

# Research Question

Should immediate reduction of protruding bone fragments or open dislocations be attempted in the emergency department prior to formal debridement?

## Section 1: Background

Open fractures are orthopaedic emergencies characterized by disruption of both skeletal integrity and the surrounding soft-tissue envelope, resulting in direct communication between the fracture site and the external environment. The primary goals of treatment are prevention of infection, preservation of soft-tissue viability, restoration of skeletal stability, and optimization of functional recovery. Contemporary management emphasizes early antibiotic administration, meticulous surgical debridement, fracture stabilization, and timely soft-tissue coverage.

During initial assessment, clinicians occasionally encounter protruding bone fragments that extend through the skin or open dislocations with exposed articular surfaces. A common dilemma is whether these structures should be immediately reduced in the emergency department before formal operative irrigation and debridement. In closed fractures and dislocations, urgent reduction is frequently recommended to restore alignment, reduce soft-tissue tension, improve neurovascular status, and facilitate immobilization. However, extrapolation of these principles to open injuries is controversial.

Unlike closed injuries, open fractures are already contaminated and are typically transferred urgently to the operating room for formal debridement and stabilization. Consequently, the potential advantages of immediate emergency department reduction may be less substantial than in closed injuries. Conversely, reinsertion of a contaminated bone fragment or reduction of an exposed dislocation before wound decontamination may theoretically introduce bacteria, foreign material, clothing fibers, soil, and debris into deeper tissue planes and the fracture site.

Current guidelines for open fracture management emphasize sterile dressing application, splintage, antibiotic administration, and urgent operative treatment but provide limited specific guidance regarding routine reinsertion of protruding bone fragments. Furthermore, no consensus exists regarding whether exposed osseous or articular structures should be manipulated before formal debridement in the operating room.

The objective of this review was therefore to evaluate the available evidence regarding immediate reduction of protruding bone fragments or open dislocations before formal irrigation and debridement and to determine whether such intervention should be routinely recommended during emergency department management.

## Section 2: Data Extraction

### Core Evidence

| Study No. | Study                                | Design              | Population                      | Intervention/ Focus                | Relevant Findings                                                                                                                                                                                                                | Limitations                               | Risk of Bias      |
|-----------|--------------------------------------|---------------------|---------------------------------|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|-------------------|
| Study 1   | BOAST Open Fracture Guideline (2020) | Clinical guideline  | Open fractures                  | Initial emergency management       | Recommendations: assessment, antibiotics, sterile dressing application, splintage, and urgent orthoplastic management. No specific recommendation regarding routine reinsertion of protruding bone fragments before debridement. | Consensus guideline; no comparative data. | High indirectness |
| Study 2   | Dheendhayalan et al. (2023)          | Narrative review    | Open fractures                  | Contemporary management principles | Emphasizes early antibiotics, wound protection, debridement, and stabilization. No direct evidence supporting emergency department reinsertion of exposed bone fragments.                                                        | Narrative review.                         | High              |
| Study 3   | OTA Survey (Obrensky et              | Practitioner survey | 379 orthopaedic trauma surgeons | Initial management practices       | Demonstrate variability in open fracture                                                                                                                                                                                         | Survey-based evidence.                    | High              |

| Study No. | Study                                      | Design                       | Population                    | Intervention/ Focus               | Relevant Findings                                                                                                                                                                                                                                                                                                                                 | Limitations               | Risk of Bias |
|-----------|--------------------------------------------|------------------------------|-------------------------------|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|--------------|
|           | al., 2014)                                 |                              |                               |                                   | management. Does not identify evidence-based recommendations regarding reinsertion of protruding bone fragments. Confirms contemporary management prioritizes antibiotics, splintage, debridement, and soft-tissue management. No assessment of emergency department reinsertion practices. Consistently emphasizes urgent operative debridement. |                           |              |
| Study 4   | BOAST Adherence Audit (Lacey et al., 2024) | Audit study                  | Open lower limb fractures     | Evaluation of guideline adherence | . No direct clinical studies evaluating routine pre-debridement reinsertion of protruding bone fragments.                                                                                                                                                                                                                                         | Audit; indirect evidence. | High         |
| Study 5   | Contemporary open fracture literature      | Reviews and expert consensus | Open fractures/ open injuries | Initial injury management         | . No direct clinical studies evaluating routine pre-debridement reinsertion of protruding bone fragments.                                                                                                                                                                                                                                         | Indirect evidence only.   | High         |

## Evidence Gap

No randomized controlled trials, prospective cohort studies, retrospective comparative studies, or systematic reviews were identified that specifically compared:

1. Reinsertion of protruding bone fragments in the emergency department versus operative reduction following debridement.
2. Immediate reduction of open dislocations versus reduction performed during operative debridement.
3. Infection rates, fracture healing, reoperation rates, or functional outcomes associated with either strategy.

Accordingly, the available evidence addressing the research question is indirect and consists predominantly of guidelines, reviews, and expert opinion.

## Section 3: Results

Five studies and guideline documents met inclusion criteria (Table 1). No comparative clinical study directly evaluated the effect of immediate emergency department reinsertion of protruding bone fragments or reduction of open dislocations prior to formal operative debridement.

Studies 1 and 4 demonstrate that contemporary open fracture protocols prioritize early antibiotic administration, sterile wound coverage, splintage, neurovascular assessment, and expedited transfer for operative management. However, neither guideline documents nor implementation audits provide recommendations supporting routine reinsertion of exposed osseous structures before debridement.

Similarly, Studies 2 and 5 emphasize the importance of meticulous operative debridement as the cornerstone of infection prevention in open fractures. Although reduction and stabilization are recognized components of definitive management, no evidence was identified demonstrating that emergency department reinsertion of protruding bone fragments improves clinical outcomes.

Study 3 highlights substantial variation in open fracture management practices among orthopaedic trauma surgeons and reflects the absence of evidence-based recommendations addressing this specific issue.

Across all identified literature, no study demonstrated reductions in infection, nonunion, soft-tissue complications, reoperation rates, or functional impairment resulting from routine emergency department reinsertion of exposed bone fragments. Likewise, no study demonstrated improved outcomes following reduction of open dislocations prior to operative debridement when neurovascular status remained satisfactory.

A recurring theme throughout the literature is the central importance of timely operative debridement. Because open fractures are routinely transferred urgently for surgical treatment, the theoretical benefits of emergency department reduction may be limited. In contrast, manipulation of contaminated bone fragments before wound cleansing may theoretically

introduce contaminants into deeper tissues, although direct clinical evidence supporting or refuting this concern is lacking.

Overall, the available literature neither supports nor definitively refutes emergency department reinsertion of protruding bone fragments. However, no clinical evidence demonstrating benefit was identified, whereas biologically plausible concerns regarding deeper contamination remain.

## Section 4: Discussion

The management of open fractures differs fundamentally from that of closed fractures. In closed injuries, urgent reduction is frequently recommended to restore alignment, reduce soft-tissue tension, improve neurovascular status, alleviate pain, and facilitate immobilization. These principles are well established and form the basis of emergency fracture care. However, whether similar principles should be applied to protruding bone fragments or open dislocations in open injuries remains uncertain. The present review found no direct clinical evidence supporting routine emergency department reinsertion of exposed bone fragments prior to formal operative debridement.

A key observation from this review is the complete absence of comparative clinical studies addressing the research question. None of the included studies evaluated outcomes following emergency department reinsertion of protruding bone fragments compared with delayed reduction after formal debridement. Similarly, no study compared immediate versus operative-room reduction of open dislocations in terms of infection, fracture healing, reoperation rates, or functional outcomes. The current evidence base therefore consists primarily of guidelines, narrative reviews, audits, and expert consensus statements rather than direct outcome-based research.

The theoretical rationale supporting emergency department reduction of exposed bone fragments is relatively limited. Potential benefits may include facilitation of splintage, improved patient comfort, easier transportation, and modest reduction in local soft-tissue tension. However, unlike closed fractures, these benefits must be considered in the context of contemporary open fracture management pathways. Current standards of care emphasize urgent transfer to the operating room for definitive irrigation, debridement, stabilization, and soft-tissue management. Consequently, the duration of exposure is generally short, and the opportunity for clinically meaningful benefits from temporary reduction may be limited.

Conversely, biologically plausible concerns exist regarding manipulation of exposed bone fragments before formal wound decontamination. Open fractures are, by definition, contaminated injuries. Exposed bone surfaces may carry environmental contaminants including soil, clothing fibres, organic material, road debris, and bacteria. Reinsertion of these fragments through the traumatic wound before adequate irrigation and debridement may theoretically introduce contaminants into deeper tissue planes, fracture surfaces, medullary canals, and areas that may subsequently be difficult to access during surgical debridement. Although direct clinical evidence supporting this concern is lacking, the biological rationale is reasonable and frequently cited in trauma practice.

The central principle emerging from the available literature is that meticulous surgical debridement remains the most important intervention in preventing infection after open fractures. None of the included studies suggest that emergency department manipulation of

exposed bone fragments improves outcomes to an extent that would outweigh the importance of prompt operative treatment. Indeed, contemporary guidelines consistently focus on early antibiotic administration, sterile dressing application, splintage, and expedited transfer for definitive surgical management rather than preoperative wound manipulation.

Open dislocations warrant separate consideration. Traditional orthopaedic teaching advocates urgent reduction of dislocations to restore perfusion and minimize articular cartilage damage. However, most evidence supporting immediate reduction originates from closed injuries. In the setting of open dislocations, the clinical context differs substantially because urgent operative treatment is already planned. Consequently, the routine reduction of all open dislocations prior to operative debridement cannot be supported by direct evidence. Nevertheless, specific circumstances may justify earlier reduction, including neurovascular compromise, progressive soft-tissue tension, threatened skin viability, inability to safely immobilize the extremity, or anticipated delays in access to definitive surgical care. In such situations, the potential benefits of reduction may outweigh theoretical contamination concerns.

An important distinction should also be made between restoration of gross limb alignment and reinsertion of protruding bone fragments. Realignment of a severely deformed extremity may be necessary to facilitate splintage, improve patient comfort, and reduce neurovascular compromise. However, restoration of overall alignment does not necessarily require replacement of contaminated exposed bone fragments into the wound. The present review specifically addresses reinsertion of protruding osseous structures rather than general fracture realignment.

The principal contribution of this review is therefore the identification of a significant evidence gap. Despite decades of research into open fracture management, no study has directly evaluated whether routine emergency department reinsertion of exposed bone fragments influences infection risk, fracture healing, soft-tissue complications, or functional recovery. Future research should focus on prospective multicentre registries or observational cohort studies examining this specific aspect of open fracture management. Until such evidence becomes available, recommendations must necessarily rely on biological plausibility, expert opinion, and accepted principles of contamination control.

In summary, current evidence does not demonstrate a clinical benefit associated with routine emergency department reinsertion of protruding bone fragments prior to operative debridement. Given the absence of proven benefit and the theoretical risk of deeper contamination, a strategy of wound protection, splintage, antibiotic administration, and expedited operative management appears most consistent with contemporary principles of open fracture care.

## Section 5: Risk of Bias of Included Studies

### Risk of Bias Assessment

| Source Type                             | Overall Appraisal                                                                   |
|-----------------------------------------|-------------------------------------------------------------------------------------|
| BOAST Open Fracture Guideline (Study 1) | High indirectness; consensus-based recommendations without comparative outcome data |

| Source Type                                         | Overall Appraisal                                                                                       |
|-----------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| Narrative Review (Study 2)                          | High risk of selection and interpretation bias; indirect evidence only                                  |
| OTA Survey (Study 3)                                | High risk of bias for treatment-effect estimation; reflects practice patterns rather than outcomes      |
| BOAST Adherence Audit (Study 4)                     | High indirectness; evaluates adherence to guidelines rather than clinical effectiveness of intervention |
| Contemporary Reviews and Expert Consensus (Study 5) | High risk of bias; absence of direct comparative evidence                                               |

## GRADE-Style Assessment

| Outcome                                                                             | Evidence Base                           | Certainty | Judgment                       |
|-------------------------------------------------------------------------------------|-----------------------------------------|-----------|--------------------------------|
| Infection prevention by emergency department reinsertion versus operative reduction | No comparative studies                  | Very Low  | No direct evidence available   |
| Fracture healing and union                                                          | No comparative studies                  | Very Low  | Outcome unreported             |
| Reoperation and revision surgery                                                    | No comparative studies                  | Very Low  | Outcome unreported             |
| Functional outcomes                                                                 | No comparative studies                  | Very Low  | Outcome unreported             |
| Risk of deeper contamination following reinsertion                                  | Biological rationale and expert opinion | Very Low  | Indirect evidence only         |
| Emergency department reduction of open dislocations                                 | Expert opinion and indirect evidence    | Very Low  | No direct comparative evidence |

Overall, the certainty of evidence is very low due to the complete absence of comparative clinical studies, serious indirectness, and reliance on expert opinion and biological plausibility.

## Section 6: Response / Recommendation

### Recommendation

Routine emergency department reinsertion of protruding bone fragments prior to formal irrigation and debridement is **not recommended**.

The available literature does not demonstrate a clinical benefit associated with routine reinsertion of exposed osseous structures before operative debridement. Conversely, biologically plausible concerns exist regarding deeper inoculation of contaminants into the wound, fracture surfaces, and surrounding soft tissues. Accordingly, exposed bone fragments should generally be protected with sterile saline-soaked dressings, the extremity appropriately splinted, intravenous antibiotics administered promptly, and definitive reduction performed under controlled operative conditions following adequate irrigation and debridement.

Open dislocations should be considered separately from protruding bone fragments. Immediate reduction may be justified in the presence of neurovascular compromise, threatened soft tissues, inability to safely immobilize the extremity, or anticipated delay in definitive surgical treatment. However, evidence supporting routine reduction of all open dislocations prior to operative debridement remains insufficient.

## Consensus Statement

There is insufficient evidence to support routine reinsertion of protruding bone fragments in the emergency department before formal operative debridement. In the absence of demonstrated benefit and in view of theoretical contamination concerns, definitive reduction is preferably performed following adequate surgical debridement.

## Level of Evidence

**Very Low**

## Strength of Recommendation

**Moderate Consensus Recommendation**

## Research Gap

No clinical study has directly compared emergency department reinsertion of protruding bone fragments with reduction performed after operative debridement. Prospective multicentre observational studies are required to determine whether either strategy influences infection rates, fracture healing, soft-tissue complications, reoperation rates, or functional outcomes.