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Retrograde Ankle Fusion with ETN PROtect and autologous bone with Bioactive Glass as a Bone Substitute for Infected Non-union: A Case Report

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ABSTRACT

Non-unions are an important complication to fractures and the treatment thereof is often challenging. The presented Case Report shows how interdisciplinary cooperation and an individualized therapeutic approach lead to successful therapy in challenging circumstances. A retrogradely implanted antibiotic coated Tibia Nail can be used for Ankle Arthrodesis and combined with RIA harvested autologous bone and Bioactive Glass for defect augmentation. Beforehand a large soft tissue defect was addressed by transferring a latissimus dorsi muscle flap.

INTRODUCTION

The development of nonunion in bones is one of the most relevant complications in the treatment of fractures. In Germany between 2007 and 2019 about 2% of all diagnosed fractures developed into a non-union [1]. Depending on the localization and other factors such as smoking, degree of soft tissue damage and comorbidities, the likeliness of non-unions can rise up to 30% [2]. While causing pain and discomfort, it leads to permanently reduced function of the musculoskeletal system and, thus, impaired ability to participate in work and social life. Therefore, non-unions pose not only a health, but also a great socio-economic concern.

The clinical process from the initial fracture to the development of non-union, its treatment, managing possible complications and reaching a definitive therapy often is a long and complex journey for patients as well as treating medical personnel. It frequently involves complex osteosynthetic procedures and new therapeutic approaches to improve chances of bone healing and reduce the risk of secondary complications.

CASE DESCRIPTION

We hereby present the case of a 39-year-old female who suffered a comminuted, first degree open tibial plafond-associated fracture (AO 43C3) after a climbing accident involving a 3-meter fall in September 2020, which turned into an infected nonunion in the lower tibia requiring multiple revision-surgeries in the process.

The patient was initially treated with an external fixator across the ankle followed by an open reduction of the distal tibia and internal fixation using screws and an NCB-DT Plate. This initially implanted plate was replaced by an intramedullary tibial nail in early 2021 after material failure due to delayed fracture healing. After another year a nonunion was diagnosed and revision surgery was again performed. After removal of the inlaying tibia nail, the bone was stabilized with an external fixator. On the bony side, radical debridement of the non-union area and defect augmentation with a PMMA Spacer was done. To bridge the resulting defect, a segment transport provided by a TSF-Ring fixator was initiated. The docking procedure included plate osteosynthesis for the docking site, and after removal of the fixator two proximal plates were used to support the regenerated bone. Three months later, the patient showed another infection of the distal tibia. Hence, the distal plate was removed and substituted by an external fixator, and an active vacuum-assisted wound therapy system was applied to treat the resulting skin defect which needed weekly changing.

When the patient first presented in our hospital for consultation, the CT diagnostics confirmed the lack of consolidation in the proximal tibial area as well as a non-union at the distal tibia and fibula. There was a bone defect measuring 1 × 3 cm in the distal tibia area.

An explorative operation was performed, including removal of external fixation, microbiological sampling and the placement of local and intramedullary G/V PMMA spacers with a new VAC system.

Subsequently, the skin defect was covered using a latissimus dorsi muscle transfer flap by specialists of the Department of Plastic Surgery at the BG-Klinik Ludwigshafen. After approximately eight weeks, the definitive surgical procedure was performed. Here, the flap was first mobilized, followed by the removal of local and intramedullary spacers. Hereafter, the temporary arthrodesis and distal screws of the adjacent plates were removed. The tibia medullary space was then prepared, and autologous spongiosa was harvested from the proximal femur using the Reamer-Irrigator-Aspirator-System. This was followed by the definitive ankle and hindfoot arthrodesis and tibia osteosynthesis using a retrogradely implanted ETN PROtect Gentamicin coated intramedullary nail, along with the implantation of autologous spongiosa and bioactive glass into the defect. The Nails length was chosen to bridge the former proximal docking site and provide internal stabilization.

The postoperative stay proceeded without any further complications. Clinical and radiological follow-up assessments were conducted after six, twelve, and eighteen weeks and at 7 and 12 Months postoperatively, during which the patient was found to be pain-free with the desired healing progress. Partial weight-bearing was initiated after six weeks, followed by progressively increased weight-bearing after twelve weeks. After 7 Months the patient could walk freely without being dependent on crutches. By the last follow-up after 1 year, the patient was able to bear full weight without assistance and could convert from orthopedic supportive shoes to regular shoes. The knee mobility was good, and the transferred flap showed adequate perfusion in all clinical reevaluations. Throughout the follow-ups, the radiographic assessment showed progressive bone healing with mostly consolidated areas in the proximal tibial docking site, the distal tibial fracture site and the ankle fusion.

DISCUSSION

In our presented case, the patient exhibited unsuccessful bone healing following an open distal tibia fracture. After several attempts at osteosynthesis, there was an infected non-union and a bone defect due to segmental transport.

Distal tibial fractures have a higher risk to develop non-unions due to thin soft tissue coverage and relatively lower perfusion compared to most other bones [3]. Therefore, in this case the patient faced an increased risk for recurrent infection and insufficient osteosynthesis with the potential necessity of amputation at a later point in time [4]. Given the existing condition, the goals were defined as enabling full weight-bearing in the lower leg and avoiding lower leg amputation. The following points were identified as crucial to achieve these goals:

- Intra- and postoperative (wound) sterility
- Securing soft tissue coverage and adequate perfusion of the bone
- Implant to support the longitudinally unstable bone
- Substrate to support bone healing in the presence of a large defect

Sterility, perfusion and skin closure could be addressed by following established methods of septic surgery and nonunion-therapy described in standard literature, for example by Schmidmaier et al. [2]. To spare the fragile skin and reduce the risk of persistent infection, intramedullary osteosynthesis was considered [5]. The ETN PROtect intramedullary nail is designed to treat diaphyseal tibia fractures, not initially for retrograde implantation nor ankle arthrodesis. Compared to a Hindfoot Arthrodesis-Nail like the HAN, which are only available in 180 or 240 cm of size, a retrogradely implanted ETN-PROtect however offered two important advantages: Firstly, providing long-span support, bridging the proximal and distal tibia defect, and secondly, antibiotic gentamicin coating of the osteosynthesis material, which has shown significant reduction in infections and nonunion for tibia fractures in previous studies [6,7]. Pujol et al. found evidence in a case series study that the retrograde use of an ETN PROtect nail may help manage the risk of infection and can provide stability to the ankle and regenerated bone after insufficient ankle arthrodesis and distraction osteogenesis in distal tibial fractures [8].

While there are various reports about the combination of intramedullary osteosynthesis with bioactive glass and bone graft, we are the first to report about the use of a retrogradely implanted ETN PROtect combined with Reamer-Irrigator-Aspirator-System harvested bone graft and bioactive glass as a bone substitute to bridge long range bone defects.

CONCLUSION

The retrograde implantation of the ETN PROtect combined with bone graft and bioactive glass appears to be a successful therapeutic option for patients needing both, an ankle arthrodesis with extensive bone defect, and a long-range tibial stabilization. Also our results show the benefit of interdisciplinary cooperation including plastic surgery for soft-tissue management before definitive osteosynthesis. Establishing an interdisciplinary board including plastic surgery and infectiology for optimized vascularization and soft tissue environment can improve outcomes after complex fractures and should be discussed.

While evidence has been provided for the reduced risk of infection using the ETN Protect our Case Report shows the feasibility of the combination with bone graft and bioactive glass and suggests that it also provides the necessary stability.

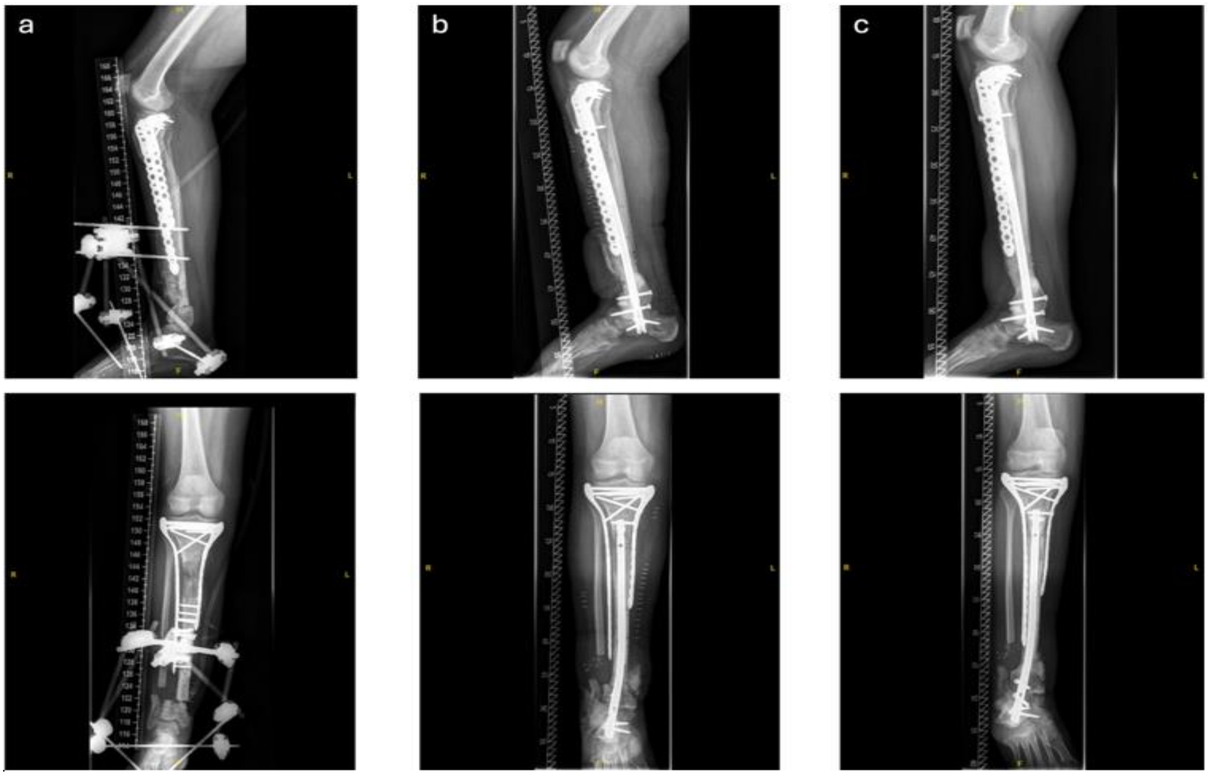

Figure 1: Radiographic comparison before definitive surgery (a), directly after surgery (b) and 1 year after surgery (c) in lateral (above) and a. p. projection (below).

Figure 2: Computertomographic comparison in sagittal view before definitive surgery (a) and 1 year after surgery (b).

Figure 3: Intraoperative imaging showing ETN PROtect nail bridging the former docking site of the proximal tibia.

Figure 4: Latissimus dorsi muscle transfer flap showing adequate perfusion 1 year after surgery.

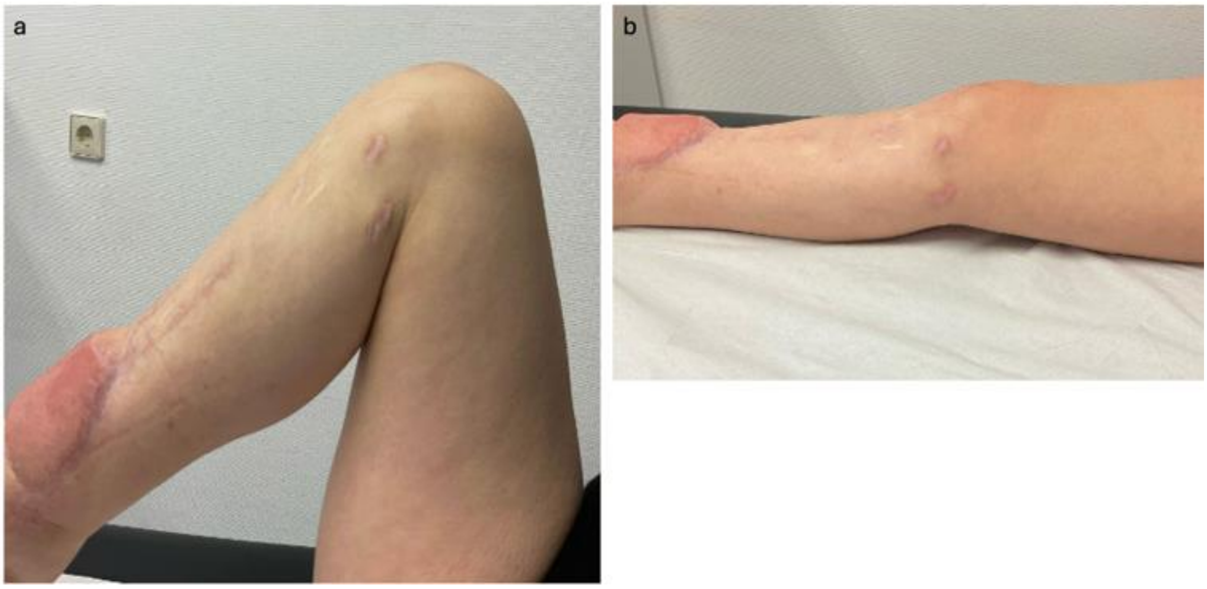

Figure 5: Knee mobility 1 year after surgery with up to 150° flexion (a) and 0° extension (b).

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