

Nail Position Has an Influence on Anterior Knee Pain after Tibial Intramedullary Nailing

Nikica Darabos¹, Ivana Dovzak Bajcs¹, Zeljko Rutic², Anela Darabos³, Damir Poljak³ and Jasminka Dobsa⁴

¹ University of Zagreb, University Clinic for Traumatology, Zagreb, Croatia

² Varaždin General Hospital, Department of Traumatology, Varaždin, Croatia

³ Varaždin General Hospital, Scientific Unit, Varaždin, Croatia

⁴ University of Zagreb, Faculty of Organization and Informatics, Varaždin, Croatia

ABSTRACT

Our aim was to determine the possible relationship between anterior knee pain (AKP) and nail position marked as a distance from tip of nail to tibial plateau (NP) and to the tuberositas tibiae (NT). Nail position has an influence on anterior knee pain after tibial intramedullary nailing. We evaluated postoperative outcome results of 50 patients in the last 3 years with healed fractures initially treated with intramedullary (IM) reamed nails with 2 or 3 interlocking screws on both parts of the nail and with the use of medial paratendinous incision for nail entry portal. Patients marked a point on the visual analog scale (VAS) that corresponded to the level of postoperative AKP felt. Two groups of patients were formed on the basis of AKP (pain level was neglected): groups A and B, with and without pain, respectively. The difference between the two groups concerning NP measurements was statistically significant ($P < 0.05$), but not concerning NT measurements at the $P < 0.05$ level. Patients were classified by pain with high accuracy (98%) according to a classification tree. Symptoms of AKP did not appear if the tip of the nail position was more than 6.0 mm from the NP and more than 2.6 mm from the NT. However, for better evaluation of these results it will be necessary to examine a larger number of postoperative patients with AKP.

Key words: tibial fractures, knee, pain, osteosynthesis, intramedullary nailing

Introduction

Multiple studies have shown that the outcome of treatment of a tibial shaft fracture using locked intramedullary (IM) nailing is superior to that of cast treatment¹⁻¹⁰. Anterior knee pain (AKP) is a very common complication after IM fixation of a tibial shaft fracture. The etiology of pain is often not known⁸. The use of the central patellar tendon splitted approach, nail protrusion observed on radiographs, and the insertion of a non-locking IM nail were all significant risk factors for AKP after surgery. All these risk factors should be avoided in tibial nailing to decrease the problem of postoperative knee pain¹⁰.

The purpose of this prospective study was to determine if there is an association between AKP and nail position. We analyzed postoperative outcome results and the possible relationship between AKP according to the visual-analog scale (VAS) scale, and the distance (mm) of

the nail from the tip of the nail to the tibial plateau (NP) and tuberositas tibiae (NT) was measured postoperatively on L-L knee X-rays.

Materials and Methods

In our prospective trial we evaluated postoperative outcome results of 94 patients with tibial shaft fractures in the Department of Traumatology in the last 3 years with a yearly follow-up visit *per* patient. All of them were treated with IM reamed nails with 2 or 3 interlocking screws on both ends of the nail. We invited all of the 94 patients for a physical examination. Fifty one patients came to our physical examination, and out of these one patient had his limb which was operated on amputated because of vascular disease and therefore was excluded

from our study. Twenty eight out of 50 patients that were included in our study were male (mean age 54 years), and 22 were female (mean age 47 years). Each patient was fully informed about the purpose of the trial, expected benefits, possible risks, as well as all the other details pertaining to the study. This trial was conducted with the written consent of each subject and approval by the University of Zagreb, School of Medicine's Ethics Committee.

In our study, we analyzed postoperative outcome results and the possible relationship between AKP after tibial nailing and nail position. All of our patients' operations were performed using the paratendinous approach. A medial longitudinal incision was made, with care being taken not to damage the patellar tendon or its sheath (Figures 1-3). Standard proximal and distal locking screws were used (Figure 4). Postoperative immobilization with a cast was not used. Patients were allowed partial bearing on the operated side for 12 weeks, then full weight bearing for 12 weeks post-surgery. All patients were given postoperative instructions for thigh muscle rehabilitation and the same physiotherapy was performed after IM nailing during hospitalization. Nails were removed from some of the patients with the presence of knee pain or pain at the insertion points of the locking screws, however, no nails were removed earlier than one year postoperatively. Proof of the healed bone fracture was confirmed by radiologic examination.

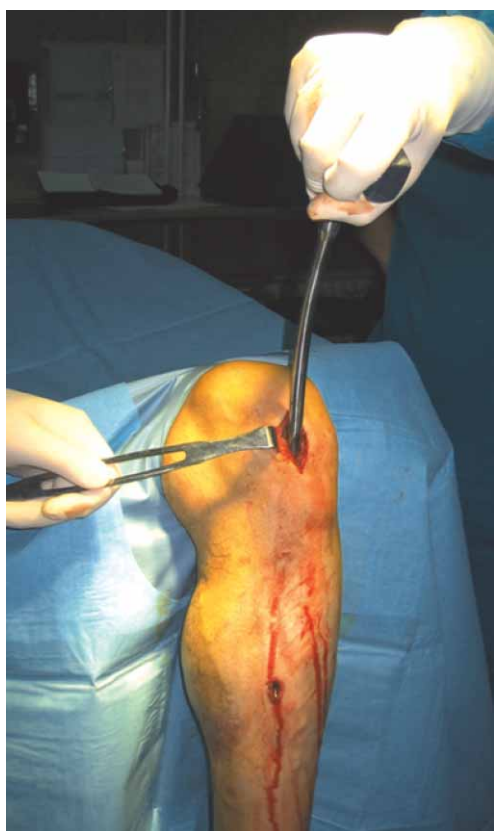


Fig. 1. Operative approach. A medial longitudinal incision is shown in the figure.

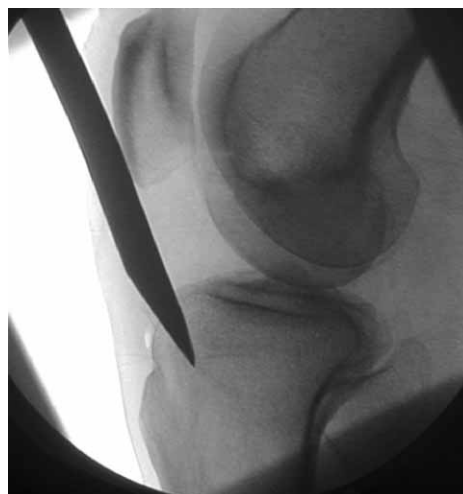


Fig. 2. LL x-ray of nail entrance point.

VAS pain score was obtained by the patients marking a 10 cm VAS line at a point that represented the chronic AKP they experienced, with 0 denoting no pain and 10 denoting the worst pain the patient could imagine. Two groups of patients were formed on the basis of the presence of pain related to AKP (the level of pain was neglected): Group A with pain and Group B without pain. All patients' interviews were conducted by the same physician. The distance of the nail position to the proximal tip of the nail to the NP and to the NT was measured (Figure 5). Measurements performed on the knee with postoperative L-L radiographs were confirmed by two independent intra- and inter-observers.

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) statistical software program version 16.0 (SPSS Inc., Chicago, IL, USA). Student's t-test was used to test if the means of groups A (with pain) and B (without pain) in NP and NT measurements differ in comparison. The chi-square test



Fig. 3. AP x-ray of nail entrance point.



Fig. 4. Postoperative x-rays of tibial fracture. Shows the use of standard proximal and distal locking screws.

was used to test the association between the existence of pain and sex. Boundaries for NP and NT measurements which divide patients with and without the pain were revealed using classification trees (QUEST algorithm). Significance was set at $P < 0.05$.

Results

Out of 50 patients that came to an exam, no patient had complications, such as deep or superficial infections, compartment syndrome, broken hardware, or patellar tendon rupture. The distance from the proximal tip of the nail to the tibial plateau varied from 32 mm below the plateau to 6 mm over the plateau (the tip of the nail was intraarticular in 2 patients) with a mean value of 9.6 mm below the tibial plateau. The distance from the tip of



Fig. 5. Measured distances (mm) of the nail tip to the tibial plateau (NP) and to the tuberositas tibiae (NT).

the nail to the tuberositas tibiae varied from 10 mm below the cortical bone of the tibia to 7 mm over the cortical bone of the tuberositas tibiae with a mean value of 1.8 mm below the cortical bone of the tibia.

Twenty four out of fifty examined patients had symptoms related to surgery (Figure 6). Nine patients complained of anterior knee pain (VAS range 4 – 6). Four of them had anterior knee pain only when kneeling. Nine patients had pain at the insertion point of proximal and/or distal screws. One patient had isolated ankle pain. One patient had isolated sensory changes in the knee region. Two patients had posterior knee pain in maximal flexion of the knee. Two patients had preoperative combination fractures of the tibial condyle and tibial diaphysis and complained of knee pain. Two patients had the tip of the nail intraarticular, but one of them had no symptoms (Figure 7). The measurements on knee X-rays showed that Group A patients had nails implanted 10 mm or less from the NP and 4 mm or less from the NT.

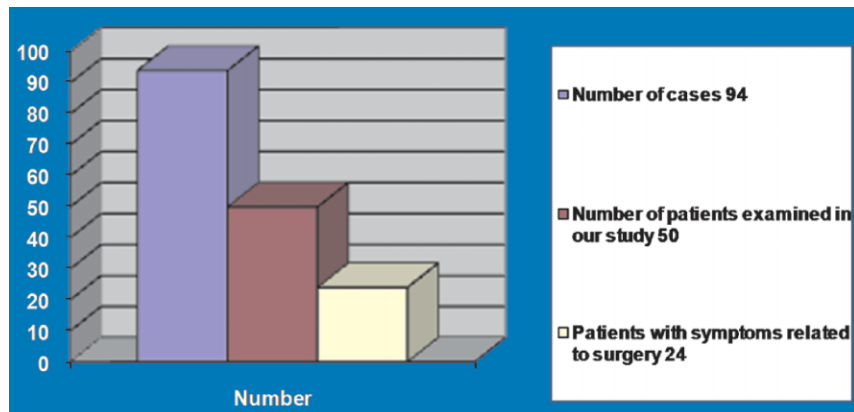


Fig. 6. Patients in study. Shows patient symptoms related to surgery.

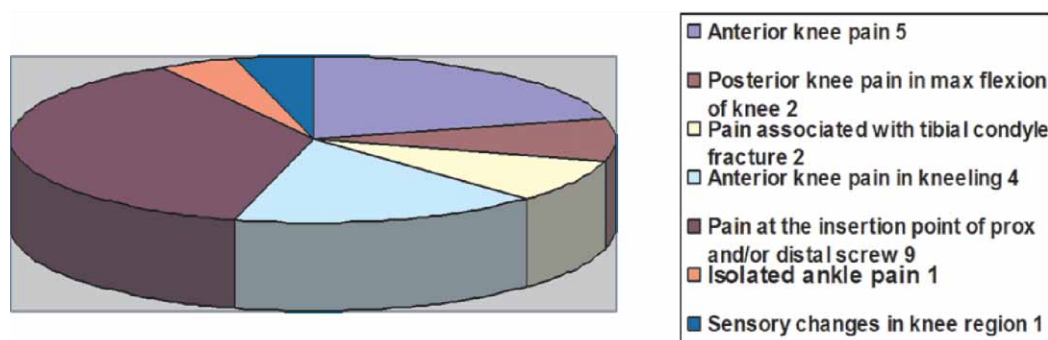


Fig. 7. Postoperative outcome. Illustrates various postoperative outcomes in patients.

Group B patients had nails implanted 6 – 32 mm from NP and 0 to 10 mm from NT.

The difference between groups A and B, concerning NP measurement was statistically significant ($P < 0.05$), while the difference between groups concerning NT measurement was not statistically significant at $P < 0.05$ level. According to the chi-square test, there was no association between the presence of pain and sex ($P < 0.05$). Using a classification tree, we found that the insertion point of the tibial nail should be medial to the patellar tendon and the tip of the nail should be more than 6.0 mm from the tibial plateau and more than 2.6 mm from the tuberositas tibiae. The classification tree correctly classified 49 out of 50 patients according to the presence of pain; an accuracy of 98%.

Discussion

Although the percentage of patients with AKP in this study is relatively low compared to the percentage found in the literature (10% vs. 20–70%)^{6,10}, there were additional pain symptoms that patients complained about. Multiple factors are described to influence AKP: nail prominence¹, younger age of the patient², deficiency in the flexion strength of the thigh muscles⁸, insertion of a non-locking IM nail¹⁰, female sex¹, and smaller plateau width¹. Dissection of the patellar tendon and its sheath during nailing is thought to be a contributing cause of chronic AKP (15). The paratendinous vs. transtendinous approach was reported to lower the incidence rate of AKP^{3,10}, but the most recent reports on the basis of simple functional tests and the ultrasound investigation of patients' patellar tendons^{6,11}, suggest it does not appear to make any difference which approach is used.

Although Vaisto et al.⁷ suggested that in the long term patients seem to be relieved from AKP upon nail removal, we found that the nail removal resolved or improved the pain symptoms in all cases. Bhattacharyya et al.¹ found that subjective knee pain was more common in women. There was no association between the presence of pain and sex in our study. However, evidence shows the importance of the implantation site of the nail regarding AKP. Bhattacharyya et al.¹ suggested that nail promi-

nence is correlated with increased knee pain and concluded that anterior nail prominence was associated with increased pain at rest, while superior nail prominence caused increased pain with kneeling and walking. Surgeons can decrease, but not eliminate, the severity of knee pain after tibial nailing by burying the tip of the nail as reflected on lateral radiographs¹. Still, previously published studies have not emphasized the main reason for the degrees of knee pain.

In a healthy patellar tendon, the innervation is confined to the paratenon, whereas the tendon proper is devoid of nerve fibers. Also, the infrapatellar fat pad of the knee joint has innervation. The resurgence of interest in the infrapatellar fat pad has arisen from its perceived involvement in AKP¹². These include direct injury to the fat pad, and impingement syndromes resulting from repetitive microtrauma or following acute trauma to the fat pad¹³, such as during the managing of the nail entry point. Bennell et al.¹⁴ reported that the source of the capsule, patellar tendon, meniscal synovial junction, and infrapatellar fat pad innervation is the posterior articular branch of the posterior tibial nerve, while Gardner et al.¹¹ described the innervation of the anteromedial portion of these structures arise from branches of the saphenous, tibial, and obturator nerves and the nerve to the vastus medialis, while the anterolateral portion is supplied by articular branches from the nerve to the vastus lateralis, and the tibial, recurrent peroneal, and common peroneal nerves¹¹. Also, the innervation pattern of the area dorsal to the patellar tendon is under marked influence by the sympathetic nervous system¹⁵. Such an extensive nerve supply has important clinical implications regarding the variety of possible pain patterns¹⁵⁻¹⁷.

On the basis of our results from two different groups regarding AKP, we confirmed an association between AKP and nail position. We presume that the position of the proximal tip of the nail and its negative influence on the innervation pattern of the area dorsal to the patellar tendon could be the key factor of AKP. Altered sensory-sympathetic innervation has implications in the pathophysiology of AKP.

In our study, there was a statistically significant difference between two groups concerning NP measure-

ments ($P < 0.05$). However, a significant difference was not found in NT measurements between the two groups at $P < 0.05$ level. Patients were classified by pain with a high accuracy according to the classification tree. We conclude that the symptoms of AKP will not appear if the tip of the tibial nail position is more than 6.0 mm from (NP) and more than 2.6 mm from (NT). Our study may provide useful therapeutic procedures to enhance the postoperative outcome after IM fixation of a tibial shaft fracture. Additionally, this study could provide significant educational value as the nailing methods used may influence the traditional method of IM nailing.

The limitation of this study is that a small number of patients are used to draw conclusions about the influ-

ence of nail position on AKP after tibial IM nailing. A future randomized control trial involving a large number of patients could provide more insight into the relationship between AKP and nail position.

Acknowledgements

This work was supported by the Croatian National Institute for Health Insurance. We thank Vera Srsan Živanović (Department of Traumatology, Varaždin General Hospital, Croatia).

REFERENCES

1. BHATTACHARYA T, SENG K, NASSIF NA, FREEDMAN I, Clin Orthop Relat Res, 449 (2006) 303. — 2. COURT-BROWN CM, GUSTILLO T, SHAW AD, J Orthop Trauma, 11 (1997) 103. — 3. KEATING JF, ORFLAY R, O'BRIEN PJ, J Orthop Trauma, 11 (1997) 10. — 4. LOH WY, SHIH Y, Stat Sin, 7 (1997) 815. — 5. SOBOTA-SALAMON B, DOBSA J, MIHOKOVIC V, Modeling a food industry process by decision tree. In: Proceedings (Sixth EUROSIM Congress on Modeling and Simulation, Ljubljana, 2007). — 6. TOIVANEN JA, VAISTO O, KANNUS P, LATVALA K, HONKONEN SE, JARVINEN MJ, J Bone Joint Surg Am, 84 (2002) 580. — 7. VAISTO O, TOIVANEN J, KANNUS P, JARVINEN MJ, Trauma, 64 (2008) 1511. — 8. VAISTO O, TOIVANEN J, KANNUS P, JARVINEN M, J Orthop Trauma, 18 (2004) 18. — 9. VAISTO O, TOIVANEN J, PAAK-

KALA T, JARVELA T, KANNUS P, JARVINEN M, J Orthop Trauma, 19 (2005) 311. — 10. YU SW, TU YK, FAN KF, SU JY, Changgeng Yi Xue Za Zhi, 22 (1999) 604. — 11. GARDNER E, Anat Rec 101 (1948) 109. — 12. MCCONNELL J, Clin Sports Med, 21 (2002) 363. — 13. SADDIK D, MCNALLY EG, RICHARDSON M, Skeletal Radiol, 33 (2004) 433. — 14. BENNELL K, HODGES, P, MELLOR R, BEXANDER C, SOUVLIS T, J Orthop Res, 22 (2004) 116. — 15. DANIELSON P, ANDERSSON G, ALFREDSON H, Knee Surg Sports Traumatol Arthrosc, 17 (2008) 1841. — 16. OSTOJIC Z, MORO G., KVESIC A, ROTH S, BEKAVAC J, MANOJLOVIC S, Coll Antropol, 34 (2010) 243. — 17. SISLJAGIC V, JOVANOVIC S, MRCELA T, RADIC R, SELTHOFER R, MRCELA M, Coll Antropol, 34 (2010) 83.

N. Darabos

University of Zagreb, University Clinic for Traumatology, Draškovićeva 19, 10000 Zagreb, Croatia
e-mail: darabos.dr@vz.t-com.hr

????????????

SAŽETAK

Željeli smo odrediti moguću povezanost između prednje koljenske boli (AKP) i pozicije čavla označene kao udaljenost vrha čavla od tibijalnog platoa (NP) i od tuberositasa tibije (NT). Istražili smo poslijeoperacijske rezultate 50 bolesnika u posljednje 3 godine sa zaraslim prijelomom potkoljenične kosti primarno tretiranim intramedularnim (IM) boranim čavlom. Bolesnici su označavali točku na analognoj skali boli (VAS) koja je odgovarala stupnju poslijeoperacijske AKP koju su trpili. Formirano je dvije grupe bolesnika na temelju AKP: grupa A, sa boli, i grupa B, bez boli. Razlika između dvije grupe bolesnika bila je statistički značajna ($P < 0.05$) obzirom na mjerenje NP udaljenosti, no ne i obzirom na mjerenje NT udaljenosti. Simptomi AKP se nisu pojavili ako je vrh čavla bio za više od 6.0 mm udaljen od NP i više od 2.6 mm od NT. Pozicija čavla ima utjecaj na prednju koljensku bol nakon intramedularne osteosinteze prijeloma potkoljenične kosti.