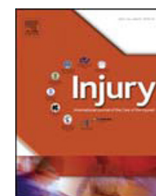




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Masquelet technique: myth or reality? A systematic review and meta-analysis

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KEY WORDS

Masquelet technique
induced membrane technique
systematic review
meta-analysis
bone non-union treatment
osteomyelitis
bone defect

ABSTRACT

Introduction: The induced membrane technique (IMT) or Masquelet technique, is a two-step surgical procedure used to treat pseudoarthroses and bony defects. Many authors have introduced variants to the technique. This study aims to compare the surgical variants of IMT and to evaluate its efficacy in achieving infection eradication and bone union.

Methods: A systematic review was carried out following the PRISMA guidelines. PubMed and other medical databases were explored using keywords “Masquelet technique” and “induced membrane technique”. Articles were included if written in English, French or Italian, dealing with IMT employed to long bones in adults, reporting at least 5 cases with a 12 months-mean follow-up. Patients’ clinical features, bone defect features, aetiologies, surgical data, complications, reinterventions, union rates and infection eradication rates were searched. Fischer’s exact test, chi-square test and unpaired t-test were used for the statistical analysis on the individual patient’s data.

Results: Seventeen papers met the inclusion criteria (427 patients). Among these, only 10 studies reported individual patient’s data (137 cases). The union rate was 89.7% and the infections rectified in 91.1% of cases. The bone defect length ranged from 0.6 to 26 cm. The main complications were superficial (21; 4.9%) and deep surgical site infections (19; 4.4%), failure of one of the IMT steps (persistence of infections or non unions, 77, 18%), with subsequent requirement for further surgery. The surgical variants included the use of antibiotic-coated spacers, internal fixation during the first step, use of Reamer-Irrigator-Aspirator technique, iliac crest grafting, bone substitutes and growth factors. However, univariate analysis only showed a positive correlation of the need for re-interventions with poorer bone union rates ($p = 0.005$) and complications ($p < 0.001$), while patients undergoing IMT because of bone infections had a higher risk of surgical complications ($p < 0.001$).

Discussion: IMT aims to achieve bone union and infection eradication, but persistence of infection or non-union was noted in 18% of cases necessitating re-interventions. This may be related to the different anatomical sites that the technique has been applied and different local and patient related conditions. We believe the choice of a surgical technique to achieve union should be tailored to the individual patient’s needs. This systematic review was limited by the few studies meeting our inclusion criteria, and their high variability in data reporting, making it impossible to undertake a meta-analysis.

Conclusion: Further studies are needed to demonstrate the role the patients’ clinical features and IMT variants have upon achieving bone union and infection eradication.

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Introduction

The induced membrane technique (IMT) firstly described by Masquelet et al. is a two-step procedure to treat bone defects and non-unions [1]. Masquelet describes an initial debridement of soft

tissues and necrotic bone to bleeding healthy tissue (“paprika sign”), and the use of a polymethyl methacrylate (PMMA) cement spacer placed in the bony defect, which is stabilised with a temporary external fixator [2,3]. During the initial stage, soft tissue reconstruction is required if coverage is inadequate [1–8].

The role of the spacer is two-fold; it prevents fibrous tissue invasion of the defect area, whilst inducing the development of a surrounding pseudo-synovial membrane, as a result of a foreign body reaction [9]. After 6–8 weeks, the second step is undertaken. The induced membrane is carefully incised and the spacer removed. Morcellized

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cancellous bone from the iliac crest is implanted and the membrane closed with definitive fixation [1].

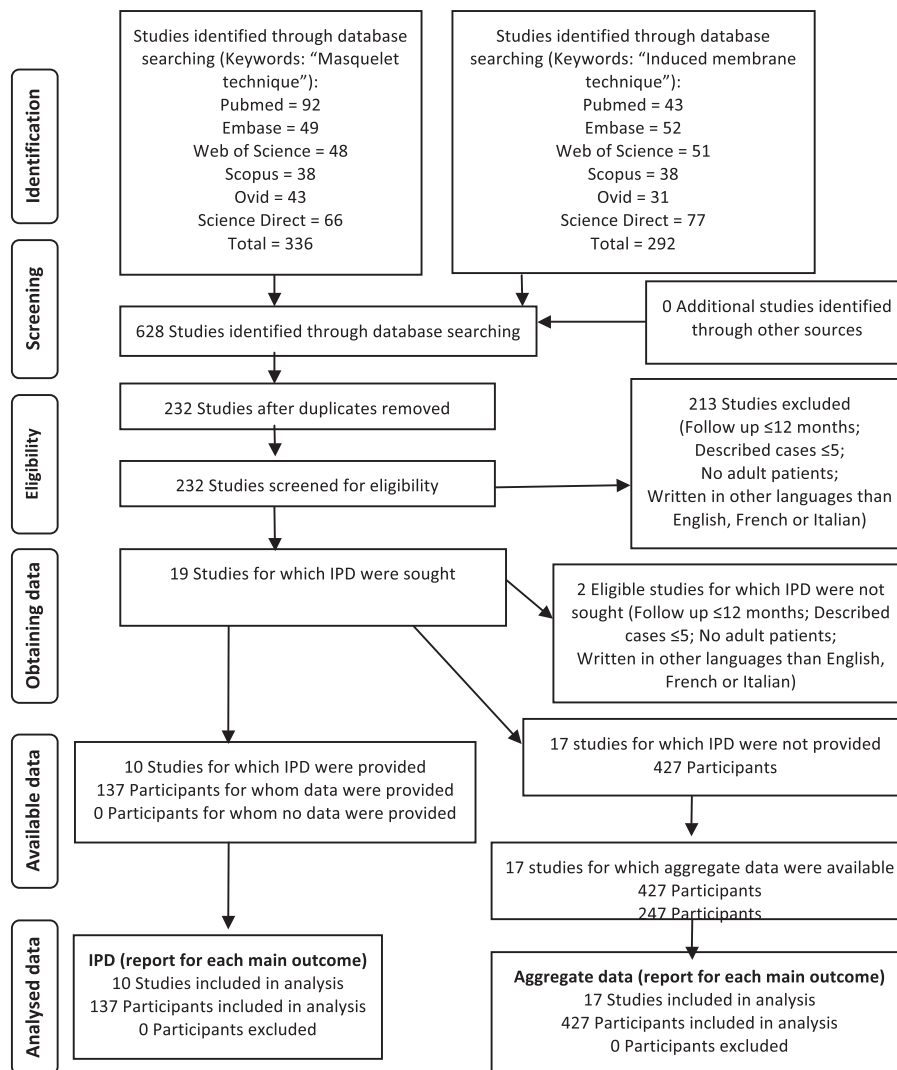
The membrane is key to provide a vascular source to the bone graft [10] and also secretes growth factors (such as BMP-2, VEGF and TGF-beta1) [9]. The autologous bone graft is then able to allow osteoconduction (acting as a scaffold), osteoinduction and osteogenesis (containing further growth factors and osteoprogenitor cells) [11]. Several small case series reports have demonstrated the efficiency of IMT, particularly in post-traumatic defects, septic and aseptic non-unions, tumor resections, and irradiated bones.

The original technique has been modified in a variety of ways and includes the use of antibiotic-coated or impregnated spacers (used in septic pseudoarthroses and infected bone resections) [2,4,5,7,8,12–15], internal and/or definitive fixation during the first stage [1,3–8,16–19] and utilisation of spongy autograft obtained through the Reamer-Irrigator-Aspirator (RIA) technique [4–7,12]. Hydroxyapatite and tricalcium phosphate bone substitutes, as well as demineralized bone matrix (DBM) and demineralized bovine bone (DBB) have been added to the graft to increase graft volume [1,2,6,7,12,20]. The addition of growth factors, such as BMP-7, has been used to improve osteoinductivity [3–7,10,12,13], and non-vascularized or vascularized bone grafts can provide additional structural support [1,3,6–8].

In spite of these modifications, a systematic review evaluating the impact of these on the efficacy of the Masquelet technique, is still absent in the medical literature. Therefore, in this systematic review we aim to evaluate the impact of these variants on the efficacy of IMT, specifically comparing infection eradication and union rates for long bones defects and non-union in adults.

Methods

In agreement with the Preferred Reported Items for Systematic Reviews and Meta-Analyses Statement for Individual Patient Data (PRISMA-IPD), a systematic review of the medical literature was carried out. PubMed, Scopus, Ovid, Embase, Science Direct, Web of Science databases were searched using the keywords “Masquelet technique” and “induced membrane technique,” from 2000 until the end of July 2016 (Figure 1). Original articles written in English, French, or Italian reporting more than 5 cases of IMT employed for long bones in adult patients (≥15 years old), with a mean follow up of 12 months were included. After excluding the duplicates, two independent reviewers (IM, EG) screened the identified articles for inclusions following the review of the abstracts. In case of disagreement, uncertain articles had been read in full to assess their relevance to the study. The selected



The PRISMA IPD flow diagram
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Fig. 1. PRISMA IPD flow diagram.

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