Bifocal Compression Distraction for Combined Bone and Soft Tissue Defects in Post-traumatic Tibial Nonunion

Thesis

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List of Abbreviations

CBC	Complete blood count
CRP	C-reactive protein
ESR	Erythrocytes sedimentation rate
WBC	White blood cell
CT	Computed Tomography
MRI	Magnetic resonance imaging
RI	Radionuclide Imaging
PET	Positron Emission Tomography
FDG	F18-Fluorodeoxyglucose
FIZ	Fibrous Interzone
PMF	Primary matrix front
MCF	Micro column formation
DO	Distraction ontogenesis
QTS	Quantitative technetium scintigraphy
QCT	Quantitative computer tomography
AP	Anteroposterior
ROM	Range of motion
RBC	Red blood cell
EFI	External fixation index
ASAMI	Association for the Study and Application of the Method of Ilizarov
LLD	Leg length discrepancy
RSD	Reflex sympathetic dystrophy
EFT	External fixation time
RTA	Road traffic accident
IMN	Intramedullary nail
BG	Bone graft
VFG	Vascularized Fibular Graft

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Abstract

A soft tissue defect is one of the most challenging problems that may accompany tibial nonunion with bone defects. Forty patients with composite bone and soft tissue defects in post-traumatic tibial nonunion were managed by ilizarov distraction osteogenesis techniques between 2010 and 2015 by the senior author.

In this prospective, one-center study we compared two techniques of distraction osteogenesis; 20 patients treated using segmental bone transport technique and 20 patients were treated using acute compression and distraction technique. The mean age of the patients was 33.7 years (18 to 58) and the mean bone gap after resection and debridement was 3.6 cm in acute shortening (group I) and 6.9 cm in bone transport (group II). The mean follow-up was 20 months (12 to 32).

At latest follow-up, functional and radiographic results were evaluated. There was no difference on ASAMI scoring system regarding bony (p=0.64) and functional (p=0.73) results between two techniques, and in the total number of complication (p=0.19). Mean external fixator index was lower in the acute shortening group compared to bone transport group (p=0.03). The bone transport group required additional bone grafting in four patients (20%) prior to union compared to one (5%) in the acute shortening group.

Keywords

Bone loss; Non-union; Tibial; External fixation; Ilizarov; Bone transport; Acute shortening; Distraction osteogenesis; Docking site.

Introduction

Non-union of long bones with segmental defect is a major problem. It usually follows high energy trauma leading to open fractures with soft tissue damage and may be further complicated by infection. Segmental bone loss may be due to initial injury, secondary to debridement or produced by post-traumatic osteomyelitis that needs resection of the necrotic bone segment for treatment [(1)].

High-energy tibial fractures often present with a soft-tissue defect, owing to the subcutaneous situation of the tibia, even closed fractures may result in soft-tissue problems. Soft-tissue defects often cannot be closed. They often require some form of coverage, for which different types of rotation or free microvascular flaps have been described. These flaps usually result in good coverage of the defect but have the disadvantage of donor-site morbidity [(2)].

Several different surgical treatment options have been proposed, including bone grafting, free tissue transfer, antibiotic cement, and Ilizarov methods. There are some limitations in bone grafting, such as the size of bone defects, donor site morbidity, and extended graft incorporation time. Although free tissue transfer is suitable for the treatment of large bone and soft tissue loss, it is a technically demanding surgery, and it is usually associated with stress fractures and nonunion [(3)].

Ilizarov methods can overcome all these difficulties and address coexisting problems simultaneously. Progressive bone histogenesis following corticotomy and bone transport help in filling bone gaps eradicating infection and promoting fracture union [(3)]. Radical debridement is the key step to control bone infection [(4)].

Distraction osteogenesis is a process capable of generating viable osseous tissue by gradual separation of osteotomized bone edges.

This technique was originally described by Ilizarov in Russia [5]. Osteotomy is made in one of the major fragment. Slow gradual transport of the middle fragment at a rate of 1 mm per day is started after 7 days. This slow distraction causes recruitment of progenitor cells from the endosteum at the osteotomy site [1].

Various difficulties are encountered like axial deviation, deformities, anatomical malalignment, soft tissue invasion at docking site , prolonged fixator time, pin tract sepsis, longer hospital stay and associated psychological problems [6].

An alternative technique for Posttraumatic segmental bone defects (PTSBDs) involves acute limb shortening with subsequent lengthening of the limb. This technique has the theoretic advantage of faster healing of the traumatic fracture because it does not require waiting until docking is achieved to begin healing. Another advantage is that shortening assists with the closure of soft-tissue defects. However, acute shortening of large defects may cause soft-tissue redundancy and swelling [7].

Bifocal compression-distraction osteogenesis using an external circular fixator is a safe and successful method in selected cases [8].

This is called bifocal because there are two segments with activity. One segment (the defect) is undergoing compression/shortening, and one segment (the bony regenerate) is undergoing distraction/lengthening to maintain the length of the limb [9]. The technique allows for union together with realignment, reorientation, and normal leg length of the extremity [8].