Implant bone reconstruction Using allogenic bone grafts

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The implant bone reconstruction using allogenic bone grafts is a technique based on, not only the bone regeneration advantages, but also those of the tissue increase to correct the bone volume lacks in the peri-implant areas. This is about an increase in width of the alveolar crest by adjunctions of allogenic bone grafts which are first adapted to the local tissues and then stabilized with micro-screws.

This technique should not be considered like a small variation of the guided bone regeneration technique (GBR), but rather like secured bone grafting, surgical process which has made its proofs with autogenic bone.

If we compare the simplicity of this technique compared to the heaviness of the interventions for volume increase by autogenic grafts taken as blocks, we note – when we assess them in terms of risk – that it is the technique to use for patients not requiring too large bone restorations.

Translated from the original French article

The success of implant-carried prosthesis is obtained by respecting the conditions defined during the study of the diagnostic waxes (axis, site, etc.), without take account of the available bone volume. To answer to these requirements, reconstruction techniques of a crestal volume are sometimes necessary.

HISTORY

The bone lesions' treatment by bone grafting techniques is not new. Barth, at the end of the XIXe century, carried out the first bone transfers and begun to study the mechanisms of graft incorporation by the host [1]. However, the bone grafts are only commonly used since the 20's years [2]. The used material was the autogenic bone, but the difficulty to obtain a sufficient amount from it, has encouraged the authors to use the bone allograft proposed by the tissue banks.

BIOLOGICAL ASPECTS OF THE BONE GRAFTS

After a bone autograft, most of the graft's cells do not survive to the transplantation and must be replaced to allow the bone remodelling to take place normally. The dynamic phenomenon of died tissue resorption and its replacement by living tissue are designed as "crawling substitution". By the Bone Morphogenetic Protein (BMP) release, the graft induces a cellular metaplasy at the graft's bed, allowing osteogenic cells differentiation. This phenomenon is named osteoinduction [3].

The BMP discovery dates from the end of the last century. The bone tissue lets itself invaded, with more or less facility depending if it is cancellous or cortical bone, by vascular buds coming from the graft's bed. Those allow the penetration of mesenchymal cells into the graft. This phenomenon is called osteoconduction [3]. In the bone autografts, the osteoinduction potentiates the osteoconduction which takes place faster than with allogenic material.

With the latter, the initial hypervascularization phase of the graft's bed is identical, but the vascular buds' penetration is delayed and the crawling substitution is slower, in comparison to the bone autografts [4].

INSTALLATION OF THE PERI-IMPLANT BONE VOLUME

A crest width of 5 mm and a bone height between 10 and 12 mm, a crest/prosthetic axis angle of 30 degrees and a ratio crown/implant under 1 are necessary to place an implant in good conditions [5]. In order to improve the anatomical situation of the implant site, it is often essential to adjust the available bone volume.

Various methods of alveolar crest increase were developed:

the plastic extension [6];

the increase techniques by guided bone regeneration [7];

the increase techniques by lateral grafts [8, 9].

The plastic extension techniques, either by lateral osteotomy or by crest greenstick fracture, can only be carried out in certain shapes of crests and for small expansions.

The guided bone regeneration gives the most complications, a bone gain restricted in the vestibulo-palatal plan and less important in the mesio-distal direction [7]. The increase techniques by lateral grafts with autogenic bone grafts or allogenic bone grafts seem the best adapted. The autogenic bone grafts need donor sites either extra-buccal (skull, tibia, ribs and iliac crest) [9, 10] or intra-buccal (tuberosity, palate, zygomatic arch, coronoïd apophysis, mandibular symphysis, and mandibular retromolar zone).

The symphysis and retromolar mandibular biopsy represents the most interesting alternative. It provides a good quality bone of endomembraneous origin [11-14].

The intra-buccal biopsies only provide a limited bone amount and are indicated for low- or mean-extensive reconstruction. The extra-buccal sites not only need a second operative site, but also a hospitalization, which limits the indications (cooperative patient and in perfect physical and psychological health). Besides, there is a risk of secondary complication induced by the bone biopsy.

The bone allografts or allogenic bone grafts make the operative procedure simpler and offer an unlimited bone amount.

BONE ALLOGRAFTS

Reconstructions with allografts have been practiced by Merle D'Aubigné since 1966 [15].

The allograft [16] is a human origin graft, from a living donor presenting no general pathology history, particularly infectious. The biopsy, the tissues' selection and their security are carried out in accredited tissue banks. For a use in implantology, the bone tissue is cleaned from its cellular components and sterilized by various processes. The preservation at long-term is, generally, ensured by a lyophilization, which improves the bone allografts incorporation while decreasing the local immune reactions [17].

Classically, two allografts families are distinguished:

The non-demineralized freeze dried bone

The non-demineralized freeze dried bone is an osteoconductive material which does not release any osteoconductive BMP. Nevertheless, it is made up of a mineral, inorganic hydroxyapatite (HA) phase which provides a mechanical resistance [18, 19].

The demineralized freeze dried bone

The freeze dried bone, demineralized with an acid treatment, releases the BMP from the mineral matrix. These proteins would provide an osteoinductor potential to the allograft, but this property remains much debated [18]. Moreover, the decalcification induces, with the elimination of hydroxyapatite crystals, the fragilization of this material. In a near future, with the commercialization of the rhBMP-2, bone protein able to induce the formation of bone de novo in an ectopic site, the grafts will be able to be a support for this protein and become osteoinductor [20]. This osteomorphogenic rhBMP-2 protein can be obtained thanks to the progress of genetic engineering, in vitro in unlimited amount from the human DNA. The results obtained on macaque monkeys [20], from collagen sponge soaked with rhBMP-2 for the filling-in of bone defect and, more recently, for the human sinuses filling-in seem to be similar to those obtained with autogenic bone [21]. With the allografts, the immunological and microbiological risks remain. No case of viro-transmission has been reported after their use. Do we really take a risk for

our patients with these materials? The absence of contamination until today does not eliminate a negligible risk [22].

MATERIAL AND METHOD

This presentation aims to describe the indications and the technical steps of the bone volume regeneration with allogenic bone grafts.

Fig. 1 / TBF® cortico-cancellous graft.

Fig. 2 / Non-demineralized cancellous bone powder of 0,5 to 1 mm particles TBF®.

MATERIAL

The implants used for our surgeries are Serf Ciny® implants, commercially pure titanium screw, of 3,5 mm diameter and 14 and 16 mm length in one case and 4 mm diameter and 16 mm length in the other case. The implants have an asymmetric thread which ensures a good primary stability. They are used in two surgical steps and allow the watertight closing of the site at the end of the surgery, which is essential in bone graftings.

The allogenic grafts are bone lamellae from bank, non-demineralized cancellous or cortico-cancellous bone (20 x 15 x 5 mm) and non-demineralized cancellous bone

powder with particles of 0, 5

to 1 mm, provided by the TBF laboratory (Fig. 1 and 2).

METHOD

The technique can be carried out:

- either in one single surgery: increase of the peri-implant bed and implant placement simultaneously;

- or in two steps, the implants' placement is conducted after the bone volume increase.

INDICATIONS OF THE SINGLE SURGERY TECHNIQUE

We prefer, when it is possible, the method in one single surgery step. It allows shortening the waiting time for the patient and avoids the graft lysis by the intra-bone stimulation, resulting from the load exerted on the implant [23]. It will only be possible if the receiver site presents a sufficient (4 to 5 mm) residual bone volume, allowing a primary stability of the implant in a correct position according to the requirements of the ulterior prosthetic rehabilitation [24].

We also take the crestal profile into consideration which, as the n°1 clinical case (concave crest), allows the apical and cervical locking of the implant in spite of a large bone defect in vestibular.

PRESENTATION OF THE N°1 CLINICAL CASE (FIG. 3 TO 11)

The patient is a 48 years old woman with a final loss of teeth at the maxilla (Fig. 3). After a study of the pre-operative CT scan (Fig. 4), we have decided to place six implants to carry out a reamed bar. We have only studied the left side which will be the only one grafted. The available width to implant is very weak. A bicortical locking of the implants is possible (Fig. 4). The implants will be placed at 21, 23 and 25.

Simultaneously, an allogenic bone graft will be carried out in apposition to increase the crest width in this zone.

- **Surgical and prosthetic step**

A crestal incision and unloading incisions allow peeling off a full thickness flap at the receiver site. The site is prepared to eliminate any granulation tissue. The vestibular cortical is perforated to allow a better graft vascularization. The subjacent cancellous tissue's bleeding is immediate. The intracortical cells only have a minimal role in the osteogenesis of a bone graft, but the cells of the endosteum and trabecular stroma can be at the origin of more than the half of the neo-formed bone [25], underlining the importance of a contact as narrow as possible between these cells and the bed receiving the graft. The shaping of the allogenic graft is conducted with the help of a rotary instrumentation in order to fit to the bone defect's anatomy (Fig. 5), and is then placed and stabilized using fixation screws (Fig. 6).

It is essential to take specific care to the finishing of the graft's outlines, at the level of the marginal edges, in order to avoid the perforation of the covering tissues.

After the implants placement and the checking of their good primary stability (Fig. 7), the graft is covered by TBF non-demineralized bone powder, of 0, 5 to 1 mm granulometry (Fig. 8) to supplement the volume and soften the profile.

The surgery ends by the closing of the incisions, avoiding all potential tension of the soft tissues.

- **Postoperative follow-up**

The sutures are removed after 10 days. The patient has to avoid carrying his temporary prosthesis during the days following the surgical phase. A clinical control is performed between two and four weeks after the surgery. It allows checking the tissular healing and the morphology of the alveolar reconstruction.

- **Results**

At the reopening at 6 months, the fixation screws are removed and the grafted site is assessed. The concavity disappeared. The bone volume increase is perceptible (Fig. 8) as will confirm, later, the control CT scan at 18 months postoperative (Fig. 9 A and B).

The integration of the cortico-cancellous graft seems to be completely satisfactory. The prosthesis (here, reamed bar) is performed without any problem (Fig. 10 A and B).

Technique in two steps: indications

The choice of this second method is determined by the lack of primary fixation of the implant in the existing bone. In this case, it is necessary to plan a first surgical step to perform the local increase of the peri-implant bone tissue, then some months later, when the grafted bone is fixed and integrated, a second surgical step for the implant placement.
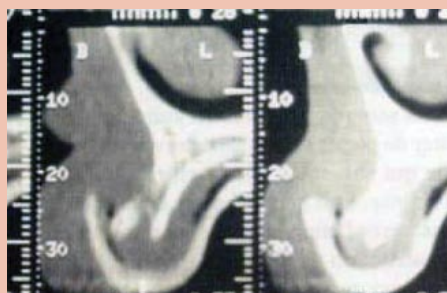
Fig. 3 / Preoperative panoramic.

Fig. 4 / pre-operative oblique CTscan section revealing the small available width.
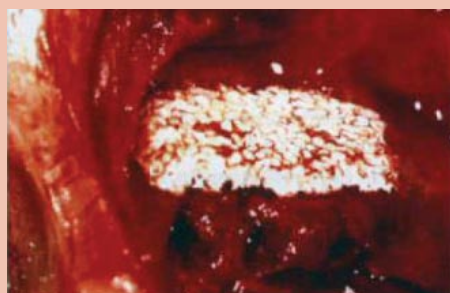

Fig. 5 / Graft's preparation.
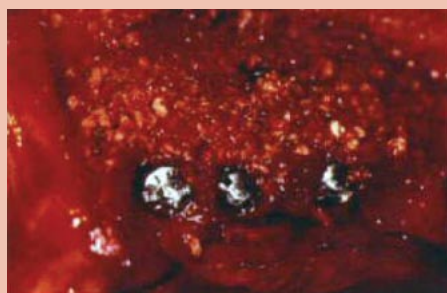

Fig. 6 / Graft's implantation.

Fig. 7 / The graft has been fixed with an osteosynthesis screw, and covered by TBF° bone powder.
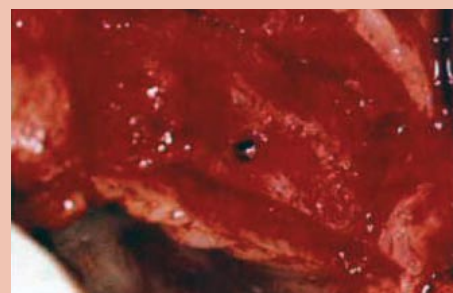

Fig. 8 / Reopening at 6 months: bone volume increase. The implants are entirely covered by bone, the fixation screw only is visible.

Fig. 9 A and B / Control CT scan at 18 months. Axial and coronal sections n°28 revealing the perfect integration of the graft and the obtaining of a good crest width.

Fig. 10 A and B / Total prosthesis stabilized by a reamed bar with 4 Céka° pressure buttons.

Fig. 11 / Control Panoramic after the prosthesis implantation.

PRESENTATION OF THE CLINICAL CASE N°2 (FIG. 12 TO 16)

The patient is an 18 year old boy who has lost accidentally the 11 (rest of channels paste). Moreover, a rhizalysis on the 12 remains after orthodontic treatment (Fig. 12 A).

In spite of the large bone defect (Fig. 12 B), the parents are against an autogenic bone biopsy. The fitting of the crest bone volume will be conducted with an allogenic bone graft.

- **Surgical and prosthetic steps**

They are the same ones as for the first case. The apposition graft is a TBF® non-demineralized cancellous bone lamella (20 x 15 x 5 mm) of which the preparation and the implantation (Fig. 13) are carried out as previously. In both cases, in order to avoid cutting the vascularization coming from the periosteum, no membrane was implanted; the periosteum contributes for 30 % to the new bone formation during the osteogenesis of a bone graft [25].

- **Results**

At the reopening, 3 months postoperative, the fixation screws are removed, and the implant then placed.

At the loading, six months later, the obtained bone volume at the grafted site is checked by control x-rays: axial and coronal CTscan sections as well as retroalveolar (Fig. 14 A, B and C).

The crest appears significantly thickened with a good bone density. We have its confirmation, in situ, at the surgery (Fig. 15).

IN SUMMARY

The grafts, checked in situ at the loading, were osteointegrated, stable and of good quality. The x-rays controls, carried out in both cases, more than 1 year after the bone graft, have showed a significantly thickened crest with a good bone density (Fig. 9 A and B, 14 A, B and C).

In the clinical case n°2 (surgery in two surgical steps), during the implant placement (three months postoperative), the bone quality of the implant site was poor, bone of type 4 [26], but at the loading, one year after the graft, the bone quality was good (Fig. 15), confirming a relatively long maturation of the allogenic grafts which are only osteoconductive.

The progressive loading of the neo-formed bone is then necessary and is obtained by the placement of a long period provisional prosthesis before the final prosthesis (Fig. 16).

The mean follow up for the presented cases is of more than 3 years and the prosthesis is, in both cases, functional: no abnormal bone resorption was observed during the routine checkings.

DISCUSSION

The described technique here cannot be considered as being some variant of the guided bone regeneration technique, but rather as secured bone grafting, surgical process which has proven its efficiency with the autogenic bone [27].

Some drawbacks persist:

- the graft is, until now, only osteoconductive;
- the grafts maturation is relatively long, especially if the graft's volume is important;
- the graft partial osteointegration at the implantation can cause a primary fixation problem.

On the histology sections, the graft strengthening as well as the obtained bone quality are satisfactory, but must be confirmed by a biopsy.

Certain advantages emerge from this surgical technique. Indeed, when comparing its simplicity with the heaviness of the surgeries for bone increase by autogenic grafts, we note that the treatment is facilitated:

- there is only one surgery site;
- the operative time and the postoperative pains are decreased;
- an unlimited bone volume is available.

When we assess this technique in a risk perspective, is essential:

- for the old patients;
- for the patients for which the general health does not allow envisaging long and painful surgeries;
- for the timorous patients refusing an autogenic biopsy.

CONCLUSION

At short-term, this technique seems simple, handy and easily integrated in an implantology exercise. Its efficiency, on the long term, will have to be assessed by a clinical study, including a larger number of patients; the study will then show if the technique is able to answer to the expectations.

The evolution of the genetic engineering can, in a near future, considerably widen the indications of this method. The manufacturing and the use of bone substitutes are not yet completely codified, but we hope that one day, they are as true as "nature".

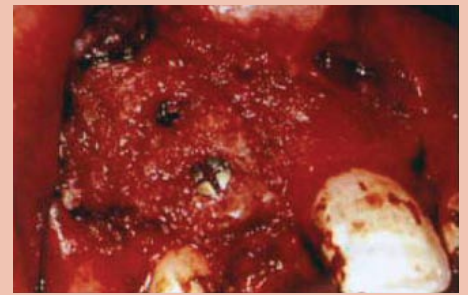**Fig. 12 A and B / Presentation of the site to graft.**

Fig. 13 / Graft's implantation.

Fig. 14 A, B and C / Control X-rays one year after the graft implantation. CTscan sections: a/ axial; b/ coronal; and c/ retro-alveolar x-rays.

Fig. 15 / Opening of the grafted site at the loading.

Fig. 16 / Implantation of the final prosthesis.

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