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Technical note

Minimally invasive harvesting of nonvascularized fibular graft in children

G. Lucas[a,b], J. Lopez[a,b], B. Fraisse[a,b], S. Marleix[a,b], P. Violas[a,*,b]

[a] Service de chirurgie pédiatrique, CHU de Rennes, 35033 Rennes, France
[b] Faculté de médecine, université Rennes 1, 35043 Rennes, France

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ABSTRACT

Using a nonvascularized fibular graft is part of the therapeutic arsenal for filling bone loss defects. It is conventionally performed by open surgery. The authors propose a minimally invasive technique for harvesting a free fibular graft. The fibula was removed subperiosteally by two or three small incisions in five patients with a mean age of nine years and nine months. The mean surgical time was 21 min and 40.5% of the length of the fibula was harvested. At the donor site, we found no removal-related complications, regeneration of the fibula was observed in 80% of cases, and the cosmetic result was considered excellent by all patients with a mean 4.3 years follow-up. This minimally invasive technique is simple and fast, with very low morbidity in our experience.

1. Introduction

The nonvascularized autologous bone graft has been used for more than 100 years, most particularly for reconstruction after resection of bone tumors [1], with the first use of a fibular graft described by Walter in 1911 [2]. The vascularized fibular grafting technique appeared in 1975 [3]. Using a nonvascularized fibular graft can provide an autograft for a variety of reconstruction surgeries [1,4,5]. Classically, nonvascularized fibula has been harvested via a large lateral approach of the leg. Herein we propose a minimally invasive technique.

2. Technique

Bone was harvested surgically on patients in the supine position with a pillow under the buttocks, with a tourniquet cuff in place. The site planned for the osteotomy (Fig. 1a) was at least 8 cm from the distal fibula (Fig. 1b) so as not to risk destabilizing the ankle. The proximal end of the fibula was at least 6 cm from the site to remain sufficiently distant from the fibular nerve (Fig. 1c). Two or three 2- to 3-cm incisions were required depending on the length of graft material needed, at least 10 cm apart (Fig. 1d). The fibular diaphysis approach was used after opening the crural fascia and identifying the space between the soleus and fibular muscles, followed by an incision of the periosteum and step-by-step subperiosteal detachment performed cautiously on each of the fibula surfaces using a spatula (Fig. 2a). Then the osteotomy was performed proximally and distally using an oscillating saw (Fig. 2b). The graft was grasped with clamps (Fig. 2c), then the graft was mobilized on its axis by rotating it, allowing the periosteum to be completely detached and the bone graft extracted (Fig. 2d). Postoperatively, crutches were prescribed with partial weight-bearing allowed as well as daily physical therapy with passive and active mobilization of the toes to prevent muscle and tendon retractions.

3. Preliminary series

Six nonvascularized fibula samples per minimally invasive approach were harvested between 2001 and 2012. One patient was excluded because her growth cartilages were closed. This series included five patients (three girls and two boys), with a mean age of nine years and nine months (range, 3–14 years). The indications were the following: two pelvic Ewing sarcomas, one ballistic injury to the proximal tibia (Fig. 3), one epiphysiodesis of the femoral neck in a case of epiphysiolysis, and one anterior vertebral bone graft (Pott's cervicothoracic abscess with kyphosis). The mean follow-up was 4.3 years (range, 1.3–10.5 years). The mean length of the grafts was 12.4 cm (range, 5–21 cm), a mean 40.5% (range, 27–60) of the total length of the fibula. The mean duration of harvesting was 21 min (range, 17–30 min). No complications related to bone harvesting or surgical problems were noted. The esthetic aspect was deemed excellent by all the patients. No valgus ankle deformity or superior or inferior tibiofibular instability was recorded,

* Corresponding author. Service de chirurgie pédiatrique, CHU de Rennes, 35033 Rennes, France. Tel.: +29 9284 321.
E-mail address: philippe.violas@chu-rennes.fr (P. Violas).

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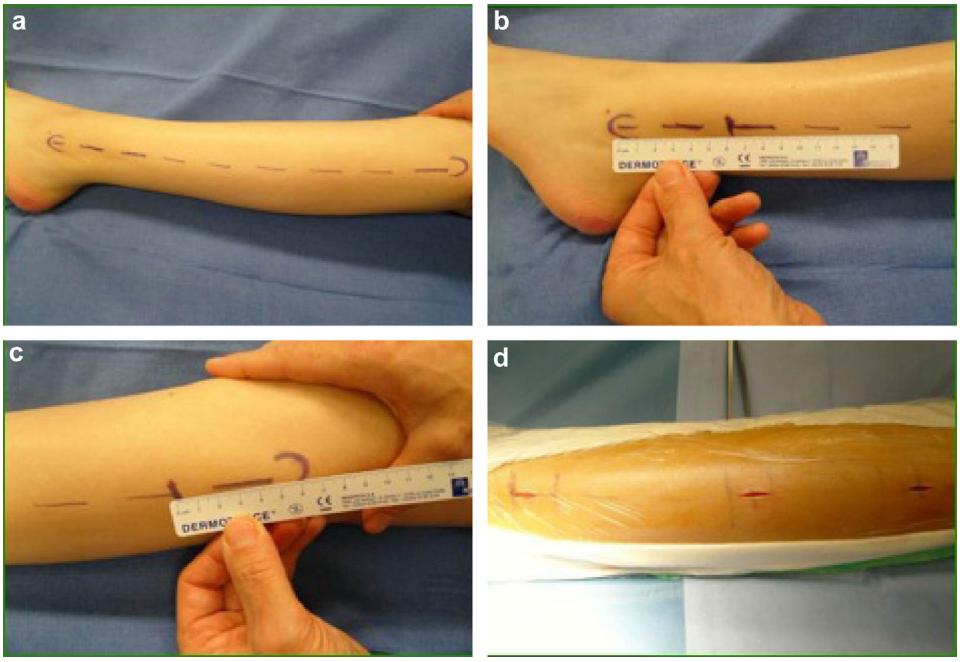

Fig. 1. 1a–c: identification of proximal and distal osteotomy areas; d: 2- to 3-cm incisions at least 10 cm apart.

including in one patient presenting 4.5 mm ascension of the lateral malleolus. In four cases (80%), donor site regeneration was complete, within a mean five months (range, 1.5–8 months) (Fig. 4). In one case, regeneration occurred along the entire length of the fibula in 22 months but with nonunion at the proximal extremity, with the distal extremity achieving bone union after three years. At the last follow-up, in three cases, the width of the newly formed fibula was greater than it had been initially. The small number of patients examined in the study made it impossible to demonstrate a significant relation between the quality of fibular regeneration and patient age.

4. Discussion

The minimally invasive harvesting of nonvascularized fibula is a simple and rapid technique and appears to have very low morbidity. After bone harvest, complete regeneration was obtained in 80% of the cases, with one case evolving toward nonunion. In the literature, after open nonvascularized bone harvesting, Bettin et al. [6] found 49% complete regeneration in 8–16 months, with age seeming to be the only factor predicting regeneration. Setting the age limit at 15 years, prediction of regeneration reached 96% sensitivity and 74% specificity. Krieg et al. [1] found 69% complete

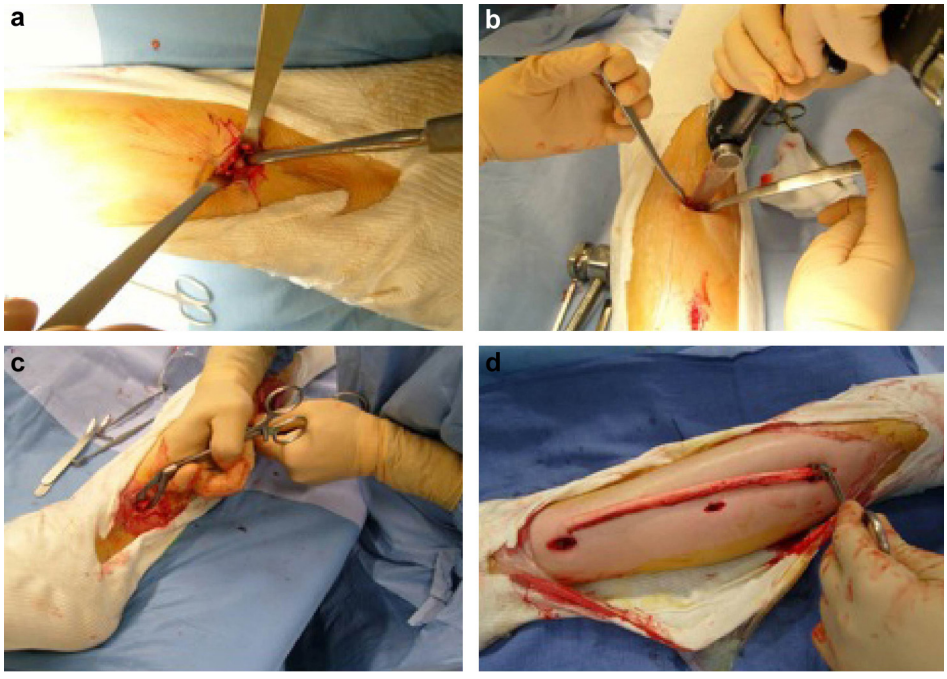

Fig. 2. a: detachment of the periosteum; b: osteotomy with the oscillating saw; c: rotational movement with a clamp to complete periosteum detachment; d: graft extraction.