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RQ [##]:

Is a 14-days interval an absolute safe interval for conversion from external fixation to internal fixation?

Background

The management of high-energy open fractures requires a delicate balance between stabilizing the skeleton and protecting compromised soft tissues. Orthopaedic damage control utilizing temporary external fixation has widely become the standard primary intervention. It allows for immediate mechanical alignment, facilitates radical serial wound debridements, and prevents further neurovascular or soft-tissue insult. However, prolonged external fixation carries an inherent risk of pin-tract contamination, hardware loosening, and high malunion rates.

To mitigate these long-term complications and achieve optimal structural stability, sequential conversion to definitive internal fixation—via intramedullary nailing or plate osteosynthesis—is highly preferred. (1) Despite its clear benefits, the secondary introduction of indwelling hardware remains a major clinical challenge. The primary concern is deep surgical site infection or secondary osteomyelitis, which can be devastating for the patient. (2)

Orthopaedic literature frequently references a "two-week window" as a safe temporal benchmark for this switch. Several retrospective reviews suggest that performing internal fixation within 14 days of the initial injury minimizes the bacterial colonization of pin tracts and keeps deep infection rates relatively low. (3) Open fractures represent a highly diverse spectrum of injuries. The severity of initial contamination, the quality of early soft-tissue coverage, host comorbidities, and fluctuating systemic inflammatory markers all actively influence the optimal surgical window. (1) However, whether this 14-day threshold represents an absolute, globally safe interval for all open injuries remains a topic of considerable debate.

Section 2: Data extraction table

S.No	Author, Year, Country	Study Design	Sample Size	Follow-up	Results
1	Ye Z et al., 2021, China (1)	Retrospective comparative cohort study	N = 122 cases	Minimum 12 months	The total infection rate was 9.8%. Found **no statistically significant differences** in deep or superficial infection rates across groups A, B, and C (p = 0.812). **Confirming a carry-time of 14 days is not an absolute safe ceiling.**
2	Eissa MO et al., 2026, Egypt (4)	Prospective single-center randomized controlled trial	N = 60 patients	Minimum 24 months	In the two-stage cohort, the mean frame duration required for definitive soft-tissue stabilization prior to conversion was **17.5 +/- 3.1 days** (exceeding the 14-day cutoff). **Staged conversion achieved excellent union rates without elevating fracture-related infection vectors.**
3	Yoon YC et al., 2024, Korea (5)	Prospective observational trauma registry cohort	N = 30 patients	Mean 33.2 months	The bridging external construct was maintained for a mean duration of **24.2 +- 11.5 days** to facilitate soft-tissue resuscitation. Delaying hardware translation until total fasciotomy closure minimized deep infections, **showing that soft-tissue health overrides fixed time intervals.**
4	Yoon YC et al., 2025, Korea (6)	Retrospective comparative cohort study	N = 54 patients	Minimum 12 months	Spanning external frames were maintained for a mean of **15.8 +/- 6.2 days** before definitive nailing. Provisional reduction plating demonstrated significantly lower overall complication and comparable deep infection rates to the external fixator cohort, **showing safe conversion windows extending past 2 weeks**
5	Javaid RH et al., 2024, Pakistan (7)	Retrospective observational guideline study	N = 20 patients	Minimum 6 months	Initial debridement occurred on admission. Time from index debridement to soft-tissue flap coverage was **19.95 +- 8.21 days**, and definitive internal fixation occurred at a mean of **44.25 +- 7.77 days** post-flap coverage. **Demonstrates excellent safety lines when conversion protocols are deferred until local soft-tissue environments are optimized.**
6	Kock FW et al., 2025, South Africa (8)	Retrospective cohort study	N = 227 patients (237 fractures)	Minimum 12 months	Delays in definitive skeletal stabilization beyond 5 days from initial trauma significantly increased the risk of fracture-related infection (FRI) (OR 4.7, 95\%CI, p < 0.05). **This highlights that while frames can be carried past 14 days safely**, the initial bridge from injury to stable external or internal containment must occur rapidly (<5 days).

7	Erdem Y et al., 2019, Turkey (9)	Retrospective clinical cohort study	N = 18 patients	Mean 25.4 months	Spanning external constructs applied on the battlefield were maintained for a mean of **5.4 days** (range 2–11 days) before conversion. **Immediate conversion within this early acute window proved highly reliable and safe, showing low deep infection rates (5.5%) despite massive combat-related soft-tissue contamination.**
8	Nishida M et al., 2025, Japan (10)	Original retrospective cohort study	N = 23 patients	Minimum 12 months	Initial temporary external frames were replaced with definitive internal hardware (plates or nails) at a mean of **6.2 days** post-injury, followed by microvascular free flap coverage at a mean of **16.0 days**. **Early frame conversion within the 14-day window was safe and effective, provided it was tightly coupled with scheduled soft-tissue reconstruction.**

Section 3: Summary of Results

Recent clinical data heavily refines the classic dogma surrounding the timing of converting temporary external fixation to definitive internal fixation. Chronologically, while a 14-day window remains a reliable clinical benchmark, recent literature demonstrates that safety is a gradient rather than an absolute binary threshold.

Chronological Cutoffs and Infection Rates

The linear relationship between the duration of external fixation and fracture-related infection (FRI) remains a dominant theme. Extended fixator retention significantly elevates bacterial colonization risks.

- **The 14-to-28-Day Window:** Ye et al. (1), established that deep infection rates remain low and statistically equivalent when conversion occurs < 14 days (6.5%) versus 15–28 days (5.9%). However, delaying conversion beyond 28 days causes infection rates to surge to 23.3%.
- **Delayed Risk Escalation:** Kock et al. (8) and Aljuhani et al. (2), confirmed that progressive delays significantly exacerbate FRI risks, with infection rates climbing drastically after 24 to 36 days.
- **High-Energy Injuries:** In highly unstable combat or ballistics injuries, delayed reconstruction remains viable if staged carefully. Erdem et al. (9), demonstrated that staged conversion to retrograde intramedullary (IM) nailing for combat-related Gustilo-Anderson (GA) Type III supracondylar femur fractures can be executed safely. Similarly, Dar et al. (11), successfully used delayed interlocking IM nails after initial external fixation for high-velocity gunshot wounds of the femur without catastrophic infection rates, provided radical debridement was maintained.

Soft-Tissue Management and Flap Timing

Modern protocols prioritize soft-tissue biology over rigid chronological timelines. Adherence to co-managed orthoplastic principles—such as the BAPRAS guidelines—dramatically influences outcomes in lower limb open fractures. (7)

- **The "Fix Followed by Flap" Paradigm:** Contemporary management of severe GA Type IIIB/IIIC open tibial fractures has shifted toward definitive internal stabilization immediately prior to soft-tissue coverage. Morris et al. (12), demonstrated that inserting an IM nail directly before flap coverage does not increase complication or infection rates.
- **Staged Protocols:** Nishida et al. (10), validated this "fix followed by flap" protocol for Type IIIB fractures, proving that executing internal fixation as a staged maneuver immediately preceding a free flap yields excellent structural and infectious outcomes.

Anatomical Site and Alternative Fixation Strategies

The safety of the 14-day window varies significantly by anatomical site and mechanical strategy.

- **Articular Fractures:** For complex tibial plateau fractures complicated by acute compartment syndrome, Yoon et al. (5), highlighted that soft-tissue restitution, rather than the calendar, dictates complication rates. For tibial plateau fractures with dislocations, a combined approach of external fixation followed by delayed internal fixation protects the fragile soft-tissue envelope. (13) For complex pilon fractures, Eissa et al. (4), demonstrated in a randomized controlled trial that a two-stage open reduction and internal fixation (ORIF) protocol provides superior alignment and identical or lower complication profiles compared to single-stage external fixation.
- **Provisional Plating:** To avoid pin-tract contamination altogether, Yoon et al. (6), compared provisional reduction plating against traditional external fixation for staged management of GA Type II–III open tibial shaft fractures. They found that provisional plating offers a clean alternative that simplifies secondary conversion. Finally, when evaluating whether to convert at all, Tabatabai and Hosseini noted that while continuing external fixation eliminates secondary surgery risks, converting to internal fixation significantly optimizes bone union rates and reduces malunion, provided it is timed before pin tracts become heavily colonized. (14)

Section 4: Discussion

In this review we aimed to critically evaluate the contemporary literature and determine whether the 14-day threshold for the conversion from an external fixator to internal fixation, represents an evidence-based approach. In a polytrauma scenarios, the patient undergoes a systemic inflammatory response syndrome (SIRS), followed by a compensatory anti-inflammatory response syndrome (CARS) which are both associated with secondary complications including infections when the timing of interventions is not well timed (15-17) Furthermore, even in isolated injuries, open fractures—particularly high-energy Gustilo-Anderson Grade III injuries—provoke a profound local tissue response characterized by severe microvascular disruption, localized ischemia, and persistent edema, making badly timed definitive fixation risky. (18, 19) Therefore temporary fixation with an external fixator is often performed under the rational of DCO or MuST. (20)

The transition from a provisional external framework to definitive internal fixation (IF)—via intramedullary nails or plates and screws—presents a precarious clinical decision. Historically, an empirical "14-day rule" emerged as a core dogma in orthopedic training, designating a two-week window as an absolute safety ceiling. The underlying premise was straightforward: converting to permanent hardware past 14 days was thought to carry an unacceptable risk of cross-contamination from colonized pin tracts into the newly opened bone bed, leading to deep fracture-related infection (FRI) and osteomyelitis. (21, 22) In large, the “safe” period of 14 days was based on observational studies as well as on the earlier understanding on the period needed for the maturation of bacterial biofilms. Also, according to the kinetics of polytrauma physiology, this time limit is considered to precede the peak of the decreased immune state during the CARS. (15, 17)

Modern literature increasingly demonstrates that subclinical medullary contamination and pin-site tracking risks are not determined by a standardized time limit alone. Instead, they depend heavily on the continuous clearance of localized bacterial burdens, complete closure of the soft-tissue envelope, and down-regulation of systemic inflammatory dynamics. (16, 23) Operating through unviable, severely edematous, or highly inflamed soft-tissue zones simply to meet a 14-day calendar deadline frequently leads to catastrophic secondary wound breakdown, skin dehiscence, and immediate hardware exposure. (1, 16) More recent evidence shows that mature bacterial biofilm formation takes less than 40 hours to develop. (24, 25) With advancements in host physiological monitoring and resuscitation, adherence to multidisciplinary prompt management, use of local antibiotics as spacers or with absorbable carriers, this rigid, calendar-driven ceiling is facing intense scientific scrutiny. (18, 26)

Consequently, more recent stratified analyses of open fracture series challenge the strict statistical association between extended external fixation and infection. In severe, high-energy cohorts complicated by severe periarticular disruptions, extensive soft-tissue stripping, or acute compartment syndrome, forcing early conversion to meet an arbitrary deadline can be highly hazardous. Data suggest that the true mathematical inflection point for a sharp increase in deep infection sits closer to 24 to 28 days rather than 14 days. (1, 2) This extended grace period allows surgeons to prioritize soft-tissue optimization. Furthermore, the success of contemporary "fix followed by flap" protocols and strict adherence to orthoplastic guidelines prove that achieving definitive internal stabilization alongside immediate or staged soft-tissue coverage outweighs strict adherence to an arbitrary calendar date. (7, 10, 12, 26)

Ultimately, the clinical question of whether 14 days represents an absolutely safe interval for conversion from external to internal fixation cannot be answered with a simple chronological consensus. The compiled evidence indicates that while the 14-day threshold remains a safe clinical target, it is not a rigid biological boundary. A rigid 14-day cutoff fails to accommodate the diverse spectrum of open injuries. Safe conversion is fundamentally dictated by the zone of injury, soft-tissue stabilization, and the mitigation of pin-tract contamination. Therefore, the transition to internal fixation must be an individualized decision based on parameters as the severity of the soft and bony injuries, the resuscitation progress of polytrauma patients, the anatomical location (such as pilon or periarticular extensions), as well as host and contamination and mechanism related factors.

Section 6: Risk of Bias

Moderate risk of bias. The recommendation is derived mainly from retrospective comparative series and non-randomized prospective observational cohorts. No particular studies have divided groups based on 14 days cut off and have not given conclusive evidence considering only the time frame as an sole factor for conversion.

Section 7: Response / Recommendation

The historical 14-day interval **for converting an external fixator to definitive internal hardware in open fracture treatment must not be regarded as an absolute safe ceiling, neither as a certain risk factor when exceeded.**

An individualised approach from open fracture trauma specialists should be adopted, considering injury and patient’s parameters, the fixed safe time windows, the state of local soft-tissues, a comprehensive panel of systemic inflammatory markers would be a more reliable strategy at present.

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