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Modified tibial cortex transverse transport for diabetic foot ulcers and its implications in contemporary diabetes management

Abstract

Diabetic foot ulcers (DFUs) remain a major cause of morbidity, lower limb amputation, and healthcare expenditure worldwide. Modified tibial cortex transverse transport (MTCTT) is an adaptation of tibial cortex transverse transport (TTT), designed to improve lower limb microcirculation through controlled distraction of the cortical bone, reducing tibial complications. A retrospective study of 98 patients with Wagner grade ≥ II DFUs treated with MTCTT demonstrated a healing rate of 95.83%, a mean healing time of 53.18/20.18 days, significant improvement in ankle-brachial index (ABI), Wound/Ischemia/Infection (WIfI) score, and pain, with a complication rate of 8.16% and no ulcer recurrence during follow-up. This study was conducted at a hospital in Beijing, China, between January 2020 and June 2022. Recent systematic reviews of transverse tibial cortex transport in diabetic and ischemic lower limb ulcers corroborate high healing rates and limb preservation, with a low incidence of pin insertion site infection and tibial fracture. This article synthesizes the current evidence on MTCTT, discusses its mechanisms, indications, and limitations, and analyzes its role in modern multidisciplinary diabetes care.[1–5]

Keywords: diabetic foot ulcer; tibial cortex transverse transport; modified tibial cortex transverse transport; limb salvage; microcirculation; diabetes mellitus.[2,3]

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Introduction

Diabetic foot ulcers affect approximately 19–34% of individuals with diabetes during their lifetime and are responsible for a large proportion of non-traumatic lower limb amputations, with amputation rates in complicated DFU often exceeding 15%. Pathophysiology is multifactorial, combining peripheral neuropathy, micro- and macroangiopathy, infection, and impaired wound healing, making chronic, ischemic or neuroischemic ulcers particularly refractory to standard care. Conventional strategies include offloading, debridement, infection control, optimization of glycemic and cardiovascular risk factors, and revascularization when feasible, yet healing remains suboptimal in many patients, especially when distal vascular disease is not amenable to bypass or endovascular interventions.[2–4,6]

Tibial cortex transverse transport (TTT), derived from Ilizarov's tension–stress principle, applies controlled distraction to a segment of tibial cortex to stimulate angiogenesis, improve microcirculation, and enhance distal perfusion. The modified tibial cortex transverse transport (MTCTT) technique reduces the osteotomy area to two rectangular bone windows of approximately 1.5 cm × 1.5 cm, aiming to preserve tibial integrity and reduce procedure-related complications while maintaining the microcirculatory benefits. In the context of a growing global diabetes burden and rising prevalence of complex DFU, MTCTT has emerged as a promising adjunctive limb salvage procedure with potential to impact amputation rates, healthcare costs, and quality of life.[1–5,7]

Methods – overview of key evidence

Pivotal MTCTT Cohort

Liu et al. 2024, conducted a retrospective study including 98 patients with DFU classified as Wagner grade ≥ II who underwent MTCTT between January 2020 and June 2022. All patients had refractory ulcers despite debridement and negative pressure wound therapy and had at least one patent tibial or peroneal arterial branch down to the ankle confirmed by imaging. The modified technique consisted of two small cortical bone windows (1.5 cm × 1.5 cm) created in the medial proximal tibia and transported transversely using an external fixator, while standard wound care, infection control, and glycemic management were maintained.[1,2,5,8]

Clinical endpoints included ulcer healing time, ulcer area, ABI, WIfI classification, and Visual Analogue Scale (VAS) pain score, measured preoperatively and up to 3 months postoperatively. Complications such as pin-site infection, tibial fracture, nonunion, and need for major amputation were recorded, and patients were followed for at least 3 months or until complete healing.[2]

Systematic review of TTT

A systematic review published in 2025 evaluated tibial cortex transverse transport in ischemic ulcers of the lower limb, including 13 studies and 924 patients, 724 of whom were treated with TTT and 701 were diabetic. Outcomes included healing rate, healing time, changes in ABI and VAS, levels of vascular endothelial growth factor (VEGF), and limb salvage rates, as well as frequency and severity of procedure-related complications.[6,7]

Comparative and guideline-oriented literature

Recent narrative reviews and guidelines summarize the evolution of TTT/MTCTT, practical indications and contraindications, operative technique, and perioperative management strategies, embedding these techniques within modern multidisciplinary DFU care pathways. Additional emerging reports explore modified transverse bone transport configurations intended to further reduce risks such as distraction osteonecrosis, deep vein thrombosis, and skin edge necrosis while optimizing microvascular regeneration.[1,2,8]

Results

In the 98 patient MTCTT cohort, the mean duration of diabetes was approximately 20.22 / 8.02 years, and many patients presented with extensive tissue loss, with more than half having gangrene of at least one toe. The postoperative wound healing rate was 95.83%, with an average healing time of 53.18 / 20.18 days. ABI, WIfI classification, and VAS scores improved significantly at 3 months after surgery compared with baseline, with p values < 0.05 for all main comparisons.[5,8]

The incidence of complications was 8.16%, mainly pin-site infections and a small number of patients requiring major amputation due to uncontrolled infection or systemic complications. During the follow-up period, there were no cases of ulcer recurrence among survivors, although two patients died due to severe perioperative events (myocardial infarction/gastrointestinal bleeding and cerebral hemorrhage), leaving 96 for full outcome analysis.[8]

Evidence from TTT systematic review

The 2025 improved systematic review of tibial cortex transverse transport in lower limb ischemic ulcers found that across 13 studies and 924 patients, TTT consistently healed rates and reduced healing times compared with baseline or conventional therapies. In diabetic cohorts, increases in VEGF levels and ABI scores, as well as decreased VAS pain scores and high limb salvage rates, were recurrent findings. Reported complications included pin-site infections and occasional tibial fractures, which were generally infrequent and manageable, supporting the safety profile of the technique when performed in experienced centers.[3,4]

Comparative and mechanistic data

Comparative work between TTT and other adjunctive modalities, such as platelet-rich plasma (PRP), suggests that TTT may offer superior limb salvage and recurrence reduction in severe DFU, likely through more robust stimulation of angiogenesis and improvement in distal blood flow. Narrative and guideline-style articles describe TTT/MTCTT as "unusually successful" in restoring perfusion and facilitating healing in ischemic ulcers that are otherwise poor candidates for conventional revascularization.[3,7]

Mechanisms of action

Tension–stress and angiogenesis

TTT and MTCTT rely on Ilizarov's tension–stress principle, whereby slow, controlled distraction of cortical bone and periosteum triggers neoangiogenesis and microcirculatory remodeling. Repeated mechanical stimulation is thought to induce upregulation of VEGF and other proangiogenic factors, enhance endothelial proliferation, and promote collateral vessel formation in the lower limb. Clinical studies report increased VEGF levels and improvements in objective perfusion measures, such as ABI and transcutaneous oxygen tension, following TTT-based procedures.[3,4,7]

Microcirculation and Inflammation

Improved microvascular perfusion at the distal extremity contributes to enhanced oxygen and nutrient delivery, supporting granulation tissue formation and re-epithelialization in DFU. In addition, some studies suggest that TTT-modulated microenvironmental changes may shift local immune responses from a chronic pro-inflammatory phenotype to a more pro-resolving, reparative profile, which could be reflected in reduced pain scores and faster wound closure. By addressing ischemia at a mechanistic level rather than just treating the ulcer surface, MTCTT functions as a limb salvage strategy that complements systemic optimization of glycemia and cardiovascular risk factors. [2,11,10,4]

Indications, contraindications, and technique

Indications

The MTCTT protocol described by Liu et al. was offered to patients with:

DFU classified as Wagner grade ≥ II.

Non-healing or limited remission for more than 2 months despite adequate debridement, vacuum sealing drainage (VSD) and other standard treatments.[8]

Age ≥ 18 years.

Imaging (duplex ultrasound or CT angiography) demonstrating patency of the popliteal and superficial femoral arteries and at least one patent distal tibial / peroneal artery down to the ankle joint level.[5,8]

MTCTT is particularly attractive in patients with neuroischemic or ischemic ulcers not optimally amenable to conventional revascularization, or in settings where endovascular and surgical revascularization resources are limited.[2,8]

Contraindications

The listed contraindications for tibial surgery (likely procedures like high tibial osteotomy or related orthopedic interventions) are standard and evidence-based precautions to minimize risks. They prioritize patient safety by excluding cases with high complication potential.[5,7]

Absolute contraindications

Life-threatening illnesses within 3 months or inability to tolerate anesthesia/surgery: Recent severe conditions (e.g., unstable cardiac disease, uncontrolled malignancy) increase perioperative mortality; general surgical guidelines deem these absolute barriers.[2,4,6,7]

Tibial osteomyelitis: Active bone infection contraindicates elective osteotomy due to risks of spread, nonunion, or failure; aggressive debridement may be needed first, but it's not suitable for standard tibial procedures.

Active wounds, injuries, or infections within ~5 cm of incision: Local infection risks surgical site complications like deep infection or poor healing.[6,7]

Patient refusal: Informed consent is mandatory; no surgery proceeds without agreement.[2]

Severe mental illness preventing postoperative compliance: Inability to follow rehab (e.g., weight-bearing protocols) leads to failure; psychiatric stability is required.[3,4,7]

Clinical context

These align with orthopedic standards for high tibial osteotomy (HTO), where additional relative contraindications include inflammatory arthritis, obesity (BMI >35), flexion contracture >15°, or >20° correction needed.[5,7]

Surgical technique – MTCTT

In MTCTT, two small rectangular cortical windows are created in the medial proximal tibia, rather than the larger cortical segment traditionally used in TTT, and these bone blocks are transferred

transversely using an external fixation system. The distraction protocol typically begins after a short latency period and proceeds at about 1 mm/day, often in divided steps, for a defined period, followed by consolidation. The smaller osteotomy area in MTCTT aims to maintain the biological and mechanical stimulus on the tibia while lowering the risk of tibial fracture, nonunion and structural compromise compared to classic TTT.[1,2,5,7,8]

Implications for contemporary diabetes management

Limb salvage and amputation reduction

By markedly improving healing rates in severe DFU and reducing the need for major amputations, MTCTT contributes directly to limb salvage goals in complex diabetic foot management. The high healing rate (≈96%) and absence of ulcer recurrence in short- to mid-term follow-up reported in the 98 patient series, alongside corroborating data from broader TTT cohorts, suggest that such techniques can significantly alter the natural history of advanced DFU.[1–3]

Integration into multidisciplinary care

MTCTT should be viewed as an adjunct to, not a replacement for, comprehensive DFU care, which includes tight glycemic control, optimization of blood pressure and lipids, smoking cessation, infection control, wound bed preparation, offloading, and when indicated, revascularization. Emerging clinical guidelines propose practical algorithms for selecting patients for TTT/MTCTT based on ulcer severity, vascular status, and comorbidities, positioning the procedure within multidisciplinary programs that involve endocrinologists, vascular and orthopedic surgeons, podiatrists, wound care specialists, and rehabilitation teams.[6,7]

Health economics and resource use

Although formal cost-effectiveness analyzes remain limited, MTCTT is likely to reduce long-term healthcare expenditures by decreasing amputations, length of hospital stay, and recurrence of DFU, which are among the most expensive complications of diabetes. For health systems with restricted access to advanced revascularization technologies, the technique may represent a relatively accessible surgical option once the necessary training and infrastructure for external fixation and postoperative follow-up are in place.[3,4,7]

Limitations of current evidence

Most MTCTT data to date comes from single-center retrospective series with modest sample sizes and limited follow-up durations, which limits generalizability and long-term safety assessment. The 2025 systematic review predominantly addresses classic TTT rather than MTCTT specifically, and heterogeneity between studies in terms of patient selection, operative technique, and adjunctive care complications pooled analyses. There is also a need for randomized controlled trials comparing MTCTT with best available standard care, including modern endovascular revascularization, advanced biologics, and adjunctive therapies such as hyperbaric oxygen, to better define its relative benefits and risks.[2–5]

Furthermore, the majority of published experience originates from specific regions and high-volume centers, so external validation in diverse populations, including Latin American settings, is essential before broad guideline incorporation.[6,7]

Conclusion

Modified tibial cortex transverse transport is an emerging microcirculation-targeted surgical technique that offers high healing and limb salvage rates in patients with severe, refractory diabetic foot ulcers, with acceptable complication profiles and minimal tibial morbidity compared to traditional TTT. By leveraging controlled cortical bone distraction to stimulate angiogenesis and improve distal perfusion, MTCTT addresses a key pathophysiologic barrier to DFU healing and has significant implications for contemporary diabetes management, particularly in high-risk patients with limited revascularization options. Future multicenter, randomized trials and long-term observational studies are required to establish its place in international guidelines and to optimize patient selection, operative protocols, and integration with comprehensive multidisciplinary diabetic foot programs.[1–4,6,7]

Acknowledgments

None.

Conflicts of interest

The author declares there is no conflict of interest.

References

1. Liu J, Yao Y, Xu X, et al. Modified tibial cortex transverse transport for diabetic foot ulcers with Wagner grade ≥ II: a study of 98 patients. *Front Endocrinol (Lausanne)*. 2024;15:1334414.
2. Emmy Oji, Gan Golshteyn, Mikhail Samchukov. Clinical guidelines for the application of tibial cortex transverse transport in the management of complex diabetic foot disease. *Diabetes Metab Syndr Obes*. 2025;5(3):100535.
3. Abby Luxon, Anxhela Syziu, Lyndon Mason, et al. A Systematic Review on Tibial Cortex Transverse Transport in the Treatment of Ischemic Ulcers of the Lower Limb. *Foot Ankle Int*. 2025;46(9).
4. Wen Y, Chen LY, Lan JP, et al. Management of severe diabetic foot using modified transverse bone transport: A retrospective study of Wagner grade 3 to 4 cases. *J Orthop Res*. 2025;104(49):e45387.
5. Pu-Xiang Zhen, Hong-Jie Su, Si-Jie Yang, et al. Comparison of clinical efficacy between tibial cortex transverse transport and platelet-rich plasma for severe diabetic foot ulcers. *Front Surg*. 2025;12:1507982.
6. Quinn M Schroeder, Dalon U Paredes, Miranda Montion, et al. Tibial cortex transverse transport: historical evolution, clinical applications, and perspectives. *Foot & Ankle Surgery: Techniques, Reports & Cases*. 2025;5(3):100513.
7. Ovya Ganesan, Dennis P Orgill. An Overview of Recent Clinical Trials for Diabetic Foot Ulcer Therapies. *J Clin Med*. 2024;13(24):7655.
8. Jiaxing Guo, Huhe Bao, Lideer, et al. Efficacy and safety of tibial cortex transverse transport for diabetic foot: A protocol for systematic review and meta-analysis. *PLoS One*. 17(11):e277269.