

# Outcomes of Septic Long-Bone Nonunions: Which Organisms are Associated with Poorer Results?

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**INTRODUCTION:** Management principles for septic long bone nonunions (SLBNU) include eradication of existing infection through surgical debridement, fracture stabilization, and antibiotic treatment. This study assessed the association between cultured organism species and outcomes of septic long bone nonunion treatment.

**METHODS:** Adult patients with septic long bone nonunion repair at a single institution from 2014-2023 were retrospectively reviewed. Septic nonunion was defined as a nonunion associated with either a history of positive nonunion cultures from an outside hospital prior to study site presentation or a positive culture from nonunion surgery at the study site. Patients with incomplete data, <6-months follow-up without osseous union, or nonunion resulting from osteotomy, fusion, or pathologic fracture were excluded. Initial injury and patient characteristics, surgical and antibiotic treatments, cultured organisms, and outcomes were collected. The primary outcomes were osseous union and unplanned operations after index study-site nonunion repair to address infection or to promote union.

## RESULTS:

One hundred and one patients with septic nonunions, were included. Mean age was 52 years (range 18–89) and 73% were male. Mean follow-up from definitive nonunion repair was 22 months (range 1.4-92.5) (**Table 1**). At final follow-up, 86% (87/101) achieved radiographic union. Patients with negative index study site nonunion cultures (n=20) were more likely to have at least one unplanned procedure versus patients with positive nonunion surgery cultures (n=81); (60% vs. 30%, p=0.018) (**Figure 1**). Polymicrobial infections (in those with positive index study site nonunion cultures) were associated with double the rate of having at least one or more unplanned operation compared to monocolonized patients (43% vs. 18%, p=0.014). Patients with both gram-positive and gram-negative bacteria had higher rates of unplanned operations than those with multiple bacteria of the same gram classification, (75% vs. 28%, p=0.007). Initial acute fracture treatment with external fixation was associated with development of polymicrobial infections (54.5% vs 25.4%, p=0.013). No differences in final union rates across bacterial species were observed (p>0.9) (**Figure 2**).

**DISCUSSION AND CONCLUSION:** Organisms cultured from septic long bone nonunions play a significant role in the number of operations needed to achieve clinical resolution. Those with polymicrobial infections may deserve more aggressive initial eradication efforts, as this group had a higher rate of unplanned operations to manage infection or to promote union.

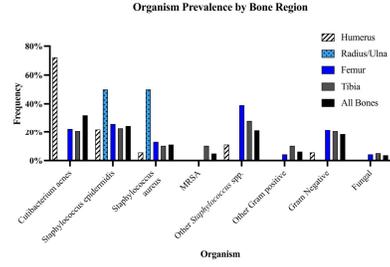
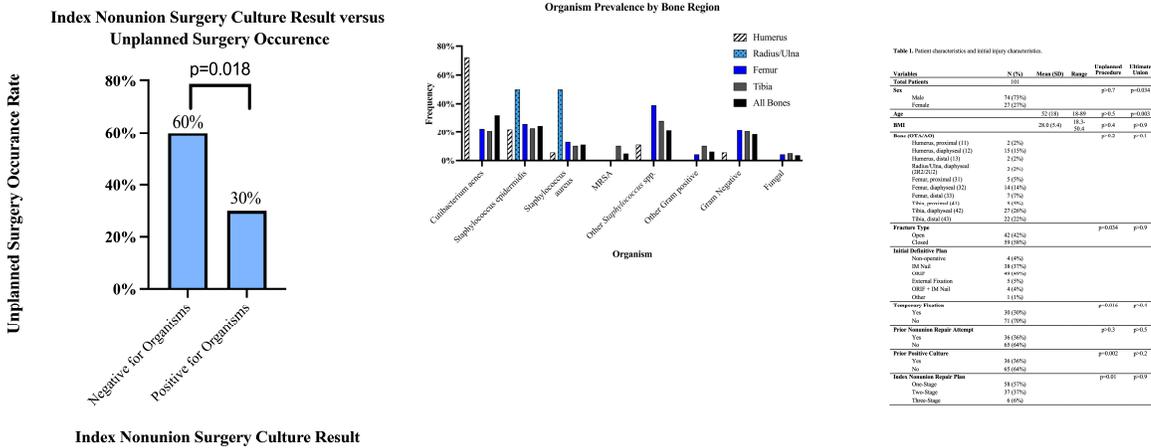


Table 1. Patient characteristics and initial injury characteristics.

Variable	N (%)	Mean (SD)	Range	Treatment Procedure	Ultimate Union
<b>Total Patients</b>	101				
<b>Sex</b>					
Male	74 (73%)				
Female	27 (27%)				
<b>Age</b>		52 (18)	18-89	p=0.17	p=0.034
<b>BMI</b>		28.8 (5.4)	18.5-55.1	p=0.64	p=0.93
<b>Initial Injury</b>					
Open (n=35)					
Humeral proximal (11)	2 (6%)				
Humeral distal (24)	11 (31%)				
Humeral distal (1)	2 (6%)				
Radius/Ulna (distal)	2 (6%)				
Distal Femur (distal)	2 (6%)				
Proximal Femur (proximal)	1 (3%)				
Femur distal (distal)	14 (41%)				
Femur distal (proximal)	1 (3%)				
Tibia proximal (proximal)	4 (12%)				
Tibia distal (distal)	21 (64%)				
Tibia distal (proximal)	27 (27%)				
<b>Fracture Type</b>					
Open	41 (41%)				
Closed	60 (60%)			p=0.004	p=0.69
<b>Initial Treatment Plan</b>					
Nonoperative	4 (4%)				
OR nail	38 (38%)				
OR nail	49 (49%)				
External fixation	9 (9%)				
ORF + IM Nail	4 (4%)				
Other	1 (1%)				
<b>Temporary Fixation</b>					
Yes	39 (39%)				
No	71 (71%)			p=0.016	p<0.1
<b>Final Nonunion Repair Attempt</b>					
Yes	26 (26%)				
No	55 (55%)			p=0.33	p=0.33
<b>Final Positive Culture</b>					
Yes	34 (34%)				
No	67 (67%)			p=0.002	p=0.62
<b>Final Nonunion Repair Plan</b>					
One-Stage	58 (57%)				
Two-Stage	37 (37%)			p=0.01	p=0.03
Three-Stage	4 (4%)				