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Orthopedic Surgery

Treatment of Septic Pseudarthrosis of the Leg by the Induced Membrane Technique (About 19 Cases)

El Mehdi Ouissaden[*], Issa Fathi, Kharmaz Mohamed, Ahmed El Bardouni, Mustapha Mahfoud, ET Mohamed Saleh Berrada

Department of Orthopedic Surgery, Ibn Sina Hospital, University Mohamed V, Rabat, Morocco

Abstract		Original Research Article

Introduction: The treatment of septic pseudarthrosis of the leg requires the removal of infected bone tissue and soft tissues. Different filling techniques have been proposed. Among them, the technique developed by A.C. Masquelet in 1986 is to provide support in 2 stages with the establishment of a PMMA cement spacer that allows the development of an induced membrane. This induced membrane is used at the 2nd time as a sleeve to set up the bone graft. The main objective of our study was to evaluate our results with this technique clinically and radiologically during a series of patients supported in our department. ***Material and Method:*** Nineteen septic pseudarthroses of traumatic origin were included from November 2007 to November 2014 in this retrospective single-centric study. Patients were routinely monitored for clinical and radiological monitoring to assess the time to consolidation. A statistical evaluation of the factors that can influence consolidation has been carried out. Results. - The series included 4 women and 14 men (19 legs), the average age was 53.9 years. In 26% of the cases, a cutaneous covering procedure was required before the 1st time. All patients were operated in 2 stages with an average delay of 7.9 weeks between the 2 times. The bone defect after 1st beat was 52.4 mm on average. The bone graft was an autograft taken at the expense of the iliac crests in the majority of cases (18/19). The focus was stabilized by an external fixator, a locked plate or a plaster after the 2nd beat. The mean follow-up was 34 months with a consolidation rate of 89% (17/19) with an average delay of 16.0 months from the second gesture. After the 2nd time, 11 patients required complementary actions (average of 2.1). The importance of cutaneous opening statistically influenced the consolidation (Gustilo III vs Gustilo I or II) and tobacco was found as a factor tending to negatively modify bone consolidation. The size of the bone defect does not influence the rate or the delay of consolidation. ***Discussion:*** This study found a correct consolidation rate of 89% but our consolidation time seems higher than what is reported in the literature. Several factors may explain this result, such as the absence of rigid fixation after the 2nd stage (use of an external fixator or plaster) or the continuation of smoking intoxication. Our results show that the induced membrane technique is effective for the treatment of septic pseudarthrosis of the leg. These results can be improved by a stable fixation after the second time and the cessation of the smoking intoxication.

Keywords: Septic pseudarthrosis, leg, induced membrane technique.

INTRODUCTION

Treatment of septic pseudarthrosis of the leg requires removal of infected bone tissue and soft tissues. The technique developed by A.C. Masquelet in 1986 consisted in performing a two-stage treatment with the installation of a cement spacer that allows the development of an induced membrane. This induced membrane is used at the 2nd time as a sleeve to set up the bone graft. The main objective of our study was to evaluate our results with this technique clinically and radiologically.

METHODS

Ten septic pseudarthroses of traumatic origin were included from November 2014 to November 2018 in this retrospective study. Patients were routinely monitored for clinical and radiological monitoring to assess the time to consolidation. A statistical evaluation of the factors that can influence consolidation has been carried out.

Patients who did not follow at least 1 year after the 2nd time were excluded, as were patients with aseptic pseudarthrosis or oncological bone loss.

Thus, our series consists of 18 patients supported for 19 septic pseudarthroses of legs. The series consisted of 4 women and 14 middle-aged men aged 53.9 (± 16.7)

The initial fracture causing septic pseudarthrosis was open in 74% of cases (14 of 19) and all fractures involved both bones of the leg. Five patients (26%) received flaps of coverage before management of septic pseudarthrosis to cover a presumed non-septic exposed site (3 internal twin flaps and 2 fascio-cutaneous flaps). The 1st time was achieved on average after a period of 15.5 months ± 20.3 (between 8 and 95 months). On average, each case of pseudarthrosis required 3.6 surgeries before the first stage.

Data Collected

We collected for all patients the demographics and medical history as well as the existence of alcohol or tobacco intoxication. After the 1st surgical time, we studied the germ found, the antibiotic set up and the size of the bone defect after resection. After the 2nd surgical time, we analyzed the mode of stabilization of the nonunion center, the type of bone graft used, the delay before bone consolidation and the need for surgical revision. All the patients were followed regularly in consultation with a radiological assessment including 2 orthogonal bearings of the leg segment to be studied. Bone healing was considered acquired when there were 2 continuous cortices on 2 radiological incidences. The WOMAC [10] functional score was completed by all patients at the last follow-up during a telephone interview.

Surgical Technique

The technique of the membrane induced for the management of septic pseudarthrosis of the leg is performed in two stages with a delay of 6 to 8 weeks between the two times [2, 5, 11]. The first surgical procedure consists of removing the remaining osteosynthesis material and debridement associated with excision of the macroscopically infected tissues with multiple bacteriological samples (at least 3). Unlike the original technique, we have chosen to use an antibiotic cement spacer (polymethylmethacrylate + gentamicin) which is then put in place at the level of tibial bone loss, promoting the formation of a membrane. pseudo-synovium (induced membrane). This spacer is positioned closer to the fibula which must be consolidated or stabilized. Stabilization of the pseudarthrosis focal point is then necessary and is provided by an external fixator. An adapted antibiotherapy is then put in place after multi-disciplinary consultation until the 2nd time.

The 2nd surgical step is to incise the induced membrane to the cold blade, to remove the cement spacer and to fill the loss of bone substance using a bone graft (autograft at the expense of the iliac crest ± allograft) after having re-permeabilized the diaphyseal casks and carried out new bacteriological samples. Then, the induced membrane is sutured en bloc with surrounding soft tissues, around the graft and stabilization by locked screw plate or by external fixator is then performed (sometimes plastered immobilization in case of technical impossibility).

RESULTS

After the 1st surgical time, the bone defect was located on the distal metaphysis in 7 cases and at the level of the diaphysis in 12 cases. It measured on average 52.4 ± 38.2 mm (between 11 and 180 mm). Stabilization of the pseudarthrosis focal point was provided by an external fixator in 15 cases (79%) and plaster immobilization in 4 cases (21%). The bacteriological samples taken during the 1st beat were positive in all cases, mostly staphylococcus (89%) and polymicrobial in 47% of cases. Double antibiotic therapy with good bone diffusion was established until the 2nd surgical time, after discussion in a multidisciplinary meeting. The 2nd time was performed on average at 7.9 weeks. The bone graft was performed by autografting at the expense of the anterior and / or posterior iliac crests in 18 cases (15 pure spongy grafts and 3 tri-cortical grafts) and by allograft alone in 1 case (bank head). An additional bone supply was performed in 9 cases (3 bank heads). Osteosynthesis was performed in 15 cases using an external fixator (7 cases) or a locked screw plate (8 cases). In the other cases, a plastered immobilization was put in place (5 cases). No patient presented any immediate or immediate postoperative complications. Bacteriological samples were taken during the second stage and were positive in 3 cases (same germ as in the first samples found in only 1 case). Fifteen patients received a total of 3 months of adapted antibiotherapy and 4 patients did not have antibiotic therapy after the negative results of second-time samples. The average follow-up of the series was 34 months (12 to 82 months). In 8 cases (42%), the consolidation was obtained directly after the surgical time without additional gesture within an average of 11 ± 10 months. Active smoking appeared to have a negative impact on bone consolidation but the strength of our workforce did not reveal a significant difference (p = 0.06). The size of the bone loss did not influence the consolidation after the 2nd time. For the 11 other cases, one or more complementary gestures were necessary because of a septic recurrence, a change of stabilization means or new bone grafts performed in case of insufficient consolidation on the radiological assessment after 6 months. We found in this series 4 septic recurrences after the 2nd time of bone graft. For these patients, bone stabilization after the 2nd time was provided by external fixation in 3 cases and by plaster in 1 case. The bacteriological samples taken during the surgical recoveries found different germs than those found during the 1st time. In cases of septic recurrence, either simple debridement associated with a change in

osteosynthesis without removal of the bone graft (2 cases) or excision of the bone graft associated with a new bone resection (2 cases) was performed. In all cases, a suitable antibiotherapy was set up for 3 months. Among these 4 septic recurrences, 1 gentamicin resistance was observed in only 1 case. Among these 11 cases (10 patients), bone consolidation was finally obtained in 9 cases with a mean delay of 23.0 ± 8, 4 months (between 10 and 36 months after 2nd surgical time). Consolidation could not be obtained in 2 patients,

with leg amputation in 1 case. In the other case, the patient was functionally satisfied (tight nonunion) and did not want further intervention.

The overall consolidation rate obtained in this series was 89% (17 out of 19 cases) with an average consolidation time of 16.0 ± 10.8 months. The average WOMAC score was 23/96 ± 22 at the time of the last follow-up.

Fig-1: Septic pseudarthrosis of the leg on intramedullary nailing

Fig-2: Removal of the material, excision of the infected tissue placement of a cement spacer and stabilization by an external fixator

Fig-3: Removal of cement and placement of bone graft and stabilization by LCP plate

DISCUSSION

A.C. Masquelet [2] in his original study in 2000, presented a series of 35 patients with 27 reconstruction of the tibial segment (23 septic pseudarthroses, or 85%). Among these 23 suppurative cases, 3 nonunions could not be treated by this technique by free flap failure and an infectious recurrence occurred in 5 cases requiring a new debridement. An additional bone graft was required in 4 cases in the 4th month. Full support was allowed on

average in the 6th month with the external fixator (4 to 15 months) and its ablation was performed on average after 8.5 months (6 to 17 months). Relatively short consolidation times have also been obtained by other authors. Taylor [12] found in his series of 69 patients (35 legs) supported with the technique of the membrane induced for a long bone nonunion, a consolidation rate of 83% with an average delay after the 1st time closely 7 months. In the series presented by Donegan [13] dealing with 11 cases of long bone nonunion (6 tibias, 50% septic) supported by this technique, he obtained a rate of consolidation of 91% within an average of 7, 5

months. Support was allowed from 4.4 months on average after 2nd beat. In these two series, there was only a low rate of septic pseudarthrosis which may explain the shorter time to consolidation. Other series found similar consolidation rates but with longer delays, as it is the case in our series. Thus, Karger [5] found at the SOFCOT symposium in 2010 a series of 84 cases including 61 shins. More than half of the cases were septic non-union (57%). They had a consolidation rate of 90% with an average delay of 14.4 months after the 1st time. These cases required on average 6.11 interventions to consolidate. Several parameters can influence the delay of bone consolidation after the second stage of the induced membrane technique. First, the type of osteosynthesis used after the time of bone grafting seems fundamental. During our series, we used several means of fixation: external fixator, locked screw plate or plaster. We have not succeeded in highlighting the favorable role of this or that mode of fixation given our small size. On the other hand, among the patients who required additional surgical procedures after the 2 steps, a reopening of locked plate osteosynthesis was performed in 6 cases in patients initially stabilized by plaster or external fixator with finally bone consolidation. It appears in our experience that the plaster immobilization is insufficient after the 2nd time because it does not allow sufficient stabilization of the home and does not allow charging. Our current preference is for locking screw plate osteosynthesis, which avoids the problems inherent in the external fixator [4]. Several authors advocate a resumption of non-painful support from the 4th month [2, 4, 14-16]. In our series, partial support was allowed on average at 8 months, which is quite a long time. From now on, the faster loading of our patients is a priority in the choice of our Therapeutic strategy. Other modes of osteosynthesis have been proposed, thus Apard [14] presented a series of 12 patients including 7 cases of septic pseudarthrosis using the technique of the induced membrane with an intramedullary nail. The authors conclude by explaining that the use of a centromedullary nail facilitates the technique but exposes to a greater risk of septic recurrence. During the follow-up, we found 4 septic recurrences requiring further interventions after the 2nd time. These septic recurrences are most often due to a defect of initial trimming as in most series [5, 11, 16, 17] and it is necessary here to underline the importance of the initial trimming and the excision of the infected tissues before gesture of bone reconstruction. Mauffrey [16] recommends performing a bone biopsy before the second step to check the sterility of the outbreak and in his study of 12 cases, no patient has presented septic recurrence.

Our statistical analysis showed a very clear tendency of tobacco as a pejorative factor of bone consolidation. Scolaro [22], in a study evaluating tobacco-related complications following a fracture, found that smoking increases the risk of nonunion in tibia fractures. These results lead us to intensify smoking cessation in these patients and to advise them systematically to consult a tobacco specialist, before taking charge of septic pseudarthrosis of the leg.

In all our patients we used antibiotic cement (PMMA + gentamicin). A.C. Masquelet advocates in his technique the use of a cement without antibiotic so as not to mask a latent infection which is likely to appear late. He considers that the treatment of the pseudarthrosis septic must be carried out during the first time by an efficient debridement at the same time bone and soft tissues [2]. Giannoudis advises using an antibiotic cement if the pseudarthrosis is of septic origin [11]. The work of Nau [23] recently made it possible to study the properties of the induced membrane obtained in contact with three antibiotic cements and a cement with calcium carbonate. The results showed a thicker membrane and a greater presence of immature vessels in the case of the use of a gentamicin cement. They explain this result by the low local level of antibiotic favoring a good balance between inflammation for the proliferation of the membrane and the cytotoxic effect. However, this study did not evaluate the osteogenic quality of the different membranes induced.

CONCLUSION

We find encouraging results with this technique in the management of septic pseudarthrosis of the leg. Among the parameters that can optimize and improve the consolidation: the rigid fixation of the nonunion center from the first stage, the strict respect of the membrane induced at the second stage and the imperative cessation of smoking.

Conflicts of Interest: The authors do not declare any conflict of interest.

Contributions of the Authors: All authors have read and approved the final version of the manuscript.

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