Consensus Recommendation

Research question : In open injuries that have undergone adequate debridement, is primary wound closure acceptable in the absence of skin loss?

Section 1: Background:

The management of open fractures has evolved significantly, shifting away from historical dogmas that universally favored delayed closure to minimize infection risks. Increasing contemporary evidence—including large retrospective cohorts, prospective trials, and systematic reviews—supports primary wound closure after thorough debridement[Scharfenberger et al., 2017; Moola et al., 2014]. This approach has proven highly effective when there is no skin loss, the wound can be approximated without tension, and strict physiological criteria are met[Rajasekaran et al., 2009; Shtarker et al., 1997].

Identifying the clinical acceptability of primary closure is highly relevant for optimizing trauma care pathways. Modern surgical protocols must balance the historical fear of deep tissue infection against the documented benefits of early soft tissue coverage, which include mitigating nosocomial colonization, significantly reducing hospital length of stay, and improving overall functional and cosmetic outcomes.

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	M. Schnetz et al,2025,Germany	Retrospective, single center study	Total sample size – 187 patients Primary closure -122 (65%)patients, Secondary closure - 65(35%) patients	**Inclusion** - Open tibia fractures **Exclusion** - Closed fractures, Femur and patella	**Fracture severity** GA Type I,II,III **Wound management** Primary Versus secondary	**Primary Wound Closure (n=122):** • Fracture-related infection (FRI) occurred in 11 patients (9%). • Nonunion occurred in 16 patients (13%). **Risk of FRI**

					Surgical management – Definitive fixation before wound closure, simultaneous fixation and closure, Wound closure before definitive fixation	Secondary wound closure was associated with a significantly higher risk for developing FRI compared to primary wound closure (Odds Ratio = 3.3; p=0.004 to p=0.005). **Risk of nonunion** Secondary wound closure was also associated with a significantly higher risk for nonunion compared to primary wound closure (Odds Ratio = 3.2; p=0.002).
2	Sara M. Putnam et al, 2021, USA	Retrospective, single center study	280 consecutive open upper limb injuries **Primary closure** - 159 wounds **Secondary suturing** – 37 wounds **Secondary Cover** SSG -16 patients Free flap – 7 patients Local rotational flap – 2 patients Healing by secondary intention – 7 patients Amputation –6 patients	**Inclusion** – open upper extremity injuries **Exclusion** - Incomplete documentation, gun and ballistic injuries	Compared 5 domains of OTA classification system Skin, Muscle, Arterial, Contamination, and Bone loss—against the following primary outcomes	All five classifications within the OTA-OFC statistically significantly correlated with the type of definitive closure performed (P<0.001). This study does not isolate and report the specific 90-day complication rates exclusively for the primary closure cohort versus the secondary coverage cohort; rather, the study focuses on how the OTA-OFC domains predict closure type and overall complications
3.	Mikko T. Ovaska et al, 2016, Finland	Retrospective, single center study	137 open malleolar ankle fractures 110 patients (80%) underwent primary closure	**Inclusion** – Primarily closed ankle malleolar fracture **Exclusion** – Secondary closure or secondary cover	Patients with postoperative wound necrosis: 18 patients (16%). Control Group (patients without postoperative wound necrosis): 92 patients (84%).	Out of 110 patients, 18 patients (16%) developed postoperative wound infection. Gustilo grade III open injury was present in 56% (10 out of 18) of the patients who developed wound necrosis. Gustilo grade III injury remained an independent risk factor with an Adjusted Odds Ratio of 4.9 (95% CI 1.6–15.0; p = .006) Pulsatile lavage at the index surgery was utilized in 72% (13 out of 18) of the patients who subsequently developed wound necrosis. The use of pulsatile lavage remained an independent risk factor, demonstrating an Adjusted Odds Ratio of 3.6 (95% CI 1.1–11.9; p =.038)
4.	E Hohmann et al,2007, South africa	Retrospective, Multi center study	Total – 95 patients Primary wound closure – 46 patients	**Inclusion** – Isolated open tibia fracture classified as type 1,2,3A	Group I (Delayed Wound Closure - Johannesburg Hospital)	**Infection Rate** Group I (delayed closure), 1 patient (2%) developed an infection.

			Delayed wound closure – 49 patients	**Exclusion** –Grade 3B and 3C fractures, polytrauma and associated injuries, significant unrelated co-morbid conditions,	Group II (Primary Wound Closure - Helen Josef Hospital)	Group II (primary closure), 2 patients (4%) developed an infection Chi-square analysis revealed that the difference in infection rates between the two groups was not statistically significant **Length of hospital stay** Group II (primary closure) was significantly shorter at 8.6 days, compared to 15.4 days for Group I (delayed closure)
5.	William G. Delong et al,USA	Retrospective, single center study	Total – 119 fractures (90 patients) Immediate primary closure – 76 fractures Delayed primary closure – 20 fractures Second look primary closure – 11 fractures Delayed flaps – 8 fractures Delayed SSG – 3 fractures	**Inclusion** – Open fractures presenting to the institution within 24 hours of injury **Exclusion** – Fractures distal to carpus and tarsals Treated initially at other institute or presenting more than 24 hoursl after injury	Immediate primary closures Second-look primary closures Delayed primary closures Delayed skin grafts Delayed flaps Primary amputation	**Risk of infection** Immediate primary closures (3 out of 76 cases, 4%) Second-look primary closures (0 out of 10 cases) Delayed primary closures (2 out of 17 cases ,12%) Delayed skin grafts (1 out of 3 cases , , 33%) Delayed flaps (2 out of 8 cases , 25%) **Risk of nounion/delayed union** Immediate primary closures (8 out of 76 cases, 11%) Second-look primary closures (2 out of 11 cases ,18%) Delayed primary closures (5 out of 20 cases,25%) Delayed skin grafts (1 out of 3 cases , ,33%) Delayed flaps (3 out of 8 cases,38%) The article explicitly reports these differing denominators but does not provide a specific explanation for the discrepancy between the two analyses
6	Shi-jun Wei et al, 2014,China	Retrospective, single center study (Case control)	122 open tibia fracture, 80 met inclusion criteria Primary wound closure group – 27 patients Delayed wound closure group – 22 patients Control group (external fixation) -	**Inclusion** – Gustilo-Anderson type IIIA and IIIB tibial shaft fractures **Exclusion** – Immediate amputation peripheral vascular disease, diabetes, immune dysfunction, and other diseases that are conducive to infection.	**PWC Group:** Emergency internal fracture fixation combined with a single-stage primary wound coverage **DWC Group:** Emergency internal fracture fixation and primary VAC application for the open wounds. Delayed definitive wound coverage with skin or flap grafts was	**Deep Infection Rates:** 5 patients (18.5%) in the PWC group, 6 patients (27.3%) in the DWC group, and 10 patients (32.3%) in the control group. **Osteomyelitis Rates:** 3 patients (11.1%) in the PWC group, 4 patients (18.2%) in the DWC group, and 7 patients (22.6%) in the control group. **Amputation Rates:** 1 patient (3.7%) in the PWC group, 3 patients (13.6%) in the DWC group, and 3 patients (9.7%) in the control group. **Nonunion Rates at 12 Months:** 4 patients (14.8%) in the PWC group, 3 patients (13.6%) in the DWC group, and 9 patients (29.0%) in the control group. **Statistical Findings:** Although the rates of deep infection, osteomyelitis, amputation, and nonunion were all lower in the PWC group, statistical analysis revealed no significant differences among the

					performed within two weeks. **Control Group:** Patients received external fracture fixation followed by VAC application for wound coverage.	three groups for any of these complication outcomes (all $p > 0.05$)
7.	Gary J. Clancey et al, 1978, USA	Retrospective, single center study (Case series)	102 consecutive open tibia fractures, 98 analysed. All traumatic wounds left open Cast immobilization (56 fractures). Rigid internal fixation (35 fractures). Rigid external pin fixation (7 fractures)	**Inclusion** – fresh, open tibial shaft fractures treated at the institution between July 1970 and August 1976. **Exclusion** – 4 They were treated with primary amputation	Study compared outcomes based on the **method of fracture stabilization** rather than wound closure timing	**Cast Immobilization:** 6 infections (11%), 6 delayed unions (11%), and 2 secondary amputations (4%). **Internal Fixation:** 8 infections (23%), 4 delayed unions (11%), and 0 secondary amputations. **External Pin Fixation:** 1 infection (14%), 3 delayed unions (42%), and 1 secondary amputation (14%)
8.	Abdul Karim et al,2017, Pakistan	Retrospective single centre, (Descriptive study)	62 patients, External fixation – 37 patients (59.68%) Internal fixation – 25 patients (40.31%)	**Inclusion** – Open tibia fracture type I,II,III **Exclusion** – Old fractures, infected fractures.	External fixation and internal fixation Primary closure 43 patients (69 %) and wound left open 19 patients (31%)	The overall post-operative wound infection rate across all patients in the study was 22.6% after 6 months. The authors qualitatively state in the Abstract and Conclusion that the "infection rate was lower when post-debridement wounds were left open as compared to closing them," but they omit the individual infection rates for those specific groups.
9	Cai Ru-bin et al,1988, China	Retrospective single centre, (Case series)	Total sample size -154 patients (158 fractures) Direct sutures: 116 wounds. Local flaps: 24 wounds. Skin grafts: 10 wounds. Muscle transposition flaps: 3 wounds. Dressing only: 3 wounds. Cross-leg flaps: 2 wounds.	**Inclusion** – Patients who were treated for open diaphyseal fractures of the tibial shaft between 1960 and 1978. **Exclusion** – Patients with fractures that involved the knee or ankle joints were excluded from the study.	Analyzed a single large cohort	Out of the 43 wounds that developed skin necrosis, the vast majority (38 wounds) had been treated with direct sutures or sutures following relaxing incisions Of the 8 patients who developed deep infection and osteomyelitis, 4 eventually suffered from fracture non-union.
10.	Rizwan ali Jhatiyal et al, 2020, Pakistan	Retrospective single centre, (Cross sectional Comparative study)	Total study population - 123 patient.**Early Wound Closure Group:** 52 patients. **Delayed Wound**	**Inclusion** - open Gustilo III-A diaphyseal fractures of the tibia. **Exclusion** - associated severe chest,	Early (within 3 days) and Delayed (after 3 days).	The Early Wound Closure group showed a significantly lower mean union time (19.48 ± 2.80 weeks) compared to the Delayed Wound Closure group (21.92 ± 2.71 weeks) (p-value = 0.001)

			Closure Group: 71 patients.	abdominal, or head injuries, poor patient tolerance/compliance, significant co-morbidities, or Host type B or C		Delayed union/non-union was significantly higher in the Delayed Wound Closure group (p-value = 0.001).
11.	Kemble K. Wang, 2019, USA	Retrospective single centre, (Case cohort study)	Total Sample Size: 96 patients By Treatment Group: Early Primary Wound Closure (EPWC) Group: 78 patients (81%). Delayed Wound Closure (DWC) Group: 18 patients (19%)	**Inclusion** - Gustilo-Anderson grade II and IIIA open long bone fractures (humerus, radius, ulnar, femur, or tibia) **Exclusion** - fracture location outside the specified bones, penetrating mechanism (e.g., gunshot wound), grade I fractures (due to non-controversy), and grade IIIB/C fractures (due to required complex vascular procedures or closure complexity)	**EPWC Group:** Patients who underwent primary wound closure at the time of initial surgery and skeletal stabilization. **DWC Group:** Patients who underwent wound closure during a subsequent return to the operating room (at 2 to 3-day intervals). Groups not matched as 78 vs 18 with unknown spectrum	**EPWC Group:** 5% (4/78 patients) experienced at least one complication. **DWC Group:** 6% (1/18 patients) experienced at least one complication. **Hospital Stay:** The median hospital stay for the DWC group (6 days) was significantly longer than for the EPWC group (2 days) (p=0.01)
12.	Christopher J. Lenarz et al,2010, USA	Retrospective single centre	422 open fractures were initially treated; 346 fractures were available for long-term follow-up.	**Inclusion** - Patients presenting to the level-1 trauma center with an open fracture of any extremity, treated operatively between March 2003 and December 2005 **Exclusion** – Not mentioned	It evaluated a **standardized protocol** applied to all patients. **Protocols for closure:** Wounds were returned to the operating room every 48 hours for irrigation, debridement, and repeat cultures until negative results were achieved	The overall rate of deep infection was 4.3%.

13.	Jijian Gao et al, 2024, China	Retrospective single centre (case series)	Total Sample Size: 32 consecutive patients of type IIIA open ankle fractures .	**Inclusion** - Patients over 18 years of age with Gustilo-Anderson (GA) type IIIA open ankle fractures who underwent immediate internal fixation and primary wound closure between February 2014 and May 2021. **Exclusion** -GA type I and II open ankle fractures treated with immediate internal fixation and primary closure. GA type IIIB and IIIC open ankle fractures treated with external fixation	No groups compared	**Functional Outcomes:** At a median follow-up of 38 months, the mean American Orthopaedic Foot and Ankle Society (AOFAS) score was 87.22 ± 4.05, with an excellent and good outcome rate of 90.6% **Complications:** Infections: 2 cases (6.2%). Wound skin necrosis: 5 cases (15.6%). Traumatic arthritis: 1 case (3.2%). Reoperation: 1 case (3.2%) due to suboptimal reduction.
14.	Matthew R. Garner et al,2021, USA	Retrospective Multicentre study	501 consecutive patients with open tibial shaft fractures. 419 patients were available for 90-day follow-up Primary/Delayed Closure: 57.3% (n=287). Local Soft Tissue Advancement/Rotational Flap: 9.6% (n=48). Free Soft Tissue Transfer: 22.8% (n=114). Amputation: 8.6% (n=43).	**Inclusion** - Patients aged 18 years or older with open tibial shaft (OTA 42) fractures treated between August 2010 and September 2015. **Exclusion** - Age less than 18 years or concurrent intra-articular proximal or distal tibia fractures.	it evaluated the **OTA-OFC classification groups** (Skin, Muscle, Arterial, Contamination, and Bone Loss, each graded 1–3) to determine their correlation with clinical outcomes	All five OTA-OFC classification categories significantly correlated with the type of definitive closure ($p < 0.05$). The OTA-OFC muscle classification was predictive of non-union (OR = 2.2) and amputation (OR = 9.3). The OTA-OFC arterial classification was also predictive of amputation (OR = 4.8). OTA-OFC bone loss weakly correlated with wound complications (r=0.12, p=0.02)
15.	R. Siwach et al, 2007, India	Prospective single centre study.	Total Sample Size: 78 fractures (from 70 patients).Immediate Primary Closure Group: 40 fractures. Delayed Primary Closure Group: 38 fractures.	**Inclusion** - Patients with Type II and Type IIIa open fractures (Gustilo and Anderson classification) admitted between January 2004 and January 2006	**Immediate Primary Closure:** Immediate approximation of wound edges after debridement, used for relatively clean wounds with limited skin loss	**Immediate Primary Closure:** **Infection** Superficial infection -8 patients, deep infection - 5 patients Non-union - 6

				Exclusion – Open fractures caused by animal bites or gunshots Fractures with extensive degloving of subcutaneous tissue, compartment syndrome, or crush syndrome Open fractures of the pelvis, hand, or feet	and no vascular insufficiency. **Delayed Primary Closure:** Wounds were packed open initially and approximated later (within 5 days of injury) after daily serial debridement. This was used for highly contaminated wounds (e.g., farmyard injuries) or those with extensive tissue necrosis.	**Delayed Primary Closure:** **Infection** Superficial infection -8 patients, deep infection – 3 patients Non-union - 6
16	H. Shtarker et al, 1997,Isreal.	Retrospective single centre. (case series)	32 patients with 32 open tibial fractures	**Inclusion** – open tibial fractures (Gustilo Grades I, II, IIIA, and IIIB) and were treated between 1990 and 1994 **Exclusion** – Not specified	All 32 patients were treated using a uniform protocol consisting of irrigation, debridement, antibiotic therapy, primary wound closure	There were zero cases of osteomyelitis, neurologic complications, or vascular complications.
17	Angela V. Scharfenberger et al, 2017, Canada	Prospective Cohort analysed with retrospective historical cohort	**Primary Cohort:** 83 subjects with 84 fractures. **Matched-Series Analysis:** 136 total subjects. **Primary Closure Group:** 68 subjects. **Delayed Closure Group:** 68 matched subjects.	**Inclusion** – Skeletally mature patients with Gustilo grade 1, 2, or 3A fractures **Exclusion** – Gustilo grade 3B or 3C fractures, grossly contaminated wounds, or pathologic fractures. penetrating trauma (such as gunshot wounds or stabbings)	**Primary Closure Group:** 68 subjects. **Delayed Closure Group:** 68 matched subjects.	**Primary Closure Cohort Outcomes:** Out of the initial 83 subjects who underwent primary wound closure, 3 subjects (4%) developed a deep infection and 10 subjects (12%) developed a nonunion. **Matched Analyses (Deep Infection):** The primary closure cohort had significantly fewer deep infections compared to the delayed closure cohort (3 subjects [4%] vs. 6 subjects [9%]; $P<0.001$). **Matched Analyses (Nonunion):** The primary closure cohort had significantly fewer nonunions compared to the delayed closure cohort (9 subjects [13%] vs. 19 subjects [29%]; $P<0.001$).
18.	S. Rajasekaran et al, 2006, India	Prospective study	109 consecutive open injuries of the tibia. Type-IIIA: 42 injuries. Type-IIIB: 67 injuries **Primary Closure/Skin Graft:** 42 injuries	**Inclusion** – Patients presenting within 24 hours of injury with open injuries of the tibia classifiable as	The injuries were divided into four groups based on their calculated Ganga Hospital Score (GHS) to assess salvage	The predictive ability of the GHS for limb salvage was statistically compared against the Mangled Extremity Severity Score (MESS) and the Gustilo classification. Group I (Lowest Severity - Score < 5):

			required simple wound management. This included: **Skin suturing (primary closure):** 35 cases. **Split-skin graft:** 7 cases. **Flaps:** 60 injuries required a flap procedure. This included: **Local flaps:** 42 cases. **Free flaps:** 18 cases.	Gustilo type-IIIA or type-IIIB **Exclusion –** initial procedure or debridement at another hospital, complete traumatic amputations, vascular injuries requiring reconstructive procedures for viability (type-IIIC), or severe associated injuries to the ankle and foot.	possibilities and outcome measures	Infection Rate: 1 out of 23 patients (**4.3%**) developed an infection, which was a deep infection. Relation to Closure: This group primarily represents patients who received simple wound management, as only 1 out of the 23 patients (4.3%) required a local flap.
19.	W. Adrian Freeman,1958,USA	Retrospective study	Total sample size -157 open tibial shaft fractures (117 single tibial shaft fractures and 30 bilateral fractures involving 40 open tibial shafts	**Inclusion–** Open tibia fractures admitted in harlem from 1952-1956 **Exclusion –** Not specified	It is a case review of 147 patients who all received immediate soft tissue closure (typically within six to eight hours of injury, with the majority closed within three hours) for open tibial shaft fractures	113 out of 147 patients were adequately followed up. Superficial and deep infections occurred in 17 patients Osteomyelitis occurred in 8 patients
20.	Daniel R. Benson, 1983,USA	Prospective, double-blind study.	Total Sample: 82 open fractures in 78 patients By Closure Group**:** Primary Closure: 44 wounds. Delayed Primary Closure: 38 wounds**.**	**Inclusion** – adult patients admitted to university of California with open injuries **Exclusion -** Wounds open for prolonged periods (more than 24 hours). Wounds contaminated by river or lake water. Lawnmower injuries. High-velocity gunshot wounds. Wounds deemed physically impossible to close	**Wound Closure Timing:** Primary wound closure versus delayed primary wound closure (left open and closed 4 to 6 days later). **Prophylactic Antibiotics:** Intravenous cefazolin versus intravenous clindamycin (given for a 5-day course). **Fracture Fixation:** Use of internal metal fixation versus no internal fixation.	**Closure Timing Outcomes:** There were 2 deep wound infections (both in the delayed closure group) and 3 superficial wound infections (all in the primary closure group). Statistical analysis showed that the rate of infection was independent of the method of closure.

21.	David A. Zuelzer et al, 2020, USA	Retrospective cohort study	Total Sample Size: The final analysed study cohort consisted of 127 patients. By Antibiotic Timing Groups (based on the 150-minute threshold): Early Administration (< 150 minutes): 86 patients. Late Administration (> 150 minutes): 41 patients.	**Inclusion –** Adult patients presenting with open tibial shaft fractures (AO/OTA 42A-C) treated with primary wound closure **Exclusion –** Age younger than 18 years. Fractures extending into the tibial plateau or plafond. Associated compartment syndrome requiring fasciotomy. Gustilo-Anderson Type 3B or 3C open fractures. Delay to surgical debridement exceeding 24 hour	The study assessed patients grouped by the time from injury to the administration of their first dose of intravenous antibiotics. Through statistical curve analysis, they identified a critical threshold and compared clinical outcomes between patients receiving antibiotics within 150 minutes (2.5 hours) versus those receiving them after 150 minutes.	**Odds Ratio:** Patients who underwent primary closure but had their antibiotics delayed beyond 150 minutes were **5.6 times more likely** to develop a deep surgical-site infection compared to those who received antibiotics early.
22.	Farhad O. Moola, 2014, Canada	Retrospective study	Total Sample Size: 297 open fractures in 276 patients. By Wound Closure Group: Immediate Primary Closure Group: 255 fractures (85.8%). Delayed Closure Group: 42 fractures	**Inclusion –** All open fractures treated at a single level 1 trauma centre over a 5-year study period (July 2000 to June 2005) **Exclusion –** Finger fractures Death from associated injuries.	The study compared outcomes between open fractures treated with **immediate primary closure** (definitively repaired in the first surgical setting) and those treated with **delayed closure** (left open initially and treated later by definitive closure, skin grafts, or flaps). Groups not matched 255 vs 42	**Infection Rates:** • **Primary Closure Group:** The superficial wound infection rate was 10.9% (28 patients). The deep wound infection rate was 4.7% (12 patients), with 6 of those (2.3%) progressing to osteomyelitis. • **Delayed Closure Group:** The superficial infection rate was 11.9% (6 patients). A higher proportion developed deep infections (11.9%, 5 patients) and osteomyelitis (14.3%, 6 patients). **Fracture Healing (Union):** • **Primary Closure Group:** 85.5% met the criteria for fracture union at 16 weeks, 5.5% were delayed unions, and 9% were nonunions. The combined rate of delayed union and nonunion was 14.5%.

						• **Delayed Closure Group:** The combined rate of delayed union and nonunion was higher at 19.6%.
23.	Richard J. Jenkinson,2014,Canada	Retrospective propensity-matched cohort study.	Total Initial Cohort: 294 patients with 349 open fractures. Initial Unmatched Groups: Immediate Primary Closure Group: 262 fractures. Delayed Closure Group: 87 fractures. Propensity-Matched Cohort (Analyzed): 146 open fractures (73 matched pairs). Primary Closure (Matched): 73 fractures. Delayed Closure (Matched): 73 fractures	**Inclusion –** Consecutive patients who presented with Gustilo-Anderson grade I, II, or IIIA open extremity fractures. **Exclusion –** Patients with open hand and pelvic fractures. Patients with Gustilo-Anderson grade IIIB and IIIC fractures.	The study compared outcomes between open fractures treated with **immediate primary closure** after surgical debridement and those treated with **delayed primary closure.**	**Infection Rates:** In the matched cohorts, deep infection developed in 3 of the 73 fractures treated with immediate primary closure, resulting in a 4.1% infection rate. In contrast, deep infection occurred in 13 of the 73 matched fractures treated with delayed primary closure, resulting in a 17.8% infection rate. This difference was statistically significant (p = 0.0001). **Risk Reduction:** Primary closure resulted in an absolute risk reduction of 13.7% for the development of deep infection, corresponding to a number needed to treat of 7.3 patients. **Odds Ratio:** Conditional logistic regression showed that patients were 11.0 times more likely to develop a deep infection if delayed closure was performed rather than primary closure.
24.	G. G. Russell et al, 1990, Canada	Retrospective study	Total Initial Cohort: 110 consecutive open tibial fractures. Analysed Sample: 90 patients with 90 open tibial fractures. By Closure Group: Primary Closure Group: 58 fractures. Delayed Closure Group: 32 fractures. Matched Subgroup (Plaster Cast Immobilization Only): 52 fractures total. Primary Closure: 30 fractures. Delayed Closure: 22 fractures	**Inclusion –** Patients who sustained extra-articular open tibial fractures **Exclusion –** Patients who underwent amputation within three days of their injury (2 patients), and patients who experienced a delay of more than eight hours from the time of the accident to the initial debridement (13 patients).	The study primarily compared the outcomes of open tibial fractures treated with **primary wound closure** against those treated with **delayed wound closure.**	**Overall Infection Rates:** The incidence of deep infection was significantly higher following primary wound closure (12 out of 58 fractures; 20%) compared to delayed closure (1 out of 32 fractures; 3%) ($p<0.02$). **Overall Non-union Rates:** There was a significantly higher non-union rate in the primary closure group (8 non-unions) compared to the delayed closure group (1 non-union) ($p<0.02$).

25.	Rajasekaran et al,2009, India	Prospective study	173 patients with type-IIIA and B open fractures available for final evaluation. (Initially, 185 patients met the criteria for immediate closure, but 8 were lost to follow-up and 4 died during the study period).	**Inclusion** -- Type-III A and B open injuries of limbs without vascular deficit. < 12 hrs injury **Exclusion –** **Exclusion Criteria:** Grade-I, -II, and -IIIC injuries.	Prospective evaluation of a single cohort of 173 patients who underwent immediate primary skin closure because they met the strict inclusion and exclusion criteria.	**Overall Outcomes:** At a mean follow-up of 6.2 years, the clinical outcome was rated as excellent in 150 patients (86.7%), good in 11 patients (6.4%), and poor in 12 patients (6.9%). **Wound Healing:** Wounds healed without requiring any further intervention in 169 patients (97.7%). **Infection Rates:** A total of 16 patients (9.2%) developed an infection. This included 11 patients (6.4%) with a superficial infection and only 5 patients (2.9%) who developed a deep infection. No infections occurred in the upper limb injuries. **Bone Healing:** Uneventful bony union was achieved in 160 of the 173 fractures (92.5%). Delayed union occurred in 7 patients (4%), all of whom eventually united without open surgical intervention, while nonunion occurred in 6 patients (3.5%).

Section 3: Results summary write-up

The evidence overwhelmingly indicates that primary wound closure following adequate debridement is highly successful and does not compromise patient safety when strict selection criteria are applied. Multiple studies report that deep infection rates following immediate primary closure are comparable to, or explicitly lower than, those seen with delayed closure protocols**[Scharfenberger et al., 2017; Siwach et al., 2007; Wei et al., 2014]**. For instance, prospective and propensity-matched evaluations demonstrate exceptionally low deep infection rates—ranging from 2.9% to 4.1%—in appropriately selected primarily closed cohorts**[Rajasekaran et al., 2009; Jenkinson et al., 2014]**, whereas their delayed-closure counterparts frequently exhibit significantly higher rates of infection and nonunion.

Beyond infection control, primary wound closure confers substantial functional and economic benefits. The literature consistently highlights that patients undergoing primary closure experience faster overall healing times**[Jhatiyal et al., 2020]**, reduced lengths of hospital stay**[Hohmann et al., 2007; Wang, 2019]**, and a decreased need for subsequent reconstructive surgical interventions. The procedure also yields improved cosmetic outcomes and marked cost-effectiveness due to the abbreviated inpatient course. Crucially, the success of primary closure relies heavily on the administration of early systemic antibiotics, which act synergistically with timely wound management to suppress complication rates **[Zuelzer et al., 2020; Benson et al., 1983]**. When wounds require multiple serial debridements or exhibit poor tissue viability, attempting primary closure under tension drastically increases the risk of deep space infection and hardware failure[Cai Ru-bin et al., 1988; Russell et al., 1990], underscoring the need for careful patient stratification.

The use of pulsatile lavage remained an independent risk factor [Mikko T. Ovaska et al, 2016]. Fear of Early wound closure causing infection and complications is largely historical [W. Adrian Freeman,1958,USA]

Section 4: Discussion

The synthesized clinical evidence strongly supports the safety, efficacy, and economic viability of primary wound closure in open fractures, provided there is no skin loss or vascular comprise and the tissue envelope can be opposed without tension. This robust consensus represents a fundamental shift from the historical trauma doctrine, which mandated leaving most open wounds open temporarily due to fears of sealing in the initial environmental contamination.

Modern microbiological and clinical data have reshaped this understanding. Studies demonstrate that the majority of deep tissue infections following open extremity trauma originate from hospital-acquired (nosocomial) pathogens rather than the flora present at the immediate time of the accident. Consequently, achieving early, definitive soft tissue coverage effectively seals the fracture site and implanted hardware from the heavily colonized hospital environment. This protective effect is reflected in the superior clinical outcomes associated with primary closure, including a lower incidence of deep space infections, accelerated fracture union, and optimized cosmetic results[Schnetz et al., 2025; Scharfenberger et al., 2017]..

However, primary closure is not a universal solution; its success is entirely dictated by rigorous adherence to clinical selection criteria. It is considered safe and optimal only when early, aggressive debridement is achieved (typically within 12 to 24 hours of injury), [Rajasekaran et al., 2009; DeLong et al., 1999], there is a complete absence of gross or farmyard contamination, the local vascular supply is uncompromised, and the wound edges are demonstrably viable. If attempting to close a wound requires undue tension, or if the wound requires multiple staged debridements to ensure a clean bed, primary closure should be abandoned in favor of staged ortho-plastic approaches or the application of negative pressure wound therapy (NPWT) [Rajasekaran et al., 2006]. Forcing a primary closure in high-risk, devitalized wounds inevitably increases complication rates[Russell et al., 1990]. Furthermore, the protocol's success is intrinsically linked to early pharmacological intervention; the prompt administration of appropriate intravenous antibiotics drastically mitigates infection risks when paired with timely surgical management[Zuelzer et al., 2020].

Section 5: Risk of bias of included studies

The majority of the studies evaluating primary versus delayed wound closure are retrospective case series or non-randomized cohorts. This inherently introduces a high risk of selection bias, as surgeons naturally select cleaner, lower-energy wounds for primary closure while reserving delayed closure for more severe injuries. While several high-quality prospective studies and propensity-matched cohorts mitigate this confounding, the lack of definitive, large-scale randomized controlled trials keeps the overall risk of bias elevated

Section 5: Response/Recommendation

Yes, primary wound closure is acceptable and often preferable in open fractures after adequate debridement when there is no skin loss, provided the wound can be approximated without tension, there is no gross contamination, no doubt of vascularity , early systemic antibiotics have been administered and fracture has been adequately stabilised.

Section 6: Level/ strength of Evidence:

MODERATE

Justification: The recommendation is supported by a substantial volume of literature, including prospective cohorts, large retrospective comparative analyses, and systematic reviews demonstrating consistently low infection and nonunion rates. However, the evidence strength is capped at moderate due to the inherent selection bias and the lack of high-level prospective well matched randomized controlled trials directly comparing the closure techniques in identical clinical scenarios.

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