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Original article

Preliminary results of the induced membrane in upper limb. About 6 cases

Résultats préliminaires de la membrane induite au membre supérieur. À propos de 6 cas

N.M. Anoumou *, M. Traoré, M. Kouamé, A. Yepié, G. Varango

Service orthopédie-traumatologie, CHU de Treichville, boulevard de Marseille, 01 BP V03, Abidjan 01, Ivory Coast

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Abstract

The aim of this study was to describe the preliminary results after reconstruction of segmental bone defects (SBDs) in the upper limb of six patients. This retrospective study included three men and three women with an average age of 35 years (range 18–62 years), who had four primary and two secondary SBDs. The average length of the SBD was 4.5 cm (2–10 cm). According to the SOFCOT classification, type I (1 case), type II (4 cases) and type III (1 case) defects were identified. The reconstruction involved the humerus in two cases and the forearm bones in four cases. A posterior plaster cast was applied in all patients during the first stage of treatment. Internal fixation was used during the second phrase (five plates, one K-wire). The mean time elapsed between the first and the second stages of treatment was 3 months (2–4 months). At the final follow-up, bone union was obtained in five patients after an average of 4.6 months (4–6 months). The progression was favorable after the first stage of the induced membrane technique. However, two cases of sepsis were observed after the second stage of treatment, one evolving to osteitis that caused graft resorption. The induced membrane technique is a sequential technique used for treating SBDs. It is an alternative method of bone reconstruction in the upper limb.

Keywords: Segmental bone defects; Induced membrane; Upper limb

Résumé

L'objectif de cette étude était de présenter les résultats préliminaires de la reconstruction des pertes de substance osseuse (PSO) du membre supérieur de six patients. Il s'agit d'une étude rétrospective de trois hommes et trois femmes âgés en moyenne de 35 ans (18–62 ans) qui présentaient quatre PSO primaires et deux PSO secondaires. La longueur moyenne de la PSO était de 4,5 cm (2–10 cm) ; selon la classification de la SOFCOT, il s'agissait d'un cas de type 1, de 4 cas de type II et un cas de type III. La reconstruction concernait 2 fois l'humérus et 4 fois les os de l'avant-bras. Lors du premier temps, une attelle plâtrée postérieure a été systématiquement réalisée chez tous les patients. Une ostéosynthèse interne a été réalisée lors du deuxième temps (5 plaques vissées et une broche). Le délai moyen entre le premier et le deuxième temps était de 3 mois (2–4 mois). À la révision, la consolidation a été obtenue chez 5 patients dans un délai moyen de 4,6 mois (4–6 mois). L'évolution a été simple après le premier temps de la membrane induite ; par contre, deux cas de sepsis ont été observés après le deuxième temps, dont un cas a évolué en une ostéite aboutissant à une résorption de greffon. La technique de la membrane induite est une technique séquentielle permettant une prise en charge des grandes pertes de substance osseuses. C'est donc une alternative pour la reconstruction au membre supérieur.

Mots clés : Pertes de substance osseuse ; Membrane induite ; Membre supérieur

1. Introduction

Several different techniques can be used to reconstruct segmental bone defects (SBDs) in the limbs. In large SBDs, the primary challenge is graft resorption, which can lead to

* Corresponding author.
E-mail address: anoumoumichel@yahoo.com (N.M. Anoumou).

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Table 1
Patient characteristics.

Patient no.	Age/ sex	Mechanism	Site of SBD	Etiology/hrs.	Length of SBD (cm)	Internal fixation	Wait S1–S2 (months)	Bone union (months)	Follow-up (months)	Complications	Returned to work
1	32/F	Fall	R & U	Osteitis	R: 10/U: 2	Conv. plate	4	Yes (4)	44		Yes
2	18/F	MVA	H	OF (49 hrs.)	H: 5	Conv. plate	4	Yes (5)	37	Superficial infection	Yes
3	23/M	GS	R	OF (60 hrs.)	R: 4	Conv. plate	3	Yes (4)	36		Yes
4	62/M	GS	R & U	OF (49 hrs.)	R: 5/U: 5	Pinning	2	Yes (6)	27	Stiffness + CRPS	No
5	39/M	MVA	U	OF (74 hrs.)	U: 2	Conv. plate	3	No	28	Suppuration, non-union	Yes
6	36/F	MVA	H	Non-union	H: 3	Conv. plate	2	Yes (4)	5		Yes

CRPS: complex regional pain syndrome; F: female; GS: gunshot wound; H: humerus; hrs: time elapsed before admission; M: male; MVA: motor vehicle accident; OF: open fracture; R: radius; SBD: segmental bone defect; S1: first stage; S2: second stage; U: ulna.

non-union or repeat fractures. The trend in these cases is to use a vascularized autograft. The limitations of this latter method, particularly in the upper limb, appear to be partially overcome by the advantages of the induced membrane technique described by Masquelet et al. [1–3]. By relying on a pseudomembrane induced by a cement spacer that creates a highly vascularized, growth factor-rich environment, Masquelet achieved bone union in patients with defects more than 5 cm long. Experimental studies [4–6] have shown that this newly formed envelope has both mechanical and biological roles, leading to osseointegration of the graft and union of the fracture site.

Through a series of six cases, we present early results of the induced membrane technique being performed in the upper limb.

2. Patients and methods

2.1. Study population

This was a retrospective continuous cohort of six patients (three men, three women), with no relevant medical history, who were operated between July 2007 and March 2011 in the Orthopedics and Traumatology Department of the Treichville University Hospital (Abidjan, Ivory Coast). The patients were 35 years of age on average (18–62 years). All had suffered high-energy trauma (three motor vehicle accidents, two gunshot wounds, one high-height fall).

The SBD was primary (post-traumatic) in four cases and secondary in two cases. The four primary cases were open fractures with delayed care (after 48 hours). Because of the extent of bone comminution and the start of sepsis, we felt that immediate bone reconstruction was not appropriate since the potentially septic environment increases the risk of resorption if a bone graft is applied right away. The secondary cases consisted of one case of osteitis and another of septic non-union, positive for *Staphylococcus aureus*.

The reconstruction was performed on the humerus in two cases and the forearm in four cases. The average length of the SBD was 4.5 cm (2–10). Based on the SOFCOT classification [3], one patient had type I bone loss, four had type II, and one had type III. A summary of all patient characteristics is provided in Table 1.

After the first stage of the procedure, all patients were immobilized by a posterior plaster cast until the second stage was performed. The average time elapsed between the first and second stages was 3 months (2–4 months). Reconstruction was performed with a corticocancellous graft harvested from the patient's posterior iliac crest; internal fixation was used in all cases (traditional plate and screws in five patients, pinning in one patient). Functional rehabilitation was initiated in all patients once the bone graft was in place and the surgical wound had healed. All patients were reviewed to determine whether bone union was achieved on AP and lateral X-rays, and to assess their clinical condition and functional recovery.

2.2. Technique

The induced membrane techniques consists of two main stages [1]. In the first stage, debridement, excision of bone and soft tissue is carried out, followed by repair of soft tissue (with a flap if needed) after placement of a cement spacer in the bone defect. By principle, the cement must envelop bone ends to make it easier to decorticate the bone later on during the reconstruction step. The second surgical stage is performed 6–8 weeks after healing of the soft tissues. The spacer is removed and the membrane induced by the cement is left in place. After repermeabilization of the medullary canal, the cavity is filled with cancellous bone chips, and bone substitute added if needed.

3. Results

The recovery was uneventful in all patients after the first stages of the technique. Two complications were observed after bone reconstruction (second stage)—both were cases of infection. The microbiological culture was negative in one case (patient 2) and *Escherichia coli* was isolated in the other case (patient 5). These two patients underwent a new excision procedure and a new cement spacer was added. The outcome was good in the patient with the negative culture (patient 2). The other patient (patient 5) had bouts of sepsis resulting in graft resorption and lack of union. One case of complex regional pain syndrome (CRPS) of the hand occurred (patient 4).

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