

The use of minimally invasive osteotomy, tibial transverse transport (TTT), and anterolateral thigh perforator (ATLP) flap for the surgical management of Wagner stage 4 DFUs

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Introduction: Diabetes-related microvascular complication results in progressive tissue necrosis and gangrene, of which surgical debridement or amputation is necessary. Tibial transverse transport (TTT) works on the principle of tension-stress.¹ By distraction, TTT induced osteogenesis, neovascularization, immunomodulation and promote the migration of stem cells.¹ This study aims to investigate the usefulness of the staged limb reconstructive strategy for the surgical management of Wagner Stage 4 wounds with underlying partial foot gangrene in Diabetes Mellitus (DM) patients.

Methods: 15 subjects were recruited between October 2017 to January 2022 from the Department of Hand and microsurgery, Peking University Shenzhen Hospital. All recruited subjects were surgically managed by several limb reconstructive modalities, which include debridement of necrotic tissue, minimally invasive osteotomy (MIO) of the proximal tibia, transverse tibial transport (TTT) technique, and anterolateral thigh perforator (ALTP) free flap to provide adequate skin coverage over amputated site. Negative pressure wound therapy (NPWT) was applied over recipient site to optimize wound closure

Minimal invasive osteotomy and tibial transverse transport (TTT) surgical technique

2 skin incisions of about 3cm were made at 2-3cm below the tibial tuberosity. The subcutaneous soft tissue was retracted, periosteum was exposed and retained. A rectangular osteotomy block of 5cm long and 1.5cm wide was made. Two 2.5mm fixation pins (Orthofix®, Italy) were inserted into the cortex of the rectangular osteotomy block for bone transport. Another two 4.5mm pins (Orthofix®, Italy) were screwed into the tibial shaft at the upper and lower ends of the osteotomy block to stabilise the external fixation. The external fixation module (Orthofix®, Italy) was then assembled to form a stable bone transport structure. On post-operative day two, the tibial bone transport was set to move 0.25 mm every 6 hour in lateral direction for the next 14 days. The position of the osteotomy block confirmed by X-ray examination before being adjusted to move in the opposite direction, in medial direction, at the same rate for the next 14 days. 4 weeks after the completion of the cortical bone transport, Ilizarov external fixator were removed and plain radiographs were obtained to determine whether the bone piece returned to its original position.

Results: Successful limb salvage was achieved in 15 patients and all flaps survived. No complications such as tibial fracture and nonunion had occurred. The patients were followed up for 12-60 (30±3) months, and the limb function was satisfactory without pain. One patient developed foot ulcer again 2 years later and healed after dressing change therapy. Three months after operation, VAS score was (2.33±0.4), ankle-brachial index was 0.87±0.02, foot skin temperature was (32.93±0.22) °C, and the difference was statistically significant ($P < 0.05$).

Discussion Tibial transverse transport can effectively improve blood flow of diabetic foot in a short term. TTT combined with ALTP can be used for limb salvage treatment of diabetic foot with severe ulcer and infection. Minimally invasive osteotomy can reduce fracture and other complications.



Figure 1 Initial presentation of Right 4th and 5th toe wet gangrene (A). Perforator free flap obtained from the anterolateral thigh (B). Two 2.5mm fixation pins were inserted into the cortex of the rectangular osteotomy block while another two 4.5 mm pins were screwed into the tibial shaft at the upper and lower ends of the osteotomy block (C). Ilizarov external fixator module was then assembled to form a stable bone transport structure (D).