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Biological Drilling: Implant Site Preparation in a Conservative Manner and Obtaining Autogenous Bone Grafts

SUMMARY

Background/Aim: *The drilling process for insertion of an implant should be as conservative as possible, as not to damage the future implant bed. If this drilling is conservative additional bone can be obtained to be used afterwards, during the same surgery, as bone graft particulate if needed. The objective of this study was to evaluate the efficiency of a biological low-speed drilling and to analyse the bone obtained in order to ascertain viability and vitality of the contained bone cells. Also, the bone obtained from the low-speed drilling was compared with bone obtained with high speed drilling and irrigation, collected through a filter in aspiration system.* ***Material and Methods:*** *In this pilot study, samples of biological drilling (low speed without irrigation) were collected in five patients undergoing implant surgery. In the same patients a high speed drilling with irrigation was also used. Bone of the drilling was collected through a filter in the aspiration system. Subsequently the samples were analysed by conventional histology and cultivated in order to observe cell growth.* ***Results:*** *The samples of bone obtained by biological drilling showed live cells in the conventional optical microscopy and cell growth after cultivation. The bone obtained with drilling at high revolutions showed no living cells and no cell growth after cultivation.* ***Conclusions:*** *The biological drilling at low speed offered two advantages compared to drilling at high speed with irrigation. The first of these is the perfect control of the drilling depth as the marks of the burs are visible during drilling; the second is possibility of collection of a large number of viable particulate bone grafts without increasing time and complexity of the surgery, which allows immediate augmentation of bone if needed.*

Key words: Biological Drilling, Bone Viability, Regeneration

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Introduction

The objective of drilling for the insertion of a dental implant is realization of a new alveolus that is adapted to the morphology of the implant that will be placed. It is accomplished by using burs to withdraw bone at the implant site. This preparation of the implant site should be as conservative as possible to avoid damage of bone cells that will be responsible for successful osseointegration of the implant once inserted. Most of the implant systems on the market use a drilling at high speed with irrigation to avoid over-heating of the bone and preserve cell viability, in addition to reducing the time required for preparation of the implant site[1-3].

The objective of this study was to evaluate the efficiency of a biological low-speed drilling and to analyse the bone obtained in order to ascertain viability and vitality of the contained bone cells. Also, the bone obtained from the low-speed drilling was compared with bone obtained with high speed drilling and irrigation, collected through a filter in aspiration system.

Material and Methods

In this pilot study, samples of biological drilling (low speed without irrigation) were collected in five patients undergoing implant surgery. In the same patients a high speed drilling with irrigation was also used. Bone of the drilling was collected through a filter in the aspiration system (Figures 1 & 2).

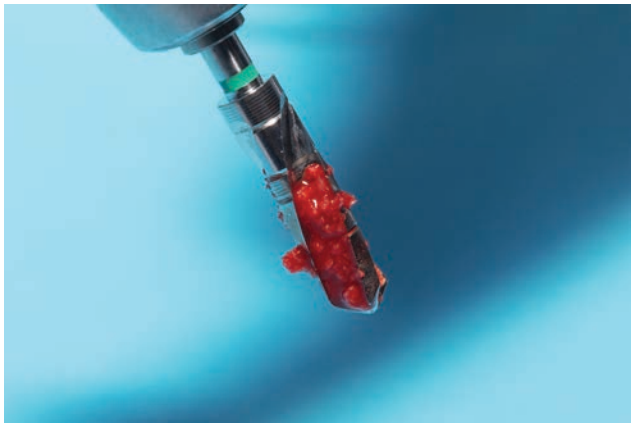

Figure 1. Collection of bone during biological drilling from the bur

Figure 2. Collection of bone during high speed drilling from the filter

The inclusion criteria were patients aged over 18 years, implants insertion in sound bone and the need for more than one implant to be able to compare the collected bone after low speed and high speed drilling.

Prior to surgery and in order to make a proper treatment plan, all patients underwent standard diagnostic protocol consisting of reviewing the medical and dental history, diagnostic casts, and radiographic evaluation (panoramic radiographs and cone-beam CT scan). The cone-beam CT scans were analysed with diagnostic software (BTI Scan II, Biotechnology Institute, Vitoria, Spain) to measure both the residual bone height and the bone density at implant sites.

The bone collected during biological drilling remained embedded in PRGF-Endoret fraction 2 (not activated) until the time of its analysis. Plasma rich in growth factor was prepared using PRGF-Endoret Kit (BTI, Vitoria, Spain). Briefly, citrated venous blood was centrifuged at 480 rpm for 8 minutes to separate blood components. Then, plasma column was fractioned into fraction 2 (F2) defined as the 2 ml of plasma above the buffy coat and fraction 1 (F1) defined as the plasma column above the F2. The bone collected from the high speed drilling (filter) was preserved in saline solution (0.9%).

Flap elevation and Bone drilling: patients received respectively 1 g of amoxicillin 1 hour before surgery and 1 g of acetaminophen 30 minutes before surgery. Under local anaesthesia, a full-thickness flap was reflected to expose the alveolar crest for implant site preparation. Bone drilling was performed at low velocity (150 rpm) without irrigation and the drilling sequence was adapted to the bone type in the selection of the diameter of the last bone drill used before implant placement. The last implant inserted at high revolutions was made with the same sequence of burs but to 1200 rpm with constant irrigation throughout the process.

Once the implants were inserted, the flap was repositioned and closed with 5/0 monofilament suture.

Histopathological analysis: A portion of each sample was analysed by conventional histological processing and optical microscope (haematoxylin-eosin and Masson's trichrome).

Isolation and culture cells: Alveolar bone cells were obtained by biological drilling (entrapped into drills) and high speed drilling (filter). The cells were collected in phosphate-buffered saline PBS with antibiotics and antimycotics. Tissue was explanted in Osteoblast Medium with antibiotics, 15% foetal bovine serum (FBS, Biochrom AG, Leonorenstr, Berlin, Germany) and osteoblast growth supplements (Sciencell Research Laboratories, Carlsbad, California, USA). Alveolar bone cultures (Figure 3) were incubated at 37ºC in a humidified 5% CO_2 atmosphere and medium was changed twice a week.

Cells derived from alveolar bone were characterized by immunofluorescence. Expression of two osteoblast markers was analysed by osteopontin (Sigma-Aldrich) and osteocalcin (Acris Antibodies GmbH, Schillerstr, Herford, Germany) antigens. Moreover, alkaline phosphatase activity (Sigma-Aldrich) was detected in all the primary bone cultures. In all cases the osteoblast phenotype was confirmed by the high positivity of the three markers.

When osteoblasts reached 60-70% confluence (after approximately 3-4 weeks), they were detached and serially passaged. Cell viability was tested by Trypan Blue dye exclusion (Sigma-Aldrich, St Louis, Missouri, USA) - Figure 4.

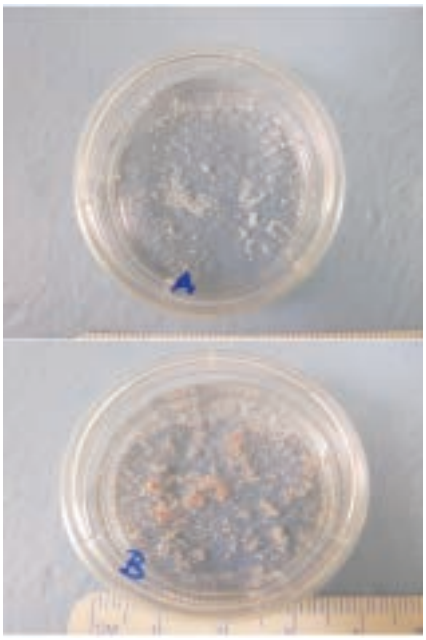

Figure 3. Alveolar bone cultures with osteoblasts

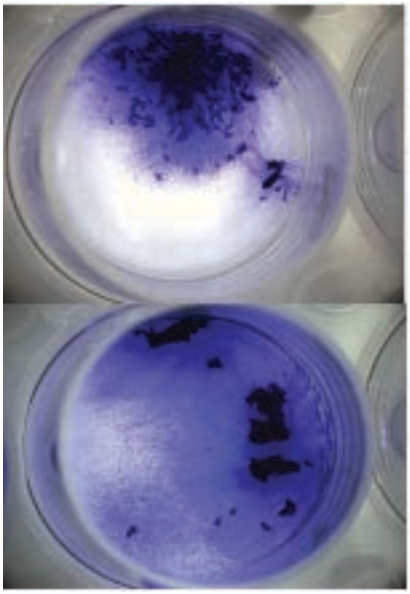

Figure 4. Cell viability tested by Trypan Blue dye exclusion

Results

Looking at all samples with conventional optical microscopy, we observe one essential difference. Bone in the filter was acellular, without living cells in the bone spaces where they should be placed (Figure 5), while in the bone obtained by biological drilling we observe living cells intact in their bone structure The bone of the biological drilling with optical microscopy shows alive cells, maintained bone architecture and the size of bone particles was significantly higher (Figure 6).

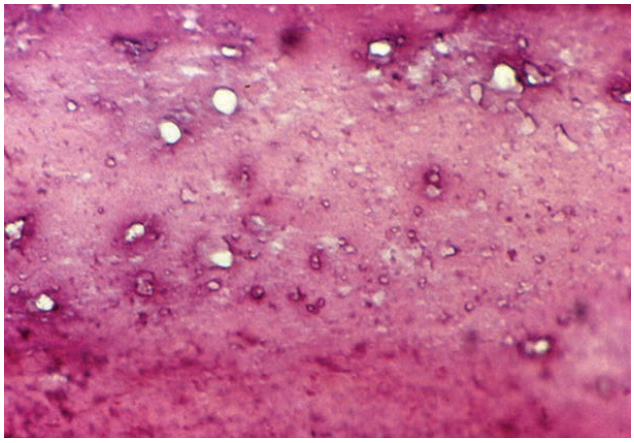

Figure 5. Sample obtained after high speed drilling process. Compact bone (hematoxylin-eosin x10 - Optical Microscopy) - the bone has no cells

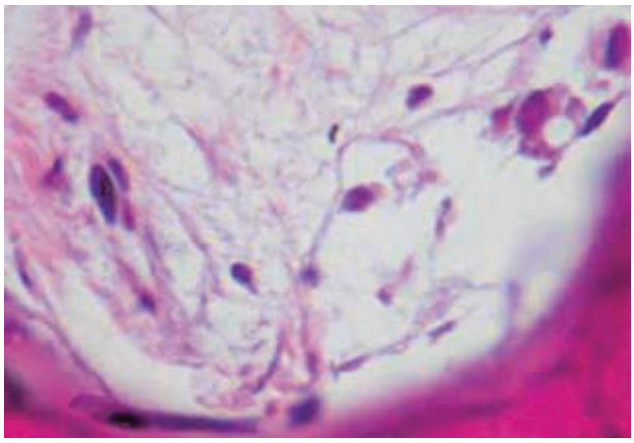

Figure 6. Sample obtained after biological drilling process. In this case the cells are alive (hematoxylin-eosin x60- Optical Microscopy)

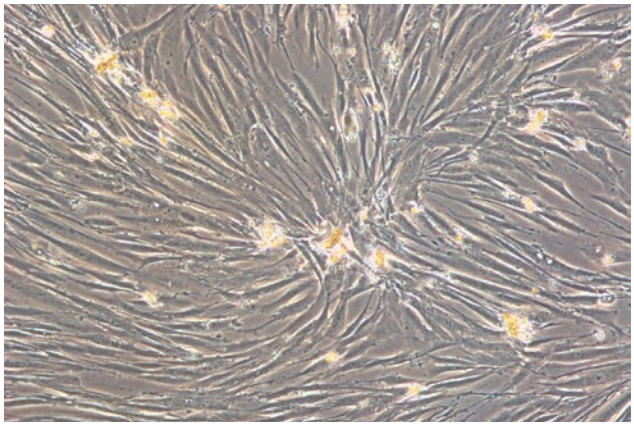

Figure 7. Images obtained with an inverted optical microscope x20 of primary cultures of osteoblasts derived after biological drilling bone using the technique of explant

Due to the absence of cells in bone obtained by high speed drilling, it was not possible to cultivate and expand osteoblasts. Bone obtained through biological drilling was cultivated by the technique of explants. This bone was distributed in fragments on the surface of cultivation. Once distributed, ObM was added with

antibiotics and antifungals (300 µl) and maintained in incubator white room. A periodic review of the surfaces of cultivation was done. The follow-up was realized 3 days a week, and annotation was done at the day in which the cells in culture appeared. The migration and proliferation of osteoblasts was positive in all the samples cultures obtained by biological drilling (Figure 7).

Discussion

Insertion of a dental implant carries perforation of bone to form a cavity that allows placing a dental implant. This procedure is an aggression to the bone due to the withdrawal of part of its mass and heat that is generated in the workplace[4-8]. To remedy the excessive heating of bone in the area of drilling, generally, irrigation with saline solution is used. This irrigation minimizes the temperature of bone, but makes impossible the collection of bone removed by drilling process[8-10]. Biological drilling at low revs maintains a safe temperature of bone, and bone can be collected during preparation of the implant bed. During such a drilling, cellular vitality is not affected[11].

Therefore, the bone graft obtained after biological drilling and embedded in the patient's plasma proteins (PRGF®-Endoret fraction 2) is a comparable alternative to the use of autologous grafts or other biomaterials for bone augmentation procedures.

Conclusions

Biological drilling at low revs gives us two advantages compared to drilling at high speed with irrigation. The first of these is the perfect control of the drilling depth as the marks of the burs are visible at all times to minimize the invasion of anatomical structures by accident. The second advantage is the collection of a large number of viable particulate bone grafts, without increasing the time and complexity of the surgery. This collection of bone allows us the treatment of areas in the same surgical phase that would require bone augmentation.

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