

Treatment of distal tibia end fractures by minimally invasive plate osteosynthesis

Distal tibia end fractures treated by MIPO

Quang-Tri Lê, Ngoc-Thanh Do, Minh-Hoang Nguyen, Huu-Hung Phan

Department of Orthopedics, 7A Military Hospital, 466 Nguyen Trai Street, Ward 8, District 5, Ho Chi Minh City, 72706, Viet Nam

Abstract

Aim: Distal tibia fractures are common in daily accidents such as traffic, work, and sports accidents. There are various treatment methods for that injury, such as casting, external fixation, and AO screw and plate fixation. However, in the cases of distal tibia fractures occurred near the ankle joint with damaged soft tissues near the fractures, minimally invasive plate osteosynthesis using the locking compression plate is a suitable fixation method. This study aimed to evaluate the bone union, functional rehabilitation, and assessment of complications of treatment of distal tibia fractures by minimally invasive plate osteosynthesis in 7A Military Hospital.

Material and Methods: This prospective cohort study was performed on 38 patients with distal tibia fractures treated from October 2014 to October 2019 in our hospital. Patients were treated with internal fixation using minimally invasive plate osteosynthesis with locking compression plate, and they were monitored for bone fusion for functional rehabilitation, and the complications were evaluated.

Results: The average monitor time was 12.5 months after the operation and the outcomes were assessed based on the American Orthopedic Foot and Ankle Score, as a result of which 24 cases (63.2%) were "very good" 10 cases (26.3%) were "good" and 4 cases (10.5%) were "fair".

Discussion: Minimal invasive plate osteosynthesis provided both postoperative and rehabilitation generally satisfied outcomes. The results were comparable to other authors. Further researches with a larger sample size are needed for better evaluation and optimal protocol conclusion.

Conclusion: Minimally invasive plate osteosynthesis was a suitable method for the treatment of distal tibia fractures as indirect reduction technique and small incision reduce damages on soft tissues during the operation.

Keywords

Distal Tibia; Fractures; Minimally Invasive; Osteosynthesis; Locking Compression; Bone Union; Functional Rehabilitation

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Corresponding Author: Quang-Tri Le, Director of 7A Military Hospital, Head of Department of Orthopedics, Head of Department of High-Tech Diagnostics, 466 Nguyen Trai Street, Ward 8, District 5, Ho Chi Minh City, 72706, Viet Nam

E-mail: lqtri@ntt.edu.vn; tsbstri@yahoo.com P: (+084)0839241868, (+084)0913126229

Corresponding Author ORCID ID: <https://orcid.org/0000-0002-2777-0828>

Introduction

Distal tibia fractures are common in orthopedics accounting for 1-5% of the lower limb and 7-10% of lower leg fractures [1,2]. Due to the limit of soft tissues and poor blood supply nature of the area, treating distal tibia fractures is a challenge and quickly poses complications such as open fractures, infections, and slow bone reunion. Careful consideration of various aspects such as fracture patterns, bone quality, and soft tissue injuries is needed when deciding appropriate treatments to ensure optimal results. There is a variety of treatments to be used, such as casting, open reduction with screw-plate fixation, and external fixation.

Minimally invasive plate osteosynthesis (MIPO) was developed to eliminate the extensive surgery to expose the fracture site. Only two small incisions are made near both ends of the fracture site. A plate then inserted through an epi-periosteal tunnel that links the two incisions and is screwed in both ends to stabilize the fracture. MIPO helps significantly reduce operation and hospitalization time comparing to the open surgery approach. It also permits the conservation of soft tissues and feeding blood vessels, reduces infection and non-union risks, and enables quick ankle joint movement after surgery.

MIPO treatment for distal tibia fractures with positive outcomes was reported worldwide [2-6]. For further research of this technique, we carried out the study on the treatment of distal tibia end fractures using minimally invasive plate osteosynthesis in 7A Military Hospital (Ho Chi Minh City, Viet Nam) in order to evaluate bone union, functional rehabilitation, and to assess the complications of treatment using this method.

Material and Methods

Experimental participants

This study was performed on 38 patients with distal tibia fractures (based on A/O classification) treated with MIPO using locking compression plate from October 2014 to October 2019. The criteria for selection were patients aged over 18 with closed distal tibia fractures based on A/O classification, having no contra-indication against surgery or anesthesia, and monitored for at least six months. The criteria for rejection include patients with pathologic fractures or multiple injuries.

Research methods

This study was a prospective cohort study with longitudinal description. The patients were given explanations about the surgery and underwent pre-operative examinations and tests. C-Arm machine, orthopedics operative table, and tools were prepared. Spinal anesthesia or endotracheal anesthesia was applied to the patients. A surgical tourniquet was employed at the thigh base for a maximum of 90 minutes and should exert a pressure of 350 - 400 mmHg.

The surgical procedure was performed in the following way [3,6]:

1. The patients lied in supine posture on the operation table.
2. If the patients had accompanied fistula fracture, the fistula had to be treated first with screw-plate or K-wire fixation.
3. The compressive locking plate must fit the size of the distal tibia fracture and had to be prepared beforehand.
4. The skin-projected position of the plate was located and the positions of the proximal and distal ends of the plate were

identified for the convenience of screw installation.

5. Skin incisions were made at the distal and proximal ends of the plate following the anterior-medial line of the tibia; the incisions were 2- 3 cm apart each other and dissected all subcutaneous layers.

6. An internal dissection of the subcutaneous tissues was made and the plate was inserted below the skin layer.

7. The bone axis and the large fragment were manually reduced (with the assistance of towel clips) by the sagittal plane.

8. Sagittal and coronal planes of the fractures were monitored using C-Arm machine to ensure a proper reduction of the bone fragments.

9. One distal screw was inserted and the distal deviation was micro-adjusted.

10. One proximal screw was inserted.

11. The sagittal and coronal deviations were micro-adjusted and the remaining screws were inserted.

12. The skin was sutured.

Post-operative care was as follows: antibiotics, analgesics, and anti-inflammatory agents were administered to the patients. The leg was put in a high position to prevent swelling and to take care of the surgical wound. The patients then had early post-operative ankle joint exercise. The patients could be discharged 3 - 5 days after the operation when the surgical wound became clean and dry, swelling reduced and active ankle and knee joints movements were possible.

Post-operative physical therapy was as follows: the patients had light angular exercise of the ankle joints 24 hours after surgery. After two weeks as swelling reduced, the plate could be removed and back and ankle angular exercises and ankle rotational exercises were started. After one month, the patients started ankle exercise with a gradual increase of resistance. After three months, the patients began walking and allowed weight bearing on the treated limb. After six months, the patients could walk normally. Treatment outcomes assessment was based on post-operative radiography, bone union and rehabilitation, and complications.

Ethics Committee Approval: Medicine Scientific Research Ethics Committee of the 7A Military Hospital approved this study (Number: 134/QĐ-HĐYD-BV7A, date: 18.05.2014)

Results

Patient general information

The patients were from 18 to 58 years of age; the average age was 36.4 years. There were more males (28 patients, accounting for 73.7%) than females (10 patients, 26.3%), and male/female ratio was 2.8/1. The leading cause for fractures was traffic accidents, 20 cases accounted for 52.6%, then workplace accident (15 cases, 39.5%), and sport accident (3 cases, 7.9%).

The average hospital stay-in was 4.9 days, and post-operative monitor time was 12.5 months.

Types of distal tibia fractures based on A/O classification

The distal tibia fracture types of studied patients were based on A/O classification [7, 8]. A1 type was the most frequent fracture types with 14 cases and accounted for 36.8%; A2, A3, and C1 types were in 11 cases (28.9%), 10 cases (26.4%), and 3 cases (7.9%), respectively.

Fibula accompanying fractures

In this study, 20/38 cases (52.6%) had accompanying fibula fractures. Amongst them, 16 cases (80%, n=20) had fibula fractures with significant deviation and unstable ankle joints; these cases were treated with the screw-plate fixations for the fibula. Four remaining cases (20%, n=20) only had small deviation and needed no fibula fusion, only required additional foot casting.

Post-operative radiography results

In the post-operative radiography results [9], the majority was “Very good” in 22 cases, accounting for 57.9%; “Good” and “Fair” results were 11 cases (28.9%) and 5 cases (13.2%), respectively. There was no case with the “Poor” result.

Bone union results based on A/O classification

In our study, all 38 patients had bone union in minimum of 16 weeks and maximum of 23 weeks.

The time for bone union by fracture type was listed in Table 1. A1 fractures had significantly faster union than A2, A3, and C1 ($p < 0.001$, ANOVA test).

Functional rehabilitation outcomes

Rehabilitation based on patients’ subjective remarks: 34 cases had no ankle pain, and 4 had slight ankle pain within an acceptable level. For daily activities, 37 cases reported no difficulties in regular walking, 1 case reported challenges in moving up and down the stairs.

Rehabilitation based on objective criteria:

The dorsiflexion, plantarflexion, eversion, inversion ankle range of motion were 18.4o, 47.8o, 16.9o and 17.4o, respectively. Angular motion usually recovered faster than other kinds of motion. Based on American Orthopedic Foot and Ankle Score [2, 3, 9], “Very good” and “good” outcomes took place in 89.5% cases and “fair” in 10.5% cases.

Complications

Infections took place in one patient and slow union in one patient. No patient had joint stiffness or non-union.

Table 1. Bone union time based on A/O classification

Classification	Patient number	Union time (weeks)		
		Shortest time	Longest time	Average time
A1	14	16	19	17.04 (0.74)
A2	11	17	20	18.42 (0.16)
A3	10	19	22	19.53 (0.74)
C1	3	19	24	21.05 (1.05)

Discussion

Minimally invasive surgery is a surgical method commonly applied in many sectors [10,11], including treatment of bone injuries as, for example, it minimizes damages on soft tissue, improves healing time, reduces decubitus complications, and enables weight bearing when possible [12,13].

In this study, the minimally invasive plate osteosynthesis was employed to treat the distal tibia fragment of 38 patients in the 7A Military Hospital, and the observed results were promising.



Figure 1. Pre- and post-operative radiography

Bone union was achieved in all the cases; radiographs showed positive outcomes generally. Post-operative complications were very few with one infection and one slow union in thirty cases; few or no complication was also reported in other literature [1, 13-15] and the complications were treated successfully.

The average time for bone union in this study within an average time of 18.7 weeks is comparable with Sanjay and Sanjay (2018) study (about 18 weeks); This result is faster than in the reports by Chandrakant and Martand (2018) [16] and Daolagupu et al. (2017) [17] (about 19 weeks and 21.7 weeks, respectively); and slower than in the study by Serban et al. (1997) [1] (about 17 weeks).

Our result can be considered as comparable with the mentioned authors, but further researches with larger samples are necessary.

Postoperative rehabilitation outcomes were generally positive in this study. Pain level was mostly nonexistence or very little and there was no interference on postoperative daily activities. Ankle range of motion in dorsiflexion and plantarflexion were 18.4o and 47.8o, respectively, which was better than the study of Helfet et al. (1997) (14 o and 42 o, respectively) [13]. Based on American Orthopedic Foot and Ankle Score, the “good” and “very good” outcome in this study (89.5%, 34/38 patients) was similar to results report by Supe et al. (2016) [2] (93.8% of the total 32 patients) and Hegazy et al. (2015) [3] (86.7% of the total

30 patients). The study by Chandrakant and Martand (2018) reported an average score of 89.9 in 32 investigated patients [16]; the results were also compatible with our research.

In general, our study result was satisfactory; still, further researches are needed to evaluate the treatment outcomes better and devise a more accurate treatment protocol for these kinds of injuries [18].

Conclusion

Thirty patients with distal tibia fractures were treated using minimally invasive plate osteosynthesis with locking compressive plate from October 2014 to October 2019 at the 7A Military Hospital, Ho Chi Minh City, Vietnam. Based on this study, it can be concluded that this method only required small incisions, reduced infection risks, promote bone union rate, enabled early post-operative ankle joint exercises. The treatment outcomes of this method were very encouraging. Further researches with larger samples are necessary to evaluate the treatment outcomes better and devise a more accurate treatment protocol for this kind of injuries.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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Conflict of interest

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