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Extraction Site and Ridge Preservation
A Peer-Reviewed Publication
Written by Dr. Aron Gonshor, BSc, PhD, DDS, FRCD(C), FAO

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Educational Objectives
Upon completion of this course, the clinician will be able to do the following:
1. Understand the importance of an atraumatic extraction technique, ridge and site preservation
2. Understand the pre-operative clinical assessment, and options to consider, for achieving atraumatic tooth extraction
3. Be knowledgeable about the various bone grafting materials available and the results that have been achieved using them
4. Know the steps involved in utilizing the Nu-Mem technique for ridge and site preservation

Abstract
It has been estimated that more than 40 million teeth were extracted in 1999. An atraumatic extraction technique, together with ridge and site preservation, is important for function and esthetics following tooth replacement. This is particularly true if an implant is being contemplated for the extraction site. Atraumatic tooth extraction using the least-invasive procedure possible is the first step. Current techniques used for ridge and site preservation include the use of bone graft materials and/or resorbable membranes. Ideally, at the end of the process the area will be filled with vital, mineralized bone. A combination technique using deproteinized bovine bone grafting material and a resorbable collagen membrane has been found to produce a consistently preserved alveolar ridge at the site. The addition of a temporary ovate pontic helps to preserve and develop soft tissue contours during healing. Use of an appropriate technique preserves alveolar ridge anatomy, facilitates prosthetic management, optimizes function and esthetics, and enables the patient to be treated in a shorter time and with fewer surgical procedures.

Introduction/Overview
Extractions occur primarily as a result of caries, periodontal disease, trauma and crowding, as well as due to other oral pathologies. Caries is endemic and epidemiologically the primary factor in tooth loss in the U.S. population, while advanced periodontal disease is responsible for 30–35% of extractions in those over 40 years of age. It has been estimated that in 1999 over 40 million teeth were extracted, of which approximately 25% were surgical extractions involving bone.

<table>
<thead>
<tr>
<th>Procedures</th>
<th>Number (in millions)</th>
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<tbody>
<tr>
<td>Single extractions</td>
<td>21.44</td>
</tr>
<tr>
<td>Soft tissue surgical extractions</td>
<td>7.75</td>
</tr>
<tr>
<td>Bony surgical extractions</td>
<td>10.85</td>
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</tbody>
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Source: ADA. The 1999 Survey of Dental Services Rendered.

Orthodontic extractions overall occur more frequently in people under 21 and most frequently it is bicuspid that are extracted. In the under-21s, 57.5% of bicuspid extractions were found in one survey to be due to orthodontic crowding. In the case of non-orthodontic extractions, missing teeth result in either a bounded or an unbounded space, which is generally detrimental to oral health. An 81% survival rate was found for teeth adjacent to unbounded spaces in one study. Both bounded and unbounded spaces can result in tilting/tipping of teeth, overeruption, oral hygiene difficulties and secondary problems associated with these changes. Clinically, it is important to replace missing teeth with the best possible option for the patient. An atraumatic extraction technique, with ridge and site preservation at the time of extraction, is important for orthodontic treatment outcomes as well as all tooth replacement treatment irrespective of the procedure used for tooth replacement.

Importance of Site Preservation
The objectives of an atraumatic extraction technique, as well as ridge and site preservation, are driven by both function and esthetics whether the extraction is for orthodontic purposes or that it will leave a space that should later be restored. Where extractions are for non-orthodontic reasons, atraumatic technique and site preservation will lead to a functional and esthetic prosthetic result in the long term. Functionally, removable dentures require the maximum possible bone and soft tissue support for ease of chewing, speaking and denture retention — ridge preservation avoids excessive loss of alveolar support and the need for bulky dentures, the latter being cumbersome and unaesthetic. In the case of fixed prostheses, the pontics will be shallower, there will be less recession and bone loss around the abutment teeth, and it will be easier to maintain periodontal health if the ridge is preserved. Since ridge and soft tissue preservation leaves a soft tissue contour that is more natural, the result will also be more pleasing esthetically. Increasingly however, implants are being placed, either with immediate or delayed placement, with an estimated two million implants now placed annually. If the bony support is poor, or if the soft tissue was severely damaged, then the soft tissue contours and dimensions will also be esthetically displeasing. This has more implications for patients with high lip lines and for the replacement of anterior teeth. Nonetheless, function and esthetics are compromised for all areas of the mouth.

For optimal implant placement, the bone’s height, width, volume and density must fall within certain parameters. In the absence of healed bone of sufficient height or width, either the implant cannot be placed in an optimal position or a shorter/narrower implant must be used.
or bone grafting must be built into the implant treatment planning and the graft placed prior to implant placement. Secondary bone grafting and ridge augmentation produces a less predictable result — and involves extra surgery — than primary ridge and site preservation followed by implant placement. It has also been found that the peri-implant bone crest height around the implant affects the ability to preserve papillae after regeneration between the implant and adjacent teeth.

Esthetic considerations dictate optimal positioning, especially in the anterior region. If the alveolar ridge has substantially resorbed, an esthetic result is unattainable regardless of the technique used, even if there is sufficient bone height and volume remaining for successful osseointegration of the implant. In the absence of ridge preservation, it has been found that major changes to the alveolar ridge at the socket site happen in the first year after extraction.

Atraumatic Tooth Extraction
Atraumatic tooth extraction is the first step in achieving optimal ridge and site preservation. The objectives are removal of the tooth while preserving the soft and hard tissue. Poor extraction technique and/or unanticipated complications can result in soft tissue tears or damage, bone dehiscence around sockets, fracture of the labial/buccal cortical plate and bone fragmentation around the socket. It is of utmost importance to preserve the buccal cortical plate in anterior cases to avoid sub-optimal healing and esthetics.

Prior to extracting the tooth, a full clinical and radiographic evaluation must be performed to assess the anatomical relationship of the tooth to adjacent structures, and to determine the tooth’s root morphology. Both single and multi-rooted teeth present potential problems for atraumatic extraction if the roots are especially long and bulbous. Multi-rooted teeth may also present with divergent roots (Figure 1), more roots than standard for that tooth, fused or partially fused roots.

Extraction is achieved using a forceps and/or elevator, selected as indicated for the individual tooth (Figures 2a, b and 3a, b, c). In some cases, using a periotome first may help by gently expanding the socket prior to tooth removal. Sectioning of roots in a multi-rooted tooth with divergent roots, or roots with other anatomically unfavorable morphology, may aid atraumatic removal in some cases. If required, sectioning should be performed with minimal invasiveness, avoiding bone removal and soft tissue involvement in the procedure. One should remove the minimum tooth substance necessary to section the roots so that the maximum amount of tooth substance remains for elevator and/or forceps positioning and root removal without fractures.

During the extraction, the least-invasive procedure possible should be performed and the use of flaps should be avoided to minimize trauma. Full thickness flaps can destroy the soft tissue architecture at the extraction site and result in soft tissue recession and potential bone loss; the vascular supply becomes compromised — limiting the future regenerative potential of the site.
and leading to soft tissue recession.\textsuperscript{11} Preserving the papillary architecture leads to more satisfactory soft tissue healing and esthetics (Figure 4).

Following tooth removal, the level of bleeding from the socket should be checked. Too much bleeding results in hemorrhage and may require the use of hemostats, whereas too little bleeding results in sub-optimal healing. Encouraging adequate bleeding results in osteoblastic cells being introduced into the socket for future bone (re)generation.\textsuperscript{12}

If insufficient bleeding is present, the socket walls should be perforated in several places to promote bleeding. The perforations should be approximately 1.1 mm each, and can be created using a 1.2 mm diameter round bur in a slow handpiece while simultaneously irrigating the site both to remove debris and to prevent heat-related osteonecrosis.

Current Techniques: Ridge and Soft Tissue Regeneration

Current techniques used for ridge and site preservation include the use of bone graft materials and/or resorbable membranes. The objective of bone grafting materials is to encourage future bone growth into the area. The bone grafting material acts as an osteoconductor. Ideally, at the end of the process the area will be filled with vital, mineralized bone, with minimal or no bone grafting material remaining.

A variety of materials have been used for bone grafting in sockets, for the purpose of ridge preservation. These include osseous mixtures of donor-retrieved bone particles (autografts), allografts and xenograft particulates. Bioabsorbable synthetic sponges consisting of polylactide-polyglycolide acid (Fisiograft\textsuperscript{\textregistered}, GHIMAS SpA) have been found to reduce ridge resorption, result in mineralized and well-structured bone growth at the site, and to resorb from the site within 6 months.\textsuperscript{13} One study found coral granules helped to preserve the alveolar ridge in young patients in the posterior region, but to be ineffective in preserving the ridge over time when used in the anterior maxillary region following trauma.\textsuperscript{14} The use of titanium membranes over extraction sockets — with or without the use of autogenous bone grafts — has been found to favor ridge preservation.\textsuperscript{15} Medical-grade calcium sulfate hemihydrate has been found to completely resorb over 4 months and to enable the growth of new trabecular bone.\textsuperscript{16}

Deproteinized bovine bone can be used and has been found to be safe and effective. One study filled sockets with deproteinized bovine bone and then covered the sockets with free gingival grafts, harvested with a soft tissue punch. The grafts were found to completely integrate and to produce an aesthetic result.\textsuperscript{17} This however does not develop a soft tissue contour for use around implants. Bovine bone derivatives have also been found to result in bone regeneration both for ridge preservation and at intra-bony periodontal defects, when used alone,\textsuperscript{18} or in combination with platelet-rich plasma (with and without guided tissue regeneration).\textsuperscript{19,20,21} and with enamel matrix derivatives.\textsuperscript{22,23}

Bovine porous bone material, in combination with collagen membranes used for guided tissue regeneration at extraction socket sites, has been found to result in more socket bone fill at 6 months than using the bovine bone materials with autologous fibrinogen/fibronectin instead of the collagen membrane.\textsuperscript{24} A recent study compared the use of deproteinized bovine bone (Bio-Oss\textsuperscript{\textregistered}, Osteohealth) in combination with a resorbable membrane (Bio-Gide\textsuperscript{\textregistered}, Osteohealth), versus use of the membrane alone during immediate implant placement. While bone levels were maintained for both groups, the soft tissue margins were more coronal and therefore more favorable esthetically in the group treated with both the bone grafting material and the resorbable membrane. The study concluded that the deproteinized bone acted as a membrane support during healing.\textsuperscript{25} Bone grafting and barrier placement have both been found to promote optimal bone remodeling and to be capable of producing an aesthetic result. It is important to
isolate the graft, and resorbable collagen can be used for this. Barrier options include the use of membranes and plugs.

A combination technique developed by Sclar has been found to be effective in preserving the ridge and in preserving/developing an acceptable soft tissue contour at the site. Sclar found that use of a deproteinized bovine bone xenograft (Bio-Oss®), in combination with a resorbable collagen membrane (CollaPlug®, Zimmer Dental), produced a consistently preserved alveolar ridge at the site. This technique has been used for extraction sites that will receive tooth replacement after bone healing, as well as for immediate implant placement sites. In the latter case, the deproteinized bovine bone fills the voids between the newly placed implant and the extraction/implant site. The technique is called the Bio-Col Technique (Bio-Oss® and CollaPlug®). Recently a product system has become available that still uses Sclar’s technique for ridge preservation, and is called the Nu-Mem System (NuOss™ and RCP/RCT-Resorbable Collagen Plugs and Tapes, ACE Surgical Supply Co., Inc.). Bio-Col and Nu-Mem combine the use of deproteinized bovine bone and resorbable collagen membranes for ridge preservation. There are a number of distinct steps in the technique.

**Nu-Mem Technique**

**Step 1.** Following atraumatic extraction, the socket is examined for residual debris and to check that the amount of bleeding is appropriate. The deproteinized bovine bone grafting material is then thoroughly packed into the socket up to the level of the crestal bone to ensure maximum bone regeneration (Figures 5 a, b, c).

If an immediate implant is indicated, it should now be inserted. In this case, there will be excess material that will be extruded as the implant is inserted into the site.

**Step 2.** After the site has been filled to the crestal bone, the barrier material is placed over the graft. The barrier consists of a resorbable collagen membrane. The collagen membranes are available as resorbable collagen plugs or tapes.

If the plug is selected, it can be cut in half and the halves placed into the site one piece on top of the other, as required (Figures 6 a, b, c).

It should be noted that Figure 6c shows a situation with a slight disturbance of the papillae following extraction. Ideally, following extraction the papillae should be undisturbed prior to filling of the socket with bone graft material (Figure 7).

Alternatively, the collagen tape can be used and cut into strips before being placed in the socket(s) (Figures 8 a, b). The shape of the strip of tape makes it particularly useful in multiple adjacent sockets.
Figure 7. Papillary anatomy maintained

Figures 8a. Resorbable collagen tape

Figure 8b. Collagen tape placed into sockets

Figure 9a. Diagram showing criss-cross and mattress sutures

Figure 9b. Horizontal mattress suture being placed

Figure 10. Resin cantilever temporary bridge, ovate pontic.

Figure 11. Removable prosthesis, ovate pontic design

Figure 12. Prepable abutment

Figure 13a. Pre-operative radiograph

Figure 13b. Post-operative
The purpose of the barrier membrane is to help hold the grafting material in position and to prevent contamination of the site. It has been found that new bone will develop apical to any debris present.27

Step 3.
Following placement of the barrier, the membrane or plug can be secured using either mattress or criss-cross sutures, or both (Figures 9 a, b). A long-lasting resorbable suture material such as a polygalactin 910 (Vicryl®, Ethicon®; Dexon®, Sherwood Davis and Geck), or a chromic-type suture, will ensure support of the membrane during the initial healing period.

Step 4.
The final part of the procedure is the placement of a provisional temporary replacement over the treated extraction site. Placing a provisional that has an ovate pontic shape to simulate the contours of the extracted tooth, encourages soft tissue contouring that will leave a natural appearance when all treatment has been completed. If a temporary bridge can be fashioned using two existing abutments adjacent to the extraction site, or if a bonded temporary pontic can be used, a well-designed ovate pontic can be created (Figure 10). The laboratory can use casts from recent impressions and, in discussion with the dentist, create a pontic shaped and contoured such that it will preserve and help develop soft tissue contours during healing. A similar technique can be used for the replacement tooth on a removable prosthesis that sits over the teeth (Figure 11).

For implants, the use of healing abutments that develop the soft tissue around the implant site has been found to be effective in preserving the soft tissue.29 A prepable abutment may serve a similar function (Figure 12).

The case and diagram in Figure 13 show a pre-extraction radiograph and a post-extraction radiograph. NuOss™ was packed into the socket, followed by placement of a resorbable collagen plug. On the second radiograph, the packed NuOss™ can be clearly seen as well as the ovate pontic and the space between where the resorbable collagen plug sits (Figures 13 a, b, c).

Using this technique helps preserve both the ridge and the soft tissue for optimal esthetics once a final prosthesis is in place.

Summary
As oral health improves, more people are retaining their teeth and patient expectations are increasing. Increasingly, implants are used to replace missing teeth. Irrespective of the method used for tooth replacement, preserving the ridge and soft tissue at extraction sites is important for both function and esthetics. Various techniques exist for bone grafting, and for membrane use for guided tissue regeneration. A combination technique using deproteinized bovine bone and a resorbable collagen barrier followed by use of an anatomical temporary tooth replacement has been found to produce consistent results in preserving both the ridge and soft tissue contours for the final restoration. As the demand for implants continues to grow, the importance of ridge and soft tissue preservation can only increase. Use of an appropriate technique preserves alveolar ridge anatomy, facilitates prosthetic management, optimizes function and esthetics, and enables the patient to be treated in a shorter time with fewer surgical procedures.

Endnotes
11 Sclar AG. Preserving alveolar ridge anatomy


27 Ibid.


Author Profile

Dr Aron Gonshor, BSc, PhD, DDS, FRCD(C), FAO

Dr. Aron Gonshor is a Maxillofacial Surgeon practicing in Montreal, Canada. He received his PhD in Neurophysiology in 1974, his DDS in 1975, and his Maxillofacial specialty at the Montreal General Hospital — all from McGill University.

He has published extensively on implant therapy, PRP and related topics, and has been a clinical consultant to ACE Surgical Supply Co., helping with the development of their RBM-surfaced implant systems. He has lectured throughout North and South America, Europe and the Far East, covering topics related to implant rehabilitation, PRP therapy and wound care, as well as bone graft reconstruction.

A past president of the Canadian Association of Oral and Maxillofacial Surgeons, he is a fellow of the Royal College of Dentistry and served for 10 years as a director of the Academy of Osseointegration.

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Questions

1. It has been estimated that in 1999, more than ________ teeth were extracted.
   a. 20 million
   b. 30 million
   c. 40 million
   d. 50 million

2. 57.5 percent of bicuspids extracted in under-21s were due to ________.
   a. Caries
   b. Orthodontic crowding
   c. Trauma
   d. None of the above

3. The objective of an atraumatic extraction is ________.
   a. Removal of the tooth
   b. Preservation of bone
   c. Preservation of soft tissue
   d. All of the above

4. The objectives of ridge and site preservation are driven by ________.
   a. Function
   b. Aesthetics
   c. a and b
   d. None of the above

5. Soft-tissue contours and dimension will be aesthetically displeasing if ________.
   a. Bony support is poor
   b. Soft tissue was severely damaged during extraction
   c. The patient is over 21
   d. a and b

6. An estimated ________ implants are placed annually.
   a. One million
   b. Two million
   c. Three million
   d. Five million

7. For optimal implant placement, the ________ must fall within certain parameters.
   a. Bone height
   b. Bone width
   c. Bone volume and density
   d. All of the above

8. Secondary bone grafting ________.
   a. Produces less predictable results
   b. Involves an extra surgery
   c. Is quicker than primary bone grafting
   d. a and b

9. Poor extraction technique can result in ________.
   a. Soft tissue damage
   b. A fracture of the buccal cortical plate
   c. Bone fragmentation
   d. All of the above

10. A ________ can be used to gently expand the socket prior to tooth extraction.
    a. Periotome
    b. Scapel
    c. Polishing bur
    d. All of the above

11. In the case of multi-rooted teeth with divergent roots, ________.
    a. The patient must always be referred to a specialist
    b. Sectioning the roots may aid atraumatic extraction
    c. The patient will always need sutures
    d. All of the above

12. Sectioning of multi-rooted teeth should ________.
    a. Be minimally invasive
    b. Avoid removing bone
    c. Remove the minimum amount of tooth substance necessary
    d. All of the above

13. Soft-tissue architecture at the extraction site can be destroyed by ________.
    a. A careful technique
    b. Full-thickness flaps
    c. Use of anesthetic
    d. All of the above

14. If insufficient bleeding is present, the socket walls should be ________.
    a. Widened
    b. Perforated in several places with a small round bur in a fast handpiece
    c. Perforated in several places with a small round bur in a slow handpiece
    d. Any of the above

15. When using a slow-speed handpiece, ________ will both remove debris and help to prevent osteonecrosis.
    a. Irrigation
    b. Anesthesia
    c. A big bur
    d. Being quick

16. Bone-grafting materials and/or resorbable membranes are currently used for ________.
    a. Removal of caries
    b. Ridge and site preservation
    c. Tooth restorations
    d. None of the above

17. Materials used for bone grafting include ________.
    a. Autografts
    b. Allografts
    c. Xenografts
    d. All of the above

18. Specific bone-grafting materials that have been used include ________.
    a. Deproteinized bovine bone
    b. Calcium sulfate hemihydrate
    c. Chalk
    d. a and b

19. Bovine bone derivatives have been found to regenerate bone at ________.
    a. Extraction sites
    b. Periodontal intra-bony defects
    c. a and b
    d. None of the above

20. Soft-tissue margins are more aesthetically favorable when extraction sites are treated with ________.
    a. Both bone grafting material and a resorbable membrane
    b. Only bone grafting material
    c. Only a resorbable membrane
    d. Full-thickness flaps

21. ________ developed a combination technique using deproteinized bovine bone and a resorbable membrane.
    a. Black
    b. Didion Fillier
    c. Sclar
    d. Mouyens

22. If an immediate implant is placed, bone-grafting material would ________.
    a. Fill the voids between the socket and the implant
    b. Make implant placement impossible
    c. Make the procedure take at least five hours
    d. None of the above

23. The Nu-Mem technique uses ________.
    a. Coral granules and a resorbable membrane
    b. Deproteinized bovine bone and a non-resorbable membrane
    c. Deproteinized bovine bone and a resorbable membrane
    d. None of the above

24. Using the Nu-Mem technique, deproteinized bovine bone should fill the socket to ________.
    a. Half the depth of the socket
    b. The level of the crestal bone
    c. Three-quarters the depth of the socket
    d. All of the above

25. The purpose of the membrane using the Nu-Mem technique is to ________.
    a. Hold the grafting material in place
    b. Prevent contamination of the site
    c. a and b
    d. None of the above

26. After placement, the resorbable membrane can be secured in place using ________.
    a. Mattress sutures
    b. Criss-cross sutures
    c. Dental cement
    d. a and b

27. A provisional with ________ encourages soft-tissue contouring.
    a. An ovate pontic shape
    b. A concave shape
    c. Extra acrylic
    d. None of the above

28. Around implants, have been found to be effective in preserving the soft tissue.
    a. Custom healing abutments
    b. Ridge studs
    c. Full-thickness flaps
    d. None of the above

29. Resorbable collagen membranes are available as ________.
    a. Collagen plugs
    b. Collagen tape
    c. a and b
    d. None of the above

30. Support of the membrane during the initial healing period is obtained with ________.
    a. A long-lasting resorbable suture
    b. A short-lasting non-resorbable suture
    c. A stainless steel stent
    d. None of the above
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