Post Extraction Alveolar Ridge Preservation

Scientific Background, Minimally Invasive Treatment Protocols and Expert Reports using Alloplastic Biomaterials

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Treatment protocol for extraction sockets

Minimally invasive ridge preservation procedures with in-situ hardening bone graft substitute

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Ridge preservation procedures reduce ridge atrophy following extraction and significantly reduce any required augmentation. Various methods and materials are available. Depending on the individual situation and functional and aesthetic objectives, the treatment should be as atraumatic as possible. Based on the authors’ years of experience, we created a treatment protocol for ridge preservation for four-walled sockets. Following atraumatic extraction, the socket is thoroughly cleaned, rinsed, and filled with an in situ hardening alloplastic biomaterial. The material hardens in contact with blood. No membrane or primary wound closure is used.
Ridge preservation reduces alveolar atrophy following tooth loss

A horizontal loss of some 15% of the original width of the alveolar ridge already occurs in the first 6–8 weeks after tooth loss in the aesthetic zone (single-rooted maxillary teeth). The buccal plate exhibits a V-shaped resorption pattern. In 42% of patients, the loss in the middle of the buccal plate is 4 mm or more (Farmer et al. 2013). Alveolar atrophy is not limited to the early healing phase. A broad systematic analysis of the relevant literature showed that vertical loss in the first 6 months equals about 1.2 mm (11–22% of the original height). In the buccolingual dimension, about 3.8 mm (29–63% of original width) is lost (Tan et al. 2012).

With physiological loss of hard and soft tissue following tooth extraction, the conditions deteriorate for proper axial alignment of the implant and aesthetically pleasing prosthetic treatment. To minimize alveolar atrophy in the course of wound healing, methods have been described that are summarized under the terms "socket preservation" or "ridge preservation". They typically involve filling the socket with bone or bone graft substitute and/or covering it with a membrane.

Ridge preservation procedures have three objectives:

1. Filling the extraction socket (wound care)
2. Preservation of the ridge volume (ridge preservation)
3. New bone formation (osteogenesis)

An extraction socket is a bone wound. Ridge preservation is a wound care procedure. It covers the wound to protect it from the infectious oral cavity and has a hemostatic function. The primary objective of ridge preservation is preserving the alveolar ridge volume. This is not necessarily associated with new bone formation within the socket. On the contrary, ridge preservation procedures seem to delay bone formation in the early healing phases, regardless of the employed bone graft substitute (Araujo et al. 2005; Araujo et al. 2009; Araujo et al. 2010). Particularly in situations with unfavorable anatomic and biological conditions (e.g. missing buccal plate or apical perforation), bone formation in the defect may be incomplete or absent.

A systematic literature analysis shows that ridge preservation procedures are effective. With ridge preservation procedures, alveolar atrophy in the first 6 months after tooth extraction is significantly lower than atrophy in non-treated control groups (Vignoletti et al. 2012). The alveolar bundle bone, in which the collagen fibres of the periodontium are anchored, is functionally dependent on the presence of a tooth root and is always absorbed following tooth loss (Araujo et al. 2005). Therefore, ridge preservation procedures cannot completely prevent loss of ridge volume following extraction, but they can significantly reduce it.

The objective of ridge preserving procedures following tooth extraction is to render augmentation (e.g. sinus floor augmentation, onlay grafts) unnecessary or to reduce the necessary amount. A systematic literature search found that the need for hard tissue augmentation at the time of implantation was reduced by a factor of five when ridge preservation procedures were performed (Rasperini et al. 2010; Weng et al. 2011).
Treatment protocol

Many ridge preservation methods have been described and evaluated in the form of clinical studies and case series (Vignoletti et al. 2012). The literature focuses on materials and membranes that are used to fill and cover the socket.

Primary wound closure often requires mobilizing a flap. Forming a flap leads to increased pain and swelling and causes changes in the mucosal anatomy. Less invasive methods for closing the filled socket, for instance using a free soft tissue graft or open healing without primary wound closure, have been described (Thoma et al. 2006; Aimetti et al. 2009; Gacic et al. 2009; Brikovic et al. 2011; Vignoletti et al. 2012).

It is not helpful to discuss materials and closure techniques separately. Ridge preservation should be considered part of a customized treatment plan. Various methods and materials are available. Depending on the individual conditions (e.g. local anatomy, anti-coagulation) as well as functional and aesthetic objectives (e.g. implant-borne prostheses in the aesthetic zone), treatment concepts should be as atraumatic as possible.

A single protocol with specific treatment suggestions cannot cover the entire treatment spectrum for ridge preservation, including all treatment alternatives and special cases. This treatment protocol therefore focuses on ridge preservation in a four-wall socket with open healing (that is, without primary wound closure).

The protocol is designed for dentists who are familiar with ridge preservation methods. General surgical treatment guidelines must be observed and are not explicitly discussed.

Treatment protocol for extraction sockets
Therapeutic indications of the treatment protocol

Indication

- Intact sockets and sockets with mild marginal injury to the buccal plate (see "Socket evaluation")
- Following extraction of single-rooted teeth and multi-rooted teeth with preserved interradicular septum

Relative indications

- Small apical perforations in the buccal plate
- Interradicular bone loss (e.g., as a result of inflammatory processes)
- Under these conditions, bone formation may be reduced
- The ridge volume will be preserved

Contraindications

- Major injury or loss of the buccal and/or oral plate:
  - Surgical bone augmentation / guided bone regeneration is required
- Acutely infected (suppurative) socket
- Avital tooth with apical fistula
### Extraction

<table>
<thead>
<tr>
<th>Premedication</th>
<th>Follow national and international guidelines for premedication (e.g. antibiotics)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local anesthesia:</td>
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<tr>
<td>Minimal use</td>
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<tr>
<td>of vasoconstrictors</td>
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<tr>
<td>Atraumatic extraction</td>
<td>Atraumatically extract the tooth, preserving the buccal plate and the interradicular septa. Although the treatment protocol does not explicitly list the methods and procedures for atraumatic extraction, they are an integral part of ridge preservation.</td>
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</tbody>
</table>

In healthy patients with normal coagulation, use minimal vasoconstrictors in the local anesthetic to avoid restricting the profuse bleeding from the bone into the socket.

Extraction protocol for extraction sockets.
Socket evaluation

Visual inspection and probing of the bony socket using a periodontal probe to determine the status of the buccal & lingual plates

- Fenestration and fractures?
- Apical perforations of the buccal plate?
- Significant marginal height loss of the buccal plate (> 1/3)?
- Previous periodontal bone loss?

The protocol can still be used in case of extraction-related fenestration or fracture of the buccal plate or apical perforation of the buccal plate. Under these conditions, bone formation may be reduced. The ridge volume will be preserved.

Do not use the treatment protocol if more than 1/3 of the buccal wall has been lost. Surgical bone augmentation / guided bone regeneration is required.

Previous periodontal bone loss: The remaining ridge volume is preserved; augmentation procedures may be required.

Apical inflammatory changes (radiological lucency)?
- Remove the apical soft tissue
- Probe the expanded bony defect

The protocol can still be used in case of fenestration in the apical region. Under these conditions, bone formation may be reduced. The ridge volume will be preserved.
Socket preparation

Socket curettage

Cleaning the socket using a round bone burr, crosscut running counterclockwise, under cooling

Clean the alveolar walls using a round bone burr, crosscut or with a diamond-coated ball-tip, under cooling.

Run the burr **counterclockwise** and guide it in a spiraling motion along the alveolar walls. Counterclockwise rotation prevents injury to or removal of healthy bone.

In multi-rooted teeth, clean each individual socket separately and thoroughly as described.

Ensure thorough cleaning down to the alveolar apex.

![Bone burr, crosscut running counterclockwise, or diamond-coated ball-tip for cleaning the socket](pictures: Gebr. Brasseler GmbH & Co KG).

Creating a retention using a small ball-tip burr under cooling

Use a small ball-tip burr under cooling to create a retention on the oral/approximal surface in the lower half of the socket without jeopardizing the integrity of the alveolar walls or the interradicular bone. The retention helps to firmly anchor the bone graft substitute in the defect and reaches the cancellous bone.

In multi-rooted teeth, apply a retention to each socket if possible. The retention should not jeopardize the integrity of the interradicular septum.

![Creating a retention using a small ball-tip burr under cooling](pictures: Gebr. Brasseler GmbH & Co KG).

Inspecting the marginal soft tissue and removing inflamed tissue.

Visually inspect the previous gingival cuff. Remove inflamed tissue, for instance using a scalpel or diamond-coated ball-tip burr under cooling.

Thorough rinsing using sterile saline solution or non-alcoholic chlorhexidine solution

Insert the cannula until it reaches the alveolar apex. Thoroughly rinse the socket to remove larger pieces of tissue.

In multi-rooted teeth, separately rinse each socket as described.
Material

For implantation after 6 months, the authors suggest using easy-graft CRYSTAL (biphasic calcium phosphate, a compound of 60% hydroxyapatite and 40% B-tricalcium phosphate).

easy-graft CLASSIC (β-tricalcium phosphate, resorbable) is recommended in case of early implantation (e.g. "delayed immediate implantation" after 6–8 weeks).

easy-graft bone graft substitute materials

easy-graft CRYSTAL and easy-graft CLASSIC are bone augmentation materials that are applied directly from the syringe into the defect. The mouldable adhesive granules can be shaped in the defect. In contact with blood, the material hardens within minutes to form a porous defect analog. The easy-graft products are 100% alloplastic and do not contain substances of animal or human origin.

easy-graft CRYSTAL consists of coated biphasic calcium phosphate (compound of 80% hydroxyapatite and 40% B-TCP). The hydroxyapatite portion remains integrated in the newly formed bone for long-term volume stability.

easy-graft CLASSIC consists of coated, phase pure β-tricalcium phosphate (β-TCP). During healing and new bone formation, it is completely resorbed and replaced by bone within a time period of 5–15 months. No material remnants remain.
Application of the biomaterial

Visually inspecting the socket

- Socket free of coagulated blood?
- Profuse bleeding (absolute requirement)

Preparing the bone graft substitute according to the instructions for use.

- Prepare the appropriate quantity of material; prepare two applications if necessary

Before filling the socket, perform a final inspection. Remove any blood that has already coagulated. This should ensure more efficient bleeding into the socket. Freshen the wound again if necessary.

If no bleeding from the bone is achieved, do not fill the socket with bone graft substitute.

Leave the liquid component (BioLinker) in contact with the granules for about 30 seconds. Before application, discard excess BioLinker.

Push mixed material to the opening of the syringe so that the strand of material slightly protrudes.

Preparation protocol for extraction sockets
Application of the biomaterial

Applying easy-graft

- Insert the applicator to the alveolar apex
- Apply the material by exerting light pressure while guiding the applicator in a crestal direction.
- Apply in one continuous process

Apply the material in one process to achieve a continuous bone graft substitute mass.

In multi-rooted teeth, fill the sockets separately without interruptions; when filling the last socket, also fill the coronal portion of the socket.

Fill height: About 3 mm below gingival level

Fill the material to about 3 mm below the gingival level (i.e. to bone level).

One of the authors uses epigingival filling. Advantage: support of the gingival cuff. Disadvantage: increased loss of material after healing; more time required for full closure of the mucosa over the material.

Shaping of the material under light pressure and smoothing of the material surface (max. 30 seconds)

Shape the bone graft substitute under gentle pressure using the plunger of the applicator syringe. Unlike particulate bone graft substitutes, the material is pressure-resistant, so there is no risk of excessive compaction.

In small sockets, amalgam condensers or Heidemann spatulas have proven useful for shaping.

Smooth the material surface (e.g. using a spatula) so that no granules stick out.

The material should be shaped for no longer than 30 seconds. Do not exert pressure on the hardened material.
## Finish and follow-up care

<table>
<thead>
<tr>
<th>No membrane</th>
<th>The described technique uses no membrane and thereby preserves soft tissue and reduces surgery time and costs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retention suture: in select cases</td>
<td>If the wound edges gape, a tension-free suture is recommended to approximate the wound edges.</td>
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<tr>
<td></td>
<td>No primary wound closure is performed.</td>
</tr>
<tr>
<td></td>
<td>No bidigital compression of the socket.</td>
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<tr>
<td>Temporary restoration</td>
<td>Whenever possible, the socket should be covered with a temporary restoration that does not exert pressure.</td>
</tr>
<tr>
<td>Follow-up care</td>
<td>The follow-up recommendations are the same as for tooth extraction.</td>
</tr>
<tr>
<td>• No chlorhexidine gel</td>
<td>In particular, use of chlorhexidine gel in the wound area is not recommended.</td>
</tr>
<tr>
<td>• No chlorhexidine rinse for 24 h</td>
<td>The patient should be informed that individual granules can come out of the wound area during healing until the mucosa is completely closed. Swallowing or chewing on the granules does not represent a problem.</td>
</tr>
<tr>
<td>Specific patient information</td>
<td>There is usually no pain following application, but the patient will feel the material in the socket.</td>
</tr>
<tr>
<td>• Loss of granules is normal</td>
<td>The patient should be asked not to explore the wound with the tongue. The surgical site should be avoided when brushing teeth.</td>
</tr>
<tr>
<td>• “Perceivable” material in socket</td>
<td></td>
</tr>
<tr>
<td>• Do not explore using tongue</td>
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</tbody>
</table>

Situation on the day of surgery (day 0), day 4, day 10, day 20 and day 35
Treatment protocol for extraction sockets

In the treatment protocol with easy-graft CRYSTAL, implantation is recommended at 6 months if one application of material was used (0.4 ml). If using two applications (about 0.8 ml), implantation is recommended at 9 months.

The generally recommended implantation time is intended for orientation purposes. When choosing the time of implantation, take into account individual local and systemic factors (e.g., patient age, defect size, condition of buccal plate). Implantation times can vary widely depending on the implantation protocol (e.g., in delayed immediate implantation: implantation after 6-8 weeks).

In the treatment protocol with easy-graft CRYSTAL, implantation is recommended at 6 months if one application of material was used (0.4 ml). If using two applications (about 0.8 ml), implantation is recommended at 9 months.

Easy-graft CRYSTAL is partially resorbable; the granules remain integrated in the hard tissue. Unlike bovine materials that look similar to bone, they are easily visible when opening the site. The integrated granules should not be removed and can be in contact with the implant surface without problems.

Individual, loose granules are found in the soft tissue.
### Case reports

<table>
<thead>
<tr>
<th>Situation</th>
<th>Deviation from the treatment protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ridge preservation in the anterior area</td>
<td>None</td>
</tr>
<tr>
<td>Intact socket</td>
<td>Example case following the treatment protocol</td>
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<tr>
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</tr>
<tr>
<td>Ridge preservation following extraction of a second premolar</td>
<td>Healing phase prolonged to 10.5 months due to unfavorable anatomic conditions</td>
</tr>
<tr>
<td>Resorption of the buccal plate (about 2/3)</td>
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<tr>
<td>Apical perforation</td>
<td>Huber A, page 35</td>
</tr>
<tr>
<td>Ridge preservation and internal sinus floor augmentation</td>
<td>Early implantation (after 4.5 months) with simultaneous transcrestal sinus floor augmentation</td>
</tr>
<tr>
<td>Intact socket</td>
<td></td>
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<tr>
<td>Small apical perforation buccally</td>
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<tr>
<td>Schug J, page 42</td>
<td></td>
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<tr>
<td>Ridge preservation following extraction of the maxillary incisors.</td>
<td>Ridge preservation with easy-graft CLASSIC (fully resorbable)</td>
</tr>
<tr>
<td>Follow-up of 34 months</td>
<td>Correspondingly early implantation (at 2.5 months)</td>
</tr>
<tr>
<td>Severe periodontal bone damage</td>
<td></td>
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<tr>
<td>Buccal plate partially resorbed</td>
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<tr>
<td>Hollay HC, page 46</td>
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</table>
Case report: Ridge preservation in the anterior area

Kirste M

**Patient:** Female, 60 years old at the start of therapy. The patient was a smoker but stopped smoking for the implant treatment. The patient is in good general condition and has not been diagnosed with any systemic diseases. She wanted a high-quality restoration that corrects the midline shift to the right.

**Indication:** The left maxillary central incisor had already had a root canal treatment and exhibited periapical lucency. The crown body was soft, and the patient did not want a crown. The patient decided in favor of a fixed prosthesis to replace the tooth that was not worth preserving and to allow functional and aesthetic restoration of the left anterior region.

**Treatment:** To preserve the buccal bone, a root extraction system was used for orthograde, straumatic root removal. The extraction wound was cleaned and freshened following the treatment protocol. The bone graft substitute was inserted to gingiva level. A dental implant was placed after 7 months.

Before extraction. The maxillary incisor with root canal treatment is not worth preserving.
Case report

I

Kirste M

Orthograde root extraction

Atraumatic extraction of the root using the Benex Root Extraction System: pilot drilling into the tooth root.

Before extraction

Orthograde root extraction
Cleaned and conditioned socket.

Thesocketwasthoroughly cleaned usingacrosscut burrenningcounterclockwise. Usingasmall ball-tip burren,aretentionwasplacedpala­tially, andthesocketwasrinsed asdescribedintheprotocol.

Socketbefore cleaning and conditioning.
The buccal bone plate has been preserved.

Extracted root

The socket was thoroughly cleaned usingacrosscut burrenningcounterclockwise. Usingasmall ball-tip burren,aretentionwasplacedpala­tially, andthesocketwasrinsedasdescribedintheprotocol.

Socket before cleaning and conditioning.
After cleaning and freshening the socket, the easy-graft CRYSTAL material is prepared.

Mixing of the liquid component (BioLinker) with the granules. The BioLinker is left in contact with the granules for about 30 seconds.

Before application, excess liquid BioLinker is thoroughly discarded.
The material was filled to gingival level.

Application of the bone graft substitute in one continuous process.

The material is shaped under gentle pressure within 30 seconds of application.
Labial-palatal cross-section, postop (digital volume tomography)

Filled socket

Immediately following extraction
After 2 weeks

Postop prosthetic restoration

After 1 week
Case report | Kirste M

After 1 month

After 3 months

After 5 months
Implantation after 7 months:
inserted surgical guide
Preparation of the implant bed:

Taking a punch biopsy in the context of preparing the implant bed.

Preparation of the implant bed:

Preparation of the implant bed: vital material.
5 months after implantation: loading of the implant, placement of a long-term temporary restoration. 3 months after implantation, the remaining right maxillary incisors were extracted, and the sockets were treated following the protocol.
Transversal cut through the drill core. Bone graft substitute granules (G) surrounded by newly formed bone (NB) are visible. The dark coloration of the granules indicates strong colonization with cells (histology: Stübinger S and Kämpf K, MSRU, University of Zurich).
**Case report: Ridge preservation following extraction of a second premolar with subsequent implantation**

**Huber A**

**Patient:** Male, 48 years old. The patient is non-smoker, in very good physical shape, and has no systemic illness.

**Indication:** The left mandibular second premolar already had a root canal and was sensitive to percussion. Radiologically, we found periapical lucency; the tooth could not be preserved.

**Treatment:** Following atraumatic extraction using elevators and forceps, we found that about two-thirds of the buccal plate had been resorbed and that the remaining buccal bone exhibited apical perforation. The osseous portions of the extraction socket were cleaned and freshened as described in the treatment protocol. While cleaning, very good bleeding from the surrounding cancellous bone was noticed, which indicated high regeneration potential of the bone. After de-epithelializing the gingival cuff using a scalpel, the defect was filled with easy-graft CRYSTAL (0.4 ml) without membrane placement. The material was secured in the defect using two single button sutures (4–0). The absence of the buccal plate resulted in poorer conditions for regeneration; therefore, the healing time to implantation was extended to 10.5 months (instead of 6 months in case of a four-walled socket).
Immediately following extraction and ridge preservation. Following extraction, loss of the buccal plate was noticed. Filling of the extraction defect using 0.4 ml easy-graft CRYSTAL. The healing proceeded without complications.

10.5 months after extraction, immediately before implantation.

After exposure, 10.5 months after extraction, Newly formed bone is visible with remaining, integrated easy-graft CRYSTAL granules. The contour of the alveolar ridge was preserved/reconstructed.
The implant (Ankylos Af1, 3.5 mm diameter) was placed slightly subcrestally.

Bone chips at the conical reamer. No biomaterial remnants are visible here.

After drilling the implant bed, the newly formed hard tissue had high drilling resistance.
Final image of implant
Case report: Ridge preservation and internal sinus floor augmentation

Schug J

Patient: Female, 40 years old. The patient is a smoker and systemically healthy.

Indication: The right maxillary second premolar exhibited increasing pain upon pressure with incipient apical osteolysis.

Treatment: Following extraction, the socket was thoroughly cleaned. The buccal wall was preserved except for a small apical perforation. The extraction defect was filled using 0.4 ml easy-graft CRYSTAL. No antibiotics were prescribed. The healing proceeded without complications. At the time of implantation, 4.5 months later, the ridge contours were perfectly preserved. During implantation, sinus floor augmentation was performed using the Summers technique. A tissue sample produced when preparing the implant bed was histologically analyzed. In the drill core, newly formed bone (26% of the area of histological thin sections) and remaining bone graft substitute material (about 20% of the area of the thin sections) were found. The remaining 54% were made up of non-calcified tissue (e.g. bone marrow, connective tissue).
During implantation, the drilling resistance was comparable to that of local maxillary bone. Internal sinus floor augmentation was performed at the time of implantation.

Histological analysis. Remaining bone graft substitute material (M) and newly formed bone (NB) are visible (undecalcified thin section, stained with azure II and pararosanilin, Nagursky H., Freiburg University Medical Center, Cell Tissue Analysis).

Histological analysis of the newly formed soft tissue. The image shows the normally formed gingival epithelium (G) and the subepithelial connective tissue (S) with an embedded bone graft substitute particle (M).
Prosthetic restoration, 7 months after extraction and ridge preservation.

14 months after extraction and ridge preservation.

14 months after extraction and ridge preservation.
Case report: Ridge preservation after extraction of the maxillary incisors: follow-up of 34 months

Hollay CH.

**Patient**: Female, 67 years old. The patient is a non-smoker and has not been diagnosed with any general illness.

**Indication**: The maxillary incisors were loose (grade II) and exhibited severe existing periodontal damage with bone loss to about half of root height. The teeth were not worth preserving.

**Treatment**: The teeth were extracted using forceps, and the apical inflamed tissue was meticulously removed. The buccal plate had been partially resorbed in all four sockets. The sockets were cleaned following the treatment protocol and rinsed using sterile saline solution. In each socket, 0.4 ml easy-graft CLASSIC was applied. The patient received a temporary model cast restoration with palate support and clasp retention. Implantation followed after 2.5 months. At this time, bone formation is not expected to be complete, but the inflammation has subsided sufficiently to allow implantation. easy-graft CLASSIC consists of phase pure B-tricalcium phosphate and is fully resorbed. Therefore, the material is used in treatment protocols where implantation is performed relatively early, as in this case.

Immediately following extraction of the maxillary incisors and ridge preservation. The healing proceeded without complications.
Exposure after 2.5 months. Vertically, the volume was preserved, and no further horizontal losses were found. Some granules are still visible.

Pilot hole. The drilling resistance was equal to that of hard bone.

Implantation
Application of vestibular resorption protection (easy-graft CLAS-SIC) following implantation.
Follow-up image 34 months after extraction
Medical science is dynamic and constantly advancing. The presented information is accurate to the best of the authors' knowledge and reflects current knowledge at the time of publication (March 2013), but we cannot guarantee its correctness and completeness. The document has been written for a professional audience that is able to place the information in the proper context and to assess the risks and advantages of the procedures and methods presented by the authors where they deviate from the traditional schools of thought.

It must be taken into account that indications differ for each patient. Treatment success significantly depends on multiple biological and medical factors as well as on adequate preliminary and follow-up treatment. The authors and the company Degradable Solutions AG can therefore not guarantee the success of treatment with the suggested protocol.

Any liability for material or immaterial damage arising from the use (or disuse) of this information is excluded. The easy-graft CLASSIC and easy-graft CRYSTAL instructions for use leaflets, which are authoritative regarding therapeutic information, must be observed. Each user is asked to study the instructions for use in detail.
References


