Anteromedial and Anterolateral Dynamic Compression Plating in Tibial Diaphyseal Fractures

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Rational: *Treatment of tibial shaft fractures with dynamic compression plates provides results equal to closed interlocking nails but results in a lower incidence of malalignment. Anteromedial plating offers a biomechanical advantage because the plate is fixed on the tension side of the tibia. A disadvantage of anteromedial dynamic compression plates, however, is a higher infection rate than with anterolateral plating.*

Objectives: *This research aimed to compare the results and complications of treatment of tibial diaphyseal fractures with anteromedial and with anterolateral plating.*

Methods: *This retrospective study compared patients with tibial shaft fractures who had undergone surgery between 1 January 2010 and 31 December 2014 using dynamic compression plates: 96 with anteromedial plating and 84 with anterolateral plating.*

Results: *Of anteromedial plating cases, two were found to have non-union, eight had infection, and there were no instances of malalignment. Among the cases of anterolateral plating, there was one non-union, one case of infection, and no cases of malalignment. There were no significant differences in rates of non-union or malalignment between the two plating methods ($p < 0.05$). The infection rate in the anterolateral group, however, was significantly lower than that in the anteromedial group ($p < 0.05$).*

Conclusions: *Treatment of tibial diaphyseal fractures both with anterolateral and with anteromedial dynamic compression plates show an equally satisfactory union rate and incidence malalignment; however, anterolateral plating has a significantly lower infection rate.*

Keywords: *Anteromedial plating, anterolateral plating, dynamic compression plate, diaphyseal fracture, tibia*

The Thai Journal of Orthopaedic Surgery: 42 No.3-4: 24-28
Full text. e journal: *http://www.rcost.or.th, http://thailand.digitaljournals.org/index.php/JRCOST*

Introduction

Tibial diaphyseal fractures are the most common type of shaft fracture. The current gold standard treatment for this type of fracture is closed interlocking nailing[1]. That treatment destroys less tissue and results in fewer complications than dynamic compression plates, so patients recover sooner. However, malalignment is more likely to occur with interlocking nails than with plates and screws, especially on the proximal and distal tibia[1-4]. Additionally, using interlocking nails requires fluoroscopy, resulting in radiation exposure. The operation also takes longer than with plates and screws.

Treatment of tibial diaphyseal fractures with a dynamic compression plate (DCP), which was developed before intramedullary nailing, provides fairly good results[16]. Dynamic compression plates are the preferred treatment for patients with tibial diaphyseal fractures in Asia and South Africa, in young patients, and in patients with small or deformed intramedullary cavities, especially those with compartment syndrome[4].

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According to Ruedi, Webb and Allgower (1976), the results of treatment with AO/ASIF dynamic compression plates among the patients with acute fractures are satisfactory: a success rate of 98.1% in closed fractures and 88.4% in open fractures. As for complication rates, in closed-fracture tibias the non-union rate and the infection rate were both 1%, while in open-fracture tibias, the non-union rate was 5.3% and the infection rate was 1.6%[5].

In simple fractures, anteromedial plating is applied because plating on the tension side enhances the coordination between the tension-band and compression plates. However, in comminuted fractures, plates are fixed to function as bridging plates. In those cases, as little tissue and periosteum as possible is removed. Nevertheless, anteromedial plating has a high incidence of complications, especially soft-tissue problems and infections[1,4] because the tissues on that side are quite thin. Presently, locking compression plates (LCP) are commonly used for treatment of tibial diaphyseal fractures because they are strong fixed-angle devices with high pullout strength. In addition, since they do not press against the periosteum, blood can flow freely to the fractured parts, especially when the minimally invasive plate osteosynthesis[7-15] (MIPO) technique is used. One drawback of LCP is that the cost is higher than

dynamic compression plates. Fixation of plates on the anterolateral side, or submuscular plating, probably reduces the incidence of complications caused by plating. This study compared the results of treatment of tibial diaphyseal fractures with anteromedial and with anterolateral plating using dynamic compression plates including subsequent complications, e.g., infection rates, non-union rates, and malalignment.

Materials and Methods

In this retrospective study, the subjects were tibial diaphyseal fracture patients who had undergone treatment at Sunprasitthiprasong Hospital in Ubon Ratchathani province between 1 January 2009 and 31 December 2015. The research was approved by the Sunprasitthiprasong Hospital Ethics Committee for Human Research. One requirement for inclusion in the study was that the patient had been given definitive treatment with dynamic compression plates (DCP) and received follow-up care until healing or for at least 9 months with no indications of nonunion as defined by the U.S. FDA. This research excluded patients who had undergone other treatment procedures prior to the definitive treatment, e.g., external fixators. Also excluded were patients with a high risk of infection, e.g., immune deficiency, uncontrolled diabetes, venous ulcer, and arterial insufficiency, as well as patients treated for non-union with dynamic compression plates, those with skin infection or skin diseases, e.g., cellulitis, psoriasis, dermatitis, and dermatophyte, and patients with pathological fractures. The Sunprasitthiprasong Hospital treats about 120 cases of tibial shaft fracture per year. The author recruited cases with ICD 10: S82.2* from the hospital database. Two groups of 150 patients each were retrospectively studied: Group I was patients treated with anteromedial DCP and Group II was patients treated with anterolateral DCP. The orthopedist performing the surgery selected the plate position based on the degree of soft tissue injuries. Each patient's previous medical records and X-ray films, information on non-union, deep infection, and malalignment (>10 degrees) were also collected and analyzed (Figure 1).

(A) (B)

Fig. 1 Treatment of tibial diaphyseal fractures with anteromedial (A) and anterolateral (B) dynamic compression plates

Results

Table 1 General Information

Demographic Data	Anteromedial group	Anterolateral group	*p*-value
Sex (Total)	96	84	
- Male	66	30	0.07
- Female	49	35	0.07
Age (mean) yrs.			
- Male	32.74	38.34	0.07
- Female	33.15	38.13	0.73
Comorbidity			
- Diabetes mellitus	6	9	0.152
Fracture type			
- Closed fracture			
- Open fracture Gr.I	76	62	0.12
- Open fracture Gr.II	19	15	0.12
	1	7	0.02*

*Statistically significant

Table 2 Results of the study

Study group	No. patients	Non-union	Infection	Malalignment
Anteromedial DCP	96	2	8	0
Anterolateral DCP	84	1	1	0

The author initially recruited 150 cases in each groups, but some patients were lost to follow-up (54 cases in anteromedial group and 66 case in anterolateral group) due to economic problems or migration.

Of the tibial diaphyseal fractures treated at Sunprasitthiprasong Hospital in Ubon Ratchathani province between 1 January 2009 and 31 December 2015, 96 cases were treated with anteromedial DCP and 84 cases with anterolateral DCP. Statistical analysis found no significant differences sex, age and comorbidity (diabetes mellitus) between the two groups.

In the anteromedial group, there were two cases of non-union and eight cases of infection; in the anterolateral group, there was one case of non-union and one case of infection. The difference in the non-union rate was not statistically significant (Z-score = 0.4668; *p*-value = 0.63836), but the infection rate in the anteromedial group was significantly higher than the anterolateral group (Z-score = 2.1936; *p*-value = 0.002852). No malalignment > 10^{o} was found in either group (Table 2).

Discussion

Tibial diaphyseal fractures are one of the most frequent shaft fracture. Although closed interlocking nailing is generally considered the gold standard treatment for this kind of fracture, it is usually accompanied by some issues including surgical equipment, longer operating time and radiation exposure from fluoroscopes. For that reason, treatment with dynamic compression plates (DCP) is widely applied because it provides equally good results while avoiding those issues. Dynamic compression plates are frequently applied for tibial diaphyseal fractures in Asia and South Africa probably because people in these regions, especially children, have smaller bones than Europeans. Additionally, in patients prone to compartment syndrome, intramedullary nails provide the result in higher pressure on the compartment which may can lead to compartment syndrome.

This research found infection rates lower than those reported by Ruedi, Webb and Allgower, that is, 8.3% (8/96) in the anteromedial plating group and 1.2% (1/84) in the anteromedial group. In this study, infected plates were found in both closed and open fractures. There were eight case of infection in the anteromedial group: five in closed fractures, two in grade I open fractures, and one in a grade II open fracture. In the anterolateral group there was only one infection in a grade II open fracture. Reasons for this difference include that only closed tibial shaft fractures and open fractures grade I or II were included in the present study, there have been improvements in soft tissue preservation and surgical techniques, and more effective antibiotics have become available. The author excluded cases of open fractures of grade III as well as more complex comminuted fractures related with other which required additional procedures, e.g., locking compression plates, external fixation, and intramedullary nailing.

Anteromedial plating involves plating on the tension side of the tibial shaft where tissue coverage is thinner than of other muscle-covered bones. As dynamic compression plates are likely to press directly against the periosteum, tissue necrosis often occurs and patients are more infection prone, especially those with open fracture wounds as those are usually on the anteromedial side. The end result is that anteromedial plating in open fractures has a high incidence of infection. Patients with this type of fracture are usually treated with disinfection, debridement, long leg slab or external fixators, as well as later definite treatment; those patients were excluded from this study.

Several techniques, e.g., minimally invasive plate osteosynthesis (MIPO) and anterolateral plating, have been developed which reduce the incidence of infection and improve union rates. Those techniques also help preserve soft tissue.

Even though coverage of muscles with anterolateral plating helps reduce infection, one biomechanical drawback of this method is that plating on the compression side may cause varus deformity of the tibial shaft especially in comminuted fractures despite even with prebent plates. Thus it is advisable to treat with locking compression plates (LCP) in anterolateral plating which, in addition to helping prevent varus tibial shaft deformity, also provides angular stability. Another advantage of LCP is reduced incidence of infection because the plate does not press against the periosteum, allowing improved blood to flow to the fracture area and avoiding the occurrence of necrotic tissue. Disadvantages of this form of plating is high cost.

The incidence of infection among patients with diabetes was not significantly different between the two groups. Analysis of the

relationship of infections and other comorbidities, e.g., smoking, obesity, and medications, was not possible as the available data was not sufficiently reliable. This study tried to exclude factors that could potentially interfere with bone union and result in infection. For that reason, patients taking medications such as antiviral drugs and those receiving chemotherapy were excluded from the study.

The union rate with both anteromedial and anterolateral plating were very high, 97.9% and 98.8%, respectively. Soft tissue preservative surgical techniques such as those specified in the AO principles and dynamic compression plates were selected for use with simple bone fractures (AO Classification 42-A, 42-B1, 42-B2) to help ensure fractures healed before any implant failure occurred.

No malalignments > 10^{o} were found in either group. Alignment evaluation in open reductions was done by direct inspection. In cases using the MIPO technique, fluoroscopic intersurgical inspection was necessary.

Conclusions

Although intramedullary nailing is the current gold standard for treatment of tibia diaphyseal fractures, treatment with plates and screws is effective in hospitals cases where insertion of intramedullary nailing is not possible. It is effective in patients who are well qualified and where soft tissue preservative surgical techniques (AO principles) are employed. Treatment of tibial diaphyseal fractures with dynamic compression plates provides satisfactory results in terms of union rate, incidence of malalignment, and infection rate. Anterolateral plating significantly reduces infection rates in tibial shaft fractures compared with anteromedial plating.

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เปรียบเทียบผลการรักษากระดูกหน้าแข้งหักด้วยแผ่นโลหะดามกระดูกทางด้าน Anteromedial และ Anterolateral

รัฐศาสตร์ สุดหนองบัว, พบ

วัตถุประสงค์: *Dynamic compression plate มีผลการรักษาที่ดีใกล้เคียงกับ Closed Interlocking Nail โดยเฉพาะการผิดรูปน้อยกว่าในการรักษากระดูกหน้าแข้งหัก การวางแผ่นโลหะดามกระดูกบริเวณ Anteromedial ในกระดูกหน้าแข้งมีข้อดีในเรื่อง Biomechanics เนื่องจากเป็นด้าน Tension side แต่มีข้อเสียคือมีการติดเชื้อสูงกว่าการวางด้าน Anterolateral การศึกษานี้จึงเป็นการศึกษาเปรียบเทียบผลการรักษากระดูกหน้าแข้งหักด้วยการวางแผ่นโลหะดามกระดูกด้าน Anteromedial และ Anterolateral*

วิธีการศึกษา: *Retrospective study ในผู้ป่วยกระดูกหน้าแข้งหักที่ได้รับการผ่าตัด ใส่แผ่นโลหะดามกระดูกแบบ Dynamic Compression Plate ในระหว่างวันที่ 1 มกราคม พ.ศ. 2553 - 31 ธันวาคม พ.ศ. 2557*

ผลการศึกษา: *ผู้ป่วยกระดูกหน้าแข้งหักที่ได้รับการผ่าตัดวางแผ่นโลหะดามกระดูกแบบ Dynamic Compression Plate ทางด้าน Anteromedial จำนวน 96 ราย พบกระดูกไม่ติด 2 ราย ติดเชื้อที่โลหะดามกระดูก 8 ราย ไม่พบกระดูกติดผิดรูป ส่วนด้าน Anterolateral จำนวน 84 ราย พบกระดูกไม่ติด 1 ราย ติดเชื้อที่โลหะดามกระดูก 1 ราย และ ไม่พบกระดูกติดผิดรูป ผลการศึกษาพบว่า กระดูกไม่ติด และ กระดูกติดผิดรูป ทั้งสองกลุ่มไม่มีความแตกต่างกันอย่างมีนัยสำคัญทางสถิติ ($p < 0.05$) แต่การติดเชื้อที่โลหะดามกระดูก ในกลุ่ม Anterolateral ต่ำกว่ากลุ่ม Anteromedial อย่างมีนัยสำคัญทางสถิติ ($p < 0.05$)*

สรุป: *การรักษากระดูกหน้าแข้งหักด้วยแผ่นโลหะดามกระดูกแบบ Dynamic compression plate ให้ผลการรักษาที่ดีทั้งในด้านอัตราการติดของกระดูก การติดผิดรูปของกระดูก และอัตราการติดเชื้อ โดยเฉพาะการวางแผ่นโลหะดามกระดูกด้าน Anterolateral สามารถลดอัตราการติดเชื้อได้อย่างมีนัยสำคัญเมื่อเปรียบเทียบกับการวางด้าน Anteromedial*