CASE REPORT

Is it safe to harvest a proximally fractured fibula as an osseocutaneous anterograde pedicled flap for proximal tibial reconstruction in subacute period? A case report and literature review

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ABSTRACT

Osteoseptocutaneous fibula flap is commonly used as the workhorse flap for bone reconstruction. However, the use of previously fractured fibula as a free or pedicled flap for bone reconstruction has a limited knowledge in the literature. There is not any data in the literature about a case with proximal level of fibula fracture which was used as an anterograde pedicled osteocutaneous fibula flap for composite tibial reconstruction after high-energy injury. Based on a patient in whom the composite defect of the proximal tibial region was reconstructed with osteocutaneous fibula flap after a gunshot injury, it was tried to show that the fibula with a proximal level fracture could be used with anterograde flow in the subacute period and it is thought that the usability of this flap should be kept in mind. It is possible to harvest the pedicled fibula flap even in the subacute period with the evaluation of CT angiography preoperatively and with the checking the patency and flow direction of peroneal artery perioperatively. The success of the procedure may be increased through total dissection of inflammatory areas of pedicle which would extend into the injury zone during the subacute period.

Keywords: Fracture; injury zone; osteocutaneous fibula flap; pedicled; subacute.

INTRODUCTION

The osteoseptocutaneous fibula flap is commonly used in bone reconstructions. Taylor et al.[1] described the free fibula flap in 1975. Chen et al.[2] applied the use of the anterograde pedicled fibula flap for femur reconstruction. Minami et al.[3] used retrograde pedicled fibula flap for distal tibial reconstruction. However, there are no data regarding the use of a previously fractured fibula as an osteocutaneous flap for proximal tibial reconstruction.

The aim of this study was to present the use of an anterograde pedicled osteoseptocutaneous fibula flap, in which there was a previously broken fibula for the reconstruction of the osseocutaneous tibial defect due to high-energy injury in subacute period.

CASE REPORT

A 41-year-old male patient who had both tibial and fibular fractures proximally in his right lower extremity due to a gunshot injury wound 3 weeks previously was evaluated. The patient did not have any comorbidity or drug use, but he was a smoker. On the day of the injury, orthopedic surgeons have accomplished an operation for reduction with external fixator (Fig. 1). On physical examination, there was an ap-

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pearance of non-viable soft tissue, of 14×4.5 cm, around the entrance wound in the proximal tibial area. When the lower extremities were compared that there was no difference in heat and color, and the capillary refill time was 2s and equal in both limbs. In the injured leg, both the dorsalis pedis and tibialis posterior arteries were palpable. On radiography, there were multiple fragmentary fractures in the proximal third of the tibia and a horizontal fracture across the proximal third of the fibula. All major arterial structures were reported to be patent on computed tomography (CT) angiography (Fig. 1). The wound was evaluated and classified as Gustilo-Anderson Type 2, Oestern-Tscherne Grade 3, and AO (Arbeits-gemeinschaft für Osteosynthesefragen) Type 42. The patient was considered for reconstructive surgery. Due to patency in all three arteries, it was thought that an ipsilateral anterograde pedicled osteocutaneous fibula flap would be a good option for the treatment of the tibial composite defect. The patient was informed in detail about the surgery, and permission was obtained for the procedure with an informed consent form.

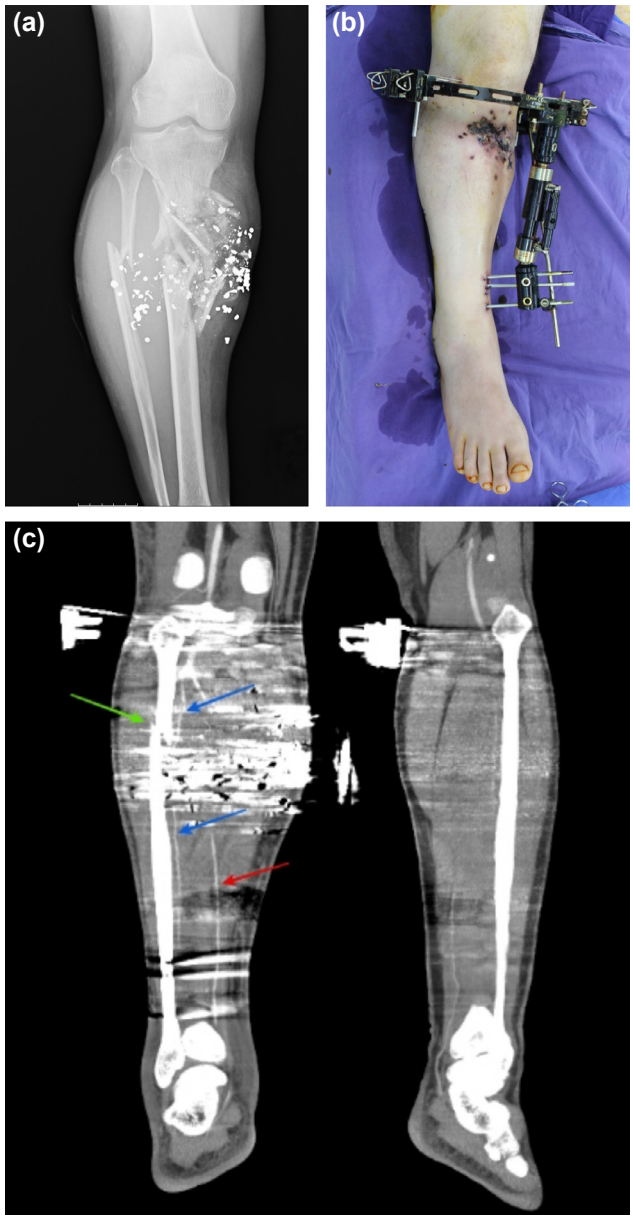

Figure 1. Anteroposterior X-ray view of the proximal cruris before the first operation. It is seen that there is one horizontal fracture in the proximal fibula and a butterfly fracture in the proximal tibia as a result of a high-energy gunshot injury. **(a)** After the external fixator application, the appearance of the cruris is shown. There is near total necrosis of the region close to the tibial plateau due to entrance wounds caused by shotgun pellets. **(b)** The evaluation of the wounded lower extremity in computed tomography angiography preoperatively. The fibula fracture line (green arrow), the sight of the filling of contrast material of the posterior tibial artery (red arrow) and both proximal and distal parts of the peroneal artery (blue arrows) are seen **(c)**.

Under general anesthesia, a radical debridement was performed for both tibial fragments and necrotic soft tissues in the proximal part of the tibia on the 21st day after trauma. Beyond the measurements of the soft-tissue defect, a cutaneous flap sized 5×15 cm was designed and marked on the planned flap after checking the perforator arteries with handheld Doppler ultrasonography (Huntleigh Healthcare Limited, 35 Portmanmoor Road, Cardiff, CF24 5HN, UK). After the application of an Esmarch bandage and tourniquet, an incision was made to harvest the fibula flap using an anterior approach. After the perforator vessels were identified and protected, the peroneus longus muscle was dissected, leaving a small part of muscle tissue on the anterior surface of the fibula. The same procedure was performed for the posterior surface of the fibula by dissecting the soleus muscle using a posterior approach. The osteotomy was executed at the point of the distal part of the fibula, leaving a 6 cm distal fibular section in situ. The length of the vascularized fibular bone graft was 15 cm. After reaching the fracture line at the proximal level, a bone segment about 1 cm in length, which was previously intact, was removed from the distal end of the intact segment of the proximal fibula to dissect the pedicle more easily and to prevent trauma to it. A capsule with a fibrotic appearance was observed on the peroneal pedicle, adjacent to the fracture line. At this level, total dissection of the capsule with pedicle was preferred (Fig. 2). The perforator branches of the peroneal

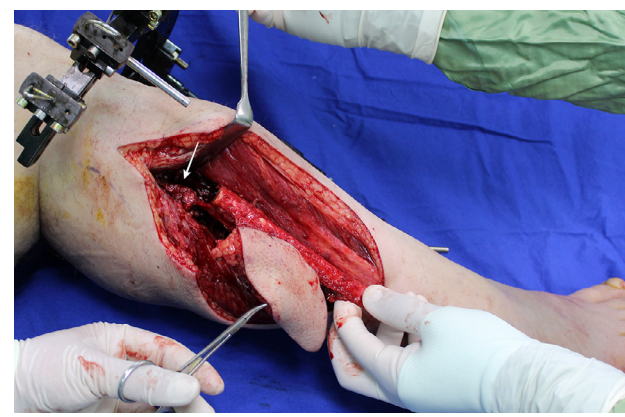

Figure 2. A capsule with a fibrotic appearance (white arrow) was observed on the peroneal pedicle, adjacent to the fracture line. At this level, total dissection of the capsule with pedicle was preferred.

artery were sacrificed, with the exception of the perforators that feed the osteoseptocutaneous flap. A tunnel was created between the defect and flap, through the posterior surface of the lateral compartment muscles. The tourniquet was deflated while keeping the flap in its anatomical position. The viability of the flap and pulse in the distal pedicle were observed. Patency of the distal portion of the peroneal artery and the direction of flow were also checked, before sacrificing the pedicle.

Both soft tissue and osseous tissue parts of the flap were adapted to the defect, after performing a midline horizontal osteotomy of the fibula to make a "double barrel"-shaped reconstruction of the tibia. The aim was to achieve cortical continuity through adapting the fibula to the tibia. Good contact and fixation between the tibia and the fibular insert were achieved by compression through shortening the vertical length of the external fixator. The flap donor site was repaired with split-thickness skin graft and drains were placed. Dressings for flap and donor site were applied and a window was left in the skin island for flap monitoring. The operation time was about 5 h from beginning to end.

After early wound healing, the patient was followed up monthly. Bone healing was monitored by radiogram and progressed satisfactorily. The external fixator was removed at the third post-operative month. Internal fixation was executed with an incisional approach from the medial border of the skin island of the fibula flap in medial and vertical directions. There was no circulatory disturbance in the flap, detachment at incision lines or infection at any time during the procedures, and a complete recovery was achieved. The lower extremity which was reconstructed was measured 3 cm shorter than the contralateral side (Fig. 3). After the first operation, the patient started to walk with the help of a walker 5 months later and started to walk without any support 7 months later.

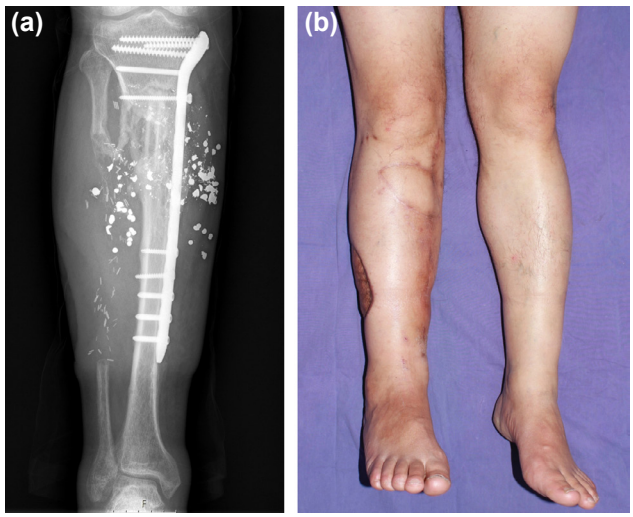

Figure 3. Six months after "double-barrel" repair with an anterograde pedicled osteoseptocutaneous fibula flap and 2 months after removal of fixator and repair with internal fixation. **(a)** The appearance of the wound and repair at 8 months postoperatively **(b)**.

Table I. Publications reporting the use of previously fractured fibula flaps for reconstruction of related anatomic fields

Author	Recipient site	Style	Timing (after fracture)	Fracture zone of fibula	Healed fracture zone with flap	Patient			
						Age	Comorbidity	Gustillo Anderson Classification	Timing to walk
Kim	IL Tibia	Pedicled	3 months	P	–	20	–	3B	16 months
Sharma	CL Tibia	Free	Not reported	D	–	43	–	3	6 m
Gören	IL Tibia	Pedicled	Days	P+D	–	33	–	3B	2 years
Jones	CL Tibia	Free	8 months	P	–	17	–	3B	2 years
Sadek	CL Tibia	Free	8 months	not known	+	22	Multitrauma	3C	20 months
Chan- Wei	Mandibula	Free	10 years	D	+	41	SCC	Not applicable	

IL: Ipsilateral; CL: Contralateral; P: Proximal; D: Distal; SCC: Squamous cell carcinoma.

DISCUSSION

Autogenous bone grafting, Ilizarov external fixators,[4] allografts[5] or endoprostheses,[6] and their combinations are used for the repair of major bone defects. Reconstructions with vascularized bone grafts provide more realistic and rapid bone healing compared to conventional grafts.[7] Osseous fibular flaps are the workhorse flaps for bone reconstruction.[7]

A fibula flap can be used as an one-piece bone flap in tibial reconstruction with classical application[8] and a "double barrel" appearance can be achieved by performing osteotomies. Thus, it provides a larger bone surface, increasing osseous contact surface area to be reconstructed, and more osseous strength that will potentially bear more load after healing. When the fibula flap is harvested and transferred with its epiphyseal component, it continues to grow in the new position.[9] In the reconstruction of complex defects, a fibula flap can be harvested with skin island or partial muscle flaps, fed by a common origin.[10]

The use of previously fractured fibula as a free or pedicled flap for bone reconstruction has rarely been reported. This surgery was performed by Kim[11] and Goren[8] using pedicled flaps. Similarly, Sharma,[12] Grewal,[13] Sadek,[14] and Chan[15] used previously fractured fibula flaps as free flaps and reported good results (Table 1). Although use of pedicled fibula is not recommended in tibial reconstructions[16] as it may cause structural support loss, there are many reports, in which this option was chosen.[17,18] The studies of Kim and Goren both reported good results using fibula flaps with proximal fractures. The difference in this case is that the timing of surgery was important, and occurring in the subacute period.

Many authors prefer the use of the fibula in the reconstruction of massive segmental bone defects. It causes minimal donor site morbidity and has remarkable advantages, both anatomically and biomechanically makes the fibula flap valuable.[19] As reported in some case series, combinations of the vascularized fibular flap and the Ilizarov technique can also give good results in injuries with bone defects,[20] but good soft-tissue coverage is required for this to be applied. In the presented case, an ipsilateral, anterograde, pedicled, and osteocutaneous fibula flap was used for the reconstruction of a tibial composite tissue defect. The osseous part of this composite flap was shaped and placed into the defect as a double-barrel reconstruction. Care was taken to ensure the continuity of the cortical bone and compression was applied with the existing external fixator. Not only does the skin island of the flap facilitate soft-tissue reconstruction but it also makes monitoring of the flap possible. The viability of the flap was seen to be good during regular post-operative follow-up. Bone healing was monitored by radiogram which showed signs of healing in the bone ends at 4 months postoperatively. After removal of the external fixator and internal fixation with a plate system, the patient started to walk 8 months after the injury and became able to carry out normal daily tasks.

The blood supply to the fibula is from both the nutrient artery from the peroneal artery and periosteally. It has been shown that the nutrient artery of the fibula is usually a single artery and its entrance is mostly in the proximal half of the fibula.[15] However, it was shown that distal tibial reconstruction was possible with retrograde osteocutaneous flaps with proximal level fibular bone component.[21] In the presented case, a fibrotic and granular soft-tissue thickening around the peroneal vascular bundle was evident, adjacent to the injury site. It was thought that the irregularity around the bundle derived from an organized hematoma and later inflammation. This structure with irregularity was dissected as a whole together with the pedicle. The flap harvesting was continued, as the vascular pedicle in proximal part of the fracture line returned to a normal anatomic appearance. In addition, there was no loss of patency, nor blood flow direction abnormality, in either the proximal or distal regions of the peroneal artery.

Conclusion

There is no previous report of a case with a proximal level fibula fracture which was then used as an anterograde pedicled osteocutaneous fibula flap for composite tibial reconstruction after high-energy injury in subacute period. This report highlights the possible utility of this type of flap despite, although the pedicle being in the injury zone. Careful pre-operative radiological examination and perioperative microvascular evaluation are important and timing of the reconstruction may also affect the outcome.

Informed Consent: Written informed consent was obtained from the patient for the publication of the case report and the accompanying images.

Peer-review: Internally peer-reviewed.

Authorship Contributions: Concept: E.K.Y.; Design: E.K.Y., M.Ş.A.; Supervision: M.Ş.A., K.M.; Resource: C.Y.; Materials: C.Y.; Data: C.İ.D., C.Y.; Analysis: K.M., C.Y.; Literature search: E.K.Y., C.İ.D.; Writing: E.K.Y., C.İ.D.; Critical revision: M.Ş.A., K.M.

Conflict of Interest: None declared.

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OLGU SUNUMU - *ÖZ*

Proksimal tibia rekonstrüksiyonu için proksimal seviye kırıklı fibulanın osseokutanöz anterograd pediküllü olarak kullanımı güvenli midir? Olgu sunumu ve literatür tarama

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Osteoseptokutanöz fibula flebi, kemik rekonstrüksiyonu için en değerli ve en yaygın kullanılan fleptir. Ancak daha önce kırılmış fibulanın kemik rekonstrüksiyonu için serbest veya pediküllü flep olarak kullanımı literatürde sınırlı bilgiye sahiptir. Literatürde, yüksek enerjili yaralanma sonrası kompozit tibial rekonstrüksiyon için anterograd pediküllü osteokutanöz fibula flebi olarak kullanılan proksimal düzeyli kırıklı fibula kemiği olan bir olgu hakkında veri bulunmamaktadır. Ateşli silah yaralanması sonrası proksimal tibial bölgenin kompozit defektinin osteokutanöz fibula flebi ile rekonstrükte edildiği bir hastada, proksimal seviyede kırığı olan fibulanın subakut dönemde anterograd akım ile pediküllü bir şekilde kullanılabileceği gösterilmiştir ve bu flebin kullanımının akılda tutulması gerektiği düşünülmektedir. Travma geçirmiş fibula kemiği içerikli fibula flebi için, ameliyat öncesi BT anjiyografinin değerlendirilmesi ve perioperatif peroneal arterin açıklığının ve akım yönünün teyit edilmesi sayesinde, bu flep subakut dönemde dahi kullanılabilir. Subakut dönemde yaralanma bölgesine giren peroneal pedikül etrafında mevcut olabilecek enflamatuar alanlarının total diseksiyonu ile işlemin başarısı artırılabilir.

Anahtar sözcükler: Kırık; osteokutanöz fibula flebi; pediküllü; subakut dönem; yaralanma alanı.

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