

DISTRAKSI OSTEOGENESIS MENGGUNAKAN KOMBINASI PELAT DAN FIKSATOR ILIZAROF PADA PENATALAKSANAAN DEFEK TULANG: SEBUAH LAPORAN KASUS

OSTEOGENESIS DISTRACTION USING COMBINED PLATE AND ILIZAROF FIXATOR IN THE TREATMENT OF BONE DEFECT: A CASE REPORT

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ABSTRAK

Distraksi osteogenesis dan pemanjangan tulang telah digunakan untuk merekonstruksi hilangnya tulang dengan memungkinkan tulang baru terbentuk pada celah. Pada penelitian sebelumnya, pemanjangan tulang yang dipandu pelat telah berhasil mengobati hilangnya tulang pada tulang paha, tibia, dan mandibula. Penelitian ini melaporkan sebuah kasus fraktur tibia dengan kehilangan tulang kominitif yang diobati dengan fiksasi pelat dan pemanjangan tulang dengan fiksator cincin Ilizarov. Pada saat pengaitan, ketika segmen pemanjangan dikompresi dengan fragmen tulang, fragmen tulang difiksasi dengan sekrup locking dan non-locking tambahan melalui pelat. Panjang defek tulang adalah 7 cm. Indeks pemanjangan atau fiksasi eksternal adalah 12,7 hari / cm. Pada kasus ini tidak ada pemendekan yang terjadi. Indeks konsolidasi radiografi rata-rata adalah 37 hari / cm. Kasus ini mencapai regenerasi segmen tulang yang bebas infeksi dan hasil fungsional yang memuaskan. Teknik ini mengurangi durasi fiksasi eksternal selama fase konsolidasi, memungkinkan koreksi panjang tulang, dan penyelarasan dan waktu rehabilitasi yang lebih singkat.

Kata kunci: Defek Tulang, Transportasi Tulang, Osteogenesis Gangguan, Teknik Ilizarov, Osteogenesis Lempeng Tulang

ABSTRACT

Osteogenesis distraction and bone transport has been used to reconstruct bone loss defect by allowing new bone to form in the gap. In previous studies, plate-guided bone transport has been successfully to treat bone loss defect in the femur, tibia, and mandible. This study reports a case of fracture of tibia with comminutive bone loss treated with plate fixation and bone transport with Ilizarov ring fixator. At the time of docking, when the transport segment is compressed with bone fragment, the bone fragment is fixed with additional locking or nonlocking screws through the plate. The bone defect size was 7 cm. The lengthening/external fixation index was 12.7 days/cm. In this case there were no shortening that present. The average radiographic consolidation index was 37 days/cm. This case achieved infection-free bone segment regeneration and satisfactorily functional outcome. This technique reduces the duration of external fixation during the consolidation phase, allows correction of length and alignment and provides earlier rehabilitation.

Keywords: Bone Defect, Bone Transport, Distraction Osteogenesis, Ilizarov Technique, Bone Plate Osteogenesis

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INTRODUCTION

Various techniques of management of large bone defect have been mentioned in literature ranging from bone grafting, using vascularized fibular bone transfer (Hoover and Santrock, 2011) or cancellous bone graft (Grivas and Magnissalis, 2011) to bone transport. Different methods of bone transport have been described by multiple authors using Ilizarov fixator, and monolateral external fixator such as transport over an intramedullary nail. Distraction osteogenesis by the Ilizarov method has been a widely used method in the last few decades (Illgner et al., 2014; Rodriguez-Collazo and Urso, 2015) but it has its own complications including prolonged use of external fixation and poor patient compliance (Sampaio et al., 2016). Monolateral external fixator has also been used to minimize the drawbacks of Ilizarov circular device (Taylor, 2002). Bone transport using a monorail fixator over an intramedullary nail is used to control anatomic length and alignment during transport and early removal of the external fixation system (Hofmann et al., 2016; Brunner et al., 2017). However, prolonged external fixation and presence of pin-tract infection are contraindications for the use of

intramedullary fixation. Plate-guided bone transport has been successfully described in the literature (Apiyatthakakul and Arpornchayanon, 2002; Girard et al., 2013; Oh et al., 2013). In addition to the reduction to the time needed for external fixation during consolidation phase and protection against refracture, the plate helps to neutralize the forces on the bone and maintain stable anatomic alignment of the proximal and distal segment. This study reports a case of fracture of tibia with comminutive bone loss, treated with plate fixation and bone transport with Ilizarov ring fixator. At the time of docking, when the transport segment is compressed with bone fragment, the bone fragment is fixed with additional nonlocking screws through the plate.

CASE REPORT

This study reports a case of a large bone segment defect in the tibia that were treated by plate and bone transport with Ilizarov ring fixation frame.

A 49-year-old male sustained a Gustilo and Anderson Type 3b open fracture of the distal 1/3rd tibia. The radiographs revealed a comminuted fracture of the distal 1/3rd shaft of

the tibia. The patient was initially treated elsewhere and fracture was stabilized with plate and screw, with primary closure of the wound. The patient presented to us with foul smelling wound with copious amount of discharge coming out of it. The patient was then treated with implant removal, and extensive debridement of dead tissues, muscle, and bone was done, resulting in 7 cm segmental bone defect of distal tibia. After repeated serial debridements; on 12th day, the articular fracture was reconstructed and fixation was done with locking compression plate and interfragmentary screw.



Figure 1. Clinical photograph and x-rays of ankle joint. This pictures showing that the patient presented with open fracture lower 3rd tibia with bone loss. External fixator was applied earlier elsewhere along with k wire fixation for fibula.

Routine wound inspection was done to look out for any signs of infection. The patient required a few more debridements until it become evident that no sign of infection was present. After 14 weeks, Ilizarov ring fixator was applied and midtibiocorticotomy was done. Bone transport began 7 days

postcorticotomy at a rate of 1 mm/day in four 0.25 mm increments. Active knee motion was encouraged and gradual partial weight bearing was advised. Gradual bone transport was carried out till the bone docked distally after 78 days. The transport segment was docked and fixed to the plate and the Ilizarov ring fixator was removed. Autologous iliac bone graft was grafted at the docking site. Total time in external fixation was 89 days. The patient was followed up for 2 years. The patient achieved good radiological bony union at both docking and distraction site and there was no recurrence of infection (Fig 2). There was no shortening present. The knee motion was 0–100° and the patient remains satisfied with his outcome (Fig 3).



Figure 2. X-ray of thigh with knee joint anteroposterior and lateral views showing complete osseous union.



Figure 3. Clinical photographs showing good range of motion at 3 years follow up.

Distraction osteogenesis is a surgical treatment designed to regenerate bone that may have been “abnormally short as a result of injury, disease, or malformation.” Distraction osteogenesis generates new tissue through the application of tensile forces to develop a callus via a controlled osteotomy. Distraction osteogenesis is characterized by three separate phases involving the latency phase immediately following the osteotomy, the active or distraction phase involving active separation of the bony segments, and the consolidation phase where active distraction has ended and healing of the callus begins. In general, the consolidation phase is twice the distraction phase.

DISCUSSION

Distraction osteogenesis by the Ilizarov method is a traditionally used technique for reconstructing bone loss defect

(Illgner et al., 2014; Rodriguez-Collazo and Urso, 2015; Peng et al., 2015; Popkov et al., 2016; Zhang et al., 2014). However, the difficulties that occurred using Ilizarov are pin track infection, axial deviation, and decreased range of motion in the surrounding joints. Prolonged use and poor patient compliance are the other important limitation factors for the Ilizarov (Sampaio et al., 2016). Bone transport using the combination of an intramedullary nail and a monolateral external fixator for transport maintains length and alignment during transport, allows earlier removal of the external fixator system (Hofmann et al., 2016; Brunner et al., 2017; Hoover and Santrock, 2011). However, it has its own minor and major complications including pin-tract infection and increased infection rate after prolonged use of external fixation system. The risk of creating a deep intramedullary infection with nailing transport is of greater concern. Infection rates as high as 22% have been reported in literature, leading to discontinuation of this technique by many surgeons. Simpson et al. (1999) reported deep infection rate of 15% in their series, where two of the three infections occurred after previous open femoral fractures. Kristiansen and Steen

(2005) reported in 3 out of 9 patients that fatigue fractures of the intramedullary nail or interlocking screws occurred that needed revision and bone grafting. In one patient, a deep intramedullary infection occurred. The maximum length of time in an external fixator before conversion to intramedullary nailing remains controversial. In a recent meta-analysis, based on the available evidence, the patients who had external fixation in place for >28 days had significantly increased rate of infection (Bhandari et al., 2005). In cases where there is angular deformity, an excessively sclerotic or narrow medullary canal, it is difficult to perform intramedullary nailing. Both the cases in our study presented with intraarticular involvement of fracture of distal tibia, where nailing might not be a good option to perform.

Distraction osteogenesis used in combination with plate-guided bone transport has been described several times in the literature. Windhager *et al.* (1996) described the technique of distraction osteogenesis in the femur of six male sheep using a custom-made osteosynthesis plate which was fixed on the lateral side of the femur, and two transporting

plates driven by the transcutaneously inserted screw driver moved two bone cylinders simultaneously over the bone defect. The result shows that distraction osteogenesis can be achieved with an internal device, and recorticalization and restoration of a medullary canal occurs despite rigid internal stabilization by the plates. Apivatthakakul and Arpornchayanon (2002) reported two cases of open fracture of the femur with segmental bone loss that were treated successfully by minimally invasive plate osteosynthesis combined with distraction osteogenesis. Both went on to bony union with good alignment. Girard *et al.* (2013) described successfully bony union in two cases of large tibial bone defects using locked bridge plating and bone transfer with a monolateral external fixation frame. Oh *et al.* (2013) reported total of ten patients who underwent distraction osteogenesis with a locking plate to treat previously infected posttraumatic segmental tibial defects. In all the cases, primary union of the docking site and distraction callus was achieved, with an excellent bony result.

Variation of this technique has also been described to successfully treat mandibular

segmental defects in humans after resection of malignancies (Herford, 2004). Similar methods described in the literature for different indications. In 2007, Iobst and Dahl (2007) described a novel technique of limb lengthening combining an Ilizarov-style circular fixator frame with percutaneously inserted locking plate. This advantage of technique of bone transport using plate with Ilizarov ring fixation includes correction of length and deformity, maintains stable anatomic alignment of the proximal and distal segments, and has the ability to treat massive bone defects. It also offers the opportunity to additionally compress and stabilize the transported segment at the time of docking using additional nonlocking or locking screw through the plate and facilitates earlier frame removal. This technique reduced the mean duration of external fixation in our cases by almost 50%. This technique of plate-guided bone transport also proved to be especially useful over nail transport in our cases where long standing external fixation pins had been in place, making the use of an intramedullary nail more problematic. The spatial configuration of the Ilizarov wires is done in such a way that it does not have any contact

with the plate or screw. External fixation pin insertion is also simplified in the absence of an intramedullary implant. Plate-guided bone segment transport has been successfully described in literature to treat open or infected large segmental bone defect without occurrence of infection (Apiyatthakakul and Arpornchayanon, 2002; Girard *et al.*, 2013; Oh *et al.*, 2013).

In this case of this study, the total time for external fixation was 89 days for a 7 cm defect. The external fixator is removed to reduce the external fixation time in the consolidation phase. With this technique, the external fixation time is only in the distraction phase. In general the consolidation phase is twice the distraction phase. In both the cases, bone grafting at the docking site was done. The lengthening/external fixation index was 12.7 days/cm. No shortening was present in either of our cases. The average radiographic consolidation index was 37 days/cm. The limitations of this technique of distraction osteogenesis using combined use of plating and Ilizarov include the risk of plate failure, infection, and these methods are technically more demanding. A common problem is pin-

tract infection during lengthening. In one of our cases, pin exchange and pin-tract debridement was done due to pin-tract infection.

CONCLUSION

This technique of combined plating and Ilizarov is an alternative method for bone transport in the cases of large segmental bone loss. This technique has the advantage of reducing the duration of external fixation, allows correction of length and alignment, prevents refracture, and provides earlier rehabilitation.

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