



## Salvage Arthrodesis of the Knee with a Vascularized Fibular Graft

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### Abstract

Failed primary knee arthrodesis or a large skeletal defect around the knee can be difficult to treat. Solitary or double fibular grafts incorporated as part of a free tissue transfer or an ipsilateral pedicled flap rotated proximally about the knee are established techniques. We describe essential surgical refinements of a salvage arthrodesis of the knee with a vascularised ipsilateral fibular graft as part of a limb-saving procedure that expand graft size and graft mobility.

**Keywords:** Vascularized Fibular Graft; Salvage Arthrodesis; Knee

### Introduction

Large skeletal defects around the knee joint may be caused by a traumatic compound fracture, a tumor resection, or osteomyelitis, failed arthroplasty or failed arthrodesis. Various reconstructive techniques, including endoprosthesis, allograft, vascularized or non-vascularized autograft, or a combination of these techniques, have been described as treatment of large skeletal defects around the knee [1,2,3].

Previously, the fibula has been used specifically for knee arthrodesis as an ipsilateral pedicled graft [4-6,2], or as a free transplant from either extremity in a single [2,5,7-9] or a double-strut fashion [10,3]. The use of a vascularized fibular graft that is rotated on its peroneal artery pedicle is technically demanding.

We present four illustrative case histories of patients with a pedicled fibular graft for a salvage arthrodesis of the knee. Refinements of the surgical technique that expand graft size and graft mobility are described.

### Method

#### Surgical technique

**Pre-operative assessment:** Vascular imaging is required to determine if the peroneal artery is expendable. In our patients, we used duplex imaging, as it is simple, efficient and does not expose the patient to radiation.

**Approach:** A lateral approach is used, with the dissection carried between the posterior and lateral compartments of the leg. The fibula is exposed by extraperiosteal dissection. First the peroneal muscle is separated from the anterior aspect of the fibula down to the anterior intramuscular septum, which is also dissected off the fibula. Further elevation of the anterior compartment muscles, including the anterior tibial artery and the deep peroneal nerve, reveals the interosseous membrane.

**Proximal and distal osteotomy:** The distal osteotomy is placed 8 cm to 10 cm proximal to the ankle to preserve the ankle stability. Normally, the fibular head is preserved to maintain the lateral stability of the knee. In these cases, this is no longer needed because an arthrodesis is performed. So, to obtain the maximal length of the graft, the fibula head is taken with the graft after dissecting and protecting the peroneal nerve.

After ligation of the peroneal artery and vein at the distal osteotomy site, the posterior tibial muscle is separated from the fibula, leaving the flexor hallucis longus muscle and the peroneal artery and vein attached to the bone.

**Transfer of the free fibular graft:** The flexor hallucis longus muscle is transected at the distal

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Figure 1: Case 1 Directly Post operative directly.



Figure 2: Case 1 Directly Post operative directly.



Figure 3: Case 1 Four years Post operative.

osteotomy site and the fibula is passed deep to the peroneal muscle and anterior muscle compartment, along the interosseous membrane and is rotated upward lateral to the tibia. The fibula is inserted into the medullary canal of both the distal femur and proximal tibia. The space between the distal femur and proximal tibia is supplemented with cancellous bone.

A uniplanar orthofix dynamic axial fixator was used to stabilize the arthrodesis. This was found suitable as it permits early cyclic movement and subsequent progressive loading thus enhancing union



Figure 4: Case 1 Four years Post operative.

of the opposing ends of the distal femur and proximal tibia as well as incorporation of the vascularized fibula. Fixation was achieved with 6 bi-cortical screws (3 proximal and 3 distal, inserted on each side and when feasible, well away from the endpoints of the fibula graft) upon which the body of the dynamic axial fixator was assembled and mounted under adequate compression. Subsequent dynamization at 3-6 weeks enhanced healing. However, it is important to note that rotational stability may be an important drawback of the uniplanar orthofix dynamic axial fixator and as such the authors recommend that the use of a multiplanar fixator, particularly in the early healing phase, be considered.

**Postoperative care:** Partial weight bearing is allowed after 3 to 6 weeks, thereafter healing is checked by radiographs.

## Case Presentation

### Case 1

A 24-year-old male sustained multiple trauma including an intra articular fracture of the left knee following a road traffic accident. The most feasible option was an arthrodesis of his left knee. Eighteen years later a re-arthrodesis was performed because of malalignment. Nine years later a total knee arthroplasty (MRH Stryker<sup>®</sup>) was performed with reconstruction of the extensor mechanism complicated by skin necrosis and a prosthetic joint infection (PJI). A debridement with antibiotics, irrigation and retention (DAIR) of the knee prosthesis was performed whilst a medial and lateral gastrocnemius flap was used to facilitate wound closure. Due to persistent PJI, the prosthesis was extracted and an arthrodesis was performed with the aid of an external fixator. At that time it was quite clear that fusion is highly unlikely due to severe bone loss. A staged pseudoarthrosis repair was planned upon adequate antibiotic treatment of the underlying infection. After four months a pseudoarthrosis repair was performed with a pedicled ipsilateral fibular graft. The flexor hallucis longus muscle and a skin paddle were taken with the graft to cover the large soft tissue defect. The reconstruction was stabilized by an external fixator. Partial weight bearing started 6 weeks after surgery.

Six weeks after the operation a superficial pin tract infection occurred, which resolved after 4 months when the external fixator was removed. The fibular graft fractured two weeks after removing the external fixator and the leg was stabilized with an above-the-knee cast. After one year a second pseudoarthrosis repair was performed using a fusion nail. Five months after the operation radiographs showed complete fusion of the fracture and full weight bearing was

allowed.

Picture 1-2. Directly post-operative.

Picture 3-4. Four years post-operative.

**Case 2**

A 60-year-old patient with a prosthetic joint infection of his right knee underwent a two-stage revision after a failed DAIR procedure. Six years later a VY quadriceps-plasty and an osteotomy of the tibial tuberosity was performed because of limited range of motion. This was complicated by another infection. A second two-stage revision was performed but failed due to recurrent infection. Due to massive bone loss, an arthrodesis of the knee with an ipsilateral vascularized fibular graft was performed. The reconstruction was stabilized by an external fixator. Partial weight bearing started after 6 weeks and full weight bearing was allowed after 12 weeks. Five months later the patient fell and sustained a traumatic fracture at the junction of the fibular graft with the tibia. This resulted in a pseudarthrosis, which united after external fixation and application of autogenous cancellous bone graft from the iliac crest.

Picture 5-6. Directly post-operative.

Picture 7-8. Two years post-operative.

**Case 3**

A 73-year-old man with osteoarthritis of the right knee underwent a total knee arthroplasty. He had previously suffered several episodes of erysipelas infections of both legs and also a septic arthritis of the right knee. Fourteen months after surgery a hematogenic infection of the prosthesis occurred and the prosthesis was extracted followed by appropriate antibiotic treatment. Because of the recurrent episodes of erysipelas infections a revision arthroplasty was not performed. Instead an arthrodesis was performed using a vascularized fibular bone graft. The reconstruction was stabilized by an external fixator.

Partial weight bearing started three weeks after surgery and full



Figure 7: Case 2 Two year directly Post operative.



Figure 8: Case 2 Two year directly Post Operative.

weight bearing at 3 months.

Three months after the operation a superficial pin tract infection occurred that resolved after removal of the external fixator and oral antibiotics. The leg was stabilized with an above- the- knee cast for an additional 6 weeks.

Five months after the operation radiographs showed complete fusion.

**Case 4**

A 49-year-old man received a total knee arthroplasty due to symptomatic osteoarthritis of the right knee. Two years later, after several recurrent infections, the prosthesis was extracted. Because of the recurrent infections revision arthroplasty was not performed directly. After one year patient received a re-implantation of his prosthesis. Due to infections the prosthesis was removed and in a single session, patient received a hinged prosthesis. One year later, this hinged prosthesis was removed due to another infection, and replaced by an external fixator in order to stabilize the joint for healing. We attempted an arthrodesis of the knee using an arthrodesis rod; however, the patient developed a pseudoarthrosis. In a last attempt to salvage the function of the leg, we performed a re-arthrodesis of the right knee using an ipsilateral vascularized fibular graft. This was eleven years after initial operation. Partial weight bearing started 6 weeks after surgery and full weight bearing at 6 months. Last outpatient clinic visit two years later, radiographs showed complete fusion and full weight bearing is possible.

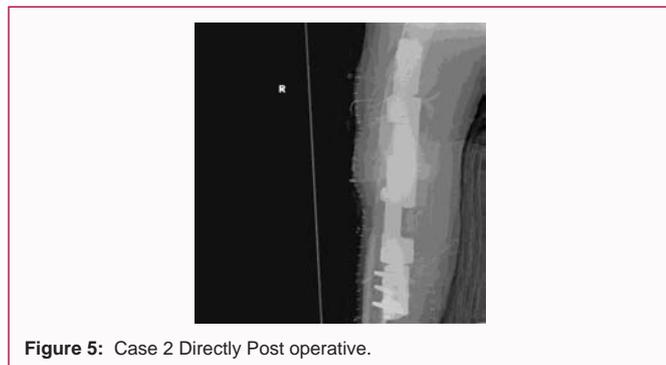


Figure 5: Case 2 Directly Post operative.

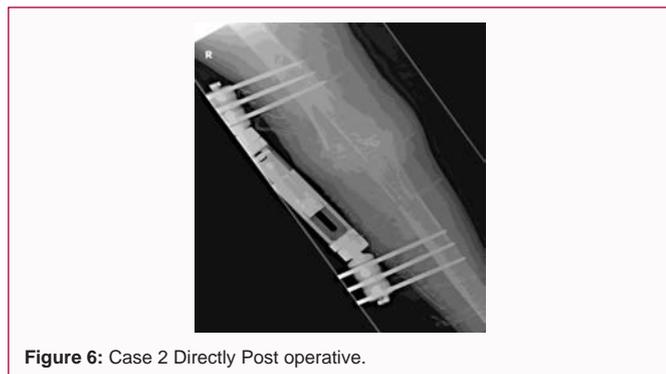


Figure 6: Case 2 Directly Post operative.



Figure 9: Case 4 Intra Post Operative.

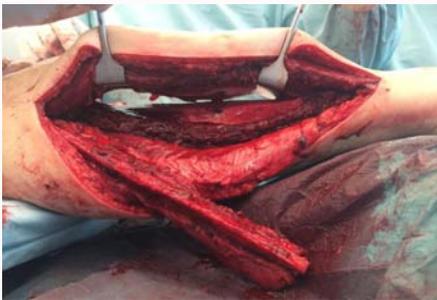


Figure 10: Case 4 Intra Post Operative.

Picture 9-11. Intra-operative.

## Discussion

Large bone defects involving the knee joint can be reconstructed by prosthetic replacement, allograft with joint cartilage, rotation plasty or arthrodesis by allograft or autogenous bone graft.

Reconstruction with a tumour or hinged knee prosthesis, or an articulating allograft provides a painless and stable knee with an adequate range of motion. However the extensor mechanism needs to be intact and there is an increased risk of infection and/or implant loosening. Arthrodesis aided with allografts are susceptible to infection, non-union and stress fractures, which may not unite [11,12].

The vascularized fibular graft has many advantages such as high union rate, early union, possibility of graft hypertrophy, early healing after fracture, higher resistance against infection when compared with other types of reconstruction, and possibility of simultaneously reconstruction of bone and skin defect (osteocutaneous composite graft) [13-17]. Also the number of further revision procedures required after use of a vascularized fibula as a salvage procedure is much less than with other modalities of reconstruction.

The case histories of these patients do illustrate that a pedicled vascularized fibula is a good option in knee arthrodesis and sometimes the only alternative to amputation.

Several studies have reported modifications of this technique [8,6,2,18]. These studies reported mostly very satisfactory results with this technique, when an ipsilateral pedicled fibula is used according to our technique, dissection of recipient vessels and performance of microvascular anastomoses is not needed. Despite the satisfactory results obtained with this technique, most authors also describe

some shortcomings of this technique. The most common problem is the limited range, due to the typical short peroneal vascular pedicle. Raising the fibula flap/graft extended as distal as possible will lengthen the pedicle and optimize the reach. In some cases a free fibula graft will allow more flexibility to the orthopaedic surgeon who can position the fibula exactly as desired. If, for instance, the femoral defect is too large, the pedicled fibula will not reach high enough, and a free fibula graft is called for.

On the basis of our case studies, we recommend some technical modifications when using a pedicled fibular graft for knee arthrodesis.

A modification we use to lengthen the graft is to include the fibular head with the graft. Usually the proximal 4-6 cm of the fibula (including the fibular head) should be retained to preserve knee stability. In arthrodesis there is no need for co-lateral ligament stability, so the fibular head can be included in the graft, aiding adequate length in larger defects, especially on the tibial side.

The second and most important modification is the routing of the flap/graft transfer. Instead of going around the outside of the knee, we use the plane of the interosseous membrane to transfer the fibula to its new position. This means we have to dissect the anterior compartment from both the tibia and fibula. The fibula is then rotated 180 degrees upward in the plane of the interosseous membrane. Obviously, the proximal origin of the anterolateral muscles is left intact. This includes the anterior tibial artery and the peroneal nerve. In this way, function of the anterolateral muscles is preserved. The pedicle of the fibula flap now follows an almost straight line from its origin to its destination, allowing for maximal reach.

When the fibula, including the fibular head is no longer in its original position, the reach of the lateral gastrocnemius muscle is greatly enhanced, aiding its mobilization for the treatment of possible anterior defects in the knee region. This is an additional advantage.

Stabilization of the arthrodesis is of paramount importance. As mentioned earlier, the authors recommend that the use of a multiplanar fixator, particularly in the early healing phase, be considered. Although aided by adequate trauma, suboptimal rotational stability may have contributed to the fracture sustained in case II of our series. Furthermore, no rotational failure was seen in any of our case series, however the number of patients is far too small to draw any conclusions in this regard.

## Conclusion

We believe that an ipsilateral pedicled fibula flap/graft is a good solution for salvage arthrodesis of the knee. The suggested modifications contribute to better use of this technique.

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