Trauma Case Reports 36 (2021) 100544

Contents lists available at ScienceDirect

Trauma Case Reports

journal homepage: www.elsevier.com/locate/tcr

A case report of extensive segmental defect of the humerus due to thermal necrosis treated with Masquelet technique

John Mukhopadhaya [a,b,c,*], Kumar Gautam [b], Janki Sharan Bhadani [a,b,**]

[a] Orthopaedics Research and Education Foundation, India
[b] Department of Orthopaedics, Paras HMRI Hospital, Patna 800014, India
[c] Orthopaedic Clinic and Research Centre, Saidpur Road, Patna 800004, India

ARTICLE INFO

Keywords:
Masquelet technique
Induced membrane technique
Segmental bone defect
Thermal necrosis reaming
Infected humerus fracture

ABSTRACT

Thermal necrosis due to over-reaming or blunt reamer may have devastating consequences. We present one such case of humerus shaft fracture referred to us at two and half months after primary surgery with active signs of infection and sequestrated segment of the humerus. The challenges were not only to achieve union, control of infection, but also the 10 cm bone gap created after removal of sequestrated part of humerus and preservation of reasonable function of adjacent joints. Emergency drainage of thick purulent material was done on day one because the patient was in excessive pain, the abscess was likely to burst and she was unfit for major surgery due to her toxic clinical state abnormal blood parameters. We had managed this case successfully using Masquelet technique.

Masquelet technique is an excellent option for bone gap reconstruction compared to other techniques. It helped us to achieve good functional outcomes and to manage large bone loss in infected humeral non-union.

Introduction

Posttraumatic segmental bone gaps are challenging with significant long-term morbidity. Critical-size bone defects are those in bone gaps, which are not expected to fill by spontaneous regeneration without intervention [1]. The treatment method should address various specific characteristic of bone defects including etiology, location, size, presence of infection, and soft-tissue conditions. There are several reconstruction options that exist: using bone transport, vascularized bone grafting and induced membrane osteosynthesis [2,3]. Each method has its own limitations and complications. The induced membrane osteogenesis technique, introduced by Alain C Masquelet, allows us to manage large segmental bone defects without distraction osteogenesis techniques and microvascular surgery. It has been used to treat infected and non-infected bone defects up to 25 cm, and may be performed with a variety of fixation methods [3,4].

In this article, we present a clinical case report of a patient treated with an induced membrane technique for a 10-cm humerus shaft defect that resulted from unsuccessful treatment of a simple oblique shaft of humerus fracture with thermal necrosis from excessive reaming leading to infection and bone loss.

* Correspondence to: J. Mukhopadhaya, Director and HOD, Department of Orthopaedic, Paras HMRI Hospital, Patna 800014, India.
** Correspondence to: J. Sharan Bhadani, C/O: Dr John Mukhopadhaya, Department of Orthopaedic, Paras HMRI Hospital, Patna 800014, India.
E-mail addresses: mukhoj@gmail.com (J. Mukhopadhaya), kmrgautam43@gmail.com (K. Gautam), jsbhadani@gmail.com, jsbhadani@yahoo.com (J.S. Bhadani).

https://doi.org/10.1016/j.tcr.2021.100544
Received 15 August 2021; Accepted 13 October 2021
Available online 19 October 2021

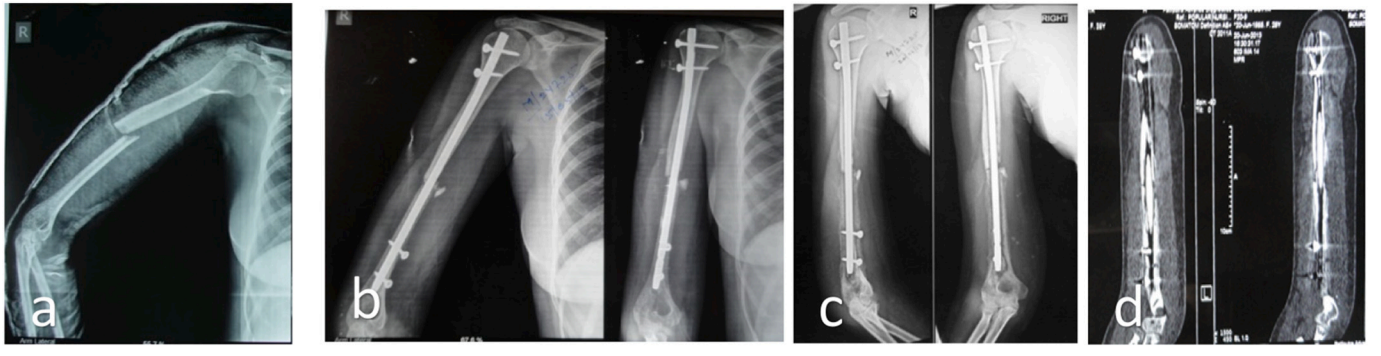

Fig. 1. (a) Preoperative x-ray after injury (b) X ray after primary surgery (interlock nailing) (c)-X-ray after 2.5 month of primary surgery (d) use of CT scan to visualise sequestrated segment of humerus, is limited due to metal artifact in this case.

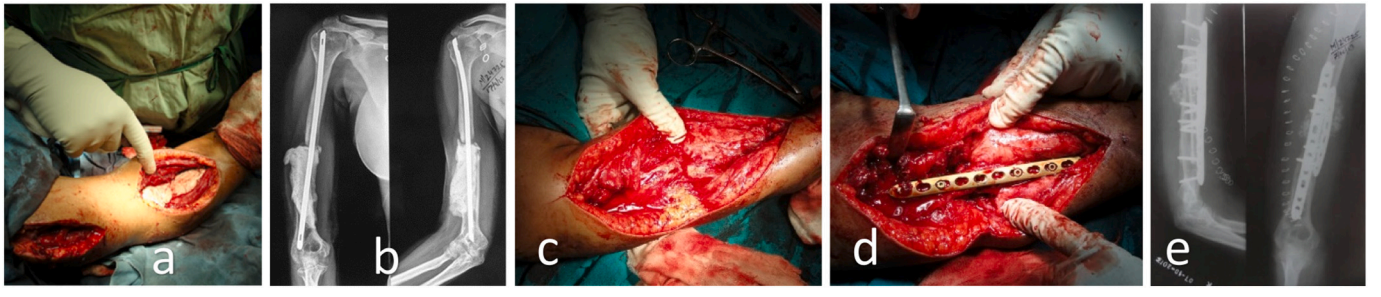

Fig. 2. (a) Cement spacer and K nail insertion after through debridement and removal of nail. (b) X-ray after 8 weeks of first surgery (c) induced membrane well preserved after cement block removal in stage two, (d) autologous graft insertion and fixation, (e) immediate post op x-ray after second stage.

Fig. 3. (a) Radiograph at 4 months (showing union), at 2 years and at 5 year 7 months (d, e, f, g) clinical photographs after 2 years showing satisfactory outcome.

Case report

A 28-year-old woman sustained a simple oblique right humeral shaft fracture (AO/OTA type: 12-A2) as a result of a fall from a standing height (Fig. 1a). The patient was treated by intra medullary nailing elsewhere (Fig. 1b). In post-operative course wound healed but some swelling and pain persisted which gradually increased for which oral antibiotics were given by primary surgeon. After 2.5 months patient presented to us with severe pain and, marked swelling over distal humerus which was warm, tender and fluctuant on examination. Patient blood parameter was Hb 7.4 G, WBC 17,000, ESR 89 and very high CRP. Looking at the size of the medullary canal in the pre-operative X-rays and the size of the nail in the post-operative X-rays it was felt that aggressive reaming may have been used during the first surgery resulting in thermal necrosis of the humeral shaft followed by infection (Fig. 1c). As the abscess was likely to burst and the patient was unfit for major surgery an emergency drainage of the abscess was performed. Thick purulent material under tension was drained.

After blood transfusion, optimising patient general condition, along with other relevant investigation, CT scan to look for sequestrum and pre anaesthetic fitness, surgery was planned. In the first stage through an anterolateral approach the fracture was exposed and a second incision made proximally for removal of the nail. Intra operatively proximal fragment was viable, distal fragment was necrosed and only thin shell of posterior cortex remained after debridement. All dead and devitalized tissues were removed. After marginal resection of the main fragments, the bone defect was 10 cm. Using previous entry point K nail was placed in proximal part and into the lateral part of the distal humerus. The defect was filled with a cylindrical polymethylmethacrylate bone cement spacer, covering bony ends which also augmented the stability (Fig. 2a). Patient was given intravenous meropenem for 6 days followed by oral tetracycline based upon culture sensitivity report (*Proteus vulgaris* group/Proteus penner, predominantly resistant and sensitive to only meropenem, tetracycline and tigecycline) for a total duration of six weeks. Post-operative period was uneventful and wound healed properly and patient was followed clinically, radiologically and haematologically on regular basis.

After 2 months infection clinically resolved there was no pain, swelling has subsided and blood parameters settled. In second stage of surgery nail was removed, using incision over previous scar bio-membrane encapsulating the cement spacer was carefully incised, the cement spacer was removed the bio-membrane capsule was irrigated to remove any residual debris (Fig. 2c). Fibular strut graft was placed in gap and fixation was done using locking compression plate anteriorly and for additional support another locking plate medially and some screws also placed through fibula for stabilization. Cancellous graft was packed around fracture site bio-membrane was closed with absorbable suture and wound was closed in standard manner (Fig. 2d, e).

Union was noted on radiograph after 4 months (Fig. 3a). We started the patient on an active rehabilitation program on follow-up visits. The patient achieved a good function of elbow (range of motion: 10–130; full pronation and supination) and shoulder joints (full recovery of range of motion), and a complete weight bearing function of the arm with a mild loss (4/5) of triceps strength (Fig. 3d, e, f, g).

Discussion

The Masquelet technique, is most commonly used for lower extremity bone defects [5] and less commonly used for humeral shaft defects. Morelli and collegues [5] found only about 23 cases of humeral defects in the 427 cases they analysed. In another study, this localization was involved in 2 of 11 cases, with the maximum defect being only 3 cm [6]. Zapatero et al [7] treated 9 cases of acute humerus shaft defect (range: 2.5–8 cm) with the Masquelet technique.

Surgical technique is most important, which ultimately determines the final outcome. Cement spacer should overlay on bony ends so that complete membrane formation occurs and avoids the formation of scar tissue at the spacer-bone junction [8]. Plate fixation is preferred by most authors [8] as evident by literature. Masquelet recommends using a piece of glove to protect the soft tissues from heat damage [9] while some recommend temporarily removing the spacer to avoid thermal damage to soft tissues [10]. The installed spacer can be fixed to the plate with a screw which prevent spacer migration and membrane damage [10].

Burk et al [11], showed the posterior iliac crest yields the highest amount of graft (33.8 mL), in a cadaveric study. For large bony defects alternative is to use a reamer irrigator-aspirator system, TCP granules for volume expander [12] and fibula can be used as a strut graft. The optimal time for the second stage is 4–6 weeks, when the membrane becomes strong enough and at the same time maintains a high osteogenic capacity [13].

The membrane above the spacer should be cut carefully with a single incision, spacer carefully extracted, scar tissue if present, carefully excised and then bone grafting is done. Failure to excise scar tissue, graft resorption will result in non-union. In addition, too dense an implantation of the graft can lead to its resorption [13]. A complete non-weight-bearing and restriction of vigorous movements should be recommended until radiologic signs of consolidation are achieved. If necessary, a cast or a brace can be used to increase the stability.

Conclusion

Conservative treatment is an option for humeral shaft fractures. Indications for surgery and implant selection need to be carefully considered and individualized and preoperative medullary canal diameter must be given importance if planning for nailing.

The Masquelet technique is a useful method for reconstruction of large segmental bone defects of almost any size. This technique in an upper extremity allows patients to avoid the discomfort observed in bone transport with prolonged use of an external fixator. Our case has shown that the use of an induced membrane technique allows one to achieve a good functional outcome in patients with severe bone defect of the humerus in this case probably due to thermal necrosis.

Any meeting at which the work was presented, wholly or in part

No.

Consent taken from patients and his guardian (father) for publication

Yes.

Financial support for the conduct of the research and/or preparation of the article

None.

I am submitting my paper for a special issue of the Trauma Case Reports Journal. I came to know about this issue via a mail to AOTrauma that submitting my paper for this issue would be free of any article-processing fees, and if accepted would be included in the special issue of Journal 'Trauma Case Reports'.

Declaration of competing interest

None.

References

[1] E.H Schemitsch, Size Matters: Defining Critical in Bone Defect Size!, J. Orthop. Trauma Suppl 5 (2017) S20–S22, https://doi.org/10.1097/BOT.0000000000000978.
[2] R. Cattaneo, A. Villa, M. Catagni, L. Tentori, Treatment of septic or nonseptic diaphyseal pseudoarthroses by Ilizarov's monofocal compression method, Rev. Chir. Orthop. Reparatrice Appar. Mot. 71 (1985) 223–229 [in French].
[3] K. Yokoyama, M. Itoman, K. Nakamura, T. Tsukamoto, Y. Saita, S. Aoki, Free vascularized fibular graft vs. Ilizarov method for post-traumatic tibial bone defect, J. Reconstr. Microsurg. 17 (2001) 17–25.
[4] A.C. Masquelet, Induced membrane technique: pearls and pitfalls, J. Orthop. Trauma 31 (Suppl 5) (2017), S36-8. October.
[5] I. Morelli, L. Drago, D.A. George, E. Gallazzi, S. Scarponi, C.L. Romano, Masquelet technique: myth or reality? A systematic review and metaanalysis, Injury 47 (Suppl 6) (2016) S68–S76, https://doi.org/10.1016/S0020-1383(16)30842-7.
[6] N.K. Kombate, A. Walla, G. Ayouba, B.M. Bakriga, Y.Y. Dellanh, A.G. Abalo, et al., Reconstruction of traumatic bone loss using the induced membrane technique: preliminary results about 11 cases, J. Orthop. 14 (2017) 489–494.
[7] T. Zappaterra, X. Ghislandi, A. Adam, S. Huard, F. Gindraux, D. Gallinet, et al., Induced membrane technique for the reconstruction of bone defects in upper limb. A prospective single center study of nine cases, Chir Main 30 (2011) 255–263, https://doi.org/10.1016/j.main.2011.06.005 [in French].
[8] P.V. Giannoudis, O. Faour, T. Goff, N. Kanakaris, R. Dimitriou, Masquelet technique for the treatment of bone defects: tips-tricks and future directions, Injury 42 (2011) 591–598, https://doi.org/10.1016/j. injury.2011.03.036.
[9] A. Masquelet, N.K. Kanakaris, L. Obert, P. Stafford, P.V. Giannoudis, Bone repair using the masquelet technique, J. Bone Joint Surg. Am. 101 (2019) 1024–1036.
[10] A.J. Micev, D.M. Kalainov, A.P. Soneru, Masquelet technique for treatment of segmental bone loss in the upper extremity, J. Hand. Surg. Am. 40 (2015) 593–598, 17. Morelli I, Drago L, George DA, Gallazzi E, Scarponi S, Romano CL. Masquelet technique: myth or reality? A systematic review and metaanalysis. Injury 2016;47(Suppl 6):S68-76. doi:10.1016/S0020-1383(16)30842-7.
[11] T. Burk, J. Del Valle, R.A. Finn, C. Phillips, Maximum quantity of bone available for harvest from the anterior iliac crest, posterior iliac crest, and proximal tibia using a standardized surgical approach: a cadaveric study, J. Oral Maxillofac. Surg. 74 (2016) 2532–2548.
[12] A.C. Masquelet, T. Begue, The concept of induced membrane for reconstruction of long bone defects, Orthop. Clin. North Am. 41 (2010) 27–37.
[13] B.C. Taylor, B.G. French, T.T. Fowler, J. Russell, A. Poka, Induced membrane technique for reconstruction to manage bone loss, J. Am. Acad. Orthop. Surg. 20 (2012) 142–150.