TREATMENT OF POSTTRAUMATIC SEGMENTAL BONE DEFECTS OF THE TIBIA THROUGH THE RECONSTRUCTION WITH NON-VASCULARISED ILIAC CREST BONE GRAFT VERSUS MICROSURGICAL DOUBLE-BARREL VASCULARISED FIBULAR FLAP TRANSFER

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Keywords: *segmental bone defects of the tibia, non-vascularised iliac bone graft, double barrel free vascularised fibular graft*

Abstract: *Purpose: The treatment of segmental bone defects of the tibia after high-energy calf trauma is demanding for both, orthopaedic and plastic surgeons. Multiple treatment options are available, including non-vascularised bone grafts, allografts, bone substitutes, callus distraction, and free vascularised bone transfers. We shall present, herein, two small series of patients with major segmental defects of the tibia treated by reconstruction of the tibia with non-vascularised iliac crest bone grafts (NVIBG) and micro-surgically transferred double-barrel fibular osteomusculocutaneous flap. Materials and Methods: Patients with segmental bone defects of the tibia, 5 cm or more in length, have been included in the two series. The bone reconstruction of the tibia was performed by means of non-vascularised bone grafts harvested from the iliac crest and double-barrel fibular osteomusculocutaneous flap. Bone fixation has been ensured through external fixation in two cases and screws and initial external fixation followed by early conversion to locking plate internal fixation in the other cases. Results: In all cases included in the two series, bone union has been achieved. No case of irreversible graft loss or infection occurred in the process. Stress fractures developed in the cases treated by non-vascularised iliac crest bone grafts reconstruction. Time to bone union was of 25 months in the cases treated with non-vascularised iliac crest bone graft and, 5 to 8 months in the cases treated with double-barrel free vascularised fibular graft. Conclusions: The use of double-barrel free vascularised fibular flap was successful and it is the best option in the management of segmental tibial defects. Treatment with non-vascularised iliac crest graft can be successful in segmental bone defects of the tibia not exceeding 10 cm, but this requires a longer recovery time.*

INTRODUCTION

The major calf traumas incidence has considerably increased along with the road traffic development, being relatively frequent in industrialised countries.(1) Major calf traumas may lead to both, primary and secondary segmental bone defects due to the subsequent complications.

The segmental bone defects of the tibia are life-threatening cases and their treatment consists in the reconstruction of the tibia with non-vascularised bone grafts, allografts, bone substitutes, callus distraction, and microsurgical free tissue transfers.(2-8)

PURPOSE

This paper aims at outlining the experience of the authors in the tibia reconstruction secondary to the significant posttraumatic defects (≥ 5 cm) with iliac crest grafts and free microsurgical vascularised fibular transfer.

MATERIALS AND METHODS

Within the period 2011-2013, in the Orthopaedics Department of "Prof. Dr. Agrippa Ionescu" Clinical Emergency Hospital, two patients have been operated on for segmental defects of the tibia, reconstructed with non-vascularised iliac crest grafts. The two male patients were 52 and 18 years old, respectively. The bone defects were secondary to the resection of the osteitis appeared post-traumatically. In both cases, we performed an excisional debridement, external fixation and antibiotic treatment according to the antibiogram. The antibiotherapy has been deployed until the values of the inflammatory markers (complete blood count-CBC, erythrocyte sedimentation rate-ESR, C-reactive protein-CRP) were back to normal. The size of the bone defects was of 6 cm and 10 cm, respectively.

The restoration of the tibial continuity was made with non-vascularised iliac crest grafts. The bone defect was reconstructed in two stages through the grafting of an iliac crest and its positioning in the defect at a 7-month interval. The medullary channel was opened and the first graft was introduced in it. The second graft was placed parallel to the previous one. Stabilisation was ensured on an external fixation for 13 and 22 months, respectively.

The patients' follow-up period was of 34 and 30 months, respectively. The X-rays performed at 3-month intervals enabled us to monitor the bone integration of the grafts.

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Article received on 01.10.2015 and accepted for publication on 26.11.2015
ACTA MEDICA TRANSILVANICA December 2015;20(4):122-125

Figure no. 1. Radiograph at 6 months after the reconstruction of the tibia with iliac crest graft

Figure no. 2. Radiograph after the removal of the external fixation, with an apparent iliac graft union

Figure no. 3. Radiograph of iliac graft fracture after one month from the commencement of the full weight-bearing on pelvic limb

Figure no. 4. Radiograph of the iliac graft fracture consolidation after 3 months from its occurrence

Within the period 2012-2013, in the Bucharest Clinical Hospital, a mixed team of orthopaedic and plastic surgeons operated on four patients with segmental bone defects (figure no. 5) for which a reconstruction of the tibia with micro-surgically transferred vascularised fibular flaps has been performed. The bone defects were secondary to the debridement in case of necrosis. The size of the bone defect ranged from 5 to 9 cm. The patients' follow-up was of 7 to 24 months. The X-rays performed once every 3 months enabled us to monitor the bone union of the grafts. In the septic cases with bone necrosis and lack of soft tissues we performed excisional debridement, external fixation and antibiotherapy. The tibia defect was reconstructed with a micro-surgically transferred double-barrel fibula, monitored through a cutaneous isle of approximately 8 cm x 5 cm. Before surgery, we carried out a Doppler examination and an arteriography in order to optimally map and select the donor and acceptor vessels. The harvesting procedure of the double-barrel fibular osteomusculocutaneous flap was the standardised one, described by Gilbert.(9) From a lateral approach, between the peroneal and soleus muscles, the pedicle was identified under the flexor halluces longus muscle and we performed the distal osteotomy of the peroneus. After the pedicle, deep to the soleus muscle along the posterior edge of the fibula was proximally identified, we performed the proximal osteotomy. We made sure to harvest a 15 cm fibula segment because the graft must be about 4-5 cm longer than the length of the tibia defect (figures no. 6 and 7). In the acceptor sites, the second operative team exposed the tibial segment. The acceptor pedicle, made of the anterior tibial artery with the satellite veins, was dissected. Vascular termino-terminal anastomoses with a ½ arteries/veins ratio have been performed. The medullary canal was opened and enlarged to allow the fixation of the fibular graft. The bone graft was fixed with tetracortical screws, changed after 3 months postoperatively with a compression plate. The external fixation was maintained for 3-6 months.

Figure no. 5. Radiograph of the tibial bone defect

Figure no. 6. Harvesting of the fibular osteomusculocutaneous flap

Figure no. 7. Grafted double – barrel fibular osteomusculocutaneous flap

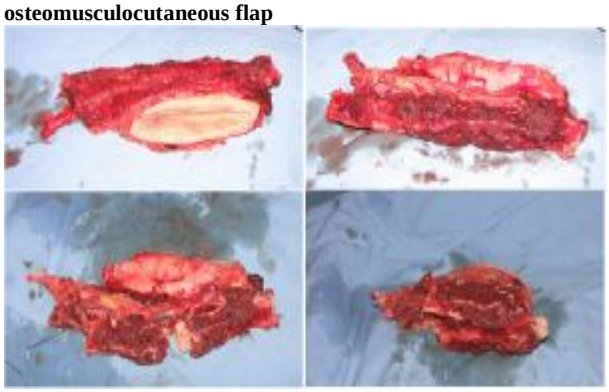

Figure no. 8. Radiograph at 10 months postoperatively showing the bone graft union

RESULTS

In the two patients treated with non-vascularised bone grafts harvested from the iliac crest, the apparent bone graft union was achieved within 13 and 22 months respectively (figure no. 2). After the removal of the external fixation and the resumption of weight-bearing, both patients developed graft fractures (figure no. 3), which required – for one of them the resumption of the external fixation for another 12 months, non-weight-bearing for 3 months and then gradual weight-bearing for 9 months and for the other - non-weight-bearing for 6 weeks and then, gradual weight-bearing for 2 months. The full graft union was achieved in both cases within 25 months after reconstruction (figure no. 4). The morbidity of the donor site was minimal.

In the series of the cases treated by vascularised fibula microsurgical transfer, bone union was achieved in approximately 5-8 months (figure no. 8). The success rate of the microsurgical fibular transfer was 100%. All patients progressed to full weight-bearing within 4-6 months after surgery. The morbidity of the donor site was minimal.

DISCUSSIONS

The treatment of calf traumas has been long debated, amputation being sometimes contemplated. The segmental bone defects can appear primarily or secondarily as a result of complications. The conventional treatment options include cancellous bone grafts, autologous non-vascularised fibular graft, allografts, and bone substitutes techniques by the induction of the bone regeneration through callus distraction or by the use of microsurgical composite free osteomusculocutaneous flap transfers. Non-vascularised autografts (10) are reserved to small bone defects, but not recommended for the reconstruction of massive bone defects, especially in infectious, precariously vascularised environments. Reconstruction with allografts is indicated in the management of post-tumour resections.(11) In case of bone defects larger than 6-8 cm, the free bone transfer is the best option.(12,13,14,15)

The success of the intervention depends on the surgical experience, as well as on the patient's collaboration.(15) Previous clinical studies highlighted the inherent advantages of the vascularised bone.(16,17,18) The vascularised fibular graft is deemed to be the most adequate graft for the reconstruction of long bones due to its straight shape, adequate length, mechanical resistance, the predictable vascular pedicle and the low morbidity in the donor site.(11,12)

There have been reported cases with post-traumatic reconstructions with vascularised grafts with a success rate of 89%, infection rate of 8% and a mean time to bone union of 8.5 months.(6,19,20)

Other studies mention larger rates of complications with a 12% incidence of amputations.(7) The fibula grafting at the level of the limb with previous traumas presents a series of risks, either due to fibular satellite vein clots or due to the callus that increases the stress fracture risk.(21) Minami and co. report satisfactory results in case of delayed reconstruction with vascularised fibula and discourage the per primam reconstruction in septic cases.(22)

CONCLUSIONS

The treatment of major calf traumas is complex and controversial. The microsurgical osteomusculocutaneous flap transfer is the best therapeutic solution in the management of bone defects, ensuring a quick functional recovery, with no major complications. The use of non-vascularised iliac crest grafts may be useful in the treatment of the tibial bone defects with a length not exceeding 10 cm, but with a much longer functional recovery.

Acknowledgement:

This paper was co-financed from European Social Fund, through the Sectoral Operational Programme Human Resources Development Program 2007-2013, priority axis 1 "Education and professional training in support of economic growth and knowledge-based development of the society", major domain of intervention 1.5 "Doctoral and post-doctoral programs to support research activities", Project title: "Program of excellence in doctoral and postdoctoral multidisciplinary research in chronic diseases", contract identification number: POSDRU/159/1.5/S/133377.

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