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Perforator-based propeller flaps for leg reconstruction in pediatric patients

Burhan Özalp*, Mustafa Aydınol

Division of Plastic and Aesthetic Surgery, Dicle University, Diyarbakır, Turkey

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Summary *Background:* Perforator-based propeller flaps provide adequate soft tissue coverage for leg reconstruction. The aim of this study was to assess the versatility and reliability of the use of propeller flaps for leg reconstruction in pediatric patients.
Method: Seven male pediatric patients ranging in age from 2 to 13 years with a mean age of 6.7 underwent perforator-based propeller flap surgery over a four-year period. The defects resulted from burn injuries ($n = 4$) and traffic accidents ($n = 3$). The injuries were located on the ankles of four patients and on the knee, anterior lower tibia, and foot dorsum of the other three patients, respectively.
Results: The flap sizes ranged from 5 × 3 to 10 × 6 cm with a mean flap size of 7.6 × 4.3 cm. Flap harvesting time ranged from 38 to 56 m with a mean of 46 m. The rotation degree range of the flaps was from 90° to 180°. The propeller flaps were based on the posterior tibial artery ($n = 4$), anterior tibial artery ($n = 2$), and the descending branch of the lateral circumflex femoral artery ($n = 1$). All flaps survived completely without surgical complication; however, one patient developed disseminated intravascular coagulation syndrome two days post-surgery and died within four days.
Conclusion: Perforator-based propeller flap reconstruction is a safe, reliable, and versatile method for lower extremities in pediatric patients; however, it requires meticulous surgical dissection and extreme patience during the surgical procedure.

Introduction

Reconstruction of lower limb soft tissue defects, including exposed bone, tendon, or neurovascular structure, is a challenging procedure. Free flaps had been the gold standard of treatment until perforator flaps were devised because random pattern local flaps of the leg are unreliable and unsafe for covering large size defects.[1,2]

* Corresponding author. Acil ve Travmatoloji Hastanesi, Dicle Üniversitesi Tıp Fakültesi, Diyarbakır, Turkey. Fax: +90 412 248 85 23.
E-mail address: burhanozalp@hotmail.com (B. Özalp).

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When free flaps are compared to perforator-based propeller flaps in leg reconstruction, the latter exhibit some definite advantages. Free flap surgery requires a microsurgical technique, recipient vessels, and an extended surgery time, whereas the propeller flap procedure is easier to perform, requires less surgery time, spares major vessels, and can be performed without microsurgical anastomosis. In terms of flap tissue features, there are skin texture and color differences between the flap and the recipient area and a degree of donor site morbidity occurs with the use of free flaps, but propeller flaps cause less donor site morbidity and provide excellent skin texture and color harmony with the recipient area.[3]

Bekara et al. published their review of the literature from 1991 to 2014 regarding perforator-based propeller flaps.[4] They analyzed 40 articles about perforator flaps to identify risk factors for flap survival. Despite that the review presents comprehensive and factual knowledge about perforator flaps, there is a lack of data for pediatric patients. The authors concluded that age, older than 60 years, is a risk factor affecting the success of the propeller flap surgery, but they made no statement about this in relation to the pediatric age group.[4]

There are many articles about propeller flaps in lower extremity reconstruction; however, most are related to adult patients. The literature search for this study did not reveal any studies that focused on propeller flap surgery of the lower extremities in pediatric patients. However, there are some limited data in the articles that indicate that the authors had performed propeller flap surgery in pediatric patients, but most of the articles reported this information for giving information the age of pediatric patients. It was observed that there is a lack of knowledge and published literature about the results of propeller flap surgery performed on pediatric patients.

The aim of this report is to present the results of surgical procedures of soft tissue reconstruction of the lower extremities using propeller flap surgery in pediatric patients to determine whether youth is a risk factor, as old age is, for perforator-based propeller flap survival.

Patients and methods

A retrospective study was conducted of seven pediatric patients operated on from March 2012 to September 2015 for the reconstruction of soft tissue defects of the lower extremity using the perforator-based propeller flap procedure. The unique exclusion criterion was an age that did exceed 15 years. All the patients were males ranging in age from 2 to 13 years with a mean age of 6.7.

The defects resulted from acute burn injuries ($n = 4$, 57%) and traffic accidents ($n = 3$, 43%). The location of the defects was the peri-ankle region in four patients (57%); the knee, the lower anterior tibia, and the foot dorsum in one each of the other three patients (14% each). There were bone fractures in two patients due to traffic accidents; one was an open tibial fracture within tendon exposition, and the other was an open malleolus fracture. The five remaining patients had exposed bone, tendon or joints.

Debridement and/or negative pressure wound care were applied to prepare the wound for definitive surgery in four patients. One patient (Case 1) was accepted from another hospital where a split thickness skin graft (STSG) had been taken from the anterior thigh where the perforator flap was raised.

Surgical technique

A handheld Doppler ultrasound was used to determine perforators. A minimum of two or three possible perforators near the defect area were marked preoperatively and propeller flap borderlines were designed based on the perforators. The length and width of the part of the flap required to cover the defect side were determined to be 1 cm more than the defect dimension that would be reconstructed.

All the patients were operated on under general anesthesia. The leg was raised, the vessels were evacuated with a hand pat, and a tourniquet was inflated. Esmarch bandages were not used to make it easier to identify small perforators filled with blood. We raised the flap proximal to the distal direction in the subfascial plane. We stitched fascia to the skin to prevent shearing forces and impairment of fascial blood circulation. When the dissection was closed to the marked perforators at about 5 mm, we included a piece of surrounding muscle and fascia with perforator vessels. We did not skeletonize the perforator to prevent iatrogenic injury. The flap was based on two perforators if both of them were close to each other. If the defect area was too large, the flap was turned over the exposed anatomical structures such as bone, tendon, or joint, and the remaining defect area was resurfaced with a STSG. The flap was fixed to the recipient area with separated stitches, and a surgical drain was not placed under the flap. The lower extremity was stabilized for two weeks with a splint.

A number of photos taken of the cases are presented in Figures 1 through 3.

Case examples

Case 1

A two-year-old boy was admitted from another hospital 19 days after a burn injury. The patient suffered from a second-degree hot liquid burn on the right leg which affected more than 6% of the total body surface. He had been treated in a hospital, and debridement had been followed by a STSG. In follow-up controls, the knee joint had been exposed, and the patient was referred to our hospital.

We observed that the right knee joint was exposed, there was a soft tissue defect 8 × 4 cm in size, and joint fluid was leaking spontaneously on the lateral side of the joint (Figure 1a, 1b). The remainder of the physical examination was unremarkable, and the patient was scheduled for propeller flap surgery.

A perforator-based propeller flap from the anterior lateral thigh region was planned for soft tissue reconstruction. The lateral circumflex femoral artery (LCFA) is the main source of the arterial supply to the anterolateral thigh region. It branches from the profunda femoris artery and divides into ascending, descending, and transverse