

Intramedullary nailing treatment of proximal and distal tibia metaphyseal fractures. Medial parapatellar approach in semi-extended position

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ABSTRACT

Objective: To review the results of a series of metaphyseal tibial fractures treated with intramedullary nailing (IMN) in a semi-extended position using a medial parapatellar approach. To report reduction quality, bone consolidation, range of motion (ROM) and postoperative knee pain at final follow-up. **Materials and Method:** Twenty-three metaphyseal tibia fractures were treated with IMN. Twelve were distal tibial fractures (AO/OTA 43A), nine were proximal tibial fractures (AO/OTA 41A2/3), and two had segmental tibia fractures (AO/OTA 42C2). The minimum follow-up was 1 year. **Results:** Radiograph angulation at the fracture site was <5 degrees. All patients achieved bone healing. One patient (AO/OTA 42C2) required plate augmentation and bone autografting. Twenty-one out of 23 patients had knee pain scores of >20 according to the Lysholm scale. **Conclusion:** The parapatellar approach in a semi-extended position is a safe and useful technique for IMN of metaphyseal tibia fractures with no associated increased postoperative knee pain.

Key words: Metaphyseal tibial fracture; intramedullary nail; semi-extended position.

Level of Evidence: IV

Tratamiento con clavo endomedular de las fracturas metafisarias proximales y distales de tibia. Abordaje pararrotuliano medial en posición de semiextensión

RESUMEN

Objetivo: El enclavado endomedular de las fracturas metafisarias de tibia se asocia a algunas complicaciones relacionadas con la necesidad de flexionar la rodilla durante la introducción del clavo endomedular con la técnica infrarrotuliana clásica. Es por ello, que se han diseñado diferentes abordajes para la colocación del clavo en una posición de semiextensión de rodilla. El objetivo fue evaluar nuestros resultados, de forma retrospectiva, con el abordaje pararrotuliano medial en semiextensión, para el tratamiento de las fracturas metafisarias proximales y distales de tibia con clavo endomedular. **Materiales y Métodos:** Se incluyó a 23 pacientes con un seguimiento posoperatorio mínimo de un año. Doce eran fracturas distales de tibia; 9, proximales y 2, segmentarias. Se evaluaron el rango de movilidad de la rodilla, el dolor posoperatorio con la escala de Lysholm, el eje posoperatorio y la tasa de consolidación. **Resultados:** El arco de movilidad de la rodilla fue de 125° (110-140°). Al año de la cirugía, 16 de 23 pacientes no tenían dolor, 5 de 23 refirieron un leve dolor durante la actividad física y 2, dolores intensos durante la actividad física. En todos los casos, se consiguió un eje posoperatorio aceptable y la consolidación ósea. Un paciente requirió un aumento con una placa e injerto óseo. **Conclusión:** La colocación de un clavo de tibia a través de un abordaje pararrotuliano medial con la rodilla en semiextensión es una técnica segura y simple para el tratamiento de las fracturas metafisarias de tibia.

Palabras claves: Fracturas metafisarias de tibia; clavo endomedular; semiextensión.

Nivel de Evidencia: IV

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INTRODUCTION

Internal fixation using IMN is considered the first-choice method to treat tibial diaphyseal fractures. However, choosing the optimal treatment for tibial diaphyseal fractures (both proximal and distal) is far more controversial. Intramedullary nails, even large-diameter reamed nails, fail to achieve adequate nail-cortical contact in the wide metaphyseal medullary canal. Additionally, the poor fixation results provided by the use of blocking screws for nails designed for diaphyseal fractures have been associated with the high rate of postoperative misalignment as compared to plate fixations.¹⁻⁴ However, recently developed surgical techniques and improvements in the design of multidirectional locking screws have increased the interest of nailing in the fixation of tibial metaphyseal fractures.⁵

Tibial nail insertion using the infrapatellar approach hinders achieving and maintaining fracture reduction as it requires flexing the knee to access the portal. In order to avoid these difficulties, several approaches have been designed for nailing in a semi-extended position.⁶⁻⁸

The purpose of this study is to assess the results we have obtained using the tibial IMN technique via a semi-extended, medial parapatellar approach for the treatment of proximal and distal tibia metaphyseal fractures.

MATERIALS AND METHODS

Between January 2016 and December 2017, 57 patients underwent IMN of a tibial fracture. The inclusion criteria were: tibial fracture with proximal or distal metaphysis involvement, without articular extension, treated via a parapatellar approach, and with a follow-up period of at least 1 year. The exclusion criteria were: diaphyseal fractures, pathologic fractures, skeletally immature patients, follow-up periods of less than 1 year, and patellar tendon-splitting approaches. The application of inclusion and exclusion criteria resulted in a population of 23 patients.

All patients were initially underwent radiological evaluation (plain AP and lateral X-rays) of the leg and a CT evaluation of the knee or ankle, depending on the fracture location (Figure 1). There were 3 cases of open fractures, which were immediately managed with surgical debridement and external fixation as early stabilization. The open fractures were classified according to the Gustilo-Anderson classification.⁹ Patient demographics and fracture characteristics are summarized in the Table.

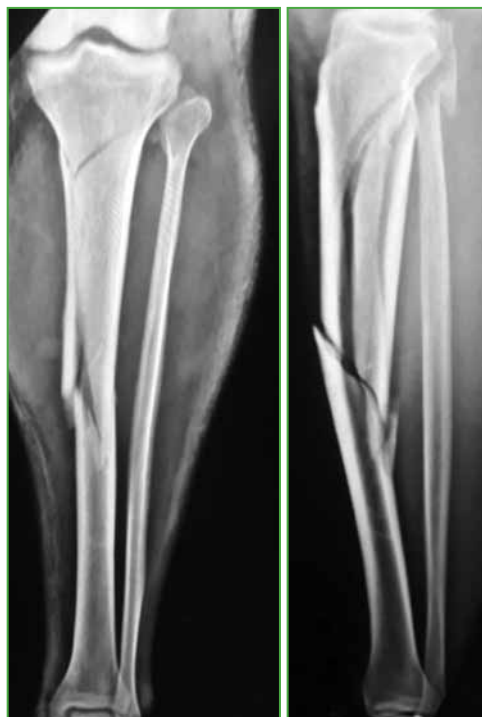


Figure 1. Case 11. A 41A.3 tibial fracture.

Table. Demographics

	Sex	Age	Side	AO/OTA Classification	Open?
1	M	33	L	41A.2	-
2	M	47	R	41A.2	-
3	F	29	R	43A.1	-
4	M	36	L	42C.2	3B
5	M	50	L	43A.3	-
6	M	76	L	43A.2	-
7	F	46	R	43A.1	-
8	F	55	L	42C.2	2
9	M	26	R	43A.3	-
10	M	48	R	41A.2	-
11	M	35	L	41A.3	-
12	F	30	R	43A.2	-
13	M	34	R	43A.3	-
14	F	36	L	43A.2	-
15	M	50	L	41A.3	-
16	F	76	L	43A.2	-
17	M	46	R	43A.1	3A
18	M	55	L	43A.1	-
19	F	26	R	41A.2	-
20	M	48	R	41A.2	-
21	M	35	L	41A.2	-
22	M	30	R	43A.	-
23	F	34	R	43A.3	-

F: female; L: left; M: Male; R: right.

The study variables were knee pain, knee range of motion (ROM), postoperative tibial alignment, and fracture consolidation rate. The Tegner-Lysholm scale was used to study the postoperative pain impact on the activities of daily living.¹⁰

The postoperative alignment was measured on the full-length AP and lateral leg films using a goniometer. Malalignment was defined as more than 5 degrees angulatory deformity in any plane. Our Center bone union criteria for tibial fractures are radiographic evidence of bridging callus across at least 3 of the 4 cortices and pain-free weight-bearing.

The average follow-up was 22 months (range, 12-38 months).

Surgical technique

The patients were placed in supine position on a radiolucent fracture table. A bolster was placed under the affected lower leg to obtain a 30-degree hip/knee flexion.

The first cases of our series involved oblique 5-6 cm skin incisions from the medial border of the patellar tendon distal insertion that extended medial to the border of the patella. In the last cases of our series, skin incisions were made just medial to midline. Deep incisions were made medial to the patellar tendon and extended through the distal two-thirds of the medial patellar retinaculum. This allows for patellar lateralization and exposure of the nail entry point (Figure 2).



Figure 2. Parapatellar medial approach. Skin incision slightly medial to the median line and medial parapatellar capsulotomy.

Procedures involved different strategies (percutaneous clamps, post screws, monocortical locking plates, femoral distractors), depending on fracture pattern, to achieve reduction. Semi-extended position of legs also facilitated reduction by neutralizing the muscle-deforming forces. To protect the articular cartilage during reaming, a 20 mm syringe was used (Figure 3).



Figure 3. Intramedullary reaming in semi-extended position.

The nail is impacted in a semi-extended leg, preventing the knee to extend, thus avoiding iatrogenic injury to the articular cartilage (Figure 4). The number and configuration of the locking mechanisms were established according to the fracture characteristics, making sure that at least two screws were used on the small fragment.



Figure 4. Tibia nailing with no need for changing the leg position.

Postoperative protocol

All patients began knee and ankle range-of-motion exercises early in the postoperative period. Progressive weight-bearing crutch was encouraged as tolerated.

RESULTS

Joint mobility

The average ROM at final follow-up was 125° (110-140°) for the affected leg compared to a 135° ROM for the contralateral knee.

Anterior knee pain

The results from the anterior knee pain using the Lysholm scale for the 23 patients were: 16 were painless (25/25); 5 had mild pain during physical activity (20/25); and the remaining 2 obtained Lysholm scores of ≤ 15 .

Malalignment

Adequate alignment ($<5^\circ$) was confirmed for all patients both with AP and lateral views in the immediate postoperative period. No patient presented residual displacement at the following follow-up controls.

Bone healing

Bone healing was achieved in all patients at a mean of 5 months (range, 3-10). One patient (4%) that had a segmental fracture (case 4) required augmentation at the proximal site with a plate over the nail supplemented with bone autograft to achieve bone healing (Figure 5).



Figure 5. Images taken in the distant postoperative period Reveal evidence of bone union and adequate alignment.

DISCUSSION

IMN is considered the first-choice treatment for tibial diaphyseal fractures. However, metaphyseal fractures present an inadequate nail-cortical contact in their wide medullary canal which hinders achieving good results. Although there are reported data of malalignment rates of up to 58% following proximal tibial fractures treated with IMN^{2,3,5} and up to 29% for distal tibial fractures,¹¹ recently developed surgical techniques and improvements in nail design have achieved malalignment rates comparable to those of plating techniques. There are no current comparative studies that demonstrate any clear difference in favor of either plating or nailing treatments for these fractures. However, based on the biomechanical advantages of nailing over plating, we chose the IMN as our first-choice treatment for proximal and distal tibia diaphyseal fractures.

In 2006, Nork *et al.* reported the results of their series of 37 patients with proximal tibial fractures treated with IMN using the infrapatellar approach. They stressed the difficulty associated with maintaining reduction during the procedure and that in 27 out of the 37 cases supplemental methods were required to assist maintaining reduction, including unicortical plating and placing a femoral distractor. Acceptable postoperative alignment was obtained in 34 out of the 37 cases.¹²

Aiming at simplifying the technique, other approaches have been developed, such as the suprapatellar⁸ and the parapatellar⁶ approaches, to place the nail in a semi-extended knee position so as to neutralize the forces of the extensor mechanism and to avoid leg manipulation during canal reaming and implant insertion.

In 1996, Tornetta *et al.*⁶ developed the medial parapatellar approach, which allows for lateral subluxation and nail placement in the semi-extended position and so reduces the risk of damaging the patellofemoral articular cartilage. They achieved acceptable alignments in 23 out of the 25 patients of their series. They reported as an additional benefit the parapatellar approach less fluoroscopy time as compared to the traditional infrapatellar technique.

Another of the most recent approaches reported for tibia nailing in semiextension is the suprapatellar approach, via an incision along the quadriceps tendon.⁸ This approach requires using specific nailing set to avoid damaging the patellofemoral articular cartilage during canal reaming and nail insertion. In 2014, Sanders *et al.* reported close

to zero patellofemoral joint damage following the IMN of 51 diaphyseal tibial fractures using a suprapatellar portal. They stressed that their series rate of postoperative anterior knee pain was even lower than the rates reported for the traditional infrapatellar technique.¹³

The same year, Tornetta *et al.* reported a series of 185 tibial fractures, including 84 fractures of the proximal or distal metaphysis, that were treated with IMN using a parapatellar approach. Acceptable postoperative alignment was achieved in all cases. Additionally, they studied the postoperative knee pain and found no significant difference at a 2.3-year follow-up between their approach and the traditional infrapatellar approach.¹⁴

In 2019, Kubiak *et al.* presented a randomized comparative study on postoperative knee pain between the semi-extended, parapatellar lateral technique vs. the traditional infrapatellar technique. The study reported that less knee pain scores were found in the group of patients that underwent surgery using the parapatellar technique.¹⁵

Ibrahim *et al.* published a literature review comprised mainly by comparative studies between semi-extended nailing versus traditional infrapatellar approaches, and concluded that the semi-extended technique provides better postoperative knee pain and functional outcomes.¹⁶

Mitchel *et al.* addressed the risks inherent to the intra-articular approach, even in open tibia fractures. They studied 131 open tibia fractures treated with IMN using a suprapatellar approach and reported greater risk of septic arthritis using a suprapatellar portal as compared with an infrapatellar one.¹⁷

In consistent with the aforementioned authors, our findings suggest that using the semi-extended, parapatellar technique is easier to achieve and maintain fracture reduction during canal reaming and nail insertion. This technique allowed us to perform, whenever necessary, the distal interlocking of the nail without leg manipulation and to follow by using the “back-slapping” technique to achieve the desired compression of the fracture. Additionally, this technique offers the advantage of performing the entire procedure using a standard nailing set, which is not possible when using the suprapatellar technique. Finally, we consider another advantage of this technique to be the possibility to perform the surgery using a more accurate and efficient C-arm visualization.

The limitations of our study include the failure to conduct a deeper and more systematic analysis of the postoperative patellofemoral joint, the low number of study subjects, and the lack of a control group with the traditional infrapatellar technique.

CONCLUSION

The parapatellar approach in a semi-extended position is a safe and useful technique for IMN of metaphyseal tibia fractures that provides excellent outcomes regarding bone healing and alignment with no associated increased postoperative knee pain.

Conflict of interests: Authors claim they do not have any conflict of interests.

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