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ORIGINAL ARTICLE

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Postoperative analysis of a free fibular graft due to bone failure caused by a metatarsal bone tumor

Análise pós-operatória de enxerto livre de fíbula por falha óssea causado por tumor em ossos do metatarso

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ABSTRACT

Objective: To evaluate the postoperative clinical outcomes of patients undergoing fibular grafting due to bone loss caused by metatarsal tumors.
Methods: This retrospective cross-sectional study was conducted between January 2010 and December 2018 with three patients who were treated with a free fibular graft after bone loss due to metatarsal tumor resection. The patients underwent surgery with a dorsal longitudinal incision over the tumor lesion for subsequent tumor resection. The fibular graft was harvested from the distal third of the ipsilateral leg. The graft was fixed using Kirschner wires and a mini-fragment plate and cortical screws. An analysis of the patients' ages, sex, tumor types, need for adjuvant or neoadjuvant therapy and postoperative complications was conducted.
Results: All three patients who were subjected to fibular grafting for metatarsal replacement were female (100%), with a mean age of 10.3 years (± 0.61). The type of tumor found in the three patients (100%) was an aneurysmal cyst, and only the affected metatarsal showed changes. None of the patients required adjuvant or neoadjuvant therapy. Regarding the postoperative complications, two patients (66.6%) presented pseudoarthrosis, and one did not present any complications.
Conclusion: Free fibular grafting is a viable option for the treatment of bone loss caused by metatarsal tumors.
Level of Evidence IV, Therapeutic Studies; Case Series.

Keywords: Foot deformities, Bone tumor, Pseudoarthrosis.

RESUMO

Objetivo: Avaliar desfechos clínicos pós-operatórios de método cirúrgico em pacientes submetidos à enxertia de fíbula por perda óssea, gerada por tumores metatarsianos.
Métodos: Trata-se de estudo transversal retrospectivo, realizado entre janeiro de 2010 e dezembro de 2018, com total de 3 pacientes submetidos a enxerto livre de fíbula após perda óssea por ressecção tumoral metatarsiana. Os pacientes foram operados com acesso longitudinal dorsal sobre a lesão tumoral, para posterior ressecção da mesma. O enxerto fibular foi retirado da perna ipsilateral no terço distal. A fixação da enxertia ocorreu tanto por fio de Kirschner quanto por placa mini micro fragmentos, somada a parafusos corticais. Os pacientes foram analisados quanto à idade, sexo, tipo de tumor, necessidade de adjuvância ou neoadjuvância e complicações pós-operatórias.
Resultados: Do total de 3 pacientes submetidos à enxertia de fíbula para substituição metatarsal, todos eram do sexo feminino (100%), com uma média de idade de 10,3 anos (± 0,61). O tipo de tumor encontrado nas 3 pacientes (100%) foi cisto aneurismático, apresentando mudança apenas no metatarso acometido. Na avaliação da necessidade de adjuvância e neoadjuvância, em nenhum dos casos estudado apontou esta necessidade. Em se tratando de complicações pós-operatórias, duas pacientes (66,6%) apresentaram pseudoartrose e em uma não ocorreu complicação.

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Conclusão: A realização da enxertia livre de fíbula torna-se uma opção possível na gama de tratamentos para casos de perda óssea gerada por tumor metatarsiano.
Nível de Evidência IV; Estudos Terapêuticos; Série de Casos.

Descritores: Deformidades do pé; Neoplasias ósseas; Pseudoartrose.

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INTRODUCTION

Malignant and benign foot tumors are rare conditions[1-3] that are epidemiologically more common in children and adolescents, affecting the calcaneal region[1]. Anatomical division based on functional relationships divides the foot into tarsal, intertarsal and metatarsal areas, and the latter includes the anterior part of the tarsus, the midfoot and the toes[2]. The involvement of the metatarsal is less common than the involvement of the distal tibia and calcaneus but more prevalent than the involvement of the cuboid, cuneiform and phalanges[3].

Foot and ankle involvement in patients with bone tumors (osteosarcoma and Ewing sarcoma) is very uncommon. Soft tissue tumors (epithelioid sarcoma and clear cell sarcoma) have a relatively higher incidence[1]. Sixteen malignant forms of foot tumors, either primary or metastatic, have been reported to date[2].

Benign foot and ankle tumors are more common than malignant tumors; among the latter, a giant-cell tumor is the most common diagnosis. Nevertheless, 17 benign tumor subtypes have been identified[3].

In patients with considerable bone loss, free grafting with the fibular segment is a low-cost alternative with a considerable chance of success, without the need for amputation[4-7]. This technique was successfully described for the first time in 1911, after the resection of bone tumors[8].

The present study evaluated patients who were treated with free fibular grafting for metatarsal tumors in which there was bone loss and the possibility of local reconstruction, with no progression to amputation.

METHODS

This study was approved by the Research Ethics Committee with registration in the Brazil Platform under CAAE number: 06911219.4.0000.5361.

This cross-sectional retrospective study evaluated free fibular graft surgery in patients with metatarsal tumors performed between January 2010 and December 2018 in a pediatric referral hospital. The inclusion criteria were (1) patients younger than 15 years old who were (2) undergoing fibula bone grafting after bone loss caused by tumor removal, and (3) the tumor was located in the metatarsal bone.

After reviewing the criteria, the data were collected from electronic medical records, and epidemiological data, such as age and sex, as well as clinical data related to progression, such as tumor type, the need for adjuvant or neoadjuvant therapy and postoperative complications, were analyzed.

In all cases, the surgical procedure consisted of a dorsal longitudinal incision over the top of the tumor lesion at the level of the affected metatarsal, dissection and resection of the lesion (Figures 1 and 2).

Next, the graft was harvested from the distal third of the fibula (distal diaphyseal portion) in the ipsilateral leg using a lateral approach and a sufficient bone length was collected for reallocation in the metatarsal position.

Figure 1. Preoperative imaging showing tumor growth.
Source: Author's personal archive.

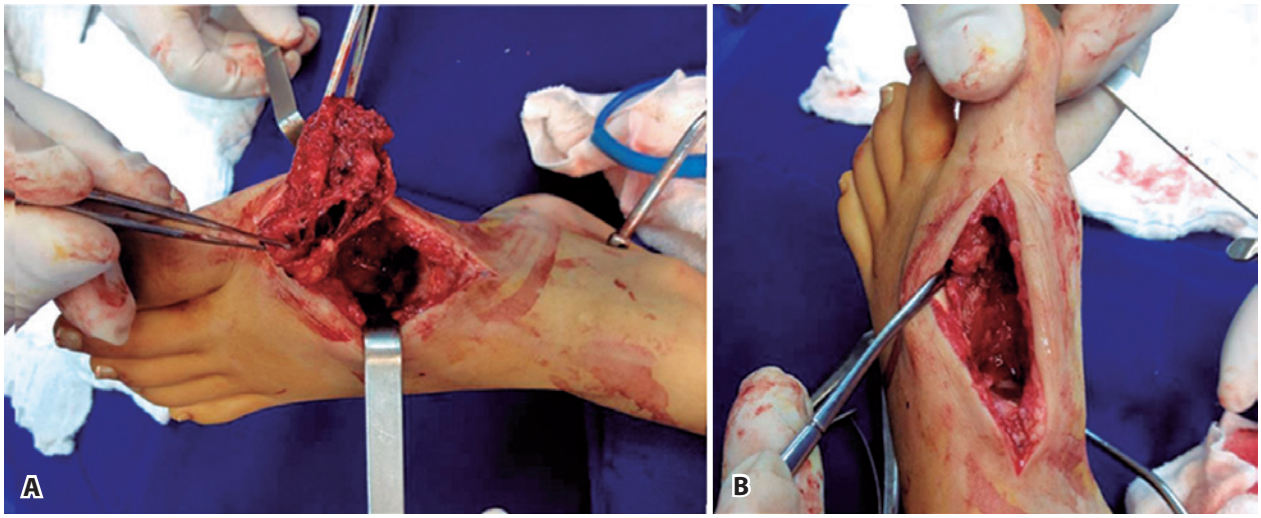

Figure 2. Images of the intraoperative phase of the surgical procedure. A. Dorsal longitudinal incision over the affected metatarsus, dissection and tumor exposure. B. Intraoperative appearance after tumor resection.
Source: Author's personal archive.

Figure 3. Postoperative radiograph. Anteroposterior view showing graft fixation in the second metatarsal with Kirschner wire.
Source: Author's personal archive.

The graft was positioned through Kirschner wire fixation (Figure 3) or fixation with mini-fragment plate and cortical screws (Figure 4); in this case, the graft was fixed with proximal screws and distally fixed using only Kirschner wires. The optimal graft position was then confirmed by X-ray. At the end of the procedure, a fixation device was used for toe alignment, and the patient was allowed to bear weight on the operated leg after postoperative confirmation of consolidation.

RESULTS

During the study period (January 2010 to December 2018), three patients (n=3) met the inclusion criteria. All patients in the sample were female (100%), with a mean age of 10.3 years (± 0.61).

The tumor type presented by all patients was an aneurysmal bone cyst (100%) that was diagnosed clinically and histopathologically.

None of the patients required adjuvant or neoadjuvant therapy, as the complete resection of the tumor lesion with subsequent grafting was curative in all patients.

Regarding complications, two patients (66.6%) developed pseudoarthrosis, requiring a reoperation. Notably, an association between complications and the grafting fixation method was not observed. Likewise, after the second intervention, in which the patients underwent fixation with a mini-fragment plate and cortical screws, subsequent complications were not observed, with consolidation in all patients.

Figure 4. Postoperative radiograph. Anteroposterior view showing graft fixation in the third metatarsal with a mini-fragment plate and cortical screws.
Source: Author's personal archive.

DISCUSSION

According to Mascard et al.[1], the literature reports a higher prevalence of malignant foot and ankle tumors in pediatric and elderly patients, without sex differences. Subsequently, Chou et al.[3] examined both benign and malignant foot and ankle tumors and reported a slight predominance among female patients (54.9%) and of benign tumors (60.8%). In the present study, a predominance of these tumors was observed in female pediatric patients.

Krieg et al.[8] evaluated the use of fibular grafts for bone tumors without specific localization in a series of 31 patients and found that none of the patients underwent fibular grafting for metatarsal reconstruction, but the technique was used for the pelvis, humerus, femur, tibia and radius. In the same study, only two cases were aneurysmal bone cysts, with a predominance of Ewing sarcoma, chondrosarcoma and osteochondroma. The use of chemotherapy or radiotherapy did not exert a statistically significant effect on graft stabilization. Regarding complications, three patients presented delayed graft consolidation, and two patients presented nonconsolidation. In addition, seven patients experienced stress fractures. Petersen et al.[9] reported a series of eight patients who underwent surgery for malignant tumors with bone replacement, and osteosarcoma was the most frequently diagnosed tumor type in the recipient sites, namely, the femur, humerus, ulna and tibia. Regarding complications, half of the patients experienced fractures after grafting, and two others developed pseudoarthrosis. This finding reinforces the possibility of using the fibula graft as an alternative treatment to improve patient morbidity, particularly in patients with well-localized tumors. The cases of pseudoarthrosis observed in our study (both proximal and distal pseudoarthrosis) showed good progression after the second surgery, as an initial fixation associated with a spongy bone graft and a more rigid fixation using the technique with a mini-fragment plate and cortical screws prevented the progression to pseudoarthrosis.

After weighing the risks and benefits of the fibula graft, Bae et al.[10] describe certain indications for use, subdivided into two categories: (1) bone defects greater than 6-8cm – traumatic bone loss, tumor resection, osteomyelitis, infected failed union; and (2) minor defects with failed bone healing – persistent nonunion, osteonecrosis and congenital pseudoarthrosis. In addition, the fibula graft possesses good osteoconductive (support for vascular and adjacent tissue growth), osteoinductive (recruitment of osteoprogenitor cells) and osteogenic (ability to generate new bone from the graft) abilities.

Lucas et al.[11] described a minimally invasive fibular graft harvesting technique that was performed using three small 2-3cm incisions for a graft of approximately 10cm. The patients presented no postoperative complications, which occurred when conventional harvesting was used, and increased aesthetic satisfaction. In the present study, fibular graft harvesting was performed using the conventional technique, as described above.

Maraskolhe et al.[12] reported complications after harvesting the fibula graft from the donor site at 3, 6, 9 and 12 months of follow-up. At the initial evaluation at 3 months, 37% of the patients experienced local pain and 13% had a superficial infection, and at the follow-up visit at the end of 12 months, only 10% of the patients experienced local pain, without other symptoms. Lee et al.[13] evaluated 10 patients, two of whom experienced early postoperative complications – paralysis of the lateral popliteal nerve. In the clinical assessment, six patients were asymptomatic, but two showed muscle weakness, one complained of dis-

comfort during walking associated with numbness of the medial side of the foot and experienced weakness of the extensor hallucis longus, flexor hallucis longus and extensor digitorum longus, and the remaining three patients presented mild symptoms with no clinical relevance. In addition, the patients showed kinetic and kinematic changes (when evaluated), with a reduction in ankle dorsiflexion and lateral flexion. Goodacre et al.[14] evaluated nine patients who were subjected to fibular transfer, and the most frequently described functional morbidity was a weakness of hallux dorsiflexion, indicating damage to the fibular nerve and healing of the flexor and extensor digitorum longus after the removal of the fibular graft and peroneal artery. With advances in the technique, the description of morbidity decreased in the literature; however, the patient should be advised about possible complications at the donor site after graft harvesting. The patients described in the present study did not exhibit significant morbidity at the donor site.

Ramseier et al.[15] presented a case series of four patients who underwent an operation for malignant tumors and revealed the postoperative changes in function using pedobarography. Case 1 was a patient who underwent an operation using the technique described in the present study, and less force under the operated metatarsal was observed, with lateral displacement of the center of pressure during the push-off or digitigrade phases. Nevertheless, the patient's functional status was excellent, similar to the patients who underwent an operation in our service.

According to Meohas et al.[16], aneurysmal bone cysts have an incidence of 0.14 per 100,000 people and are more common in the first 20 years of life, corroborating that the pediatric age group is the group that is most frequently afflicted with foot and ankle tumors. This tumor type also affects the femur, tibia and humerus, particularly in the proximal metaphyses.

Otsuka et al.[17] describe general symptoms, such as pain and swelling, with an increase in the size of the soft tissue and gradual worsening. Traoré et al.[18] described two possible treatments: (1) marginal resection combined with neoadjuvant therapy and (2) radical resection. In long bones, the first option is usually used with subsequent bone grafting. It is indicated in bones in which total resection is not disabling. The recurrence rate is approximately 25% when the first technique is performed, which does not occur after radical resection.

The present study has considerable limitations: a sample with a small number of cases, which precluded a statistical analysis of significance for the sample, in addition to the use of a retrospective design without frequent follow-up for functional and pain evaluations. This rarely used surgical technique requires a statistical analysis of its efficacy.

CONCLUSIONS

Although this study included a small sample of patients who were analyzed at an age that favored the diagnosis of the most commonly detected tumor subtype, patients who underwent a fibular graft procedure after tumor resection in the metatarsal benefited from a rarely used treatment option that we believe is worth considering because the other options are associated with greater patient morbidity.

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