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Original Article

Bone spur formation in transtibial amputation in pediatric patients

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Abstract

Objective: Amputating a limb during childhood is a rare yet significant event often perceived as a catastrophe by families and subsequently by the child. A multidisciplinary team, including wound care, rehabilitation, and prosthesis fitting specialists, plays a crucial role in managing these patients. The objective of this study is to retrospectively evaluate transtibial amputations performed on children aiming to assess the percentage of individuals who developed symptomatic spurs after the initial amputation procedure.

Method: This study retrospectively evaluates transtibial amputations performed on children from 1990 to 2021, focusing on the development of symptomatic bone spurs post-surgery.

Results: Our findings indicate that out of 27 patients under 12 years of age, 66.66% developed symptomatic spurs requiring revision surgery, with a mean time to identify these spurs being approximately 53 months post-amputation. The primary indications for amputation were congenital issues (51.85%), trauma, and infections. Although bone overgrowth is the most common complication in 66.66% of cases, younger individuals are more likely to experience this issue. Despite the high revision rates, amputation remains critical for long-term functional outcomes. Limitations of the study include a small sample size and retrospective design, yet it highlights the importance of vigilance regarding bone spur formation in pediatric amputees.

Conclusion: Bone spurs are a common complication of transtibial amputation in children, regardless of the technique used for the procedure. Understanding the existence of this condition allows physicians to educate families and children about this possibility and prepare them for possible new procedures.

Level of evidence IV; Therapeutic studies - investigating the results of treatment.

Keywords: Amputation, surgical; Child; Osteophyte.

Introduction

Amputating a limb during childhood is a rare event that families often perceive as a catastrophe, followed by the child. The principles required to create a stump capable of accepting a prosthesis that restores function must be fully understood[1,2].

A multidisciplinary team, including wound care, rehabilitation, prosthesis selection and fitting, and social support specialists, plays a crucial role in managing these patients. Additionally, the orthopedic surgeon and other team members should collaborate to monitor the patient's development and growth, making decisions about prosthesis replacement and fitting[3,4].

Researchers and developers have made considerable advances in prosthetics in recent years. Experts have introduced new materials and prosthetic designs to improve performance and facilitate the child's adaptation to the prosthesis. These changes have prompted a re-evaluation of the principles underlying amputation surgery[2].

Study performed at the Faculdade de Medicina, Universidade de São Paulo, São Paulo, SP, Brazil.

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Transtibial amputation preserves the growth plate, and this can be considered an advantage of the procedure at this level since the amputated limb can follow the child's global development, generating a better proportion between the stump and the rest of the body. However, other theories attempt to explain these characteristics, such as the fact that in the immature skeleton, the characteristic of the periosteum causes it to move away from the end of the amputated stump and form the spurs. These bony prominences grow rapidly, creating a sharp and rigid formation that can penetrate overlying soft tissues, gradually increasing local pressure and leading to ulcerations and pain. This results in many surgical revisions for this reason[5-8] (Figures 1 and 2).

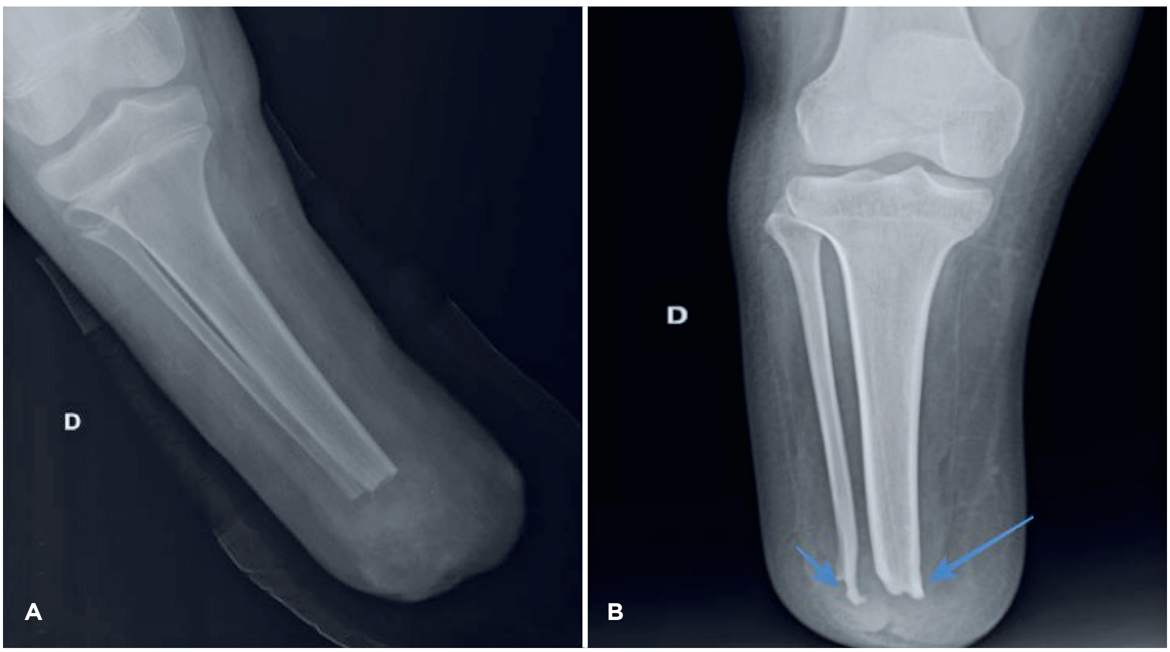

Figure 1. Radiographic images of the right transtibial amputation stump in a child. (A) The stump is shown immediately after the initial amputation procedure, with the proximal growth plates of the fibula and tibia open (B) 43 months postoperatively, prominent bone spurs (blue arrow) are visible at the distal end of the stump.

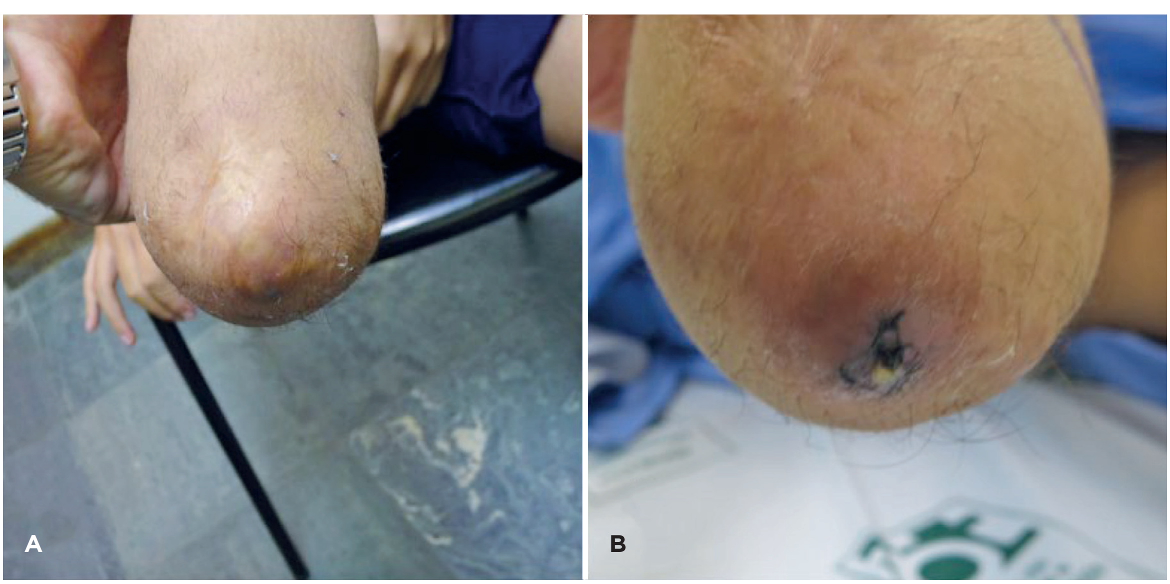

Figure 2. Image of the right transtibial amputation stump in a child. (A) The prominent stump shows an area of overload and a painful point (B) Several months later, ulceration is present with discharge and local signs of infection.

The objective of this study is to retrospectively evaluate transtibial amputations performed on children from 1990 to 2021, aiming to assess the percentage of individuals who developed symptomatic spurs after the initial amputation procedure.

The hypothesis is that a significant percentage of children submitted to transtibial amputation develop spurs and require further intervention.

Material and Method

The study was approved by the Institutional Review Board under the number 8398.6924.5.0000.0068. This is a retrospective case series with patients submitted to transtibial amputation before the age of 12 years old in one outpatient clinic.

The procedure consisted of transtibial amputation with the bone level defined by the location and characteristics of the deformity. Generally, the surgeon inflates the tourniquet in the thigh, makes a fish-mouth incision in the limb to be operated on, and performs dissection down to the bone level. After performing the tibia osteotomy, the fibula was cut more proximally, if present, and a periosteal bridge was created between the fibula and tibia. The surgeon ligates all arteries and veins and cuts the nerves with a new blade more proximally to avoid the formation of symptomatic neuromas in the stump. At this point, the tourniquet was released and checked for hemostasis. Then, myodesis and myoplasty procedures were performed, and the skin closure was also performed. Sterile dressings were applied to keep the stump rounded.

Data was collected through anamnesis, clinical examination, and imaging tests performed at the institute between 1990 and 2021.

The inclusion criteria were patients submitted to transtibial amputation surgery in our institute and also followed up at the outpatient clinic. The first surgery was performed on a patient under 12 years of age. The exclusion criteria were patients with a postoperative infection.

Epidemiological data, including sex, age, comorbidities, and clinical and imaging evolution, was collected in search of spur formation and the need to review the initial procedure.

Results

From 1990 to 2021, 27 transtibial amputation procedures were performed on patients under 12 years. The mean time a patient was submitted to surgery was approximately every 14.4 months.

Table 1 presents the epidemiological data. There were 11 (40.74%) male and 16 (59.26%) female patients. The median age at the initial procedure was 43 months.

The main diagnoses that motivated the initial transtibial amputation procedure were congenital (14; 51.85%), trauma (6; 22.22%), infectious (6; 22.22%), and rheumatological (1; 3.71%).

Eighteen patients developed symptomatic spurs that required revision, corresponding to 66.66% of the operated cases. The mean time to identify the spur in those submitted to new procedures was 53 months after the first procedure, while the time until the new approach was around 62 months. When comparing each group, there was no statistical difference between them (p = 0.351).

The survival rates leading to surgery were compared across different diagnoses. Patients requiring surgery due to congenital infections showed a mean survival of 44.2 months (SD 15.52). In contrast, patients with traumatic amputations demonstrated the lowest survival, with a mean of 25.1 months (SD 5.84). The overall survival rate for amputation was 43.2 months (SD 14.24) (Figure 3). The age difference at primary amputation between those who presented spurs and those who did not was one year. The younger individuals were more likely to show this complication. However, this difference did not present statistical significance (p = 0.64).

Table 1. Epidemiological data

Sex	Age of the amputation (months)	Diagnosis	Bone overgrowth	Time between amputation and revision (months)
F	24.1	Trauma	Yes	8.3
F	116.4	Infection	Yes	9.7
F	95.5	Congenital	Yes	16.3
F	145.4	Congenital	Yes	16.5
M	106	Trauma	Yes	22.7
M	24.3	Infection	Yes	24.4
F	15.2	Trauma	Yes	27.5
M	18.9	Congenital	Yes	29.7
F	124.4	Congenital	Yes	31.7
F	60.9	Trauma	Yes	41
M	60.1	Congenital	Yes	43.2
M	22.3	Infection	Yes	44.2
M	17.9	Congenital	Yes	71.2
F	118.5	Congenital	Yes	78.6
F	42.7	Infection	Yes	84.1
F	20	Congenital	Yes	99.6
M	43.2	Infection	Yes	100.8
F	6.1	Congenital	Yes	152.6
M	5	Reumatologic	No	
F	8	Congenital	No	
M	26.7	Congenital	No	
F	32.2	Congenital	No	
F	84.5	Trauma	No	
M	92.2	Congenital	No	
F	107.6	Infection	No	
F	110.6	Congenital	No	
M	147.3	Trauma	No	
Mean (SD)	62.1 (47)			50.1 (39)

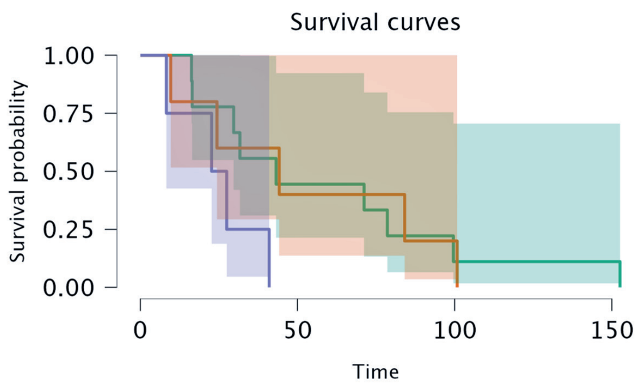

Figure 3. Graph showing the survival time of the procedure between each diagnosis. Purple line trauma, orange line infection, and green line congenital.

Discussion

Twenty-seven patients were included for descriptive analysis. All of them were children or adolescents under 12 years. In our sample, it was observed a female predominance, representing 59.26% of amputated patients. This differs from the study by Horsch et al.[6], who presented a case series of 22 juvenile amputations with male predominance. Most of the strong evidence available provides data related to adult patients, and in this case, male predominance in amputation is a pattern observed in all age groups[9,10]. However, this still justifies further investigation to determine the reasons behind this predominance since the sample size in both studies in children is too small to define a determining pattern.

The indication for lower limb amputation in the pediatric population is quite variable. While in adults, 80% to 90% of amputations occur due to vascular abnormalities, in Brazil, pediatric amputations are performed mainly to treat tumors, trauma, infections, and congenital alterations[1,2,5,6,11]. In our sample, the highest prevalence was among congenital amputations (51.85%), followed by trauma and infection (22.22% each). The absence of patients with tumors is related to a specific group performing oncological surgeries in our institute, and new treatments with limb preservation methods are highly effective[12].

Bone overgrowth is the most frequent complication observed in the amputation stumps of our patients, occurring in 18 of the 27 amputated patients (66.66%). Although preserving the proximal growth plate, transtibial amputation often leads to bone overgrowth at the distal end, which may grow until growth becomes stationary in amputees[12]. Consistent with our findings, the literature shows that bone overgrowth is the most prevalent complication following lower limb amputation in this population, occurring in up to 50% of cases, with younger individuals being more likely to experience this issue[13-15]. This may explain why this complication is so frequent in our population, secondary to the young age of the individuals included.

All amputees in our study who presented with complaints related to bone spurs underwent revision surgery (18 of 18 patients). Unlike in adults, where soft tissue pathology is reported to be the most common indication for revision surgery, followed by infections[16], in our pediatric sample, all revisions were related to bone overgrowth pathology. Although different from what the literature described in the adult population, our study confirms what Horsch et al.[6] described, presenting retrospective cases in which nine patients underwent bone revision. In contrast, only one case underwent soft tissue revision surgery.

Despite the high revision rate due to bone growth, there is no alternative to amputation in terms of providing a good long-term functional result. Although some studies suggest that bone bridges may be more durable[17,18], they have methodological flaws that make comparative analysis difficult. Other studies do not confirm this, and in our sample, there were also amputations in which it was performed bone bridges evolved with the need for revision due to spur formation since the presence of the elastic periosteum in itself constitutes a risk factor for stimulating local bone growth when moving away from the stump[7].

Another method to reduce overgrowth is using caps, which can be biological or synthetical[19-21]. The synthetic materials described for use in this technique include Teflon and synthetic polytetrafluoroethylene, while the biological materials reported in the literature comprise vascularized bone segments, the proximal or distal cartilaginous portion of the fibula, and iliac grafts[19-21]. Studies indicate that both techniques reduce the likelihood of overgrowth but introduce new risks, such as infection and foreign body reactions in the affected region.

Transtibial amputations in children are rare; however, when they occur, it is common for a sharp spur to form at the bone end that can gradually penetrate the overlying soft tissues. This, in turn, results in a significant impact on the lives of affected patients in terms of pain and activities of daily living, which can also negatively impact their mental health. In these circumstances, revision surgery is often essential to improve function, and it is important that patients—and especially their family members—understand how frequently such revision procedures may be necessary (Figure 4).

Our study has several limitations, most notably its limited sample size, retrospective design, and the evaluation of multiple amputation techniques within the same sample. Despite these limitations, it presents a large series of transtibial amputations, demonstrating that the emergence of spurs remains a significant issue and that surgeons and family members should remain vigilant.

Conclusion

Bone spurs are a common complication of transtibial amputation in children, regardless of the technique used for the procedure. Understanding the existence of this condition allows physicians to educate families and children about this possibility and prepare them for possible new procedures.

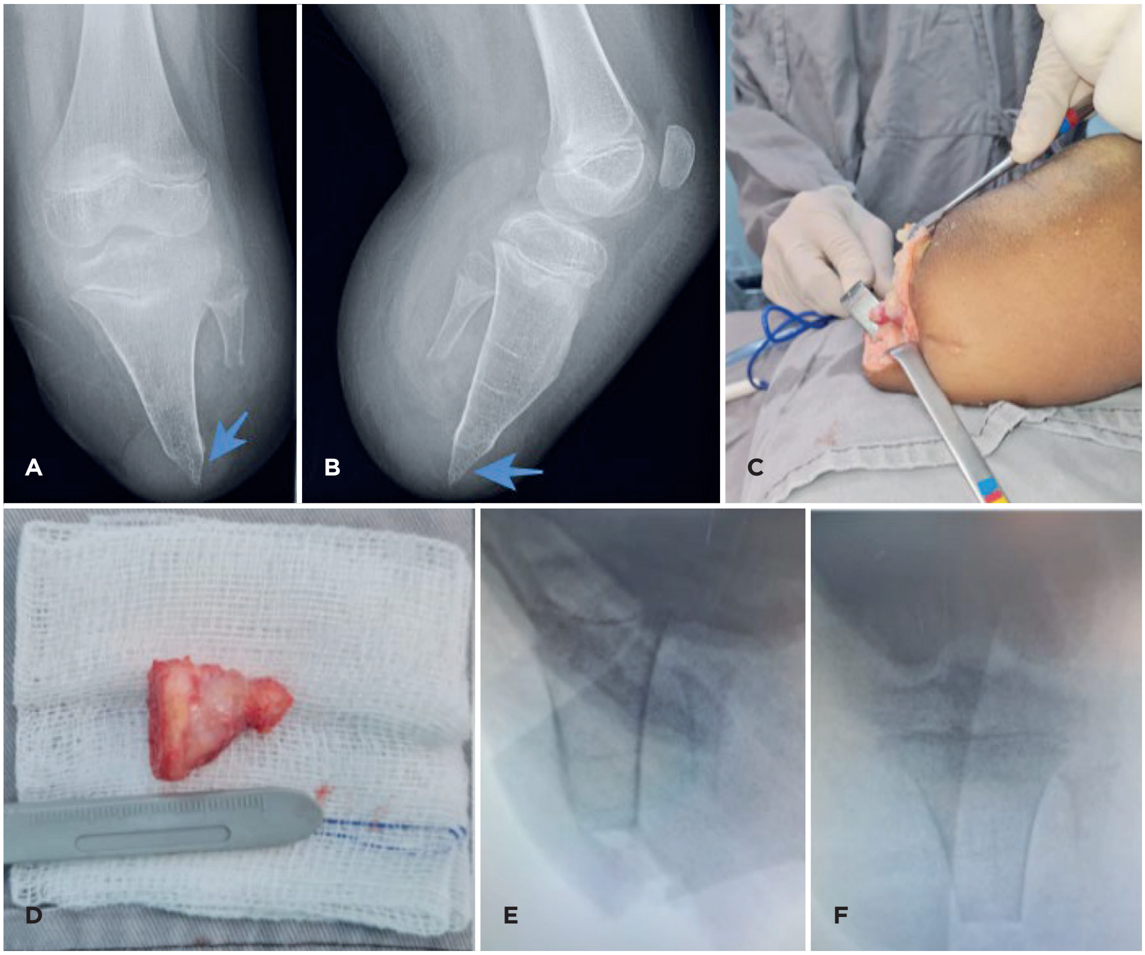

Figure 4. (A and B) Anteroposterior and lateral radiograph images showing a distal spur formation on the tibia (blue arrow) (C and D) Surgical procedure involving exposure and resection of the spur, respectively (E and F) Intraoperative fluoroscopy images demonstrating the resection of the bone spur.

Authors' contributions: Each author contributed individually and significantly to the development of this article: SM *(https://orcid.org/0000-0002-5025-4338) Conceived or planned the activities that led to the paper, interpreted the results achieved, or both; ERC *(https://orcid.org/0000-0003-0348-382[1]) Conceived or planned the activities that led to the paper, interpreted the results achieved, or both; DLR *(https://orcid.org/0000-0003-0183-8641) Written the paper or reviewed the successive versions and participated in the reviewing process, approved the final version; RBS *(https://orcid.org/0000-0003-1085-0917) Written the paper or reviewed the successive versions and participated in the reviewing process, approved the final version; GF *(https://orcid.org/0009-0002-3377-8006) Written the paper or reviewed the successive versions and participated in the reviewing process, approved the final version; TDF *(https://orcid.org/0000-0002-9687-7143) Written the paper or reviewed the successive versions and participated in the reviewing process, approved the final version; ALGS *(https://orcid.org/0000-0002-6672-1869) Written the paper or reviewed the successive versions and participated in the reviewing process, approved the final version. All authors read and approved the final manuscript. *ORCID (Open Researcher and Contributor ID) iD.

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