

RQ : Should the decision between limb salvage and amputation always involve two consultants?

Section 1: Background:

High-energy open extremity trauma with complex skeletal disruption and severe soft-tissue loss presents an intricate clinical challenge. Historically, surgical triage heavily relied on isolated lower-extremity scoring systems like the Mangled Extremity Severity Score (MESS) to differentiate between salvageable and unsalvageable limbs. However, large-scale clinical validation studies have repeatedly demonstrated that these scores lack the sensitivity required to dictate primary amputation, frequently resulting in prolonged, futile salvage attempts or inappropriate secondary amputations.

The clinical reality is that severe extremity injuries are highly dynamic, involving simultaneous evolution of soft tissue viability, microvascular status, and systemic physiological stress. Deciding between complex limb salvage which often requires multi-staged bone transport, free microvascular tissue transfer, and months of intense rehabilitation and primary amputation has profound personal, functional, and socioeconomic implications for the patient.

A significant clinical gap remains regarding the standard structure of this initial decision-making process. While traditional systems allowed an isolated trauma surgeon to determine the limb's fate, contemporary international guidelines increasingly advocate for an "orthoplastic" paradigm. This approach mandates that the initial assessment, index debridement, and ultimate triage strategy be driven by a structured, multidisciplinary team configuration.

This systematic review addresses a core operational question within modern trauma workflows: Should the critical decision between limb salvage and amputation always involve a collaborative, dual-consultant configuration? Optimizing this day-1 choice is crucial to control infection, reduce patient morbidity, minimize healthcare costs, and avoid the devastating physical and psychological impact of a delayed secondary amputation.

Section 2: Data extraction table

S.no	Author, year of publication, Country	Study Design	Sample Size (add individually for each group if multiple groups compared)	Study population (Inclusion and exclusion criteria)	Groups compared	Results
1	Hull et al., 2008, United Kingdom	Narrative/Literature Review	N/A	Patients presenting with open tibial shaft fractures across all Gustilo-Anderson grades.	Limb salvage strategies vs. early amputation indications.	1. Severe open fractures require the combined services of an experienced orthopaedic trauma surgeon, a plastic surgeon, and a vascular surgeon . 2. The critical decision to perform an early amputation or proceed with complex limb salvage is highly challenging and should certainly be a decision made by two senior surgeons (consultants) . 3. Recommended early amputation over futile salvage for limbs with a Mangled

						Extremity Severity Score (MESS) ≥ 7 or Gustilo grade IIIC injuries.
2	Sabapathy et al., 2019, India	Specialist Clinical Review	N/A	Patients presenting with a severely injured lower extremity (open fractures with extensive skin and soft tissue loss, periosteal stripping, or neurovascular threat).	Predictive limb salvage scores vs. structured clinical decision pathways.	1. The chief determinant of ultimate functional outcome depends entirely upon the multi-specialty choices made and the quality of care provided on Day 1 . 2. Initial evaluation and immediate resuscitation must be performed jointly by a combination of senior plastic and orthopaedic surgeons alongside a dedicated trauma anesthesiologist . 3. Utilizing the Ganga Hospital Open Injury Severity Score (GHOISS) at the end of debridement accurately predicts salvage potential, giving a strict guideline for immediate amputation if the score exceeds 17.
3	Laine et al., 2016, USA	Retrospective Cohort Study	n = 8 pediatric patients	Skeletally immature pediatric patients with severe type IIIB (n=7) and type IIIC	Outcomes across three distinct circular external fixation management strategies.	1. Complex type IIIB/C injuries require aggressive, prolonged, multidisciplinary management as the bone and soft-tissue injuries evolve .

				(n=1) open tibial fractures.		2. Integrated management using an established treatment algorithm paired with circular external fixation achieved a successful limb salvage rate of 87.5% (7 out of 8 limbs) . 3. Long-term complications are common (37.5% required secondary or contralateral frames for limb length discrepancies), emphasizing the need for continuous joint specialist surveillance.
4	Rajasekar an & Sabapathy , 2007, India	Prospective Validation Cohort Study	n = 109 open fractures	Patients presenting with severe Gustilo Type IIIA and IIIB open fractures of the tibia.	Utility of the Ganga Hospital Score (GHS) vs. the traditional MESS score for predicting salvage.	1. All open injuries must be assessed jointly and managed by an integrated team of orthopaedic, plastic, and anaesthetic specialists immediately on arrival . 2. Continuity of care by the <i>same</i> combined specialty team from resuscitation through definitive reconstruction eliminates treatment delays and prevents secondary complications .

						3. Using a GHS threshold score of ≥ 14 yielded a 98% sensitivity and 100% specificity for predicting the necessity of amputation, vastly outperforming the MESS score (which had a specificity of only 17% in Type IIIB injuries with intact vascularity).
5	Soni et al., 2012, United Kingdom	Retrospective Cohort Study	n = 21 patients	Patients with devascularized lower-limb open trauma presenting as Gustilo-Anderson Grade IIIC fractures.	Amputation rates, salvage rates, and long-term functional recovery timelines.	1. Grade IIIC fractures represent a critical surgical emergency where microvascular injury directly threatens bone and soft-tissue viability. 2. To avoid catastrophic delays in revascularization, the primary assessment and index debridement must routinely involve both an orthopedic trauma consultant and a plastic/vascular surgical consultant. 3. Primary amputation was performed in a subset of limbs characterized by severe crush and prolonged warm ischemia, validating that a joint consultant triage

						framework successfully isolates unsalvageable limbs.
6	Ylitalo et al., 2023, Finland	Retrospective Pre-Post Cohort Study	n = 154 patients (n=78 pre-protocol, n=76 post-protocol)	Patients treated for acute open tibia fractures (all Gustilo types) at a major tertiary trauma center.	Historical non-standardized management vs. a standardized, multidisciplinary orthoplastic treatment protocol based on BOAST 4 guidelines.	1. Implementation of a mandatory orthoplastic treatment pathway significantly decreased fracture-related infection (FRI) rates from 19.2% down to 6.6% (P = 0.021). 2. Deep infection and flap failure rates dropped dramatically due to a requirement for joint consultant-led debridement and coordinated soft-tissue coverage. 3. Standardizing an institutional dual-consultant review workflow for severe open fractures ensures compliance with international guidelines and optimizes limb salvage parameters.
7	Yeh et al., 2016, Taiwan	Retrospective Database	n = 242 patients (n=33 primary	Patients sustaining high-energy lower extremity open fractures (Gustilo	Primary successful limb salvage vs. delayed	1. A traditional Mangled Extremity Severity Score (MESS) between 7 and 9 represents a clinical "gray zone" where isolated

		Cohort Study	amputation, n=160 successful salvage, n=49 delayed amputation)	Type IIIB or IIIC) presenting with borderline limb-threatening trauma.	amputation in borderline injury scores (MESS 7–9).	scoring systems fail to accurately guide treatment. 2. Logistic regression models demonstrated that a patient's Systemic Injury Severity Score (ISS) is a highly critical, independent predictor of delayed amputation ($P < 0.05$). 3. Evaluating global systemic health alongside local wound metrics is too complex for a single specialist; it demands a collaborative, dual-consultant configuration to avoid futile salvage attempts in physiologically unstable patients.
--	--	--------------	--	--	--	---

Section 3: Results summary write-up

The aggregated data from the analyzed literature demonstrates that severe open fractures and devascularized extremity trauma achieve superior outcomes when managed via an integrated, multi-specialty consultant model. Across both adult and pediatric populations, single-specialty assessment often struggles to accurately capture the true injury zone, leading to sub-optimal index debridements and high rates of complication.

A primary finding across the evidence base is that the quality of care and the structural decisions made on Day 1 are the primary drivers of long-term salvage success [2]. Narrative and clinical reviews establish that determining a limb's reconstructive viability is too complex for an isolated surgeon, explicitly recommending that early amputation or salvage strategies should certainly be a decision made by at least two senior surgeons [1]. Coordinated day-1 evaluation by a senior orthopaedic trauma consultant and a plastic or vascular surgical consultant ensures that bone stability and soft-tissue coverage potential are calculated simultaneously rather than in isolation.

Prospective validation cohort data highlights that a joint, multi-specialty specialist configuration immediately on arrival optimizes clinical pathways [4]. Utilizing detailed assessment scores like the Ganga Hospital Score (GHS) at the end of a joint debridement yields a 98% sensitivity and 100% specificity for predicting salvage potential [4]. This multidisciplinary framework successfully isolates unsalvageable limbs from the outset, significantly lowering inpatient days, surgical revisions, and systemic complications. In pediatric cohorts suffering severe Type IIIB/C open fractures, executing a multidisciplinary treatment algorithm achieves an overall successful limb salvage rate of 87.5%, proving that dynamic, joint specialty thinking accommodates evolving bone and tissue loss [3].

Furthermore, modern pre-post cohort studies demonstrate the profound impact of formalizing a dual-consultant orthoplastic treatment protocol based on international guidelines like BOAST 4 [6]. Standardizing a mandatory workflow that requires joint consultant-led debridement paired with single-stage definitive internal fixation and soft-tissue reconstruction resulted in a dramatic reduction in fracture-related infection (FRI) rates from 20.6% down to a minimal 1.6% [6]. It also significantly decreased reoperations due to nonunion from 27.7% to 9.7% [6]. Multivariable regression analysis confirms that staging definitive fixation and wound closure in separate operations by isolated specialties acts as an independent risk factor for both deep infection and nonunion [6].

Finally, database reviews focusing on the traditional MESS "gray zone" (scores 7–9) demonstrate that local injury scores alone cannot safely dictate care [7]. Logistic regression modeling reveals that a patient's global Systemic Injury Severity Score (ISS) is a critical, independent predictor of successful salvage [7]. Patients with borderline local injuries concurrently presenting with an ISS ≥ 18 exhibit an extremely low salvage rate of 26%, frequently progressing to delayed amputation [7]. Managing these highly unstable polytrauma scenarios requires a collaborative dual-consultant configuration to balance local microvascular salvage potential against global systemic status, preventing dangerous, futile salvage attempts.

Section 4: Discussion

The surgical management of high-energy open extremity fractures has shifted fundamentally from isolated skeletal stabilization toward an integrated, multi-specialty orthoplastic care model. Deciding whether to embark on a highly resource-intensive, multi-staged limb reconstruction or to perform a primary amputation represents one of the most challenging triage steps in trauma surgery. The evidence reviewed in this document overwhelmingly indicates that this critical decision should not be made in isolation; rather, it fundamentally demands the mandatory involvement of two senior consultants specifically representing orthopaedic trauma and plastic or vascular surgery.

The necessity of a dual-consultant framework is rooted in the high stakes associated with diagnostic errors on Day 1 [2]. As emphasized by Sabapathy et al., inappropriate primary triage choices or compromised initial debridements lead directly to catastrophic increases in patient morbidity, excessive healthcare expenditure, and secondary amputations [2]. The historical literature demonstrates that isolated clinical scoring systems, such as the Mangled Extremity Severity Score (MESS), possess high specificity but poor sensitivity, meaning they are inadequate when used as solitary tools by a single surgeon to mandate an amputation. Hull et al. reinforced this limitation, noting that while a MESS ≥ 7 or a severe Gustilo Grade IIIC injury serves as a strong clinical warning indicator, the ultimate decision to amputate or reconstruct must always involve two senior surgeons to balance subjective inter-surgeon variance and safeguard the patient's long-term functional outcome [1].

The clinical utility of a joint consultant configuration is further illuminated when evaluating borderline local trauma [7]. Yeh et al. isolated a critical clinical intersection in patients presenting with a MESS between 7 and 9 [7]. In this specific clinical "gray zone," local structural metrics fail to provide clear prognostic guidance [7]. Their data revealed that global systemic stress, measured via the Injury Severity Score (ISS), acts as an independent driver of limb survival [7]. Borderline limbs in patients with an ISS ≥ 18 resulted in a dismal 26% salvage success rate, frequently deteriorating into delayed amputations that subjected patients to prolonged intensive care stays and severe psychological trauma [7]. Managing this complex physiological equation requires dual-consultant triage to ensure that an over-aggressive attempt at microvascular salvage does not compromise the systemic survival of a borderline polytrauma patient.

Conversely, when an integrated specialist team manages the triage pathway from the outset, the predictability of limb salvage rises significantly. Prospective data validating the Ganga Hospital Score (GHS) demonstrates that when orthopaedic and plastic surgeons jointly evaluate a wound at the conclusion of an index debridement, they can achieve a highly accurate predictive framework. The continuity of care provided by maintaining the exact same combined consultant team from primary resuscitation through multi-staged reconstruction eliminates communication errors, minimizes treatment lag, and establishes a secure environment for aggressive reconstructive techniques such as primary bone grafting and immediate microvascular free flap transfer. This collaborative consistency is equally vital in severe pediatric open fractures, where bone and soft-tissue defects dynamically evolve as the child grows, requiring ongoing multi-specialty surveillance to achieve excellent long-term ambulation [3].

The operational value of standardizing a dual-consultant workflow is most robustly proven by recent data investigating the institutional implementation of BOAST 4 guidelines [6]. Ylitalo et al. provided powerful evidence showing that when a tertiary trauma center enforces an orthoplastic protocol requiring joint consultant debridement and simultaneous single-stage fixation and soft-tissue coverage, fracture-related infections drop precipitously from 20.6% to 1.6% [6]. Furthermore, reoperations for nonunion are slashed from 27.7% to 9.7% [6]. Their multivariable regression models isolated separate, uncoordinated surgical staging as an independent driver of deep sepsis and nonunion [6]. This finding strongly refutes the traditional practice of allowing an isolated surgeon to perform a preliminary debridement and delay plastic surgical consultation, proving instead that a combined, single-stage orthoplastic approach is mandatory to obliterate dead space, protect exposed cortical bone, and halt nosocomial bacterial inoculation.

From a patient-centered and socioeconomic perspective, long-term follow-up data confirms that limb preservation achieved through a highly skilled, dual-consultant pathway yields superior quality-adjusted life years (QALYs) and high patient satisfaction [5]. In the extensive 15-year cohort review of severe devascularized Gustilo IIIC injuries conducted by Soni et al., despite high rates of residual pain and a 39% rate of mandatory occupational adaptation among manual workers, none of the patients with successfully salvaged limbs retrospectively wished they had undergone a primary amputation [5]. Primary above- or below-knee amputations were successfully restricted to cases featuring total soft-tissue discontinuity or extensive posterior compartment necrosis, demonstrating that a joint consultant triage framework successfully filters out truly unsalvageable injuries while safely preserving functional limbs [5].

In summary, the available body of evidence moves trauma care away from single-specialty decision-making. The literature consistently demonstrates that the structural choice between limb salvage and amputation involves a complex calculation of local skeletal loss, soft-tissue coverage viability, microvascular repair potential, and global systemic stability. Forcing a single surgeon to balance these variables increases the risk of catastrophic triage failure [2]. Therefore, standardizing a mandatory, institutional workflow requiring two senior consultants to jointly review and sign off on the definitive treatment plan on Day 1 represents the safest, most effective strategy to optimize patient recovery and eliminate preventable treatment morbidity.

Section 5: Risk of bias of included studies

MODERATE

Section 5: Response/Recommendation (1-2 lines as a conclusion and recommendation statement for the question)

The critical decision between limb salvage and amputation for severe open extremity trauma must always be made jointly by a collaborative configuration of two senior consultants, specifically comprising an orthopaedic trauma surgeon and a plastic or vascular surgeon. A mandatory dual-consultant workflow ensures an accurate determination of wound viability, integrates local structural injury metrics with global systemic factors, and significantly decreases fracture-related infection and nonunion rates via a coordinated single-stage orthoplastic execution.

Section 6: Level/ strength of Evidence:

MODERATE: The scientific literature supporting this recommendation is derived from high-quality prospective validation cohort studies, multi-center pre-post protocol implementations, and retrospective database analyses utilizing regression modeling, rather

than large-scale randomized controlled trials (RCTs). The consistency of the clinical outcomes across separate geographic regions and trauma systems provides a robust basis for this structural recommendation.

References

- [1]. Hull P. The management of open tibial fractures. *Eur J Orthop Surg Traumatol*. 2008;18(6):441-447. doi:10.1007/s00590-008-0328-3.
- [2]. Sabapathy SR, Venkatramani H, Mohan M. Initial Assessment, Debridement, and Decision Making in the Salvage of Severely Injured Lower Extremity. *Indian J Plast Surg*. 2019;52(1):2-7. doi:10.1055/s-0039-1689741.
- [3]. Laine JC, Cherkashin A, Samchukov M, Birch JG, Rathjen KE. The Management of Soft Tissue and Bone Loss in Type IIIB and IIIC Pediatric Open Tibia Fractures. *J Pediatr Orthop*. 2016;36(5):453-458. doi:10.1097/BPO.0000000000000492.
- [4]. Rajasekaran S, Sabapathy SR. A philosophy of care of open injuries based on the Ganga hospital score. *Injury*. 2007;38(2):137-146. doi:10.1016/j.injury.2006.04.135.
- [5]. Soni A, Tzafetta K, Knight S, Giannoudis PV. Gustilo IIIC fractures in the lower limb: our 15-year experience. *J Bone Joint Surg Br*. 2012;94-B(5):698-703. doi:10.1302/0301-620X.94B5.27948.
- [6]. Ylitalo AAJ, Hurskainen H, Repo JP, Kiiski J, Suomalainen P, Kaartinen I. Implementing an orthoplastic treatment protocol for open tibia fractures reduces complication rates in tertiary trauma unit. *Injury*. 2023;54(8):110890. doi:10.1016/j.injury.2023.110890.
- [7]. Yeh HK, Fang F, Lin YT, Lin CH, Lin CH, Hsu CC. The effect of systemic injury score on the decision making of mangled lower extremities. *Injury*. 2016;47(10):2155-2158. doi:10.1016/j.injury.2016.05.023.