

Single-Stage Repair of Infected Humeral Nonunion After Fixation: A Critical Narrative Review

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Abstract: ***Background:** Infection complicating humeral nonunion challenges both eradication and mechanical reconstruction. **Objective:** To appraise a recent Journal of Orthopaedic Trauma (JOT) series of planned single-stage revision following prior fixation, in the context of a multicentre infected shaft nonunion cohort and fracture-related infection (FRI) definitions. **Methods:** Selective narrative review of original clinical evidence and the international consensus definition; no systematic search or meta-analysis. **Results:** In the JOT series of 15 culture-positive patients, 13 (86.7%) ultimately united, but only 10 (66.7%) did so after the index repair alone. Five (33.3%) required unplanned reoperation and two (13.3%) developed recurrent infection. Cutibacterium acnes accounted for 80% of cultures. A separate 26-patient multicentre shaft cohort reported 13 unions (50%) after infected nonunion repair, with similar observed proportions after planned one- and multistage care; its population and endpoints differ. **Conclusion:** One-stage repair can succeed in selected patients, but frequent additional operations and uncertain generalizability preclude a claim of superiority over staged care. [1–3]*

Keywords: infected humeral nonunion; fracture-related infection; single-stage revision; Cutibacterium acnes; union; reoperation

1. Introduction

Clinical question and scope

Revision of a humeral nonunion after prior osteosynthesis must address devitalized tissue, implant-associated infection, stable fixation, and a viable biological environment for union. A single-stage plan combines debridement and definitive reconstruction at one operation; staged care deliberately separates those phases, often when soft-tissue or infection circumstances require it. The new JOT study reports what happened after a planned single-stage approach. It has no concurrent staged control group, so it informs feasibility and burden of further treatment rather than a comparative choice. [1]

The August 2026 JOT series

Katzir and colleagues retrospectively reviewed patients treated at a tertiary referral hospital in 2016–2024 after prior fracture fixation. All 15 underwent a planned one-stage repair and had positive intraoperative cultures. Nine initial fractures involved the shaft (AO/OTA 12), four the proximal humerus (11), and two the distal humerus (13); 12 had originally been closed injuries. Thirteen revisions used plate and screw fixation, two used nails, and 13 included bone graft. Only two used local antibiotics. Mean systemic antibiotic treatment was 8.1 months, with a wide range of 1.2–26.4 months. [1]

Reported outcome	Number of 15	Interpretation
Union after index operation alone	10 (66.7%)	Single planned operation sufficed
Additional intervention then union	3 (20.0%)	Contributes to ultimate union
Ultimate union	13 (86.7%)	Includes subsequent procedures
Unplanned reoperation	5 (33.3%)	For infection or impaired union
Recurrent infection	2 (13.3%)	Reported during follow-up

The 10 and 3 union categories sum to 13; the reoperation and recurrent-infection rows can overlap and should not be added. The abstract does not provide follow-up distribution or detailed criteria for infection eradication. [1]

The distinction between index success and ultimate union is material. Describing an 86.7% union rate as the result of a single operation conceals the three patients who required additional intervention to unite. Two others did not achieve union, and one third of the cohort required an unplanned operation. With only 15 people, each outcome changes the percentage by 6.7 points. The series is best read as evidence of a possible pathway with substantial retreatment, not a precise estimate for general practice. [1]

Microbiology and diagnostic interpretation

Cutibacterium acnes was isolated in 12 of 15 patients, Staphylococcus aureus in two, and Staphylococcus epidermidis in one. Seven patients had normal serum inflammatory markers, three had elevations, and results were unavailable in five. A normal marker profile does not resolve the infection question in an indolent nonunion. The published abstract says cultures were positive but does not state how many separate deep samples yielded the same organism or whether there were other confirmatory signs. With an organism that may also contaminate samples, that distinction matters. [1, 3]

The international FRI consensus regards matching organisms from at least two separate deep tissue or implant specimens as confirmatory; sinus or wound breakdown communicating with bone/implant, purulence, or histopathological demonstration of microorganisms are other confirmatory routes. One unexpected positive sample should be interpreted with sampling quality, clinical signs, histology, and organism characteristics rather than assumed equivalent to established FRI. The JOT abstract alone does not allow every included case to be independently classified by these criteria. [1,3]

Why the multicentre result differs

Pallitto and colleagues reported 26 infected humeral shaft nonunions across eight Level I centres. Their definition included a draining sinus or at least two positive intraoperative cultures, and only shaft cases were analyzed. Thirteen of 26 achieved union after revision. Planned single-stage treatment united three of seven (42.9%) and staged treatment ten of 19 (52.6%; $P = .99$), an exploratory comparison with small, surgeon-selected groups. Persistent infection occurred in about 27%. These data do not demonstrate that staging is ineffective or that one-stage care is better. [2]

A direct 86.7% versus 50% comparison would mislead. The JOT cohort spans proximal, shaft, and distal nonunions and reports ultimate union even after further intervention; the multicentre study focuses on shaft injury and classifies failure when further surgery for nonunion was required. Organism mix, referral selection, severity, fixation, grafting, follow-up, and definitions may differ. The studies agree on the need to describe repeat procedures and infection control separately from radiographic union. [1,2]

2. Practical Interpretation

A one-stage plan is most plausible when meticulous debridement and implant exchange can be paired with stable fixation, adequate coverage, viable grafting as required, reliable deep sampling, and an antimicrobial plan that can be revised when cultures finalize. Intraoperative findings may require changing the plan. A sinus, major bone or soft-tissue loss, uncertain debridement margins, or compromised coverage may favor a staged reconstruction, but neither series tests a decision rule for these choices. Antibiotic selection and duration must account for microbiology, fixation strategy, and infectious-disease input; the JOT cohort's mean duration is a description, not a universal prescription. [1–3]

Before promising “one operation,” surgeons should explain the observed one-in-three unplanned reoperation rate in the small JOT cohort, along with the possibility of prolonged antibiotics and later surgery to obtain union. Complication reporting should separate persistent infection, recurrent infection, failure of union, and implant failure, and should give time to event. Function and patient burden are also important; the abstract reports neither validated arm function nor a comparative cost or quality-of-life outcome. [1]

3. Limitations and Future Study

The JOT study is Level IV, retrospective, referral-based, and lacks a staged comparator. Its high proportion of *C. acnes* cultures and mixed anatomical sites limit transportability to patients with virulent infection or large defects. Antibiotic duration varied markedly. The multicentre comparison is likewise confounded by surgeon selection and differing case mix. A prospective registry should use consensus FRI criteria, document at least several separately obtained deep cultures and histology, distinguish known from unexpected infection, stratify shaft and periarticular sites, and report both index-operation success and ultimate infection-free union at a fixed interval. A comparative study would need careful adjustment or allocation for severity and treatment selection. [1–3]

4. Conclusion

The 2026 JOT series shows that planned single-stage repair can achieve ultimate union in selected culture-positive humeral nonunions, often with substantial antibiotic treatment. Ten of 15 patients united after the index operation alone, and five required unplanned reoperation. Consistent diagnostic definitions and comparable endpoints are essential before choosing one stage over staged reconstruction on the basis of these small series. [1–3]

Declarations

Selective narrative review of published clinical studies and consensus definition; no new patient data, formal systematic search, or meta-analysis. Author names, affiliations, funding, conflicts, and journal-specific declarations must be completed before submission. Verify full-text diagnostic methods and follow-up for the August 2026 JOT paper before submission.

References

- [1] Katzir A, Bilodeau RE, Bhadouriya RS, et al. Outcomes of one-stage infected humerus nonunion repair in patients with prior operative fracture fixation. *J Orthop Trauma*. Published online August 19, 2026. doi:10.1097/BOT.0000000000003264.
- [2] Pallitto P, Koutlas N, Harrison N, et al. Outcomes after infected humeral shaft nonunion surgery. *OTA Int*. 2025;8(4):e454. doi:10.1097/OI9.0000000000000454.
- [3] Metsemakers WJ, Morgenstern M, McNally MA, et al. Fracture-related infection: a consensus on definition from an international expert group. *Injury*. 2018;49(3):505–510. doi:10.1016/j.injury.2017.08.040.