Bone regeneration/repairing with an innovative bone substitute

Antonio Scarano[1]
Francesco Inchingolo[2]
Gianna Dipalma[2]
Maura Boggian[3]
Luca Signorini[4]

[1] Department of Innovative Technologies in Medicine and Dentistry, University of Chieti-Pescara, 66100 Chieti, Italy.
[2] Department of Interdisciplinary Medicine, University of Medicine Aldo Moro, 70124 Bari, Italy.
[3] Scientific Consultant, Ubgen Research Unit
[4] School of Dentistry, Saint Camillus University of Health Science, 00198 Rome, Italy.

Corresponding:
Prof. Luca Signorini

Abstract

The healing of a post-extraction socket and the final remodeling of the residual ridge represent a moment of fundamental importance in the study of bone regeneration and in the assessment all the methods to be implemented in order to guide this process in a profitable way. The purpose of this clinical evaluation is therefore to assess the effectiveness of a granular bovine bone (RE-BONE bone substitute, Ubgen System, Vigonza-PD, Italy) in promoting the formation of new bone and preserving the volume of the pre-existing one at the extraction site. 30 patients were involved in this study, involving a total of 30 alveolar sockets treated with new medical devices. Each patient was treated 4g of bovine bone in granular form. Our pilot study, carried out on the samples considered suitable by the operator, identified the presence or absence of mineralized bone, soft tissue and graft material, through a qualitative and quantitative percentage assessment.
The results showed an optimal percentage of new bone formation, with a prevalence of hard tissue. The presence of grafting material constituted only a small percentage in most of the analyzed samples, demonstrating that the substituted material was optimally resorbed and replaced with new mature bone tissue.

Keywords: Dental Implants; Implantology

Introduction

The healing of a post-extraction socket and the final remodeling of the residual ridge represents a moment of fundamental importance in the study of bone regeneration and in the assessment of all the methods to be implemented, in order to guide this process in a profitable way.
Following the loss of the tooth, in fact, various events take place and lead to a variable amount of bone resorption due to the qualitative and quantitative changes that occur in the alveolar bone itself, around the extraction site (the alveolar process and more generally the bone). Alveolar tooth-dependent structure (1) undergoes remodeling that is definitely characterized by a marked reabsorption. Chronologically, during the first year following tooth extraction, large portions of cortical bone are replaced with trabecular and medullary bone (2-4) and there is a marked reduction in the size of the extraction site both in the apico-coronal and in the bucco-lingual direction. In particular, some data are highlighted in the literature: after the first six months there is a reduction of about 30% of the vestibular volume of the residual alveolar ridge, but at the same time, new bone is formed which fills the post-extraction defect. In a radiographic study Tan et al. (2012) quantified the reabsorption, this was about 1.24mm vertically and 3.8 mm horizontally, 6 months after the extraction. Some authors have pointed out that bone loss is more marked on the buccal side and leads to a shift of the alveolar ridge 2/3 lingually/palatally compared to the original position. In order to delay the processes of modification of the alveolar ridge (horizontally and vertically) and of volumetric reduction, that begin at the same time as the healing process due to dental extraction, it is considered appropriate to preserve the post-extraction alveolus to allow a subsequent implant-prosthetic rehabilitation (4-7). To date, there are various techniques that preserve the post-extraction socket. These employ the use of grafting materials (or biomaterials) with or without the association with biological membranes.
The purpose of this clinical evaluation is therefore to assess the effectiveness of a granular bovine bone (RE-BONE bone substitute, Ubgen System, Vigonza-PD, Italy) in promoting the formation of new bone and preserving the volume of bone at the extraction site.

Materials and Methods

All medical devices used in this study are approved for commercial use and are freely provided by UBGEN, to carry on the aims of this study. The supply of materials has been stored in an appropriate and safe place, and is accessible only to people authorized to carry out this protocol. Medical devices are:
- BMrebone01B (0,5g – 0,25-1 mm)
- BMrebone01C (1g – 0,25-1 mm)

Patient sample size

30 patients were involved in this study, involving a total of 30 alveolar sockets treated with the new medical devices. Each patient was treated 4g of bovine bone in granular form in the following quantities:

- BMrebone01B (0,5g - 0,25-1 mm)
- BMrebone01C (1g - 0.25-1 mm)

Criteria for admission to the study

Inclusion criteria

Patients involved in the study, and which therefore responded to the inclusion criteria, were aged between 20 and 70 years with one or more teeth to be extracted and substituted with implants. Those presented a medical history without significant pathologies and were not using drugs that could condition the bone metabolism. These are healthy subjects, at most, with the presence of compensated arterial hypertension and / or compensated hypercholesterolemia. The patients selected in the study presented post-extraction sockets with buccal wall and the simultaneous presence of upper premolars with chronic periapical pathologies refractory to orthograde orthodontic treatment and / or with reduced coronal support.

Because of the impossibility to find cases with premolars to be extracted, subjects with upper incisors and canines to be removed were also included in the study for the aforementioned reasons.

Exclusion criteria

Smoking patients, pregnant women, patients with chronic systemic diseases (e.g. diabetes) and neoplastic of the facial district, patients using bisphosphate were excluded from the study. Equally, all those subjects who presented any sites already implant failure localized, untreated periodontitis, sites with acute infections, chronic inflammatory diseases of the oral cavity. Finally, subjects with autoimmune diseases (taking cortisone), declared allergy to one or more medications to be used during treatment and finally alcoholics and /or drug addicts were also excluded.

Plan of the study

The study plan was divided into eight visits.

Visit 1 - Pre-surgical evaluation

Patients were evaluated according to the inclusion and exclusion criteria. To start the recruitment, informed consent was signed, and an identification code was generated and assigned for each patient.

Visit 2 - Extraction and filling of the site with bone substitute REBONE

The patient underwent antibiotic coverage with Amoxicillin Clavulanate 1000 mg: 1 tablet every 8 hours for 7 days before intake, 1 tablet 3 hours before surgery. Infiltration anesthesia was administered on site (Articaine with 1 / 100K vasoconstrictor) and an extraction as atraumatic as possible (odontotomy) was performed. The sockets were cleaned, the granulation tissue was removed and a local bleeding was stimulated. The site was filled with RE-BONE® pre-hydrated with sterile physiological solution (without overfilling), the graft was then covered with a fragment of Condress Collagen on suture with horizontal “U” or “8” (silk 4-0). Finally, 600 mg of ibuprofen was given every 8 hours, as needed, on a full stomach.

Visit 3 - Suture Removal.

Removed the sutures after 12 days.

Visit 4 - Check-up at 30 days

The check has been performed.

Visit 5 - Checkup at 60 days

The check has been performed.

Visit 6 - Checkup at 90 days

The check has been performed.

Visit 7 - Check-up at 120 days

The patient underwent antibiotic coverage (Amoxicillin Clavulanate 1000 mg: 1 tablet every 8 hours for 7 days before intake, 1 tablet 3 hours before surgery).

Infiltration anesthesia (Articaine with 1/100K vasoconstrictor) was administered on site. Bone biopsy was performed with a drill (internal diameter 2 mm) and subsequent implant placement. Finally, the site was sutured.

Visit 8– after 4/5 months prosthetic finalization

The check has been performed.

Biopsy

Samples until processing were stored by neutral buffered formalin fixation process in a dark glass bottle and bakelite cap.

Fixation

The sample was fixed in neutral buffered formalin and placed in the glass bottle with stopper provided at the start of the clinical trial.

Identification

An identification tag was placed on each bottle with the patient identification code.

Processing

The biopsy samples were dehydrated in order to include them in paraffin to obtain sections prepared on special slides subjected to staining with hematoxylin-eosin.

Histological and histomorphometric analysis

In order to carry out histological and histomorphometric analysis, the various samples taken were analyzed and photographed, at various magnifications; an optical microscope, with digital image reconstruction, with a transmitted and polarized illumination, was used. In the various sections, the tissues and materials present, such as mineralized bone, medulla and grafting material, were identified. Therefore, we proceeded with the qualitative and quantitative evaluation of each sample with dedicated software and finally, the data were analyzed for statistical purposes.

Results

Our pilot study, carried out on the samples considered suitable by the operator, identified the presence or absence of mineralized bone, soft tissue and graft mate-

rial, through a qualitative and quantitative percentage assessment (Table1). The results showed an optimal percentage of new bone formation, with a prevalence of hard tissue. The presence of grafting material constituted only a small percentage in most of the analyzed samples, demonstrating that the substituted material was optimally resorbed and replaced with new mature bone tissue (Fig. 1).

Table 1.

Histological samples of post-extraction alveolar bone treated with RE-BONE			
	Bone (%)	Soft tissue (%)	Graft (%)
Sample 1	20.87	25.33	53.80
Sample 2	68.76	3.30	27.95
Sample 3	15.27	50.39	34.34
Sample 4	45.87	31.61	22.64
Sample 5	48.99	10.46	40.66
Sample 6	30.30	22.75	46.95
Sample 7	54.49	12.42	33.08
Sample 8	0	39.43	60.57
Sample 9	24.58	20.59	54.83
Sample 10	30.30	22.75	46.95
Sample 11	22.41	19.32	58.27

Also, the clinical findings showed how the healing of the sockets treated with RE-BONE at the initial time (T0) and at a control time (after 120 days) was excellent locally and macroscopically (Figg. 2, 3).

The samples taken from the biopsy were dehydrated, embedded in paraffin to obtain sections, stained with hematoxylin-eosin, prepared on special slides. The samples were photographed and analyzed accordingly at various magnifications; an optical microscope, with digital image reconstruction, with a transmitted and polarized illumination, was used. The results show that after 30 days (Figure 3) an intense osteogenic activity was present. The bone was immature but already present to ensure clinical support. After 90 days (Figure 4) the mineralization was almost completed and the bone had replaced most part of REBONE material.

Discussion

Regenerative medicine is a discipline aimed at tissue regeneration that uses external means to improve or restore the natural healing capacity of our body. Immediate implant placement does not prevent the resorption of the buccal bone crest (1) and several oral tissues may have more difficulties in triggering their own repair mechanisms. These situations are hampered by conditions such as: the absence of oxygen and nutrients, a chronic inflammatory state, a particularly complex tissue matrix to remodel. From a clinical point of view, the preservation of the ridge and the socket often needs a bone tissue graft for the proper management of defects in the buccal bone before insertion of implants (2). The

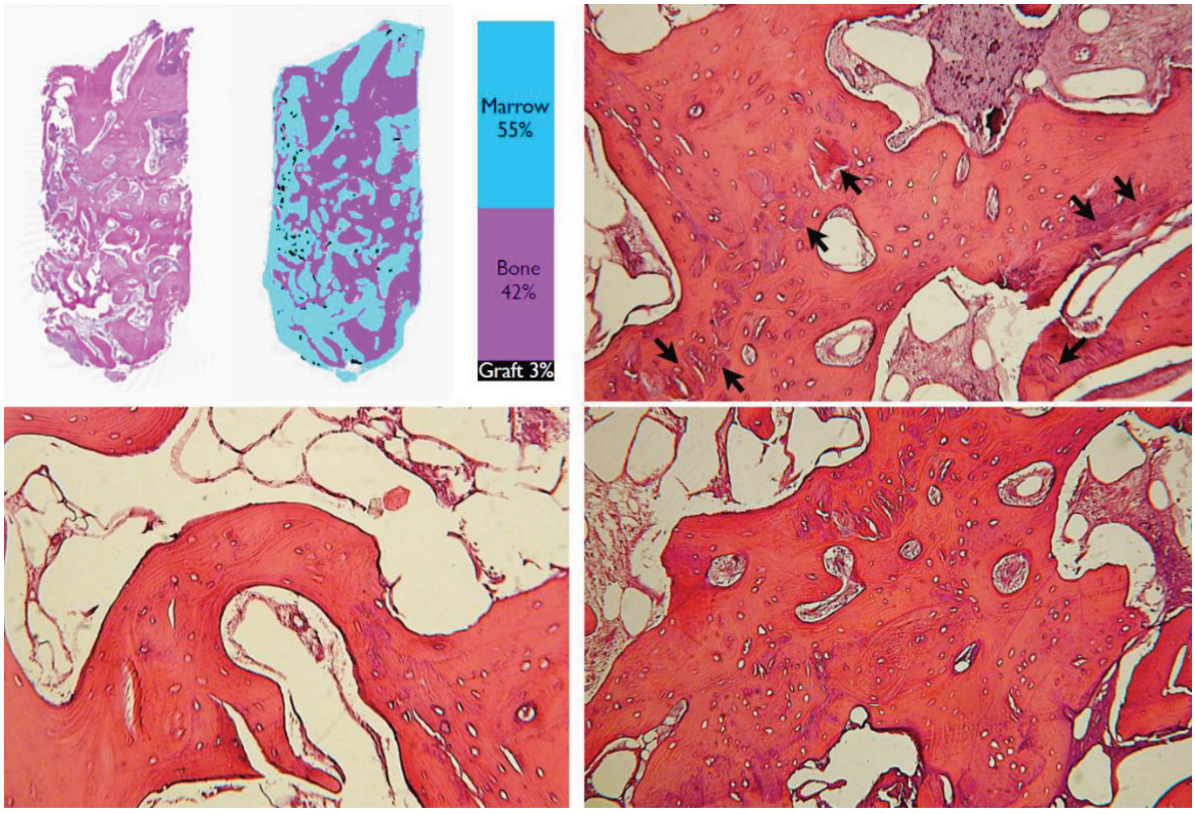

Figure 1.

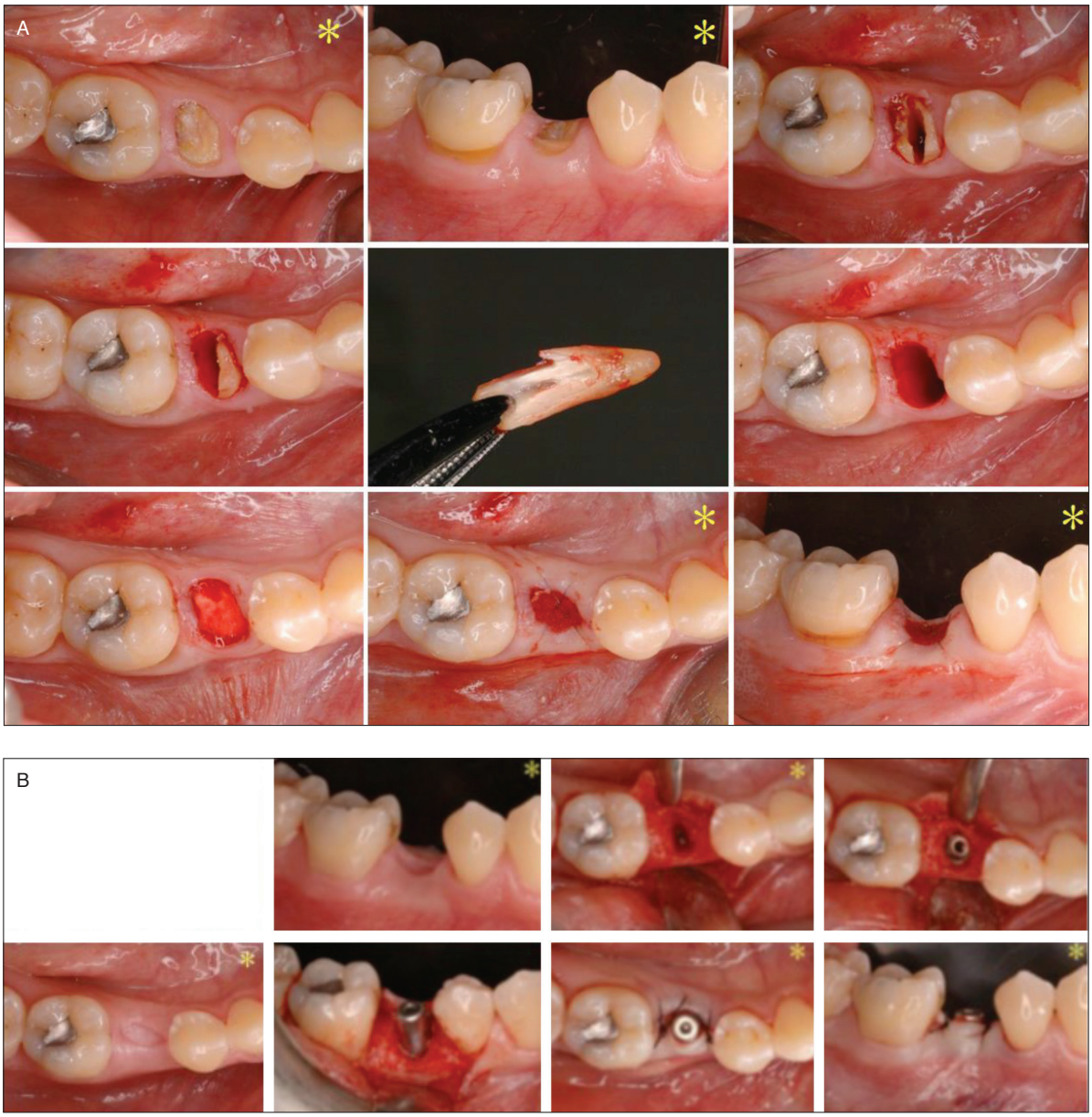

Figure 2. A. (T0). B. After 120 days.

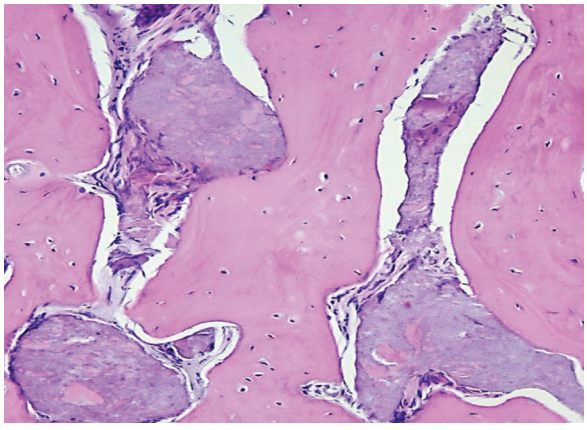

Figure 3. After 30 days.

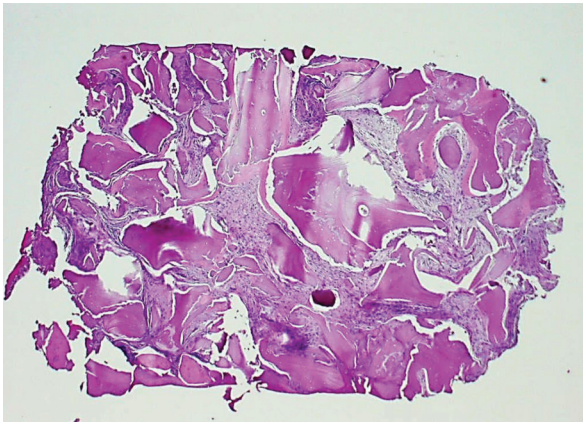

Figure 4. After 60 days.

REBONE bone substitute, thanks to the high surface/volume ratio, is an ideal scaffold for osseointegration and osteoinduction, furthermore, the highly porous and interconnected structure carries out an osteoconductive action capable of promoting cell colonization, the circulation of substances nutrients and rapid vascularization. After having carried out the function of filling, support and osteoconduction, the bone substitutes used in this study are completely degraded by osteoclastic activity and physiologically remodeled into new vital bone tissue already after 60 days.

Conflicts of Interest: "The authors declare no conflict of interest."

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