



Review Article

Outcomes following the treatment of bicondylar tibial plateau fractures with fine wire circular frame external fixation compared to open reduction and internal fixation: A systematic review



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ABSTRACT

Purpose: The aim of this study was to determine whether circular frame external fixation provides better outcome and fewer complications when compared to open reduction internal fixation.

Methods: A systematic search was carried out and studies were critically appraised with narrative data synthesis.

Results: The systematic search yielded 131 titles and following a rigorous review only five articles were found to directly compare the two treatment methods.

Conclusions: Fine wire frame external fixation offers a modest advantage of better soft tissue outcomes. All in all, there is no current high-level evidence to suggest that newer osteosynthesis plates provide better results.

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1. Introduction

Bicondylar tibial plateau fractures present significant challenges both in terms of treatment and outcomes.^{1–3} They constitute high-energy injuries with associated insult on the soft tissue envelope.⁴ Displaced bicondylar tibial plateau fractures (Schatzker type V and IV, AO/OTA types C1 C2 C3) remain relatively rare at an estimated 1% of all adult fractures and 10–30% of all tibial fractures.^{5–8} They have a bimodal distribution determined by mechanism, magnitude of energy and quality of bone stock.⁹ Albuquerque et al found a peak incidence among male patients and in the fifth decade. The same study showed a rate of 22.6% associated injuries.¹⁰ Moreover, intra-articular tibial plateau fractures have a significant impact on knee function. Mehin et al reported an incidence of post-traumatic end-stage osteoarthritis of 13% at 10 years.¹¹ Equally, a five-fold increase in the likelihood of needing a total knee arthroplasty compared with the general population has been shown.¹² Such consequences have been linked to the ensuing quality of alignment restoration and joint congruity following fracture treatment.^{11,13} The resulting abnormal joint kinematics and load transmission remain the principal

contributing factors.¹⁴ These are compounded by an altered post-traumatic articular biology. An analysis of cartilage and synovial fluid following tibial plateau fractures found decreased lubrication properties with a nine-fold fall in hyaluronic acid concentration.¹⁵

Treatment principles for these injuries consist of minimising secondary surgical insults while aiming for anatomic reduction and rigid fixation of the skeletal element of the injury.¹⁶ Achieving articular congruity and proximal tibial alignment conventionally required open reduction and internal fixation with plates and screws through an extensile anterior approach.^{2,17} Such techniques offered the advantage of optimal visualisation and direct reduction of fracture at the expense of soft tissue preservation.^{8,18} Such approach has however lost popularity over the last two decades owing to a higher rate of wound complications and infection.^{1,19} Despite the evolution of treatment strategies and quality of fixation implants, the literature continued to report poor outcomes and a high rate of complications associated with these fractures.²⁰ Barei et al demonstrated a deep infection rate of 8.4% despite the introduction of osteosynthesis with soft tissue preserving techniques.²¹ Similar observations led to the adaptation of alternative techniques in the form of percutaneous wire fixation frames and adjuvant percutaneous lag screw fixation. Early results from single-arm studies reported comparable clinical and functional outcomes, with reduced complications rate.^{22,23} Nevertheless, these early studies had limited impact on practice.²⁴ It is

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important to underline here the difference in terminology between *hybrid-fixator* a combination of proximal fine wire ring fixation and distal half pin fixation, from *hybrid-fixation* a fine wire frame fixation with adjuvant percutaneous screw fixation.²⁵ It is equally crucial to highlight that analyses of modern internal fixation implants under simulated load established the need for dual-plate fixation in this type of injury.^{26,27}

This subject received wide attention in the literature. Mahadeva et al conducted a systematic review comparing open reduction internal fixation with hybrid fixation.²⁵ The authors concluded that there was a modest advantage over internal fixation in relation to soft tissue preservation.²⁵ They however, included monoplane external fixation and laboratory studies. Additionally, since the publication of these results, there have been newer treatment developments. Low profile periarticular locking plates have become more widespread and often combined with minimally invasive techniques.²⁰ They demonstrated satisfactory reduction and fixation compared to earlier studies.²⁸ Similarly, the use of fine wire circular frame as primary fixation was potentiated by the introduction of modern frames.^{29,30} Despite this relatively wide interest, general consensus remains absent. Unanswered questions prevail on the superiority of fine wire circular frame fixation in terms of reduced soft tissue complication and their non-inferiority in terms of quality of fracture reduction and stabilisation. Hence, this systematic review aimed to address the question: whether fine wire circular frame external fixation provides better outcomes and fewer complications when compared to open reduction and internal fixation? The objective of this review was to appraise the evidence pertinent to the research question. Using a systematic approach the authors aimed to determine if treatment recommendations can be made on the basis of improved outcomes as well as reduced complications.

2. Methods

A systematic review of the literature was performed according to the methods described in the *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* (PRISMA)³¹ using terms related to: *Bicondylar tibial plateau fracture; Schatzker Type V and VI;*

Open reduction and internal fixation; Fine wire external fixation; Circular frame external fixation; Taylor spatial frame. The search syntax, alternative keywords, term variations and search strategy are outlined in Table 1. Search database utilised were: MEDLINE[®], Embase[™], CINAHL[®] (cumulative index to nursing and allied health literature) and the Cochrane Central Register of Controlled Trials (CENTRAL). Search dates intervals included were from their year of inception to the first week of December ending 05/12/2014 and limited to English language and humans. PubMed was used as the primary source and search engine for MEDLINE and MeSH (Medical Subject Headings) were used.³² The same terms were used as search keywords for the other sources.

2.1. Eligibility criteria

Eligibility criteria were derived from the research question outlined above and the following research parameters:

- I Participants – skeletally mature patients with displaced bicondylar tibial plateau fracture (Schatzker type V and VI) undergoing primary operative management.
- II Intervention – Periarticular open reduction and internal fixation (ORIF).
- III Comparison – fine wire circular frame external fixation (ExFix).
- IV Outcomes – Primary outcome measure: specific knee function outcome scores. Secondary outcome measure: clinical outcomes, health status questionnaire, and patients satisfaction.

Primary inclusion criteria were studies which reported outcomes of surgical treatment of acute traumatic bicondylar tibial plateau fractures with open reduction and internal fixation compared to fine wire circular frame fixation with or without adjuvant percutaneous screw fixation. Therefore, only published studies directly comparing the two methods with reported outcome measures were included. This review focused on specific knee function scores as primary outcome measure such as the validated Western Ontario McMaster University (WOMAC) score. A multidimensional, self-administered health status instrument, which has been shown to fulfill face, content and construct validity as well as reliability and responsiveness.³³ This score has been

Table 1
Database, search terms and search strategy used.

Database	Search Terms	Alternative Terms and Search Strategy
PubMed	<i>Bicondylar tibial plateau fracture</i>	("tibia"[MeSH Terms] OR "tibia"[All Fields] OR "tibial"[All Fields]) AND plateau[All Fields] AND bicondylar[All Fields] AND ("fractures, bone"[MeSH Terms] OR ("fractures"[All Fields] AND "bone"[All Fields]) OR "bone fractures"[All Fields] OR "fracture"[All Fields])
EMBASE	<i>Schatzker Type V and VI</i>	schatzker[All Fields] AND v[All Fields] schatzker[All Fields] AND vi [All Fields]
CINHAL	<i>Open reduction and internal fixation</i>	open[All Fields] AND reduction[All Fields] AND ("fracture fixation, internal"[MeSH Terms] OR ("fracture"[All Fields] AND "fixation"[All Fields] AND "internal"[All Fields]) OR "internal fracture fixation"[All Fields] OR ("internal"[All Fields] AND "fixation"[All Fields]) OR "internal fixation" [All Fields])
Cochrane-CENTRAL	<i>Fine wire external fixation</i>	Less[All Fields] AND invasive[All Fields] AND locking[All Fields] AND ("bone plates"[MeSH Terms] OR ("bone"[All Fields] AND "plates"[All Fields]) OR "bone plates"[All Fields] OR "plate"[All Fields]) AND ("fracture fixation, internal"[MeSH Terms] OR ("fracture"[All Fields] AND "fixation"[All Fields] AND "internal"[All Fields]) OR "internal fracture fixation"[All Fields] OR ("internal"[All Fields] AND "fixation"[All Fields]) OR "internal fixation" [All Fields])
	<i>Circular frame external fixation</i>	Fine[All Fields] AND ("bone wires"[MeSH Terms] OR ("bone"[All Fields] AND "wires"[All Fields]) OR "bone wires"[All Fields] OR "wire"[All Fields]) AND external[All Fields] AND fixation[All Fields]
	<i>Taylor spatial frame</i>	Circular[All Fields] AND ("reading frames"[MeSH Terms] OR ("reading"[All Fields] AND "frames"[All Fields]) OR "reading frames"[All Fields] OR "frame"[All Fields]) AND external[All Fields] AND fixation[All Fields]
		Ilizarov[All Fields]
		Taylor[All Fields] AND spatial[All Fields] AND "frames"[All Fields] OR "frame"[All Fields])

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