

A Novel Method to Prevent Terminal Appositional Overgrowth Following Pediatric Below Knee Amputations

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Background

Terminal appositional overgrowth is a well-described complication following transosseus amputations in the pediatric population. The symptoms associated overgrowth are swelling, warmth and pain at the distal aspect of the residual limb. In advanced cases, bony spicule perforation of the soft tissues has been reported.

In symptomatic patients, the traditional treatment has consisted of a revision osteotomy. However, recurrence rates as high as 85% have been reported when excision of the overgrown segment is performed in isolation.

Multiple previous implants and procedural techniques have been described with the intent of inhibiting terminal overgrowth via occlusion of the intramedullary canal and disruption of the endosteal blood supply. Despite these attempts, there is no current standard prophylaxis against, or treatment of, symptomatic overgrowth as these previous methods, and others, have demonstrated inconsistent outcomes complicated by fixation failure, infection and recurrent overgrowth.

In this article we present a novel technique for the primary prevention of terminal overgrowth following transtibial amputations performed in two skeletally immature patients. A custom metal end-cap was implanted with the use of compressive osseointegration fixation in an attempt to prevent overgrowth and maintain cortical bone stock. Compressive osseointegration was utilized in this case because it is a fixation strategy that imparts a continuously compressive force at the bone-implant interface, thereby utilizing the principle of Wolff's law to facilitate osseointegration and cortical hypertrophy.

Purposes

The purpose of this piece is to present a novel strategy to prevent terminal appositional overgrowth following pediatric below knee amputations.

Methods

A custom compressive osseointegration end-cap device was designed and manufactured by Biomet[®] PMI[®] (Warsaw, IN). The implant consisted of a highly polished cobalt alloy end-cap affixed to the residual limb via Biomet Compress[®] (Warsaw, IN), a compliant pre-stress fixation device. The interface between the spindle and the osteotomy site was coated with a titanium porous plasma spray, in an attempt to promote osseointegration.

The highly polished cobalt alloy end-cap was attached to an extramedullary spindle projection via a Morse taper connection. The end-cap was designed to be eccentric relative to intramedullary spindle, allowing intraoperative rotational adjustments in order to minimize implant overhang anteriorly and provide adequate posterior cortical coverage.

A preoperative CT scan was obtained in both cases, providing a template for custom implant design. The anticipated implant sizes were determined from the cortical and intramedullary dimensions at the planned resection level as represented on CT. All proposed implant designs were reviewed and approved by the senior author prior to manufacturing.

Results

Both cases experienced wound complications that required surgical intervention. Four months following surgery, Case One developed a superficial infection while on chemotherapy and Case Two

underwent a superficial flap advancement for delayed wound healing four weeks following amputation. Neither patient developed a deep infection necessitating implant revision.

The current duration of follow up is 30 and 12 months for Cases One and Two, respectively. At this time neither patient has experienced complications related to prosthetic wear, apart from the routine adjustments required of a growing patient with a maturing residual limb. Both patients have achieved academic success and are engaged in all desired physical activities, specifically competitive basketball and baseball.

Figures 1 and 2 are the follow-up radiographs for each case, respectively.



Figure 1. Anteroposterior and lateral knee radiographs of Case One at (A) 3 months, (B) 1 year, and (C) 2.5 years postoperatively.

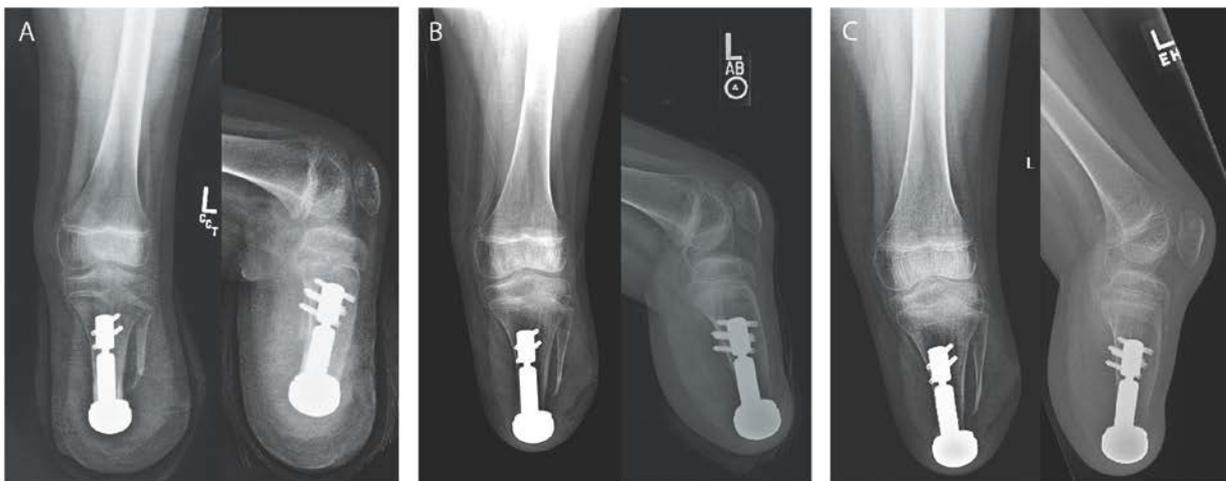


Figure 2. Anteroposterior and lateral knee radiographs of Case Two at (A) 6 weeks, (B) 6 months, and (C) 1 year postoperatively.

Conclusions

Described is a novel method to prevent terminal appositional overgrowth. In short-term follow-up, end-capping with compressive osseointegration fixation effectively inhibits bony overgrowth in pediatric transtibial amputations. The wound healing complications experienced in these patients demonstrates the importance of a tension-free closure, which may require retention of more distal soft tissue than is the norm

due to the additional length imparted by the implant itself. Longer term follow-up is required to confirm the durability of this implant construct and its efficacy.