BRIEF REPORT

Staged Treatment of Proximal Tibial Fracture Using External Locking Compression Plate

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Objective: To share our preliminary clinical success and failure with using an external locking compression plate (LCP) for proximal tibial fractures, further refine the indications for this procedure and review relevant published reports.

Methods: The current study reports two cases of proximal tibial fracture treated with external LCP as the second stage of a two-stage treatment. One patient was a 59-year-old man with a closed proximal tibial/fibular fracture caused by falling on ice while getting out of his car, and another patient was a 42-year-old male smoker with right comminuted proximal tibia, tibial plateau and proximal fibular fractures. The outcomes were evaluated by radiographs and weight bearing status.

Results: In the first case, the fracture healed uneventfully whereas the second case required further open-reduction with internal fixation because correct alignment could not be achieved with an external LCP.

Conclusion: Correct alignment of proximal tibial fractures followed by use of an external LCP can achieve favorable outcomes.

Key words: Locking compression plate; Proximal tibial fracture; Standard external fixator; Two-stage treatment

Introduction

Proximal tibial fractures (AO/OTA classification 41), which are frequently caused by high-energy trauma, continue to be challenging to treat and are associated with a high incidence of complications, including neurologic compromise and vascular injury¹⁻³. It has been reported that 90% of undisplaced tibial plateau fractures have associated meniscal, cruciate or collateral ligament tears⁴. An increasingly accepted technique for managing patients with multiple trauma, such as those whose proximal tibial fractures were caused by high-energy trauma, is damage control orthopedics, in which the least invasive method, namely temporary external fixation, is used to rapidly stabilize patients⁵. Definitive treatment has traditionally been open reduction and internal fixation (ORIF); this may be associated with complications such as

soft tissue damage and infection⁶. Kloen was recently the first to describe treating such fractures with external locking compression plates (LCP) and fixation, an approach that is gaining renewed interest⁷. Currently, there are few published reports concerning treating proximal tibial fractures by combining temporary external fixator with definitive external LCP.

This report presents two patients whose proximal tibial fractures were treated in two stages. The first stage involves a temporary standard external fixator and the second stage a definitive external LCP. One of our cases had good short-term results whereas the other required ORIF revision. Hopefully, our experience with using external LCP for proximal tibial fractures will further refine the indications for this procedure and achieve better outcomes.

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Disclosure: The authors declare that they have no conflicts of interest in the creation and publication of this manuscript and received no funding to assist in its completion. Patient identifiers have been removed and this project had prior Institutional Review Board approval.

Received 31 October 2013; accepted 19 February 2014

Fig. 1 A 59-year-old man (case 1). Preoperative (a) antero-posterior and (b) lateral radiographs of proximal tibial and fibular fractures. Postoperative (c) antero-posterior and (d) lateral radiographs of proximal tibial and fibular fractures with temporary standard external fixator. (e) View of external LCP applied to the proximal tibia 6 weeks after the causative accident. Postoperative (f) antero-posterior and (g) lateral views of external LCP. (h) Antero-posterior and (i) lateral radiographs after external LCP had been removed.

Materials and Methods

Case 1

A 59-year-old man was transferred to our institution from another hospital because of a closed proximal tibial/fibular fracture caused by falling on ice while getting out of his car. On examination, there was right leg swelling, limited range of motion due to pain, tenderness to palpation and the skin was abraded with ecchymoses. Radiographs showed proximal tibial and fibular fractures (Fig. 1a and 1b). Because of medical comorbidities, including alcoholism and delirium tremens, surgery was delayed until the following day. The plan was to perform external fixation rather than open-reduction with internal fixation because his skin quality was poor.

The day after admission, he underwent closed reduction of the right tibia and fibula, which was confirmed fluoroscopically. Further reduction and alignment adjustments were made with a standard external fixator spanning the tibia (Fig. 1c and 1d). The external fixator was removed after four weeks, at which time intraoperative fluoroscopy confirmed that the alignment and reduction was appropriate, and an external LCP was fitted (Fig. 1e, 1f, and 1g). The patient started incremental range of motion exercises and weight-bearing as tolerated.

Two months later the external LCP was removed. The patient was then able to flex to 140° range of motion, was weight-bearing with no pain on the side of the fracture and radiography showed callus at the fracture site (Fig. 1h and 1i). Thus, the fracture was clinically healed.

Fig. 2 A 42-year-old man (case 2) with proximal tibial and fibular fractures. Preoperative (a) antero-posterior and (b) lateral radiographs. Postoperative (c) antero-posterior and (d) lateral radiographs of temporary standard external fixator. Postoperative (e) antero-posterior and (f) lateral radiographs of external LCP. (g) Antero-posterior and (h) lateral radiographs after removal of external LCP showing delayed union. (i) Antero-posterior and (j) lateral after performing ORIF.

Case 2

A 42-year-old male smoker was transferred from another hospital after a motorcycle accident had resulted in right comminuted proximal tibia, tibial plateau and proximal fibular fractures (Fig. 2a and 2b). On admission to our institution, he was found to have right lower extremity swelling and deformity in the proximal tibial area and any movement resulted in excruciating pain. An anterior bone fragment was tenting the skin, raising concern about possible soft tissue compromise with skin necrosis.

Within 10 hours of admission, closed reduction was performed and a standard external fixator spanning the right knee fitted (Fig. 2c and 2d). The right knee joint yielded over 100 mL of bloody aspirate. After this procedure, there were no longer any signs of skin tenting. The right knee was aspirated once again postoperatively. The external fixator was adjusted to align the medial proximal tibia compressed fracture; however, this was unsuccessful, likely because the medial ligaments and capsule of the knee shielded the stress. Four weeks later, the external fixator was removed and, because of his poor skin condition, a medial external LCP fitted in an attempt to further correct the alignment (Fig. 2e and 2f).

The patient started routine post-surgical rehabilitation. Three months later, the external LCP was removed and a patellar weight-bearing cast fitted (Fig. 2g and 2h). One month later he reported continuing pain and follow-up imaging continued to show delayed union of the proximal tibia. ORIF with iliac crest bone graft was performed (Fig. 2i and 2j). After this procedure, the patient started using a bone stimulation device; two months later he was weight-bearing.

Discussion

Treating tibial fractures with external LCP is not new. Kloen was the first to describe a case of a tibial fracture treated with external fixation with LCP: the patient had a midshaft tibial fracture that had been managed by ORIF over a year previously and had developed a postoperative infection⁷. The implant was removed and eight months later an external LCP was fitted after a residual intramedullary infection had been debrided. External LCPs have been used more recently, in one case to maintain tibial alignment by distraction⁸ and in another 25 segmental tibial fractures as temporary fixators⁹. Kanchanomai and Phiphobmongkol focused on biomechanical evaluation of an external LCP after one individual with

tibial and fibular shaft fractures had been treated by single stage closed reduction and external LCP fixation and achieved bony union after four months¹⁰. Recently, Ma *et al.* reported biomechanical stiffness associated with external LCP's in eight individuals with tibial fractures (three proximal, three shaft and two distal) who had been treated with only the first-stage, an external LCP, and whose fractures had healed after they refused second-stage treatment¹¹. Bony union was achieved in all eight individuals in an average of 37.5 weeks; there were three complications, namely screw tract infection and broken screw. Tulner *et al.* studied seven individuals with distal tibial fractures who had been treated by single-stage external LCPs for an average of 17.5 weeks; three of these patients needed addition internal plate fixation or reamed intramedullary nail fixation¹². Reports of a proximal tibial fractures treated with external LCPs are rare. Woon *et al.* focused on reporting the technical challenges involved in using external LCPs in a case study of two tibial fractures (one proximal and one distal) as part of a two-stage technique in which the first stage was fitting of a temporary standard external fixator and the second definitive external LCP; one of these patients required additional ORIF¹³. There is minimal information regarding proximal tibial fractures treated with external LCPs by a two-stage technique.

External LCPs have significant advantages and, in some clinical settings, are preferable to ORIF. General advantages include that they can be removed in an outpatient setting and that there is less soft tissue and vascular damage (which are frequent concerns in trauma patients with concurrent soft tissue damage)^{7,13,14}. In proximal tibial fixation, the decreased amount of soft tissue manipulation probably decreases the infection rates; external LCPs have been shown to decrease infections in distal tibial fractures¹². The absence of a large incision also decreases the likelihood of bone necrosis as compared with the dynamic compression plates used in ORIF¹⁴. The current study shows that, at least in the short-term, correctly

used external LCPs can preserve the range of motion of the knee and maintain the fixation necessary for bony union. The authors suspect that this less invasive technique has the benefit of preserving the ligaments, joint capsule, and periosteum better than ORIF in the setting of proximal tibial fractures.

Our first proximal tibial fracture case had good short-term results, achieving bony union within two months of the staged treatments. In the second case, external LCP was not successful and additional ORIF was required; this patient will probably need further treatment in the future. The authors tried to correct the alignment by using a temporary external fixator and external LCP; however, neither achieved satisfactory alignment. In this case, delayed bony union was likely attributable to both smoking status and repeated correction of the malalignment. These cases provide evidence that the short-term success of external LCPs for proximal tibial fractures depends on achieving prior proper alignment and reduction with stage one. That is to say, the degree of alignment and reduction achieved in stage one directly determines the success of stage two. Moreover, because external LCPs have limited ability to modify the alignment, the bony callous union and alignment at the time of removing the temporary standard external fixator should determine which technique to proceed with. If the alignment is adequate, an external LCP may be appropriate. However, if the alignment needs to be adjusted, then ORIF is probably a better choice. Further confirmatory studies are needed to assess the long-term functional outcomes. Specifically, external LCP fixation for proximal tibial fractures is not a replacement for ORIF and standard external fixators. However, if used properly in the second stage, LCPs have some advantages.

This brief report of two cases shows that combining external LCP and external standard fixator in a two-stage method produces good short-term results. However, external LCPs should be used only after achieving satisfactory alignment and reduction in stage one.

References

1. Tejwani NC, Achan P. Staged management of high-energy proximal tibia fractures. *Bull Hosp Jt Dis*, 2004, 62: 62–66.
2. Mills WJ, Nork SE. Open reduction and internal fixation of high-energy tibial plateau fractures. *Orthop Clin North Am*, 2002, 33: 177–198.
3. Perry CR, Evans LG, Rice S, Fogarty J, Burdge RE. A new surgical approach to fractures of the lateral tibial plateau. *J Bone Joint Surg Am*, 1984, 66: 1236–1240.
4. Shepherd L, Abdollahi K, Lee J, Vangsness CT Jr. The prevalence of soft tissue injuries in nonoperative tibial plateau fractures as determined by magnetic resonance imaging. *J Orthop Trauma*, 2002, 16: 628–631.
5. Scalea TM, Boswell SA, Scott JD, Mitchell KA, Kramer ME, Pollak AN. External fixation as a bridge to intramedullary nailing for patients with multiple injuries and with femur fractures: damage control orthopedics. *J Trauma*, 2000, 48: 613–621.
6. Starman JS, Castillo RC, Bosse MJ, Mackenzie EJ. Proximal tibial metaphyseal fractures with severe soft tissue injury: clinical and functional results at 2 years. *Clin Orthop Relat Res*, 2010, 468: 1669–1675.
7. Kloen P. Supercutaneous plating: use of a locking compression plate as an external fixator. *J Orthop Trauma*, 2009, 23: 72–75.
8. Apivatthakakul T, Sananpanich K. The locking compression plate as an external fixator for bone transport in the treatment of a large distal tibial defect: a case report. *Injury*, 2007, 38: 1318–1325.
9. Ma CH, Tu YK, Yeh JH, Yang SC, Wu CH. Using external and internal locking plates in a two-stage protocol for treatment of segmental tibial fractures. *J Trauma*, 2011, 71: 614–619.
10. Kanchanomai C, Phiphobmongkol V. Biomechanical evaluation of fractured tibia externally fixed with an LCP. *J Appl Biomech*, 2012, 28: 587–592.
11. Ma CH, Wu CH, Tu YK, Lin TS. Metaphyseal locking plate as a definitive external fixator for treating open tibial fractures—clinical outcome and a finite element study. *Injury*, 2013, 44: 1097–1101.
12. Tulner SA, Strackee SD, Kloen P. Metaphyseal locking compression plate as an external fixator for the distal tibia. *Int Orthop*, 2012, 36: 1923–1927.
13. Woon CY, Wong MK, Howe TS. LCP external fixation—external application of an internal fixator: two cases and a review of the literature. *J Orthop Surg Res*, 2010, 5: 19.
14. Feng W, Fu L, Liu J, Qi X, Li D, Yang C. Biomechanical evaluation of various fixation methods for proximal extra-articular tibial fractures. *J Surg Res*, 2012, 178: 722–727.