

# EXPERT TIBIAL NAIL PROTECT

Enhance your first line of defense



This publication is not intended for distribution in the USA.

**CLINICAL EVIDENCE**

# CONTENT

AUTHOR	TITLE OF CHAPTER	PAGE
	ETN PROtect clinical evidence summaries	3
Raschke M, Vordemvenne T, Fuchs T	Limb salvage or amputation? The use of a gentamicin coated nail in a severe, grade IIIC tibia fracture	4
Fuchs T, Stange R, Schmidmaier G, Raschke M	The use of gentamicin-coated nails in the tibia: preliminary results of a prospective study	5
Raschke M, Rosslbroich S, Fuchs T	Gentamicin-coated Tibia Nails: Can We Afford NOT to Use Them?	6
Metsemakers W, Reul M, Nijs S	The use of gentamicin-coated nails in complex open tibia fracture and revision cases: a retrospective analysis of a single centre case series and review of the literature	7

# ETN PROTECT CLINICAL EVIDENCE SUMMARIES

The PROtect Coating has been applied to Expert Tibial Nail (ETN) PROtect and its predecessor the Unreamed Tibial Nail (UTN) PROtect. Clinical experience has demonstrated the performance and safety of the two intramedullary nails featuring the PROtect Coating.

A literature search was performed using PubMed, OVID and QUOSA to identify studies performed using ETN PROtect. The scope of the search included studies on UTN PROtect, as it has an identical antibiotic coating to ETN PROtect and a similar nail design\*, and therefore is expected to have a similar effectiveness and safety profile. Studies were only included if the use of ETN or UTN PROtect was on label. As a result of this, four relevant studies were identified and summarized; two single centre case series studies and two case studies.<sup>1-4</sup>

Patients with different types and severity of injuries were included across these studies: Fuchs et al. 2011 reported on patients with both closed and open fractures Gustilo Anderson (GA) I-III,<sup>1</sup> Metsemakers et al. 2015 on patients with open fractures grades GA II-III,<sup>2</sup> Raschke et al 2010 and Raschke et al 2014 on one case of a severe GA IIIC fracture each.<sup>3,4</sup> The cohorts studied by Fuchs et al. 2011 and Metsemakers et al. 2015 included patients with multiple injuries (poly-trauma patients) and complex revision cases.<sup>1,2</sup>

The primary outcomes of interest reported were the development of a deep infection and bony union following fracture fixation with the PROtect coated nail. An overview of the results is presented in table 1. In all four studies, none of the patients de-

veloped a deep wound infection.<sup>1-4</sup> Only Fuchs et al reported a superficial infection, which was treated with debridement.<sup>1</sup>

Union outcomes were reported at different time points across the studies. In 3 out of 4 studies, full fracture healing was observed within a year in all patients.<sup>1,3,4</sup> Despite the absence of a deep infection, Metsemakers et al. 2015 found that 25% of patients (4 out of 16) suffered from non-union.<sup>2</sup> The author attributed the incidence of non-union to the complex pattern of injury of these patients.<sup>2</sup>

**Table 1:** Infection and union outcomes following the implantation of ETN or UTN PROtect.

	FUCHS ET AL 2011 <sup>1</sup>	METSEMAKERS ET AL 2015 <sup>2</sup>	RASCHKE ET AL 2014 <sup>3</sup>	RASCHKE ET AL 2010 <sup>4</sup>
SAMPLE SIZE	n=19	n=16	n=1	n=1
INTRAMEDULLARY NAIL	UTN PROtect	ETN PROtect	ETN PROtect	UTN PROtect
NON-UNION	0/19 after 3 months	4/16 (timing not reported)	0/1 one year after trauma	0/1 after 3 months
DEEP WOUND INFECTION	0/19	0/16	0/1	0/1

Adverse events (AEs) were reported, but none of the AEs was reported to have causative relationship with ETN PROtect coating. However, in the single centre case series several unrelated adverse events were recorded. Fuchs et al reported reoperation in three patients due to serious adverse events including a thromboembolic event, hip pain and issues with local wound healing.<sup>1</sup> A quarter of the pa-

tients in the study by Metsemakers et al underwent reoperation due to fracture non-union.<sup>2</sup>

\* The main difference between these two implants are the locking options, which allow a more flexible use of Expert TN compared to UTN and the treatment of a broader range of indications, specifically, fracture closer to the joint areas.<sup>5</sup>

[1] Fuchs T, Stange R, Schmidmaier G, Raschke MJ. The use of gentamicin-coated nails in the tibia: preliminary results of a prospective study. Archives of orthopaedic and trauma surgery 2011;131:1419-25.

[2] Metsemakers WJ, Reul M, Nijs S. The use of gentamicin-coated nails in complex open tibia

fracture and revision cases: A retrospective analysis of a single centre case series and review of the literature. Injury 2015;46:2433-7.

[3] Raschke MJ, Rosslenbroich, SB, Fuchs, TF Gentamicin-coated Tibia Nails: Can We Afford NOT to Use Them? Techniques in Orthopaedics 2014;29:62-8.

[4] Raschke M, Vordemvenne T, Fuchs T. Limb salvage or amputation? The use of a gentamicin coated nail in a severe, grade IIIC tibia fracture. European journal of trauma and emergency surgery: official publication of the European Trauma Society 2010;36:605-8

[5] Kuhn S, Hansen M, Rommens PM. Extending the Indication of Intramedullary Nailing of Tibial Fractures. European Journal of Trauma and Emergency Surgery 2007;33:159-69

# SUMMARY OF: LIMB SALVAGE OR AMPUTATION? THE USE OF A GENTAMICIN COATED NAIL IN A SEVERE, GRADE IIIC TIBIA FRACTURE

Raschke M, Vordemvenne T, Fuchs T, Eur J Trauma Emerg Surg. 2010;36: 605 - 608

## Location

University Hospital Munster, Germany.

## Objectives

“To present a case where intramedullary nailing with the UTN PROtect has been successfully used in a midshaft tibial fracture and secondary lengthening in a patient with a grade IIIC tibial fracture and a mangled extremity severity score (MESS) of 8.”

## Treatments Assessed

- Tibial fractures treated with UTN PROtect

## Study Design

### Case Report

Following a road accident, a 17 year old suffered a lower left leg subtotal amputation, which was classified as a severe GA grade IIIC open fracture. The anterior tibial artery was the only vessel maintaining blood supply to the foot.

### Initial intervention

The fracture was reduced using an external fixator with two Schanz screws, resulting in fibula shortening of 5.5cm. The wound underwent extensive debridement and cleaning by jet lavage. Microsurgery was then performed to repair five muscles and two tendons, and the open wounds were partially closed using an artificial skin graft.

To prevent compartment syndrome, the four muscular compartments were opened.

Two days following the initial trauma, a second round of debridement and

lavage was performed. The artificial skin graft was removed and replaced by vacuum-assisted closure. This process was repeated days 5, 8 and 11 post-trauma. Following surgery on the second day, the patient was prescribed Cefuroxim and Meronem for 10 days to prevent infection.

### Secondary intervention

At day 20 post-trauma, a mesh graft was taken from the upper left leg and placed on the lower left leg. One and a half weeks later, the wound had undergone sufficient healing to allow removal of the external fixation device and insertion of the UTN PROtect intramedullary nail, which was dynamically locked. Two screws were used to fix the distal fibula to the tibia. Two weeks later the patient was discharged from hospital.

At the next stage the patient received bone lengthening treatment consisting of the following steps: i) removal of the distal locking screws of the UTN PROtect and the two distal fibular screws, ii) a proximal multidimensional osteotomy, iii) transfixation of the proximal fibula with a 3.5mm cortical screw to prevent distal movement of the fibula and iv) implantation of an ILIZAROV circular external fixator (2 carbon rings and 4 distractors). The patient performed lengthening of 0.5mm – 1mm/day. This process continued for three months. Eight months after the initial fracture the UTN PROtect nail was distally locked and the external fixator was removed.

### Secondary results

The patient achieved full weight bearing three months after the initial trauma, aided with a shoe elevation

of 5cm. Osseous consolidation was confirmed using radiography.

C-reactive protein concentration consistently remained within normal ranges throughout the patient's treatment, indicating that no infection was present.

The legs became equal in length at eight months post-trauma.

The patient endured a brief period of insensibility on the sole of his foot; however the issue resolved itself in the following months. The patient did not suffer from any paraesthesia, and normal weight bearing, gait and movement were achieved.

Two years after the initial trauma, UTN PROtect was removed. There were no signs of infection reported.

## Author's Conclusions

“As a result of our treatment approach, the young man avoided amputation or prolonged external fixation. He showed no signs of infection within 1 year and 1 month after treatment... Compared to amputation as an alternative treatment, he has benefited in terms of function, life quality, and fitness for work, while the treatment period was equal in length to that which he would have faced following amputation.

We are aware that the patient's young age, excellent compliance and previous good health contributed to the success of this operation. However, the availability of this gentamicin-coated nail and the knowledge that bacterial growth is suppressed from the outset gave us the confidence to proceed with intramedullary nailing in this patient.”

# SUMMARY OF: THE USE OF GENTAMICIN-COATED NAILS IN THE TIBIA: PRELIMINARY RESULTS OF A PROSPECTIVE STUDY

Fuchs T, Stange R,  
Schmidmaier G,  
Raschke M, Arch Orthop Trauma  
Surg. 2011; 131:1419-1425

## Location

University Hospital Munster, Germany.

## Objectives

To investigate “the use of the UTN PROtect gentamicin coated intramedullary tibial nail in the surgical treatment of closed and open tibial fractures and in revision surgery.”

## Treatments Assessed

- Tibial fractures treated with UTN PROtect

## Outcomes

### Primary outcomes

- Risk of deep wound infection

### Secondary outcomes

- Fracture healing
- Weight bearing capacity
- Complications

## Study Design

### Single Centre Case Series

Twenty-one patients that sustained a tibial fracture and were treated with UTN PROtect between August 2005 to December 2007 were included in this study. The patients were followed up at 5 weeks, 3 month and 6 months postoperatively.

To be included in the study, the patient had to meet the following criteria: adult patients of age 18 years or more, provided signed informed consent, having open or closed tibial fractures or failed previous therapies following tibial fractures.

The history and time of nail implantation was recorded for each patient. Any complications or infections were recorded in the follow-up period. Physical and mental health were assessed using SF-36 scores 6 months postoperatively.<sup>1</sup>

The fractured limb was assessed using radiographic techniques; these were collected preoperatively, intraoperatively and 5 weeks, 3 months and 6 months postoperatively. Three independent, blinded radiologists assessed the results for evidence of bone union. Consolidation of fracture healing was defined as bridging of a minimum of three out of four cortices without weight bearing.

## Results

### Effectiveness

Nineteen patients were successfully followed up. Patients with open fractures had, on average, an increased level of C-reactive protein 4–7 days postoperatively in comparison to those with closed fractures (4.8mg/L vs 3.0mg/L). However, both groups maintained an average concentration of C-reactive protein beneath normal level (5mg/L). Serum gentamicin concentration was <0.3µg/ml six months postoperatively.

The amount of partially or fully healed fractures increased over time. At five weeks postoperatively, 89% of patient's had partially healed fractures, one fracture was fully healed, and one showed no signs of healing. By three months postoperatively, 47% of patient's fractures had fully healed, and the remaining patients all showed signs of healing.

Weight bearing capacity also increased over time. At 5 weeks 26% of patients could bear full weight, and by 6 months 68% of patients could bear full weight.

### Safety

No deep wound infections were reported in any of the patients. Three patients had serious adverse events requiring hospitalization due to a thromboembolic event, hip pain and issues with local wound healing. However all of these complications were resolved without any further issues.

## Author's Conclusions

“Implant-related infections pose an important challenge in the surgical treatment of tibial shaft fractures. Local administration of antibiotics, such as through antibiotic coating of implants, might minimize the risk of infections and improve clinical and radiological outcomes.

In this prospective, non-randomized case series, we showed that use of UTN PROtect gentamicin-coated intramedullary nail to treat closed and open tibial fractures was associated with an absence of deep wound infections, good fracture healing and increasing weight-bearing capacity after 6 months. These good outcomes were observed even in our series of patients with complex tibial fractures and multiple traumas.”

[1] Ware. SF-36 Health Survey Update. Spine. 2000; 25(24): 3130-3139.

# SUMMARY OF: GENTAMICIN-COATED TIBIA NAILS: CAN WE AFFORD NOT TO USE THEM?

Raschke M, Rosslénbroich S, Fuchs T, Tech Orthop. 2014;29:62-68

## Location

University Hospital Munster, Germany.

## Objectives

To present a case that displays the successful utilisation of ETN PROtect in treating a patient with a severe GA IIIC tibial fracture.

## Treatments Assessed

- Tibial fractures treated with ETN PROtect

## Study Description

### Case Report

This paper reports the treatment of an 18-year-old that sustained a tibial fracture after his right leg was driven over by a car. The patient was diagnosed with a severe GA IIIC open fracture.

### Initial intervention

Upon admission, the patient was treated prophylactically with cefuroxime. An external fixator was applied and screws were inserted into the proximal and distal segments of the tibia. The open wound was debrided and cleaned by jet-lavage. Due to the severe nature of the fracture, 7cm of tibial bone was resected. Open areas were partially closed using an artificial skin graft. The patient received intravenous cefuroxime for 8 days post-operatively.

A second operation was performed the day after the incident, allowing observation, debridement and lavage of the wound. A secondary skin closure was performed six days after the trauma.

### Secondary intervention

Three and a half weeks after initial trauma the external fixator was removed and an unreamed 9 x 375mm ETN PROtect nail was inserted. Nine days later there were no signs of infection and the patient was discharged with 20kg of weight bearing on his right leg.

Eleven weeks following the implantation of ETN PROtect, an ILIZAROV ring fixator was applied to lengthen the bone. A proximal osteotomy was performed, followed by bone transport five days later.

A pin infection was identified 4 weeks after starting callus distraction, indicated by a raised level of C-reactive protein. This was treated with cefuroxime and bone transport ceased. Within 2 weeks the concentration of C-reactive protein had return to normal limits, after which callus distraction was continued.

Reduction of the bone defect continued until the transported bone successfully contacted the distal part, which took 3 months. Spongiosa extracted from the iliac crest and bone morphogenetic protein-2 were applied to the docking zone, which was secured using a limited contact dynamic compression plate.

### Secondary results

Consolidation was confirmed four weeks following spongiosa application to the docking zone, and one year after the initial fracture, both legs were of an equal length and bone continuity of the tibia was achieved.

## Author's Conclusions

"As a result of our treatment approach, this young man avoided am-

putation or prolonged external fixation. In our opinion, there were several situations during the treatment of the young patient, where the use of an antibiotic-coated nail served well:

- Severe IIIC grade open tibia fracture with bone loss.
- One-stage exchange from external infection to an intramedullary device.
- Osteotomy of an injured leg after soft-tissue damage.
- Bone transport over nail using an ILIZAROV ring fixator.
- Pin infection.

Although there was an infected pin of the external fixator, no deep osseous infection occurred. The patient attained equal leg length, full weight-bearing, and full mobility... We are aware that the patient's young age and previous good health contributed to the success of this operation. However, the availability of this gentamicin coated nail and the knowledge that bacterial growth is suppressed from the outset gave us the confidence to proceed with intramedullary nailing in this patient."

# SUMMARY OF: THE USE OF GENTAMICIN-COATED NAILS IN COMPLEX OPEN TIBIA FRACTURE AND REVISION CASES: A RETROSPECTIVE ANALYSIS OF A SINGLE CENTRE CASE SERIES AND REVIEW OF THE LITERATURE

Metsemakers W, Reul M, Nijs S, Injury. 2015;46: 2433-2437

## Location

The University Hospitals Leuven, Belgium.

## Objectives

“The purpose of the study was to evaluate a gentamicin-coated tibia nail in the prevention of deep (implant-related) infection.”

## Treatments Assessed

- Tibial fractures treated with ETN PROtect

## Outcomes

### Primary outcomes

- Infection

### Secondary outcomes

- Non-union

## Study Design

### Single Centre Case Series

The case notes for sixteen patients treated with ETN PROtect between January 2012 and September 2013 were evaluated. Indications included patients with acute, GA II-III, open or closed tibia fractures with initial external fixation for >2 weeks before intramedullary nailing, and complex revision cases that had an average of three previous surgeries.

The patients with acute fractures were treated within 6 hours of trauma. In addition to local antibiotic treatment from ETN PROtect, patients

with open fractures were given prophylactic systemic cephalosporin. Those that had GA III open fractures received both cephalosporin and aminoglycoside antibiotic therapy.

Patients were followed up every three months for a minimum of 18 months, or until there was evidence of union. The following parameters were recorded; age, sex, injury severity score, fracture type, Gustilo type, time to nailing, primary external fixation and implant characteristics.

Infection was defined either as superficial or deep (implant related). Superficial infection was located above the fascia, whilst deep infection penetrated deeper tissues, such as the muscular fascia and bone.

The fracture was defined as healed when there was no tenderness or pain over the site of fracture, and radiographic evidence of three solid bridging callus ridges connecting the fracture fragment on the lateral and anteroposterior view. Non-union was defined as failure to complete the healing process within nine months.

## Results

### Safety

Following treatment with ETN PROtect none of the patients were reported to have deep wound infection in the 18 months of follow-up. 25% of patients had non-union after treatment with ETN PROtect, which required further surgical intervention.

The incidence of non-union was attributed to the complex pattern of injuries among these patients.

## Author's Conclusions

“The purpose of the study was to evaluate a gentamicin-coated tibia nail in the prevention of deep (implant-related) infection. In our patient population no deep infections occurred after placement of the gentamicin-coated nail. Following this study and literature data, antibiotic-coated implants seem a potential option for prevention of deep infections in trauma patients. In the future this statement needs to be confirmed by large randomised clinical trials.”



  
Synthes GmbH  
Eimattstrasse 3  
4436 Oberdorf  
Switzerland  
Tel: +41 61 965 61 11  
Fax: +41 61 965 66 00  
[www.depuysynthes.com](http://www.depuysynthes.com)

This publication is not intended for distribution in the USA.