Autologous Dentin Graft Behavior in Bone Regeneration: Two Histologies at 5 And 10 Months

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The use of autologous dentin as an alternative to conventional regeneration biomaterials has become increasingly common, having been described in the literature since the 1960s, demonstrating its efficacy. Certain components that form the teeth, such as type 2 bone morphogenetic proteins (BMP-2), type I collagen, and hydroxyapatite, have been widely proven to be effective and are essential materials in the regeneration of alveolar bone. It is known that regenerated bone is histologically indistinguishable from native bone, and therefore, conditions and materials that allow for adequate replacement by host bone and that do not persist over time are key. With the present case report, encouraging advances in the use of autologous dentin as a graft material are demonstrated. Int J Periodontics Restorative Dent 2021;41:835–842. doi: 10.11607/prd.5183

Following the extraction of a tooth, a process that involves resorption of the alveolar bone begins, leading to horizontal and vertical bone loss of 40% to 60% over the span of 6 to 12 months.1,2 Depending on the type of alveolar defect,3 different types of bone substitutes may be used to minimize this process.4,5

Amongst these materials, autologous bone is deemed to be the gold standard6,7 due to its osteogenic, osteoconductive, and osteoinductive properties. However, depending on its architecture (cortical or medullar), its characteristics and components differ.8 Several religious and cultural factors should be considered by the clinician when selecting an autologous biomaterial against an allograft or xenograft, as suggested by Bucchi et al.9 Nevertheless, acquiring autologous bone implies higher morbidity and greater risk of complications10 and patient hospitalization when obtaining an extraoral graft.11

In this sense, autologous dentin has been used since the 1960s by Yeomans and Urist.12 Kim et al13 observed that regeneration was achieved following the application of dentin particles in mandibular defects > 20 mm. Its biocompatibility was made evident after a 5-year follow-up in which no adverse effects were described.
Tooth and bone tissue share similarities in their chemical composition, both in their inorganic and organic components as well as in their water content. Certain growth factors that are part of the organic component stand out, such as insulin-like growth factor, type 2 bone morphogenetic protein (BMP-2), and beta-transforming growth factor (TGF-β), which are maintained over time. These proteins are directly involved in osteoinduction and can be obtained by tooth decalcification. Type I collagen is also important due to its key role in angiogenesis. One of the main advantages of dentin is its preservation of bone morphogenetic proteins and type I collagen over time, meaning that it can be used intraoperatively or postoperatively by preserving teeth. As for the inorganic component, it contains four distinct types of calcium phosphates (hydroxyapatite, tricalcium phosphate, octacalcium phosphate, and amorphous calcium phosphate) that provide the tooth its osteoconductive properties.

Autologous dentin as a graft material was compared against others in a systematic review by Kim et al. The authors found that in groups in which dentin had been used as part of the regenerative procedure, there was significantly less bone loss. Bone tissue surrounded the dentin, and the latter was being replaced by newly formed bone, a finding that was confirmed histologically.

Kim et al. obtained similar results to the aforementioned study, by microscopically and histomorphometrically analyzing autologous dentin grafts in 6 patients who had undergone extractions and subsequent regenerative procedures using dentin. Samples were taken for histologic assessment between 3 and 6 months, at which time newly formed bone was detected in 46% to 87% of the sampled areas. At 6 months, great dentinal resorption was observed, being replaced by new trabecular bone, demonstrating the excellent biocompatibility of the dentin grafts.

Therefore, due to its good clinical, radiographic, and histologic behavior, dentin can be used as an autologous graft material in cases of teeth with an impossible periodontal prognosis, primary teeth, retained roots, impacted teeth (third molars, canines, supernumerary teeth), and endodontically treated teeth that require extraction.

Case Report

A 57-year-old woman with an unremarkable medical history and no known allergies came for consultation regarding pain in the mandibular right posterior area. Upon clinical examination, tooth 47 (FDI tooth-numbering system) was tender to percussion, and probing depths of 15 mm were detected at the following areas: the mesial, buccal, and distal aspects of tooth 47, the distal aspect of tooth 46, and the mesial aspect of tooth 48. Mobility grades III and II were also noted for teeth 47 and 48, respectively. Radiographic examination revealed a radiotransparent image involving teeth 46, 47, and 48 (Fig 1).

Due to the vicinity of the lesion to the inferior alveolar nerve (IAN), a CBCT scan was requested to assess the magnitude and possible relation of the lesion to the IAN. Observing the sagittal sections of the CBCT, it was confirmed that the lesion was not in relation to the IAN, and the lesion did not invade the cortical surfaces. However, after extracting tooth 47, a small bony dehiscence could be seen on the buccal cortex of the mandible. Once tooth 47 had been extracted, the decision to extract tooth 48 was made due to its mobility. The presumptive diagnosis of a fissure was confirmed after extracting and examining tooth 47 (Fig 2).

Any calculus and remaining restorations were removed from teeth 47 and 48 following their extraction. Their root surfaces were polished using diamond burs and abundant irrigation to remove the periodontal ligament. The endodontic filling material was removed using Gates Glidden burs (Dentsply Sirona) in the coronal portion of the canals and using diamond burs in the areas that had been exposed by the fissure. The dry tooth was divided into fragments up to 5 mm in size and placed into the Tooth Transfor-mer mill, following the manufacturer’s instructions. Once the tooth fragments were in the device, the liquids needed to demineralize the dentin were added, releasing BMP-2 and type I collagen and eliminating any type of residual toxicity. After all components were added, the device lid was closed, and the activation button was pressed to initiate the process until the
fragments were sufficiently milled to
the correct particle size, which was
assessed with the sieve part of the
recollection container.

The autologous dentin graft was
prepared in 35 minutes, the same
time as previous studies, as it is a
standardized procedure previously
established by Minetti et al.25 The
preparation time was used for excis-
ing granulation tissue, scaling and
root planing of tooth 46’s distal root,
and obtaining leukocyte platelet-
rich fibrin (L-PRF). The L-PRF served
as a carrier for the dentin26,27 in the
form of sticky bone and promoted
soft tissue healing (membranes), as
shown in Fig 3.

Postoperative medication was
prescribed (600 mg ibuprofen; 1
tablet every 8 hours for 5 days); the

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Fig 1 Baseline (a) intraoral and (b) panoramic radiographic views.

Fig 2 (a) Preoperative CBCT scans.
(b) Clinical view following extractions of
teeth 47 and 48 (FDI tooth-numbering
system).
The rescue analgesic of choice was metamizole (575-mg tablets).

The sites’ radiographic changes from before the extraction to 5 months after the grafting procedure can be observed in Fig 4. The absence of alveolar bone around the distal root of tooth 46 is worth noting, as well as the absence of its periodontal ligament due to scaling and root planing. As the graft matures, an almost complete covering of the distal root of tooth 46 can be seen (Fig 4). Over time, the corticalization of the alveolar ridge becomes more evident, transforming from a poorly defined area to an increasingly homogenous area in terms of density.

Five months after the regenerative procedure, a new CBCT scan was requested, where an amount of bone was seen at site 47 that was sufficient for placing a 4 x 10-mm implant. The evolution of the lesion was also assessed in this CBCT scan (Fig 5).

Once the bone density was evaluated radiographically and the quality of the soft tissues was assessed, and the probing depths of tooth 46 at its distobuccal, distomedial, and distolingual sites (measured at 3 mm, a decrease from baseline values to physiologic parameters) were evaluated, reentry was performed. Bone of a vital
appearance was encountered, and a bone-level Naturactis ETK implant (Euroteknika) was placed infracrestally in the position of tooth 47 (Fig 6). Within the same procedure and using a 3-mm internal diameter trephine, a bone sample was taken for histologic analysis. The histologic findings revealed tooth fragments in direct relation to the vital bone tissue (Fig 7).

The second phase was performed 5 months after implant placement, during which time, bone apposition occurred on the coronal surface of the implant (Fig 8). A transepithelial abutment (Euroteknika) was placed on the implant to maintain its biologic width.28 Having achieved regeneration of a four-wall defect (with a dehiscence in the buccal cortex) and the placement of a resorbable membrane, the alveolar ridge corticalized as it would have in native bone29 without any type of graft. The dentin demonstrated great biocompatibility, corroborating earlier studies, such as the one published by Kim et al in 200919 and more recent studies by Minetti et al in 2020.24 At this point, a second biopsy sample of the regenerated area was

Fig 6 Clinical views at 5 months. (a) Lateral view. (b) Probing depth assessment. (c) Flap elevation. (d) Inserted implant.
taken to assess the maturation of the graft (Fig 9). The histologic analysis (Fig 10) revealed an increased amount of mature vital trabecular bone tissue, with great presence of osteocytes, osteoclastic activity, and fibroblasts. Five months after the first biopsy sample was harvested, a greater amount of vital bone was produced, with more turnover of dentin granules. The results were mostly mature trabecular bone tissue and confirm the most recent clinical evidence, based on histologic analyses, such as those of Cardaropoli et al in 2019,30 which show a progressive replacement of dentin by native bone over time.

The resolution of the case, up to the placement of the implant-supported crown, is shown in Fig 11. The peri-implant band of keratinized mucosa was preserved, the gingiva former was placed on the transepithelial abutment, and the soft tissues showed an optimal appearance in the implant area as well as the area immediately distal to it, both fully regenerated with the patient’s own teeth.

The distal root of tooth 46 was fully covered by bone. According to Saygin et al,31 the cementoblasts that are present at the root apex, in addition to the L-PRF growth factors, provide the necessary elements to activate regeneration of the periodontal tissues.

Fig 7 Histologic analysis of a biopsy sample taken at 5 months. In areas of vital bone tissue, osteoid tissue (OT) and osteocytes (Os) can be recognized. CT = connective tissue; D = tubular dentin.

Fig 8 Radiographs taken (a) at implant insertion and (b) 5 months after placement.
Fig 9  Clinical view at 10 months. Transepithelial abutment placement and sample taking for a second histologic analysis.

Fig 10  Histologic analysis of a biopsy sample taken at 10 months. CT = connective tissue; Os = osteocytes.

Fig 11  (a) Clinical and (b) radiographic views of the final crown placement.

Conclusions

Human dentin presents several advantages when used as an autologous graft material, such as high biocompatibility, no need for a donor area, less intraoperative complications, and a higher patient acceptance rate.

Autologous dentin can be obtained from endodontically treated teeth following the removal of the filling material. However, improvements in the preparation time of the grafting material are needed to achieve more fluidity in the treatment process, as the time needed to prepare the graft is 35 minutes. This represents a drawback due to the increase in operative time, a key factor in the immediate postoperative period.

Regeneration with autologous dentin was achieved satisfactorily in the present case report, without complications or adverse reactions. The histologic analysis revealed a nearly complete replacement of the dentin by bone tissue at 5 months, which was totally complete at 10 months.

To avoid ethical and legal conflicts, tooth preservation methods require standardization.
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References