

Gun-Il Im · Kee-Byung Lee

## Difficulties in removing ACE tibial intramedullary nail

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**Abstract** We experienced three cases of refracture and two cases of failure to remove the nail while trying to take out ACE tibial nails from healed tibial fractures. In order to determine the risk factors associated with difficulties in nail removal, these five patients were compared in the parameters of age, gender, duration of nail in situ, nail diameter, nail length, and level of fracture with 30 patients who had uneventful removal. Younger age of the patient was significantly associated with the difficulty in nail removal.

**Résumé** Nous avons éprouvé trois cas de refractures et deux cas d'échec d'enlever le clou en essayant de prendre le clou tibial ACE de fractures tibiales guéries. Pour déterminer les facteurs du risque associé avec les difficultés dans démantèlement du clou, ces cinq malades ont été comparés avec 30 malades qui avaient le démantèlement sans incidents dans les paramètres maturation, genre, durée de clou dans situ, diamètre du clou, longueur du clou, le niveau de fracture. L'âge puîné des malades a été associé avec la difficulté dans démantèlement de clou considérablement.

### Introduction

Tibial intramedullary nailing has been widely accepted as the standard treatment for displaced tibial-shaft fractures [2, 5]. After fracture union, nail removal is frequently recommended [8]. However, unexpected problems, such as iatrogenic fracture or inability to remove the nails, can occasionally be encountered [7, 8, 9]. We experienced three cases of fracture and two failures to remove the nail while trying to take out ACE tibial nails (ACE, El Segundo, CA, USA) from healed tibial frac-

tures. The purpose of this study is to report our experience and analyze the risk factors associated with difficulties in removal of ACE tibial intramedullary nails.

### Materials and methods

During the period from January 1996 to March 2001, 35 ACE intramedullary nails were removed from healed tibial fractures. All fractures had been initially treated in our institution. Mean patient age was 37 (18–64) years at the time of removal. There were 26 men and nine women. Twenty-five fractures were closed and 12 were open (Gustilo-Anderson type I or II). The authors recommended nail removal for patients 50 years of age or younger after fractures healed and 12 months at minimum had passed from the time of fixation. The prime reason for hardware removal was the expected difficulties in treating a possible new fracture. For patients older than 50 years, nail removal was not recommended. The mean duration of nail in situ was 26 (13–61) months.

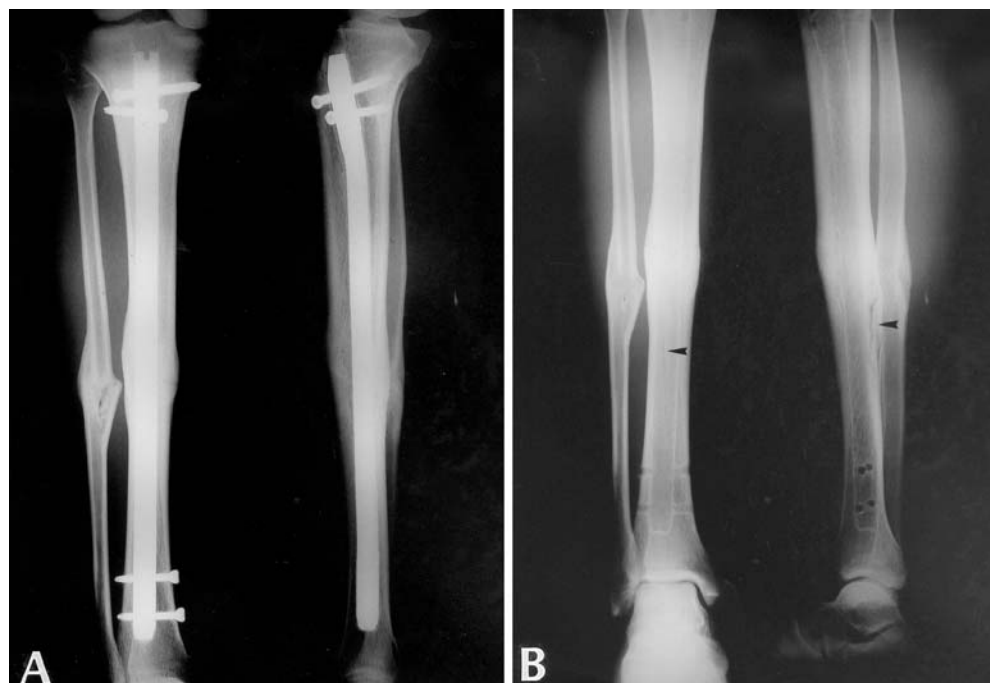
While nails were being removed, three patients had an iatrogenic fracture that occurred on the posterior aspect of the tibia. Considerable force was needed in each removal. A popping sound was noted in one patient in whom a triangular posterior wall fragment was found. A linear fracture of the posterior tibial cortex was found in two other patients on postoperative radiographs. A patellar tendon-bearing cast was applied as management of these iatrogenic fractures. The fractures united within 16 weeks. No patient had further complaints thereafter (Fig. 1, Table 1).

In two patients we failed to remove the nails. Interlocking screws were removed without difficulty. Nails came out until the tip of the nail reached the original fracture site. Thence the nails failed to move, even after several hard blows, and finally the connecting part of the removing devices fractured after further forceful hits with the sliding hammer. The authors applied vice grip on the nail shaft and attempted removal by hitting on the vice grip. These maneuvers were not successful. Consequently, the nails had to be driven back into the original location. One of the patients had intermittent knee pain until 24 months after the attempted removal (Fig. 2, Table 1).

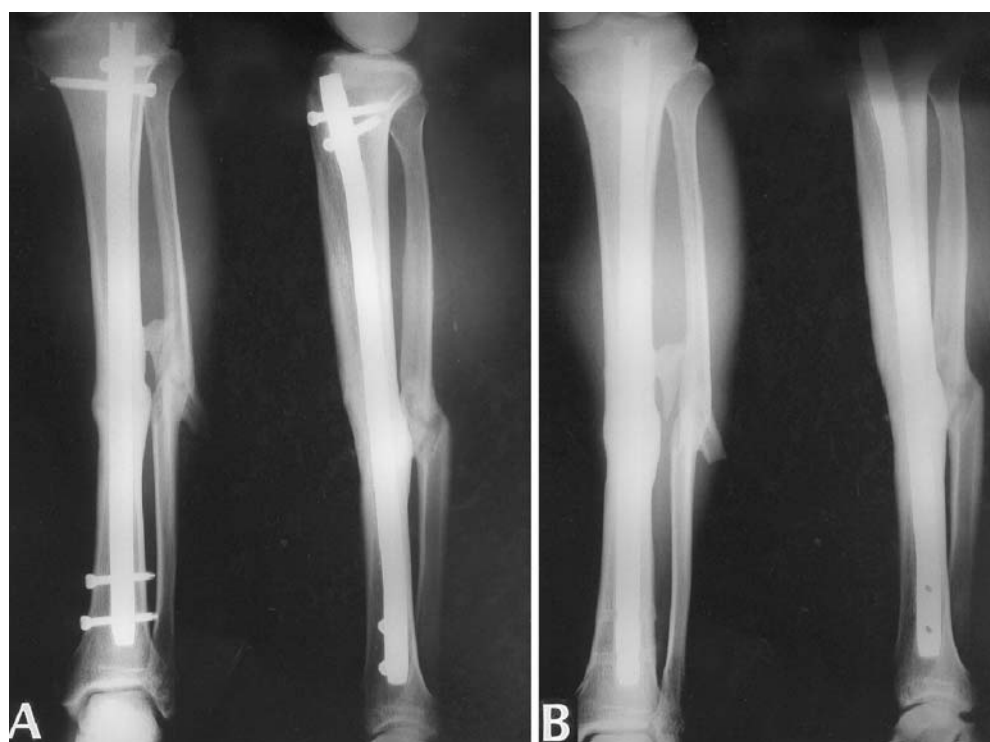
We analyzed the risk factors associated with difficulties in nail removal. The five patients who had difficulties (group 1) were compared in parameters of age, gender, duration of nail in situ, nail diameter, nail length, and the level of fracture with 30 patients who had uneventful removal (group 2). Student's *t*-test, chi square test, and Fisher's exact test were used for statistical analysis. The level of significance was set at  $p < 0.05$ .

G.-I. Im (✉) · K.-B. Lee  
Department of Orthopaedics,  
Hallym University Hospital,  
896 Pyongchon-Dong, Anyang, Korea  
e-mail: gunil@hallym.ac.kr  
Tel.: +82-31-3801886, Fax: +82-31-3801814

**Fig. 1** A 22-year-old man (case 3) sustained right tibia and fibula fractures from a motorcycle accident. He was treated with closed reduction and internal fixation with ACE tibial nail (A). When nail removal was performed after 18 months, a linear fracture (arrows) was found in post-operative radiographs (B)



**Fig. 2** A 17-year-old man (case 5) had open tibia and fibula shaft fractures on his left leg from pedestrian injury. Closed reduction and internal fixation with ACE tibial nail was performed and the fracture united (A). Removal of hardware was tried after 23 months. Interlocking screws were removed without difficulty. About a third of the nail came out. But even after several hard blows, the nail failed to be advanced. Further blows broke off the connecting part of removing device. The nails had to be driven back (B). The patient had persistent anterior knee pain until 24 months after the attempted removal



**Table 1** Clinical details of five patients in group 1

No.	Age (years)	Gender	Open fracture	Fracture level	Nail size: diameter×length (mm)	Duration of nail in situ (months)	Complication
1	44	F	No	Distal	11×300	41	Refracture
2	20	M	Yes	Mid	10×315	47	Refracture
3	23	M	No	Mid	12×315	18	Refracture
4	30	M	No	Segmental	11×345	39	Inability to remove nail
5	19	M	Yes	Mid	12×315	23	Inability to remove nail, anterior knee pain

**Table 2** Details of parameters in both groups (mean±SD). *M* men, *W* women

Parameters	Group 1	Group 2	<i>p</i> value
Age (years)	27±10	38±11	0.04
Gender:number	M:4 F:1	M:22, F:8	0.61
Duration of nail in situ (months)	34± 12	25±11	0.20
Nail diameter:number	10 mm:1 11 mm:3 12 mm:1	9 mm:4 10 mm:11 11 mm:9 12 mm:4 13 mm:2	0.41
Nail length (mm)	318±16	309±10	0.31
Level of fracture:number	Mid:3 Distal:1 Segmental:1	Proximal:1 Mid:22 Distal:7	0.50

## Results

The summary of data is presented in Table 2. Younger age of patients ( $p=0.04$ ) was the only significantly associated risk factor. Mean patient age was 27 (19–44) years in group 1 and 38 years (18–64) in group 2. Gender ( $p=0.61$ ), duration of time in situ ( $p=0.20$ ), nail diameter ( $p=0.41$ ), nail length ( $p=0.31$ ), and fracture level ( $p=0.50$ ) were not significantly associated risk factors.

## Discussion

The function of an intramedullary nail ends with fracture healing. However, there is not an agreement on how long an intramedullary nail should be in place [8]. Nor does every surgeon think that inserted nails should be removed after fracture healing [4]. Seligson et al. [8] pointed out pain and irritation at the point of insertion, the difficulty of treating a new fracture, breakage of nails that are left after fracture healing, improved diaphyseal remodeling after nail removal, and possible activation of dormant bacteria on the nail as the indications for nail removal. In Asian countries, people prefer the removal of metallic hardware for cultural reasons as well.

Objection to routine removal is based on the fact that stress shielding is negligible with intramedullary nails [3, 4]. Many patients name anterior knee pain as the reason for removal [6]. But some patients who had no anterior knee pain may become symptomatic following nail removal [1]. Although the removal of a tibial intramedullary nail is thought to be an innocuous procedure, intraoperative complications, as shown in this article, can occur. Without adequate preoperative planning, nail removal may evolve into a major procedure.

The ACE tibial nail originally had a 5° bend at the distal tip to facilitate insertion. The manufacturer now has changed the bend on the distal tip to 2.5°. In addition,

nails with diameters of 10 mm or more have a slot in the posterior aspect of the main part of nail that stops at the beginning of distal bend. Takakuwa et al. [9] reported four fractures from 19 patients who underwent removals of ACE tibial nail. They pointed out those features as possible culprits for causing refractures during nail removal. Seligson et al. [8] also reported that, as the nail was being extracted, the nonslotted end of the nails got stuck on the bone that grew into the slot.

These studies suggested that the design features originally purported to facilitate nail insertion caused trouble in removal. In our three patients who had iatrogenic fracture, great force was necessary while the nail tip passed the original fracture site. In another two patients, the connecting part of the removing device broke off after some hard blows. These nail had to be driven back into the medullary canal. If the connecting part had not been broken, fractures might have occurred in these cases, too. Therefore, the authors believe that the inability to remove the nails could be placed in the same category as that of refracture.

The biocompatibility of titanium may also have adversely affected nail removal by promoting bone ingrowth into the surface of nail. We have also experienced bone ingrowth onto the thread of locking screws, which also caused difficulty in nail removal.

As the iatrogenic fractures all were undisplaced, cast immobilization was sufficient treatment. However, the complication caused considerable emotional stress to the patients and surgeons.

Although the number of cases was small, the younger age of patients was significantly associated with difficulties in nail removal. The potential for abundant bone formation and osseous ingrowth into implants in younger patients may have contributed. The cortical bone at the site of fracture tended to be thicker in patients in whom we had difficulty removing the nail. This may also have acted against the removal because of decreased elasticity of bone required for the passing of a bent nail.

The authors now have guarded ideas about the use of ACE nails in treating tibial shaft fractures, preferring other nails that do not have a bend on the tip. It is suggested that when the removal of ACE nails is being considered, a surgeon must anticipate possible difficulties and younger patients, especially, should be warned thereof.

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