CONSENSUS RECOMMENDATION

RQ: In open injuries with segmental bone defects, is the Masquelet technique preferable to distraction osteogenesis?

Background:

Open injuries with segmental bone defects are complex limb-threatening injuries requiring Ortho-plastic approach for management of contamination, infection risk, soft-tissue loss, mechanical stability, limb length, alignment, and host factors.[1,2,3] The two common biological strategies for management of segmental bone loss are the Masquelet induced membrane technique (IMT) and distraction osteogenesis (DO)/bone transport.[4-7] IMT is a two-stage method consisting of radical debridement, dead-space control with an antibiotic loaded polymethylmethacrylate cement spacer, formation of a biologically active induced membrane, followed by grafting and definitive stabilization.[4,7,10] Its advantages include local antibiotic delivery, preservation of defect space, avoidance of long-term external fixation, and a relatively shorter treatment burden in selected defects.[4,6,7,28] DO uses Ilizarov principles of corticotomy, gradual distraction, and regenerate consolidation to reconstruct bone without large graft volumes; it can simultaneously correct shortening and deformity.[1,25,43] Its limitations include prolonged external fixation, pin-tract infection, docking-site complications, joint stiffness, and substantial psychosocial burden.[5,14,25,43] The current literature includes comparative studies, meta-analyses, reviews, cost analyses, case series, and hybrid-technique reports.[6,11,12,15,36] The evidence consistently demonstrates high union and limb-salvage rates for both techniques; however, no high-quality randomized trial has demonstrated universal superiority of one method over the other.[15,36,39] Therefore, clinical decision-making should be guided by defect size, infection burden, soft-tissue envelope, host status, surgeon expertise, patient compliance, and available resources.[2,30,41]

Data table

S.No	Author / Year	Study design	Sample size	Population	Intervention / Comparator	Key outcomes	Results	Follow-up	Risk of bias
1	Bernstein et al., 2018	Technical article	NR	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Bone transport over nail	Union, infection, complications, treatment duration, functional outcomes/costs where reported	Hybrid DO technique reduces duration of external fixation by allowing external fixation removal after transport phase; intended for massive tibial defects (>8 cm).	Published outcomes referenced in CORR 2015; follow-up NR	Moderate-High
2	Bernstein et al., 2024	Review	NR	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Review of Ilizarov, Masquelet, grafting and vascularized bone grafts	Union, infection, complications, treatment duration, functional outcomes/costs where reported	No universal algorithm; successful care requires infection control, soft-tissue reconstruction, stability and alignment.	NA	Moderate-High
3	Borzunov et al., 2022	Retrospective preliminary series	16 (7 adults, 9 children)	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Combined induced membrane and Ilizarov bone transport	Union, infection, complications, treatment duration, functional outcomes/costs where reported	Combined approach feasible after previous treatment failure; membrane/spacer may guide transport and assist soft-tissue management.	Reported follow-up in study	Moderate-High
4	Alford et al., 2021	Review	NR	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Masquelet vs alternatives including DO	Union, infection, complications, treatment duration, functional outcomes/costs where reported	IMT has practical advantages over DO but initial success may be lower than DO in adults; need standardized technique and high-quality trials.	NA	Moderate-High
5	Zhang et al., 2017	Retrospective case series	41	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Distraction osteogenesis	Union, infection, complications, treatment duration, functional outcomes/costs where reported	Defects 6-17 cm; all achieved healing; mean healing 13 months; high complication burden including pin-tract infection and knee stiffness.	Mean follow-up reported	Moderate-High
6	Kanakaris et al., 2023	Pilot cost analysis	20	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Ilizarov frame vs Masquelet/internal fixation	Union, infection, complications, treatment duration, functional outcomes/costs where reported	Masquelet favored for time-to-union, surgeries, admissions, follow-up visits and total mean cost (£18,131 vs £26,126).	Complete follow-up to union	Moderate-High
7	Giannoudis et al., 2011	Review / technical tips	NR	Open/traumatic or post-traumatic segmental long-	Masquelet technique	Union, infection, complications, treatment	Describes staged debridement, cement spacer, membrane preservation and grafting;	NA	Moderate-High

				bone defects; see individual article		duration, functional outcomes/costs where reported	autograft alone not recommended when defect >5 cm unless protected by membrane.		
8	Fraga Lavia et al., 2022	Case report	1	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Masquelet technique	Union, infection, complications, treatment duration, functional outcomes/costs where reported	Successful reconstruction of 7 cm tibial defect after Gustilo IIIA open fracture with full weight-bearing at 8 months after stage 2.	Case follow-up reported	High
9	Abdou et al., 2020	Retrospective case series	14	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Free flap + DO or Masquelet	Union, infection, complications, treatment duration, functional outcomes/costs where reported	Mean defect 65.7 mm; bone union 85.7%; limb salvage >90%; one amputation after failed bone transport with chronic osteomyelitis.	12 months for union endpoint	Moderate-High
10	Klein et al., 2020	Review	NR	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Masquelet technique review	Union, infection, complications, treatment duration, functional outcomes/costs where reported	Reviews biology, membrane maturation, animal models and technical variables; highlights need for standardization and stronger clinical evidence.	NA	Moderate-High
11	Zhang et al., 2024	Retrospective comparative study	65 (35 MFFT, 30 IBTT)	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Masquelet + free flap vs Ilizarov bone transport	Union, infection, complications, treatment duration, functional outcomes/costs where reported	Complete union in all; Masquelet had shorter bone-union time (6 vs 11 months), higher mental health scores; Ilizarov preferred for very large defects or limited microsurgical expertise.	Mean 28 months	Moderate-High
12	Gupta et al., 2022	Prospective comparative study	24 (12 BT, 12 IMT)	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Bone transport vs Masquelet	Union, infection, complications, treatment duration, functional outcomes/costs where reported	Both comparable; BT: 67% union, 25% union with graft, 8% delayed union; IMT: 75% union, 25% delayed union.	Mean follow-up about 18 months	Moderate-High
13	Krappinger et al., 2015	Technical article	NR	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Masquelet technique	Union, infection, complications, treatment duration, functional outcomes/costs where reported	German-language operative review of indications, technique, advantages and complications of IMT.	NA	Moderate-High
14	Leonetti et al., 2025	Retrospective case series	19	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Distraction osteogenesis	Union, infection, complications, treatment duration, functional outcomes/costs	Mean defect 4.8 cm; union at 25.9 weeks; ASAMI bone excellent/good in 16/19; one failure.	Mean 3.7 years	Moderate-High

						where reported			
15	Li et al., 2023	Meta-analysis	156 in 6 studies	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	IBT vs MT	Union, infection, complications, treatment duration, functional outcomes/costs where reported	No significant difference in union rate; IBT better bone results in some analyses; IBT may be preferable for defects >6 cm with composite tissue defects.	Varied	Moderate
16	Uzel et al., 2010	Case report	1	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Combined induced membrane + bone transport	Union, infection, complications, treatment duration, functional outcomes/costs where reported	10 cm tibial defect consolidated at 7 months; fixator removed at 9 months; no microsurgery or cancellous graft needed.	3.5 years	High
17	Jiang et al., 2016	Case report and hypothesis	1	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Modified Masquelet	Union, infection, complications, treatment duration, functional outcomes/costs where reported	Calcium sulfate may induce membrane and potentially allow modified one-stage strategies, but evidence is preliminary.	1 year	High
18	Pestiaux & Carlier, 2024	Case report	1	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Hybrid Masquelet + Ilizarov + RIA	Union, infection, complications, treatment duration, functional outcomes/costs where reported	Hybrid approach effective for Gustilo III open tibial defect.	Case follow-up	High
19	Unknown authors, 2015	Case report / technical article	NR	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Masquelet technique	Union, infection, complications, treatment duration, functional outcomes/costs where reported	German-language technical/case-based article describing induced membrane principles for large bone defects.	NA	High
20	Abdou et al., 2020	Retrospective case series	14	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Free flap + DO or Masquelet	Union, infection, complications, treatment duration, functional outcomes/costs where reported	Duplicate of Abdou et al.; union 85.7%, limb salvage >90%.	12 months	Moderate-High
21	Sivakumar et al., 2016	Case series	2	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Masquelet	Union, infection, complications, treatment duration, functional outcomes/costs where reported	Two open/infected long-bone defects achieved clinical and radiological union; technique avoided prolonged bone transport.	Case follow-up	Moderate-High
22	Vasios et al., 2025	Case report series	2	Open/traumatic or post-traumatic	Masquelet + Ilizarov fixation	Union, infection, complications,	Both patients achieved fracture union with satisfactory function;	Case follow-up	High

				segmental long-bone defects; see individual article		treatment duration, functional outcomes/costs where reported	combined method useful when internal fixation not feasible and infection risk high.		
23	Zhang et al., 2025	Case report	1	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Bone transport + antibiotic cement	Union, infection, complications, treatment duration, functional outcomes/costs where reported	20 cm tibial defect reconstructed with infection eradication and successful limb salvage at 26 months.	26 months	High
24	Musa et al., 2021	Retrospective case series	10	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Masquelet	Union, infection, complications, treatment duration, functional outcomes/costs where reported	Mean defect 5.7 cm; all achieved radiological union; mean union 8.5 months; no nonunion.	Minimum 3 years	Moderate-High
25	Dahl & Morrison, 2021	Review	NR	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Bone transport review	Union, infection, complications, treatment duration, functional outcomes/costs where reported	Induced membrane useful for modest 3-8 cm defects; bone transport can address large defects but requires prolonged treatment and docking procedures.	NA	Moderate-High
26	Chen et al., 2020	Retrospective case series	12	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Distraction osteogenesis adjunct	Union, infection, complications, treatment duration, functional outcomes/costs where reported	No soft-tissue incarceration in 12 tibial transports; technique may reduce one DO complication.	Study follow-up	Moderate-High
27	O Malley & Kates, 2012	Case report	1	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Masquelet + cage/nail	Union, infection, complications, treatment duration, functional outcomes/costs where reported	17 cm MRSA-infected tibial defect reconstructed; infection eradicated; independent walking at 1 year.	1 year	High
28	Wang et al., 2016	Retrospective case series	32	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Masquelet	Union, infection, complications, treatment duration, functional outcomes/costs where reported	Mean defect 5 cm; radiographic union 81% at 6 months; clinical healing 90% at 10 months; no osteomyelitis recurrence at final follow-up.	Mean 27.5 months	Moderate-High
29	Pipitone & Rehman, 2014	Review	NR	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Review of DO, Masquelet, grafting	Union, infection, complications, treatment duration, functional	DO treats massive bone loss but with frame complications; Masquelet offers antibiotic delivery, stability and membrane protection of graft.	NA	Moderate-High

						outcomes/costs where reported			
30	Rosslenbroich et al., 2023	International review	NR	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Repair vs reconstructive techniques	Union, infection, complications, treatment duration, functional outcomes/costs where reported	Treatment depends on defect etiology, size, patient condition, mental status, surgeon and resources; no one technique is universal.	NA	Moderate-High
31	Giotikas et al., 2019	Retrospective cohort	13 patients / 14 fractures	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Masquelet	Union, infection, complications, treatment duration, functional outcomes/costs where reported	Mean defect 56.6 mm; 57.1% union at 42.1 weeks; infection 21.4%; technique abandoned in 35.7% in acute trauma setting.	Mean 17 months	Moderate-High
32	Minehara et al., 2023	International review	NR	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Open fracture management review	Union, infection, complications, treatment duration, functional outcomes/costs where reported	Emphasizes early antibiotics, debridement, soft tissue management and individualized management of critical-size bone defects.	NA	Moderate-High
33	Aljaafri et al., 2023	Case report	1	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Masquelet technique	Union, infection, complications, treatment duration, functional outcomes/costs where reported	Case-based report supporting feasibility of IMT for complex distal femoral defects.	Case follow-up	High
34	Polyzois et al., 2014	Review	NR	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Review of Masquelet, Ilizarov, RIA, Papineau	Union, infection, complications, treatment duration, functional outcomes/costs where reported	Ilizarov described as method of choice for combined bone and soft-tissue loss; Masquelet useful with internal fixation and RIA graft.	NA	Moderate-High
35	Rosslenbroich et al., 2023	International review	NR	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Review	Union, infection, complications, treatment duration, functional outcomes/costs where reported	Duplicate of article 46.	NA	Moderate-High
36	McEwan et al., 2018	Review	NR	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Review of DO, Masquelet and biologics	Union, infection, complications, treatment duration, functional outcomes/costs where reported	DO has high complication rate and docking nonunion; Masquelet union up to 90% in meta-analysis but often requires additional procedures.	NA	Moderate-High
37	Mi et al., 2019	Systematic	680 IMT	Open/traumatic or	Masquelet vs bone	Union, infection,	Final IMT union 92.35%; no	Varied	Moderate

		review / narrative comparison	fractures; 37 BT papers compared	post-traumatic segmental long-bone defects; see individual article	transport literature	complications, treatment duration, functional outcomes/costs where reported	significant difference vs bone transport in union, deep infection, malunion or amputation; refracture lower with Masquelet.		
38	Dahl & Morrison, 2021	Review	NR	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Bone transport review	Union, infection, complications, treatment duration, functional outcomes/costs where reported	Duplicate of article 40.	NA	Moderate-High
39	Battiston et al., 2019	Case series	8	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Vascularized fibula + Ilizarov	Union, infection, complications, treatment duration, functional outcomes/costs where reported	Mean treatment 61 weeks, 7.6 operations; combined Ilizarov and vascularized fibula helpful in very difficult acute bone loss.	Mean follow-up in study	Moderate-High
40	Nauth et al., 2018	Review / consensus-style supplement	NR	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Review of IMT, biologics and DO	Union, infection, complications, treatment duration, functional outcomes/costs where reported	No consensus on definition/management; IMT can effectively treat defects if infection eradication, graft choice and host optimization are addressed; DO has high ultimate success but prolonged fixation.	NA	Moderate-High
41	Morelli et al., 2019	Narrative review	NR	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Masquelet technique review	Union, infection, complications, treatment duration, functional outcomes/costs where reported	Summarizes lower-limb IMT evidence and emphasizes technical variation, staged debridement, spacer use and grafting.	NA	Moderate-High
42	Ferreira & Tanwar, 2020	Treatment algorithm review	NR	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Masquelet vs bone transport algorithm	Union, infection, complications, treatment duration, functional outcomes/costs where reported	Masquelet preferred for 2-6 cm defects in favorable conditions; bone transport more predictable in type B hosts and larger defects.	NA	Moderate-High
43	Musa et al., 2021	Retrospective case series	10	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Masquelet	Union, infection, complications, treatment duration, functional outcomes/costs where reported	Duplicate of article 38.	Minimum 3 years	Moderate-High
44	Adamczyk et al., 2020	Review	NR	Open/traumatic or post-traumatic segmental long-	Review of Masquelet and DO	Union, infection, complications, treatment	Masquelet success 85-92%; DO union 91-98%; Masquelet time to union less dependent	NA	Moderate-High

				bone defects; see individual article		duration, functional outcomes/costs where reported	on defect size, DO not limited by defect size.		
45	Hohmann et al., 2017	Retrospective cohort	32	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Staged circular frame bone transport + PMMA spacer	Union, infection, complications, treatment duration, functional outcomes/costs where reported	Mean defect 66 mm; union 91%; EFI 51.9 days/cm; pin site infections common; 3 delayed amputations.	Minimum 12 months	Moderate-High
46	Blair et al., 2015	Case report	1	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Masquelet + composite fixation	Union, infection, complications, treatment duration, functional outcomes/costs where reported	17 cm femoral defect reconstructed with limb salvage	9 months and beyond	High
47	Marsh et al., 2021	Retrospective series	74	Open/traumatic or post-traumatic segmental long-bone defects; see individual article	Fixation/reconstruction strategies including TSF and Masquelet	Union, infection, complications, treatment duration, functional outcomes/costs where reported	Infection 6.7%, nonunion 4%, refracture 2.7%; mean union time 22 weeks IMN vs 38.6 weeks TSF; 33 cases had mean 5.4 cm defect.	Mean 16-25 months	Moderate-High

Results:

The included studies comprise comparative investigations, single-technique case series, systematic reviews, meta-analyses, cost studies, and reports of hybrid reconstruction strategies. Direct comparative evidence does not demonstrate universal superiority of IMT or DO. The largest recent comparative study reported complete union in both groups, with significantly shorter time to union following Masquelet reconstruction combined with free-flap coverage compared with Ilizarov bone transport (6 versus 11 months), although bone transport remained advantageous for larger defects and settings with limited microsurgical expertise.[11] A smaller prospective comparative study demonstrated comparable union and functional outcomes between bone transport and IMT.[12] A meta-analysis including six comparative studies found no significant difference in overall union rates between Ilizarov bone transport and Masquelet reconstruction, although bone transport demonstrated superior results in selected analyses and appeared advantageous in defects larger than 6 cm with composite tissue loss.[15] A cost analysis demonstrated significantly lower treatment costs, fewer admissions, fewer procedures, and shorter time to union with Masquelet reconstruction.[6]

Large Masquelet series report union rates ranging from 85% to 92%, although outcomes are less predictable in acute trauma settings with infection, compromised host biology, or inadequate fixation.[4,28,31,36] DO studies consistently report union rates exceeding 90% across large defects, but at the expense of prolonged external fixation and higher rates of pin-site infection, docking-site non-union, stiffness, and reintervention.[5,14,43] Hybrid approaches combining induced membranes with bone transport have shown promising results in infected or massive defects by combining dead-space management with the biological advantages of distraction osteogenesis.[3,16,18]

Overall, the evidence supports an indication-based approach, with IMT favoured for moderate-sized defects with adequate soft-tissue coverage and graft availability, and DO favoured for larger defects, shortening, deformity correction, and situations with limited graft resources.[15,25,30,42]

Discussion:

The available evidence indicates that both techniques are effective limb-reconstruction strategies that address segmental bone loss through different biological and mechanical mechanisms.[2,30,39]

IMT functions primarily as a reconstructive grafting strategy. Through staged debridement, spacer placement, and membrane formation, it transforms a contaminated traumatic defect into a biologically active chamber capable of supporting graft incorporation and osteogenesis.[4,7,10,40] Advantages include dead-space management, local antibiotic delivery, maintenance of limb length, compatibility with internal fixation, and avoidance of complications associated with prolonged external fixation.[4,6,7,28] These characteristics make IMT particularly attractive for moderate-sized defects, periarticular defects, and patients who are unlikely to tolerate lengthy frame treatment.[6,11,23]

Nevertheless, IMT has important limitations. Successful outcomes depend upon meticulous debridement, infection eradication, soft-tissue coverage, stable fixation, and adequate graft volume.[4,7,28,39] As defect size increases, challenges associated with graft volume, donor-site morbidity, graft resorption, and mechanical failure become increasingly relevant.[30,42] Acute trauma series have reported substantial failure rates when host biology, infection control, or fixation stability are suboptimal.[31]

In contrast, DO is fundamentally a regenerative strategy that creates living bone through mechanotransduction and is not constrained by graft availability.[1,25,43] It permits simultaneous reconstruction of large defects, correction of deformity, and restoration of limb length.[15,25,34,43] For defects exceeding 6 cm, especially when accompanied by shortening, deformity, or compromised biology, DO remains the most versatile reconstructive option.[15,25,30,42]

However, the disadvantages of DO are substantial. Treatment duration is prolonged, patient compliance is critical, and complications such as pin-tract infection, docking-site nonunion, regenerate insufficiency, joint contracture, malalignment, and refracture remain common.[5,14,25,43] External fixation indices approaching 50 days/cm have been reported in complex tibial reconstruction protocols.[43]

Taken together, the evidence supports an indication-based treatment algorithm. IMT should be preferred when the defect is moderate in size, infection is controlled, internal fixation is feasible, and sufficient graft volume is available.[6,11,23,30] DO should be preferred for larger defects, defects associated with limb shortening or deformity, and situations in which autograft reconstruction is unlikely to be reliable.[15,25,34,42] Hybrid approaches should be considered for infected or highly complex defects where the biological advantages of induced membranes and distraction osteogenesis may be complementary rather than competitive.[3,16,18,21]

Risk of bias of included studies: MODERATE to HIGH

The evidence base is dominated by retrospective series, case reports, narrative reviews, technique papers, and expert algorithms. Direct comparative studies are few, often non-randomized, and subject to treatment-selection bias because defect size, soft-tissue condition, infection, and surgeon expertise influence the chosen intervention. Meta-analytic evidence is limited by heterogeneity in indications, surgical technique, fixation construct, graft strategy, follow-up duration, and definitions of union or failure. Case reports and hybrid technique papers are valuable for feasibility but carry high risk of bias. The cost analysis is informative but small and restricted to a best-case successfully united cohort. Consequently, conclusions should be interpreted as consensus guidance rather than definitive superiority evidence.

Recommendation:

In patients with open injuries and segmental bone defects, current evidence does not support the routine preference of the Masquelet technique over distraction osteogenesis. Both techniques achieve high rates of union and limb salvage when appropriately indicated. The Masquelet technique may be preferred for moderate-sized defects with controlled infection, adequate soft-tissue coverage, stable fixation, and sufficient graft availability, whereas distraction osteogenesis remains the preferred option for larger defects, restoration of limb length, deformity correction, and biologically compromised reconstructions. Treatment selection should therefore be individualized according to defect characteristics, host factors, soft-tissue status, infection burden, available expertise, and patient-specific considerations.

Final consensus statement:

In open injuries with segmental bone defects, both the Masquelet technique and distraction osteogenesis are valid limb-salvage strategies. The decision should be individualized. Masquelet reconstruction may reduce treatment burden in moderate defects, whereas distraction osteogenesis remains the most versatile and predictable method for large or length-restoration defects. Hybrid strategies may be appropriate in selected complex infected or composite defects.

Level of evidence:
Level/strength of evidence: MODERATE.

The recommendation is supported by multiple clinical series, comparative observational studies, meta-analysis-level synthesis, and consistent expert algorithms. However, the absence of randomized trials, heterogeneous populations, and technique variability prevent a high-strength recommendation.

Practical indication-based consensus algorithm

Clinical scenario	Preferred option	Rationale
Moderate defect (about 2-6 cm), healthy soft tissue, adequate graft	Masquelet technique	Shorter treatment burden, local antibiotic delivery, avoids prolonged external fixation
Large defect (>6 cm, especially >10-12 cm)	Distraction osteogenesis / bone transport	Not limited by graft volume; restores length with living regenerate

Defect with major shortening/deformity	Distraction osteogenesis	Allows simultaneous length restoration and deformity correction
Composite defect with flap coverage and moderate bone gap	Masquelet + flap or individualized hybrid	Shorter union time reported in comparative soft-tissue tibial series
Infection or osteomyelitis with large defect	Bone transport, or staged hybrid with antibiotic spacer	Permits radical resection, infection control, and regeneration without large graft volume
Poor tolerance/compliance for frame	Masquelet if defect and host factors allow	Avoids prolonged external frame burden

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