

A Novel Approach to Managing Tibia Fractures in an Ilizarov Frame and What to do Next When Circular Frames Fail- Retrospective Analysis of 59 Cases

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Abstract

Background: The literature suggests that the use of the Ilizarov frame is the last line of treatment of tibia fracture non-unions. However, there is a lack of clear guidelines for management of the 3-18% of persistent tibial fracture non-union after management with Ilizarov method. An amputation rate of 4-10% is reported in this population. This paper describes the 'Brankov pathway' to manage this difficult scenario in order to achieve union.

Methods: Retrospective analysis of all tibia fractures managed with an Ilizarov frame by a single surgeon between 1st January 2009 and 1st January 2017 in Perth, Western Australia. Clinical and radiological fracture union was the final outcome of interest.

Results: 100% union of the 59 cases identified using our pathway. This includes 8 cases of non-union after Ilizarov frame use. These 8 cases initially had a 'frame holiday', 7 then progressed to an intramedullary nail and one had an open reduction and internal fixation. This series of 8 patients with non-union management post Ilizarov frame appears to be the largest series in the literature.

Conclusion: The 'Brankov pathway' enables earlier identification of non-union cases thus shortening the time spent in a frame for patients. In cases of non-union there are also benefits in earlier conversion of the frame to nail/plate after a 'frame holiday'. Recurrent infection is possible but less likely with this pathway.

Keywords: Ilizarov; Non-union; Tibia; Pathway; Circular frames; Infected

Key message: Non-union of Tibia fractures after Ilizarov frame use is a difficult scenario with no clear guidelines of management. An amputation rate upto 10% is reported in this population. The 'Brankov pathway' described in this paper is a safe management pathway which has achieved 100% union in our series of 59 cases.

Introduction

The tibia is vulnerable to trauma as it is one of the most subcutaneous bones in the body. It has one of the highest incidences of fractures amongst the long bones [1]. Fortunately, most operative cases can be managed with intramedullary (IM) nailing or open reduction and internal fixation (ORIF). However, when faced with a complex tibial fracture, external fixation may be necessary [2]. The Ilizarov frame is often considered one of the best external fixator for these cases [3-6].

The rate of non-union following tibial fractures ranges from 3 to 11% [7]. Tibial non-union provides a great challenge for the orthopaedic surgeon [8] and the reasons for failure of union may not be straightforward, such as a poor mechanical environment or infection [9]. Ilizarov frames are generally regarded as a last line option after multiple surgeries have failed. A systematic review and meta-analysis of the Ilizarov methods in treatment of infected non-unions of the tibia in 2015 by Yin et al. [10] report a mean time in a frame of 9.41 months. This prolonged period can cause significant discomfort and distress for patients. There are also significant material costs as well as psychological and physical trauma to patients associated with trial of multiple surgeries [11]. Following this Ilizarov method there is still a 3-18% [10-16] non-union range and an amputation rate of 4-10% [10,16,17].

There is a lack of literature that discusses the patient group when the Ilizarov method fails. This study suggests a novel approach, which

we call the 'Brankov pathway' to achieve fracture union for this patient population and likely also shortens the duration spent in a frame.

A novel approach: The 'Brankov Pathway'

Mr Brankov is an Orthopaedic surgeon working in Perth, Western Australia (WA). He has been trained by Mr Ilizarov, the father of the Ilizarov method himself. He is one of the few surgeons in WA that performs Ilizarov frame fixation for tibia fractures and has created the 'Brankov pathway' (Figure 1). As can be seen in Figure 1, weight bearing is commenced early and cases likely progressing to non-union can be identified early. Where there is insufficient callus formation at 12 weeks, the patient is kept in the Ilizarov frame for an additional 12 weeks. If there is still insufficient callus after a total of 24 weeks in the frame, a 'frame holiday' is commenced. The duration of the 'frame holiday' is guided by the infection status of the patient as per Figure 1b. These patients progress to an IM nail or ORIF ± bone graft.

Materials and Methods

All Ilizarov frames applied by Mr Brankov from 1st January 2009

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to 1st January 2017 in Perth, WA for tibia fractures were identified by searching Mr Brankov’s surgical log. All cases identified were retrospectively assessed for clinical and radiological union by screening medical records and radiological imaging. Several authors define union as the radiological presence of bridging callus at 3 out of 4 cortices on AP and lateral views [18]. Cases that failed to unite with the Ilizarov method were extracted to follow-up if union was achieved by following the ‘Brankov Pathway’.

Results

59 tibia fracture cases were identified that Mr Brankov used Ilizarov frames for. Hospital records and imaging were available for all cases.

The ‘Brankov pathway’ was used in all 59 cases. Out of these cases, only 8 went on to non-union. Table 1 shows these 8 cases, 4 were infected non-unions and the remaining 4 were not-infected. Interestingly, 4 were also open fractures and these required plastics input for soft tissue coverage. The average age of these patients was 40 and all were male.

These 8 non-union cases were managed with a ‘frame holiday’ and 7 progressed to an IM nail and one had an ORIF as an IM nail was not possible due to broken screws within the bone (Figure 2). As can be seen in Figure 2 all 8 cases went onto radiological union and clinical union as per hospital records. With the ‘Brankov pathway’ we have managed to achieve union in 100% of cases.

Age and Sex	Injury and Mechanism	Open/Closed	Past Medical History	Social History	Infection Status
29, Male	Motor vehicle accident	Closed	- Nil	- Alcohol dependence - Non-smoker - Rigger	Non-infected
28, Male	Motor vehicle accident	Open – Plastics needed for soft tissue coverage	-Depression -Anxiety -Asthma -GORD	- Social alcohol - Non-smoker - Security officer	Infected
49, Male	Motor vehicle accident	Closed	-OSA on CPAP -IHD	- Social alcohol - Social smoker - Truck driver	Infected
52, Male	Motor vehicle accident	Closed	-Bipolar -Hypothyroid -Chronic back pain -OSA on CPAP	- Social alcohol - Non-smoker - Office job	Non-infected
68, Male	Crush injury sustained when tractor rolled over and trapped leg	Open – Plastics needed for soft tissue coverage	-HTN -Diverticulitis -T2DM	- Nil alcohol - Social smoker - Gardener	Infected
38, Male	Tackled during a soccer match	Open – Plastics needed for soft tissue coverage	-Craniotomy at age 10 for benign brain tumor.	- Social alcohol - Non-smoker - Office job	Infected
30, Male	Bomb blast injury	Open – Plastics needed for soft tissue coverage	-Nil	- Nil alcohol - Non-smoker - Unemployed	Non-infected
27, Male	Motor bike accident	Closed	-Nil	- Nil alcohol - Non-smoker - Navy officer	Non-infected

Table 1: Review of 8 non-union tibia fractures after Ilizarov method.

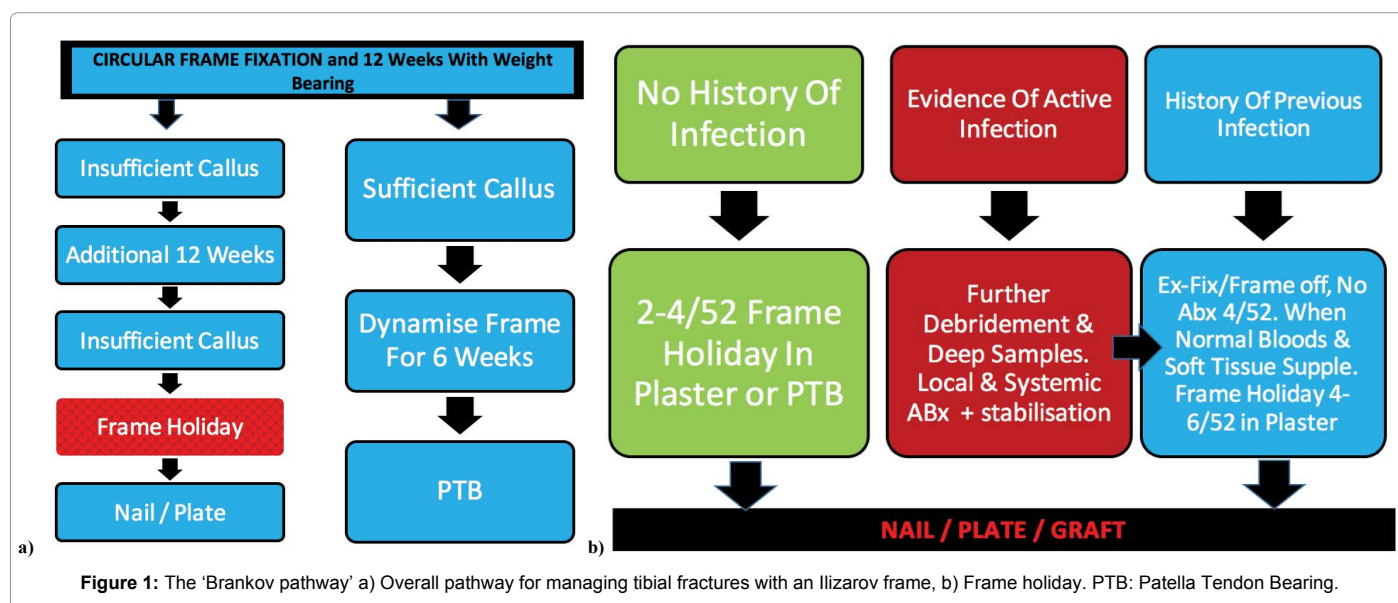




Figure 2: 8 non-union cases after the Ilizarov method. Union achieved with the 'Brankov pathway'.

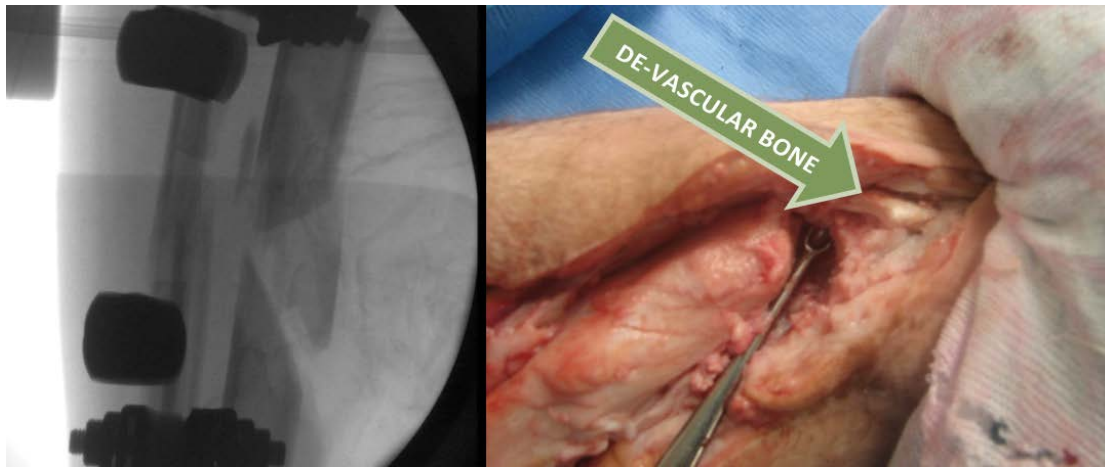


Figure 3: Large de-vascular bone in tibia non-union site.

Discussion

This study has demonstrated that it is safe to internally fix tibial fractures after a prolonged period in an Ilizarov frame and has identified a safe time period between procedures ('frame holiday'). Emara et al. [19] also support this in their study which compared the Ilizarov method alone to the Ilizarov method with early replacement with an IM nail. They report a significantly shorter time to union, lower costs (both hospital costs and medical cost) and shorter absences from work or school in the group that received an early IM nail.

The Brankov pathway also shortens the duration spent in a frame and allows early identification of the non-union population. Patients were in a frame for a maximum of 24 months. In the literature, patients require 37.64 weeks [10] in a frame on average. This can be quite uncomfortable and distressing to patients with some patients reportedly requesting amputations due to the burden of the procedure and its long duration [15].

Non-union is likely where there is persistent infection, open fractures, large sections of de-vascularised bone Figure 3 and poor hosts. Persistent infection is reported at 2-30% [13,17,20-23] and Karladani et al. [24] reports a relative risk of 8.2 for developing non-union in open fractures. Patient factors to consider include co-morbidities [24-26], age [15,25-27], malnutrition [28], smoking [29,30], alcohol consumption [31-33] and immunosuppression [34,35]. Brinker et al. [28] found that 85% of patients who developed unexplained non-unions had an underlying, undiagnosed metabolic or endocrine abnormality. The most common of which were vitamin D deficiencies.

Fracture stability is critical for eradication of infection [36,37] and liaison with infectious disease physicians is recommended to guide antibiotic therapy. With de-vascularised bone, we recommend acute shortening and nailing with early soft tissue coverage. Length can be gained if needed via bone transport simultaneously or as a secondary procedure.

The current study number is fairly modest with a series of 8 patients with non-union post Ilizarov frame. However, this appears to be the largest series in the literature. Further multicentre research would likely be useful to increase the study size.

Conclusion

The 'Brankov Pathway' described here for Ilizarov frames is the first pathway in the literature that guides management even after Ilizarov frame fails to achieve union. It is a novel approach that has shown a 100% success rate in union of tibial fractures, including eight cases of non-union after failure of the Ilizarov frame. Bone "personality" determines time in the circular frame and the pathway enables identification of cases going on to non-union earlier thus shortening time spent in a frame. In cases of non-union there are benefits in earlier conversion of the frame to nail/plate after a 'frame holiday'. Stability of bony fragments is critical for eradication of bone infection. Recurrent infection is possible but less likely with this pathway.

Conflict of Interest

Author has no conflict of interest.

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