

TEMPLATE

RQ [##]: In segmental bone defects measuring less than 4 cm, is acute limb shortening to facilitate wound closure, followed by distraction osteogenesis, an acceptable strategy?

Section 1: Background (<300 words):

- The size of a defect in a long bone is always matter of debate. Usually the treatment depends on many factors either from the patient's conditions and also from the technical skills of the surgeon.
- Autologous bone grafting ; acute shortening; Membrane induced technique; allograft substitution; distraction osteogenesis and vascularized bone graft, are the techniques that can be used in the different cases of bone defects.
- Any technique has its' pros and cons.
- When the size of the defect is less than 4cm the literature considers mainly the autologous bone graft substitution or acute shortening the optimal solution depending also on the different site of the defect (lower or upper limb)

Section 2: Data extraction table

For each included study: Author/Year, Study Design, Sample Size, Population, Intervention/Comparator, Key Outcomes, Results, and Follow-up duration.

S.no	Author, year of publication, Country	Study Design	Sample Size (add individually for each group if	Study population (Inclusion and	Groups compared	Soft tissue procedures	Results	limitation	Strength of study
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			multiple groups compared)	exclusion criteria)					
1	Cengiz Sen et al. 2003	Case series, retrospective	24 patients, 14 open grade IIIA and 10 Grade III B with soft tissue defects	Avg age 30.6 yrs (18-53), mean bone defects 5 cms (3-8.5). mean soft tissue defect 2.5 * 3.5 cms. With MESS score > 6 or with multiple injury were excluded.-	Acute docking done (< 3 cms), Ilizarov fixator was applied and bifocal corticotomy at index surgery, distraction started 10 th days, If > 3 cms add gradually compression 2 mm/day.	Debridement, resection of fibula, Primary closure of wound	Complete union in all with within alignment except one with 10* procurvatum. All wounds healed with simple closure. Complications mainly minor except one with residual 3 cms LLD, 1 chronic osteomyelitis	Small case series	
2	Alexander Lerner et al, 2003	Case series	12, severe soft tissue, acute shortening, Ilizarov fixation	Grade IIIB, high energy injury, 8 lower limb (7 tibia) and 4 upper limb; shortening < 3 cms		SSG- 7 patient , local flaps- 2: one need local + free flap, 4 patients no procedure	All fracture has healed, lengthening – 7 with ilizarov, 1 iliac bone graft, 2 elongation osteotomies. Mean healing index 30 days/ cms. No	Small study, case series	

				shortening; angulation 50- 60 degree in three patient			major complications like limb length difference (except one, shoe raise), or neurovascular deficit. Complication rate 8.3 % (pin tract infect etc)minor		
3	M A El- Rosasy, 2005	Single centre, single surgeon retrospective	21 patients, open grade III - 10 patients, post debridement in infected cases - 11	Mean age 28.8 yrs(12- 54). Late cases also	Ilizarov – 9 cases Monolateral fixator – 14. Mean lenthening 4.2 cms (3- 9.5)	20/21 – primary closure , one need SSG. < 5 cms shortening – Transverse incision, > 5 cms shortening Z shaped incision	In open fractures 9/ 10 cases , in one case Iliac bone graft was used	Single surgeon, small study	Meticulous, soft tissue care, for large defects Z shaped incision. Safe limit of acute shortening Upper 1/3- 3 cms Middle 1/3 – 3 - 5 cm Lower 1/3 <6 cms

4	Shao-Ting Jerry Tsang et al., 2024	Single centre, retrospective	96, 75/96 open fractures, 67% grade IIIB, standardised approach of critical- sized bone defects	Acute shortening 34 with mean bone defect 31 mm, bone transport 32 with mean bone defect 50 mm, induced bone 25 with mean bone defect 47 mm.	With other meta-analysis	-	Union > 90% in acute shortening and bone transport, low 72% in induced membrane; sepsis highest 40 % in induced membrane cases, 23 % in acute shortening lowest 9 % in transportation;	Soft tissue defects not mentioned	
5	Saif Salih et al, 2018qiang “Transverse Debridement”	Single centre, retrospective case series	31, open Grade III tibia; Transverse debridement soft tissue and bony, saw resection of bone ends; acute docking & primary closure,	Mean age 37.5; Mean Bone defect 3.2 cms (1-8)		Primary closure 12/ 31, +/- SSG 19/31;	Union- all united in 40.1 weeks. Median frame index 75 days/ cm. lengthening index 63 days/ mm. No soft tissue or wound related complications.	Case series, majority young patients, patient selection criteria (< 10%) with mean bone defect	First – Transverse wound debridement

			SSG; corticotomy (same 10/31 or later date) and lengthening						
6	Sarah N Pierrie and Micheal J Beltran, 2023	Review Article	Divided problems like soft tissue and bony						Over all view in managing open injury of leg without Free Flap
7	Qiang Haung et al , 2023	Single centre, retrospective, comparative	47 total Group 1 (ASDL) - 21 and Group 2 (BT) - 26	Age 18 - 65; with large bone Tibial defects > 5 cm; may be due to Trauma or Infection only; Ilizarov method used ; minimal 2 years followup after ring removal	Between ASDL and BT	-Bone union in all	ASDL and BT can be used for large tibial bone defect. ASDL reduces bone lengthening time, time in fixator and possible complications	-	Comparative study two modalities

Section 3: Results summary write-up (upto 500 words)

In open fractures results can be divided into three issues:

- 1- Soft tissue – Lost soft tissue cover is main hurdle which orthopaedic surgeons feel. Simple soft tissue closure can be achieved primarily just by acute shortening, mobilization of lax muscles and if requires may be added by with SSG. In small cases local rotation flap can used to cover wound.*
- 2- Bone defects- In all given studies bone union is rate is very high at open site. In out of 185 patients with open fractures of leg in these patient only around 10 will requires additional bone grafting. Union rate is around > 94%.*
- 3- Complications – These injuries and procedures are not without complications. In most of these series, there are minor complications like pin tract infection, which are managed with external fixator.*

Section 4: Discussion (<1000 words)

Acute shortening followed by bone lengthening is a technique with a predictable outcome that can be achieved even in these high energy injuries with composite loss of soft tissue and bone. This technique becomes more important in resource limited location where microsurgical unit for free flap surgery is not available.

Its high percentage of success may be related to some very important details:

The immediate urgent removal of all devitalised tissues during the debridement step, without adding the fear of cover the bone.

The use of vital uninjured or healthy soft tissue and bone for reconstruction.

Corticotomy and distraction far from injured area increase vascularity even at the docking site to help in bone healing.

Section 5: Risk of bias of included studies

There is a medium risk of bias in the included studies because there is not a comparative analysis of the same size of the defect in same typical patient operated with different techniques (only the article by Shao considers the induced membrane group).

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

When the defect is less than 4cm we have to analyse the general conditions of the patient; the setting of our hospital and the technical skills of the surgeon. The plan of acute shortening followed by distraction osteogenesis is a good tool to manage the very important problems encountered in severe grade open fractures

Section 6: Level/ strength of Evidence:

We give to this technique an high level of Evidence considering the number of studies analysed and the results on the good outcomes.

Reference (other than those in the table)

Rosslenbroich S.B.; Oh C-W; Kern T; Mukhopadhaya J; Raschke M; Kneser U; Krettek C: Current Management of diaphyseal long bone defects – a multidisciplinary and international perspective; J Clin Med, 2023 , sep 29; doi:10.3390/jcm12196283

Marti RK, Kloen P: Concepts and cases in non union treatment, Thieme Ed, 2011