FREE VASCULARIZED FIBULAR GRAFT IN THE RECONSTRUCTION OF LONG BONE DEFECTS

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SUMMARY
Three vascularized fibula transfer were carried out to bridge the defects of one humerus and two tibia and they have been followed up to 6-10 months. The first case had a humerus defect of the dominant arm which had been previously bridged twice with the conventional non-vascular iliac bone grafts, followed by non-union. The second transfer was carried out to an extensive tibial defect, due to a gun-shot injury. In these two patients, it was not possible to monitor the circulation of the graft in the early postoperative period. Therefore a skin flap was included with the bone graft in the third case to cover the overlying skin defect and it was also used as a monitoring flap.

Key Words: Free Vascularized Fibular Graft-Extensive Long bone defect.

INTRODUCTION
The first successful free vascularized fibula transfer in man was first reported by Taylor et al (1) in 1975 and it has been increasingly on use to bridge defects in the long bones of both the upper and lower extremities. It has become a reliable procedure in the treatment of extensive bone defects (2-8), congenital or posttraumatic pseudoarthrosis of the long bones (2, 9-11), secondary bone defects after removal of malignant bone tumors (12-14), infected forearm nonunions (15), kyphosis (16) and cervical spondylosis (17). A skin island can be transferred together with the fibular graft and that skin island serves as a monitoring flap and also provides an additional skin coverage (2, 18).

Our experience on three patients with traumatic long bone defects (one humerus two tibia) treated by free vascularized fibular graft is presented in this paper.

MATERIALS AND METHODS
Reconstruction of long bone defects using a free vascularized fibular graft was carried out in three patients and their mean age was twenty-one year. The defect was in humerus in the first case and in tibia in the others (Table I). Preoperative angiography was performed in all patients and included both the recipient (Figs 2, 11) and donor extremities.

Fibular graft was harvested through a lazy -S- shaped lateral incision over the fibula by the standard technique as outlined by Gilbert (19). The length of the defects ranged from 10 cm to 13 cm in an average of 12 cm. Both the distal and proximal ends of the graft were placed within the medullary canal and the graft was fixed to the recipient bone proximally and distally with either interfragmentary screws or plates, and cerclage wiring was added if necessary. After skeletal stabilization, the peroneal artery of the graft was anastomosed end-to-side to the brachial artery in the first case and to the posterior tibial artery in the other two cases. Anastomoses were carried out by interrupted 10-0 monoflament nylon sutures under an operation microscope. Two venae comitantes were anasotomosed to the recipient vessels in a similar way. No skin was needed to cover the recipient areas but a skin island was included incontunity with the graft in the third case, converting the procedure to an osteoseptocutaneous graft transfer, the method oulined by Carr et al (18) and Yoshimura et al (2).

All three patients had postoperative angiographies which showed well nourished bone grafts indicating patent vessel anastomoses (Figs 3, 12).

RESULTS
Case 1: A twenty-two-year old male had a traffic accident which resulted in a large defect of the right humerus. He was operated twice with conventional avascular bone transfer at another hospital with no success (Fig 1). The movements of the shoulder and elbow in this arm were very limited and there was also a pseudarthrosis in the grafted area. The 10 cm defect of the humerus was bridged with a 18 cm ip-

silateral fibular graft. The entire bone graft revascularized well after vessel anastomoses and skin was approximated with the no need of a skin graft. On the tenth postoperative day the patient fell down and the proximal bone juncture was disrupted. He was reoperated and a plate was placed to provide the bony fixation. He was discharged with a plaster cast. X-rays obtained 6 months after the operation revealed good bony union and enlargement of the graft (Fig 4) and the patient was able to use that arm with no limitation and he was able to lift weight with this arm (Fig 5) and had almost full range of movements in the shoulder and elbow joints.

Case 2: A twenty-year-old male who had a large defect of the distal tibial shaft in the left leg due to a gun-shot injury, was admitted to our department (Fig 6). It was not possible to reconstruct that 12 cm bone defect by the conventional avascular bone graft and free vascularized fibula transfer was decided. A 21 cm contralateral fibular graft was harvested and dowelled into the both ends of the tibia and stabilization was obtained with the screws and cerclage wire (Fig 7). After microvascular anastomoses, return of circulation to the graft was demonstrated by the periostal and muscle cuff bleeding. Tension-free wound coverage was obtained by direct closure of the incision. The postoperative course was uncomplicated and the patient was sent home with axillary crutches and plaster-of-Paris on the leg. Unfortunately the patient fell down and suffered a fracture at the middle portion of the transplant 4 months after the operation. Healing was so rapid and reunion occurred with a huge callus formation in seven weeks similar to that occurred with the simple bone fracture (Fig 8).

Case 3: A twenty-one-year old male had a large defect of the proximal part of the right tibial shaft and the reason was again a gun-shot injury (Fig 9). The skin was also badly scarred and it was thought that an additional skin coverage would be needed. Therefore it was decided to include the overlying skin with the bone graft. Thus the graft was transferred as a osteoseptocutaneous graft. After bony fixation and vessel anastomoses it was noticed that the skin, transplanted with the bone, has a very good blood supply through the fasciocutaneous perforators araising from the bone itself. A tension-free skin closure was obtained by the use of this transplanted skin which was also used to monitor the graft circulation. Although it was not necessary, postoperative angiography was carried out and revealed patent vessel anastomoses (Fig 12) which had been constantly monitored by observing the colour of the transplanted skin flap. Six months postoperatively, the patient began walking with axillary crutches and he was able to walk without any help when he was last seen on the eight months postoperatively.

The grafted extremity was splinted with plaster-of-Paris in the functional position in all three patients and immobilization was continued until the callus formation was seen radiologically. Thereafter they were protected from all kind of strenous activities or weight bearings until x-rays demonstrated evidence of oseous incorporation of the fibula. The patient with humerus defect was not allowed to lift weight until the fifth month when solid bony union and enlargement of the grafted fibula took place (Fig 4). In the second and third cases whose lower extremities were grafted, gradually increasing weight-bearing was permitted with the aid of axillary crutches. Full weight-bearing was allowed when the x-rays showed evidence of hypertrophy of the bone graft. None of our patients had any permanent morbidity at the donor site.

DISCUSSION

The transfer of a free vascularized fibular graft by microvascular technique has become a reliable procedure in the reconstruction of extensive defects of the long bones. When the defect is extensive or recipient bed is severly scarred or poorly vascularized, a conventional avascular bone graft often fails to provide a satisfactory repair. They carry a substantial risk for the fracture of the graft and nonunion at the junctions and that risk decreases with vascularized grafts (2, 4, 6, 7, 12, 14, 15).

It has been demonstrated that a transferred fibula hypertrophies in response to axial loading (5, 7-9, 12, 14). All of our transplants have thickened and reached almost the same size of the bone they were bridged, as a respond to mechanical stress (Figs 4, 8, 10). Although the resistance is increased with this dramatic thickening, fractures still occur as was seen in our second case who fell down and broke the fibular graft. This fracture healed in seven weeks with a huge callus formation (Fig 8). Since the vascularized bone graft is a vital bone the osteocytes and osteoblasts survive and early bony union occurs because of the preservation of this bone forming capability (20). If any fracture occurs in the grafted fibula, it usually heals readily in a shorter period than that of the non-vascularized bone graft.

It is difficult to ascertain whether or not the anastomosed vessels are patent in early postoperative period unless a monitoring skin flap was included with the fibular transplant as described by Yoshimura et al (2) and Carr et al (18). In our first two patients, it was not possible to monitor the circulation of the graft in the early postoperative period. But in the third case a skin flap was included with the bone graft to cover the skin defect and this flap was also used as a monitoring flap. Only the observation of its colour was enough to determine if any thrombosis has occurred at the site of anastomosis or not.

Another advantage of the free vascularized fibular graft is that the bone graft may still act as a conventional graft if the microvascular anastomoses fail as stated by Taylor et al (1).

Despite the distinct advantages associated with free vascularized fibular grafting, it requires two surgical teams, experience with microvascular surgical techniques, and a lengthy operation. Although the method is technically difficult and requires a long time in surgery, the early results indicate that satisfactory bony union is achieved in a relatively short period of time and that the transfer of free vascularized fibular graft is very effective in the reconstruction of long bone defects.

TABLE I. Three Patients Reconstructed with Free Vascularized Fibular Graft

CASE	AGE	LOCALIZATION	BONE DEFECT	FOLLOW-UP
1	22	Humerus	10 cm	10 Months
2	20	Tibia (Distal)	12 cm	8 Months
3	21	Tibia (Proximal)	13 cm	6 Months

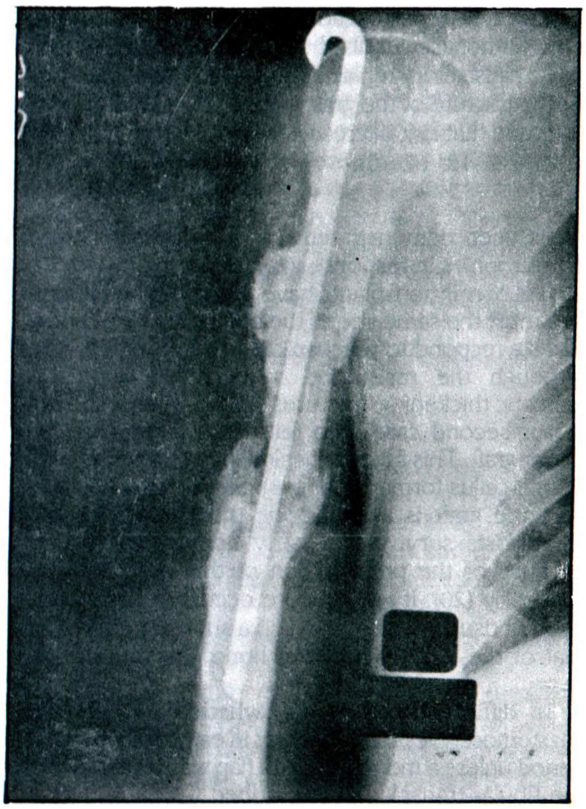

Fig 1. The x-ray of the right humerus, in admission to our department showing the previously transferred avascular bone graft with the nail.

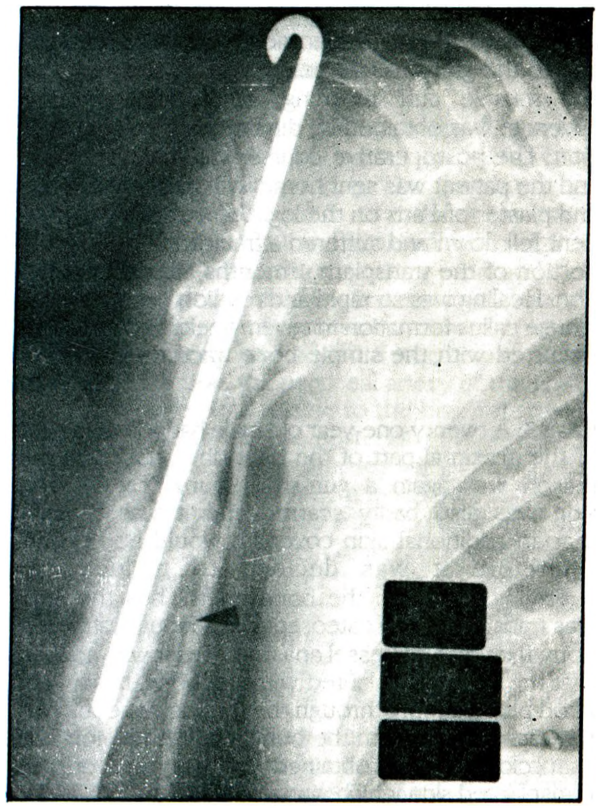

Fig 2. (Case 1) Preoperative angiography.

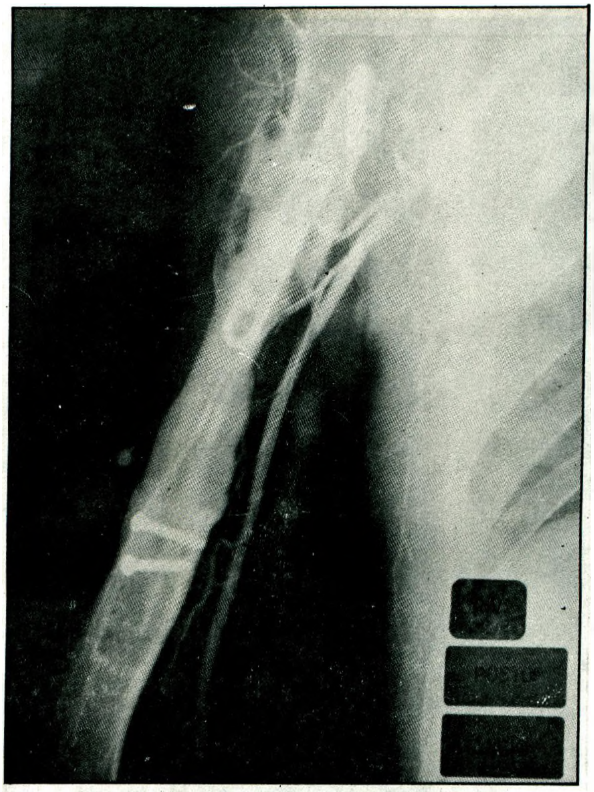

Fig 3. (Case 1) Postoperative Angiography.

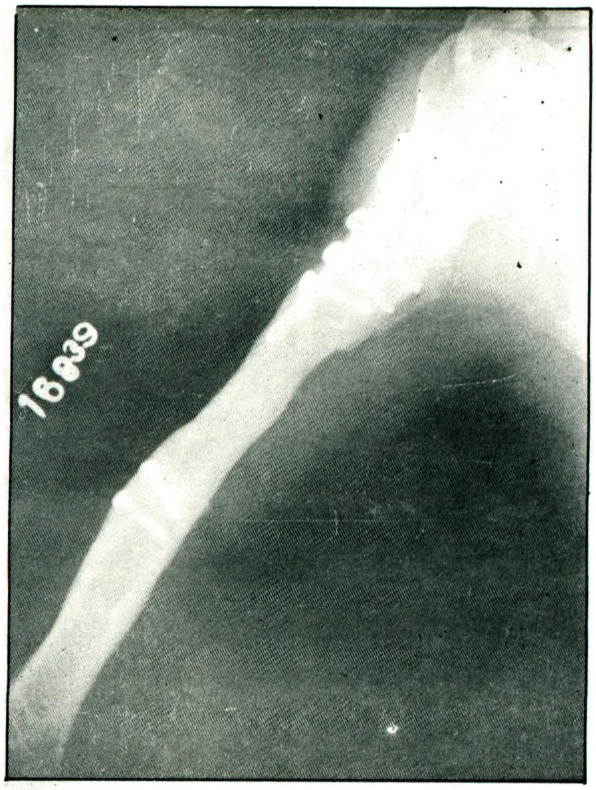

Fig 4. (Case 1) The x-ray of the grafted humerus at the 10th month postoperatively, showing the enlargement of the graft and hardly visible bone junctions.

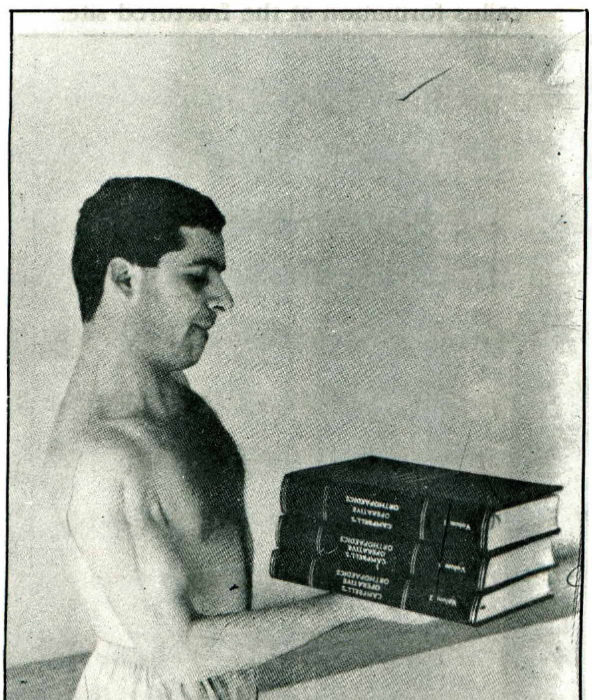

Fig 5. (Case 1) The patient was able to lift three heavy books.

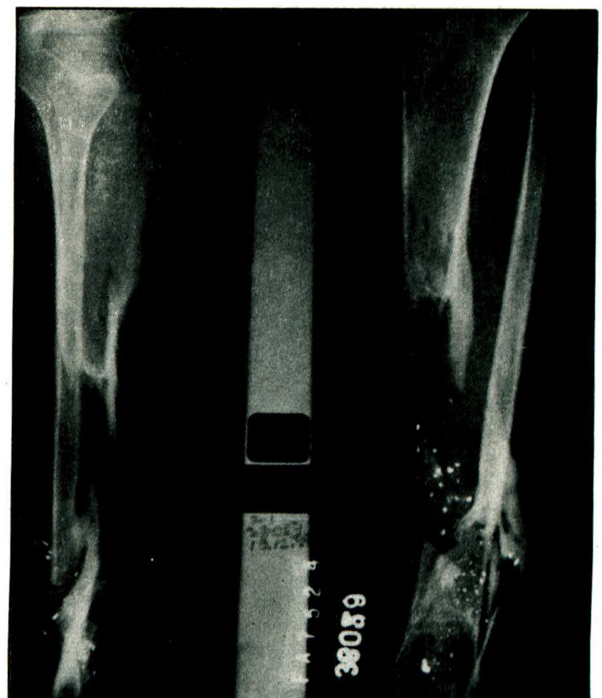

Fig 6. (Case 2) The x-ray of the lower leg showing the 12 cm bone defect in the lower portion of the tibia and the fracture of the fibula.

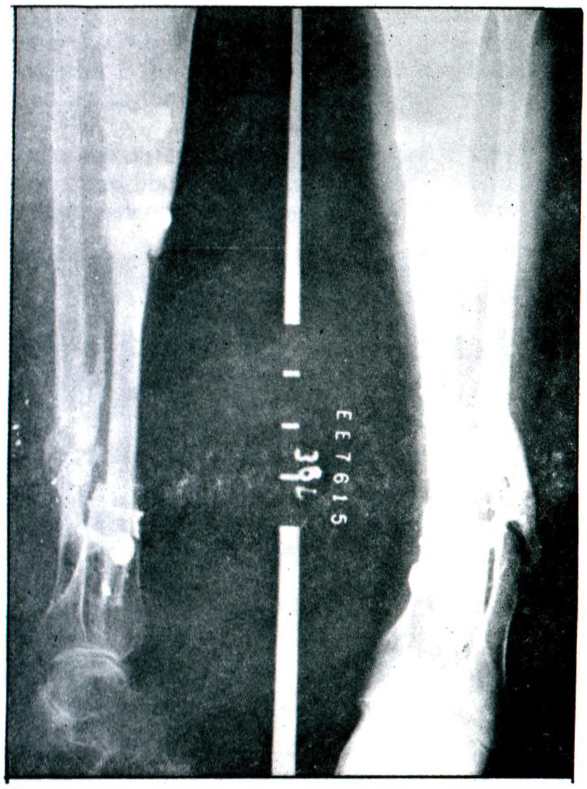

Fig 7. (Case 2) The x-ray of the lower leg showing the bone graft in place, secured with screws and cerclage wiring, in the early postoperative period.

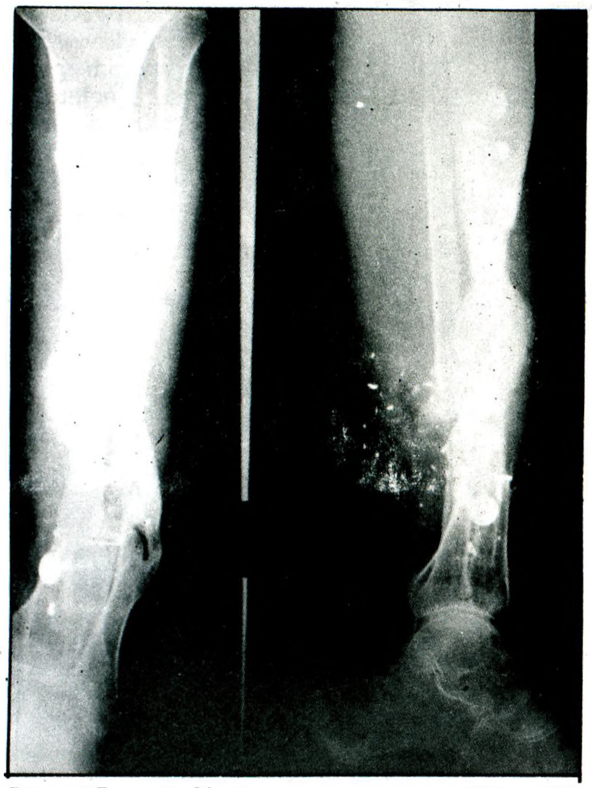

Fig 8. (Case 2) The x-ray was taken at the 6th month postoperatively showing the marked enlargement of the graft and the huge callus formation at the fractured site.

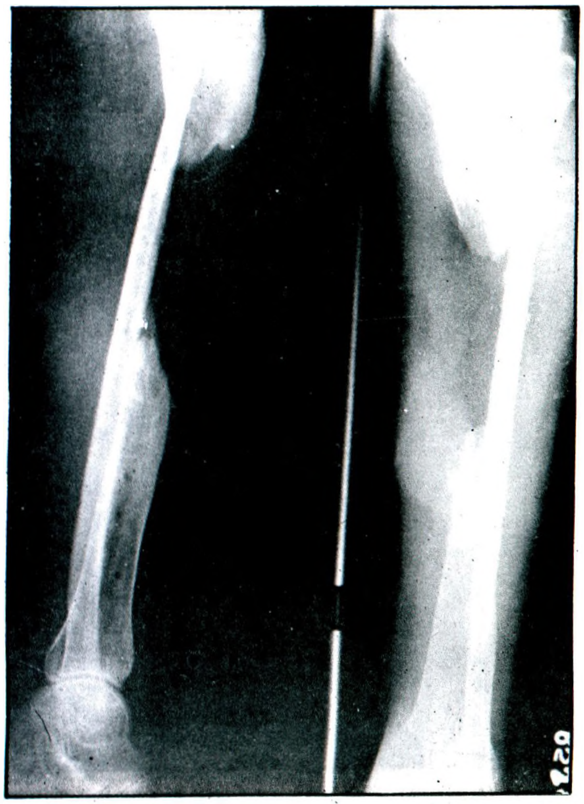

Fig 9. (Case 3) The x-ray of the right lower leg showing the 13 cm bone defect in the proximal portion of the tibia.

Fig 10. (Case 3) Postoperative x-ray showing the fibular graft in place secured with screws in the both proximal and distal junctions.

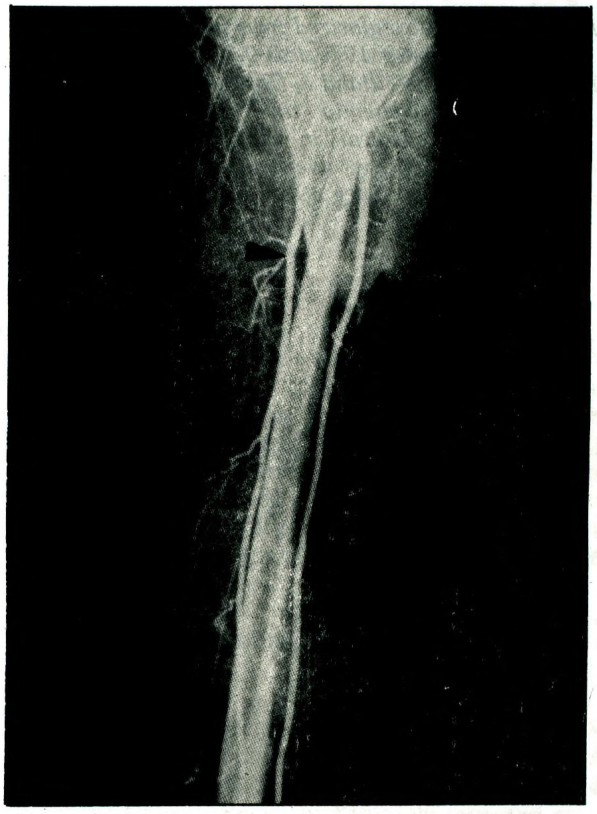

Fig 11. (Case 3) Preoperative angiography.

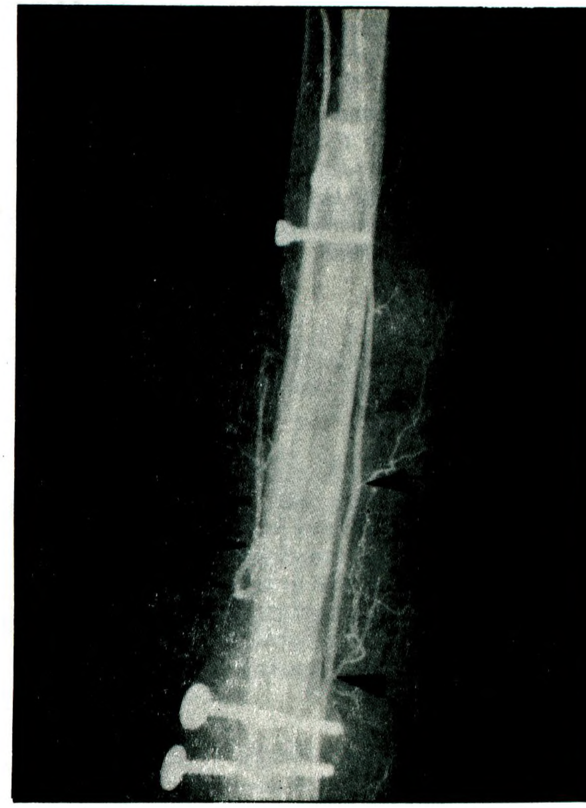

Fig 12. (Case 3) Posteparitve angiography revealing the peroneal vessels of the fibular graft indicating the patent vessel anastomoses.

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