascularisé péroné et spongieux greffe est un ajout utile à l'arsenal de chirurgien orthopédiste dans les pays en développement, tenter de gérer la perte osseuse segmentaires, si créé par un traumatisme ou l'excision des tumeurs.

Mots clés: Os perte, une allogreffe fibulaire, segment, reconstruction du squelette

Introduction

Fractures resulting in segmental bone loss challenge the orthopedic surgeon. These are commonly seen as the result of increasing civil strife and motor vehicular accidents. Such defects may also result from resection of segments of bone during treatment of tumors or tumor-like conditions. Non-vascularized fibula strut graft and cancellous bone grafting provides a reliable means of treating such conditions in developing countries.

Orthopedic surgeons in developed countries have the option of choosing vascularized bone transfers, bone transport, allogenic bone grafts, bone graft substitutes and several other means to treat such conditions.^[1] However, in developing countries where such facilities or expertise may not be readily available, the surgeon has to rely on other techniques of treatment. The aim of this study is to determine the efficacy of the use of non-vascularized fibular strut grafts combined with cancellous grafts to re-establish bone continuity for the purpose of weight bearing in lower limbs or allow for function in the upper limbs. This is an age-old technique, first reported in 1911.^[2] Fractures with segmental bone loss are more likely to be open than closed and often occur because of high-energy trauma or missile injuries. These fractures can be classified into three categories with subtypes A or B depending on whether the fracture is open or closed^[3] [Table 1].

Table 1: Classification of fractures with missing segments according to Salai

	Defect	Size	Articular
Type 1	A	Minor < 1 cc or <1 cm ²	Either
	B	Minor < 1 cc or <1 cm ²	Either
Type 2	A	Major > 5 cm or 3 cm ²	Non-articular
	B	Major > 5 cm or 3 cm ²	Non-articular
Type 3	A	Major > 1 cm ²	Articular
	B	Major > 1 cm ²	Articular

Materials and Methods

This study was conducted at the Ahmadu Bello University Teaching Hospital Zaria between 2003 and 2009; all patients with segmental bone loss either from trauma or oncologic resection were included in the study. Data concerning the type of wound, size of gap and skin loss at tumor or fracture were obtained from clinical examination and radiographs.

Results

Ten patients satisfied the inclusion criteria for the study. The average length of the fibula strut is 7 cm, the longest being 15 cm and the shortest 3 cm long. The average defect length was 6.5 cm. Five patients had Gustilo III B open tibial fractures. One patient had recurrent giant cell tumor of the distal radius and another had a polyostotic bone cyst of the femur which was later confirmed to be osteosarcoma. Another had non-union of distal tibial fracture with shortening. One other patient had gunshot injury to the femur and was initially managed by skeletal traction. The tenth patient had a comminuted femoral fracture. All trauma patients had measurement of missing segment, tissue envelope assessment, neurological examination, and debridement under general anesthesia with fracture stabilization with external fixators or casts. They also had split thickness skin grafting to achieve skin cover. None required flap transfer. The osteoclastoma of the distal radius had excision twice before the current operation with recurrence. The tumor was noticed to be encircling the radial and ulnar arteries, thus making amputation a likely option. The gap created was filled by ipsilateral fibula and cancellous graft. Stability was achieved by a combination of Kirchner wire and small fragment plate and screws.

The patient with a polyostotic bone cyst had compartmental excision with ipsilateral fibula strut and cancellous grafting and stabilization with a 14-

Table 2: Summary of patients and their outcome

Age	Sex	Diagnosis	Treatment Offered	Outcome
36	M	Gunshot injury to the leg with Gustillo 3 B open tibial fracture from gunshot	Debridement, casting, split thickness grafting, fibula strut and cancellous grafting	Good outcome. Full weight bearing
56	M	Gustillo 3 B open tibial fracture	Debridement, external fixation, split thickness skin grafting, Fibula and cancellous grafting	Fair outcome. Patient walks with assistance of calipers
60	M	Gustillo 3 B open tibial fracture	Debridement, external fixation, below knee amputation	Poor outcome. Using prosthesis
60	F	Closed tibial fracture	Open reduction, fibular and cancellous bone grafting, plating	Good outcome. Full weight bearing
45	M	Gustillo 3 B open tibial fracture	Debridement, external fixation, split thickness skin grafting, second stage fibula and cancellous skin grafting	Graft lysis due to deep infection. Had a reoperation with good outcome
50	M	Gustillo 3 B open tibial fracture	Debridement, casting, split thickness skin grafting	Full weight bearing
26	F	Gunshot injury to the femur	Debridement, skeletal traction, fibula and cancellous graft with long condylar plate.	Returned to full weight bearing
24	F	Recurrent giant cell tumor	Excision. Fibula strut and cancellous grafting with pin, plate and screw fixation	Tumor free forearm. Limitation of pronation at the wrist
M	38	Osteosarcoma of the femur	Excision, fibula and massive cancellous grafting.	Weight bearing assisted by calipers
F	24	Comminuted fracture of the femur	Failed intramedullary nail fixation. Reoperation with fibula strut and massive cancellous grafting	Good outcome Returned to full weight bearing. Shortening of 5 cm

hole broad dynamic compression plates and screws.

Discussion

Vascularized fibula combined with cancellous graft provides probably best means of dealing with fractures with gap or gaps created after removal of tumors or tumor-like conditions. However, in our environment the expertise and facilities required for this operation are not available or are in short supply. Autologous cancellous graft is osteogenic and osteoinductive but is not osteoconductive.^[4] It is also easily revascularized and is not immunogenic; all desirable attributes of a good graft.^[5] It does not allow for transmission of viral or bacterial agents from one patient to another. The main drawback of cancellous grafting is the finite number of harvest sites and volume available as well as high failure rate when used alone.^[6] Donor site morbidity is another problem. Allografts have no problem of donor site morbidity but can transmit infections, require a tissue bank which is not available in developing countries and have lower graft incorporation rates compared to autografts.

In our series, the main complication was that of infection which led to graft lysis in two patients. In both cases, osteosynthesis with plates and screws were used which agree with the finding of Jaffe and Dunham.^[7] Graft was incorporated in 80% of patients treated. This technique requires high patient compliance but not to the extent required by patients

treated by Ilizarov technique, which is usually used for treatment of congenital anomalies.^[8,9] It is important that during fibular harvest, the proximal and distal 5 cm are preserved to prevent injury to the common peroneal nerve and to retain the stability of the ankle joint.^[10,11] Functional outcome in those who had successful graft incorporation was generally good. It is noteworthy that none of our patient had stress fracture which is said to be common when the grafts are greater or equal to 12 cm long.^[12] One of our patients had shortening of 6 cm. The results are summarized in Table 2.

Conclusion

It can be drawn from the findings above that autologous free, non-vascularized fibula and cancellous graft is a useful addition to the armamentarium of orthopaedic surgeon in developing countries attempting to manage segmental bone loss, whether created by trauma or excision of tumors.

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