APPLICATIONS OF GUIDED TISSUE REGENERATION WITH DENTAL IMPLANTS

MURRAY L. ARLIN, DDS, FRCD(C)

The "Guided Tissue Regeneration"(GTR) procedure was initially demonstrated in the monkey[1] and in humans[2,3] in the 1980's. In recent years, GTR therapy has become a significant component of surgical techniques in humans when treating several types of osseous defects associated with the natural dentition, edentulous ridges and with dental implants. The technique of GTR incorporates the use of a barrier membrane that is carefully adapted directly over the treated bone site. The potential mechanisms of how the "barrier" facilitates regeneration include:

a) excluding cells that may interfere with regeneration,
b) preferentially allowing cells with "regenerative potential" to repopulate the wound,
c) creating sufficient space to allow formation of the newly regenerated tissue
d) stabilization of the blood clot to increase the predictability of regeneration.

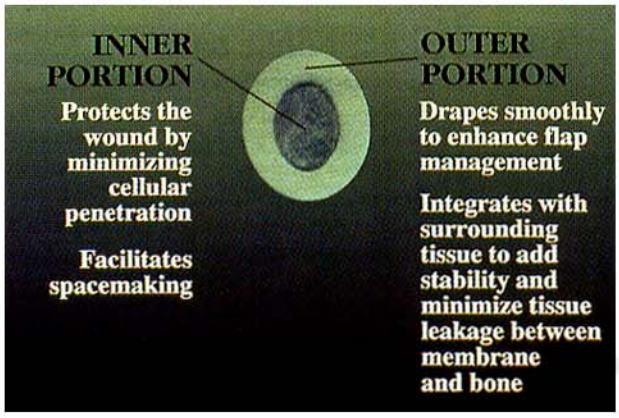

FIGURE 1: The technique of Guided Tissue Regeneration incorporates the use of one of several different "barrier" configurations. The oval shaped "Gore-Tex Augmentation Material" (GTAM) is the configuration that has been designed for dental implant applications.

The technique of GTR as applied to implant related therapy can be categorized as follows:

I. Osseous Deficiencies Encountered Prior to Implant Placement
II. Osseous Deficiencies Encountered During Implant Placement
  a) dehiscence and/or fenestration defects
  b) peri-implant space around an implant placed into an extraction socket.
III. Osseous Deficiences Encountered After Initial Implant Placement. (Repair of "Ailing" Implants)

The purpose of this article will be to discuss and illustrate some of the applications of GTR with dental implants. Specifically the barrier material discussed in this article will be Gore-Tex Ridge Augmentation Material (GTAM) from W. L. Gore and Associates Inc. (Figure 1).

I. OSSEOUS DEFICIENCIES ENCOUNTERED PRIOR TO IMPLANT PLACEMENT

Localized bone and extraction socket defects can be treated with GTR in order to maximize bone regeneration. This technique can help to achieve an augmented osseous ridge that will be more conducive to ideal implant placement and esthetic results. Numerous publications have demonstrated the predictability of this technique utilizing a variety of materials[4,5]. See Figures 2, 3, 4 and 5 which illustrate a clinical case of edentulous ridge augmentation of a defect resulting from a previous surgical extraction.

II. OSSEOUS DEFICIENCIES ENCOUNTERED DURIN IMPLANT PLACEMENT A) DEHISCENCE AND/OR FENESTRATION DEFECTS

When placing implants in osseous ridges that are narrow in the bucco-lingual dimension, one may encounter insufficient bone volume such that bone dehiscences and/or fenestrations occur around the implant. Even when the bone over the implant is extremely thin, there is a possibility of post-surgical

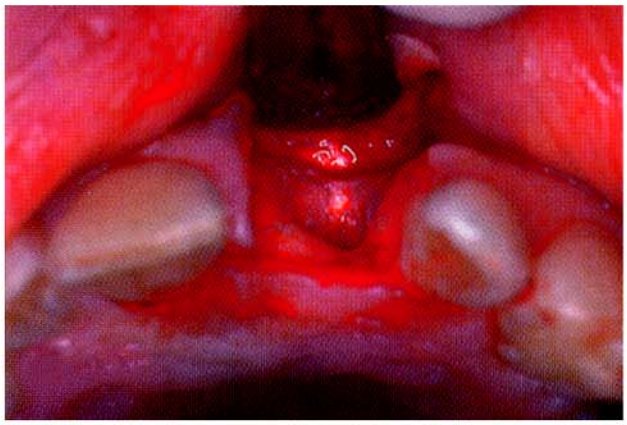

FIGURE 2: A severe ridge defect is evident after the labial flap is raised and granulation tissue is removed. Tooth #11 had been traumatized and surgically removed 2 years previously. In all likelihood the labial bone had also been lost at that time.

FIGURE 3: The ridge defect is thoroughly curetted and then densely filled with an osseous graft. In this case a freeze-dried decalcified allograft has been utilized for its potential osteoinductive and "space making" capabilities.

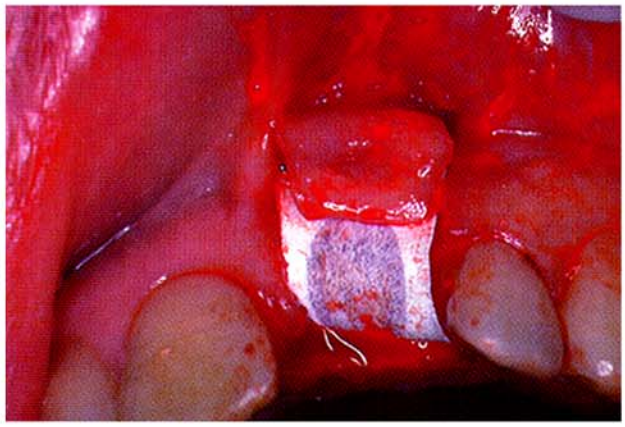

FIGURE 4: A trimmed GTAM is adapted to the surgical site and left in place for a minimum of 4 weeks. The sutured flaps will help to achieve stabalization of the GTAM.

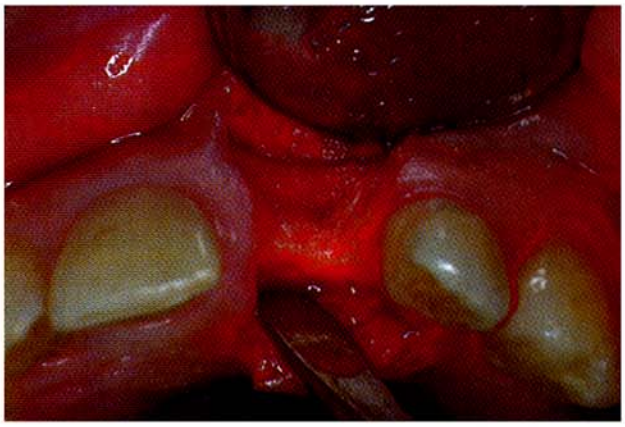

FIGURE 5: Significant osseous ridge augmentation is evident when compared to the pre-treatment osseous ridge as seen in Figure 2. The previously placed GTAM has preferentially allowed the osseous tissue to form under the barrier by excluding the overlying soft tissues.

bone resorption which could result in later development of implant dehiscences and/or fenestrations. The GTR technique can be incorporated at initial implant placement to enhance new bone growth. See Figures 6, 7, 8 and 9 which illustrate a case of bone augmentation. A controlled clinical study by Dahlin and co-workers was published in 1991[6]. This study showed that "the membrane technique is a recontructive technique able to create new bone at localized bone fenestrations at titanium fixtures". Additionally this study also demonstrated that when a barrier was not placed "the periostium alone, in adult humans, is not capable of generating new bone at exposed titanium implants".

B) PERI-IMPLANT SPACE AROUND AN IMPLANT PLACED INTO AN EXTRACTION SOCKET

There are clinical situations that arise when implants are immediately placed into extraction sockets where a significant space exists between the implant and the recipient bone site. When such a peri-implant space is present, the objective should be to achieve complete bone fill. The GTR technique provides a predictable method to achieve complete bone fill in these types of situations. See Figures 10, 11, 12 and 13 which demonstrate a typical case. For more detail on this particular technique, readers are referred to previous publications by this author on 1) "Immediate Placement of Osseointegrated Dental

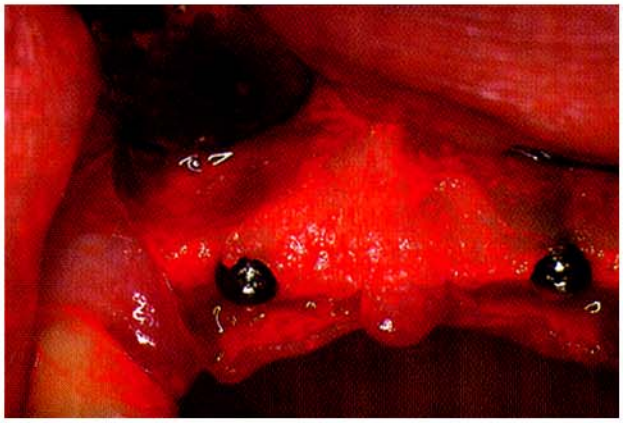

FIGURE 6: Implants have been place in the #12 and #22 positions. It is evident at this first stage surgery, that the labial undercut of the pre-maxilla has resulted in only a very thin residual layer of bone on the labial aspects of the implants.

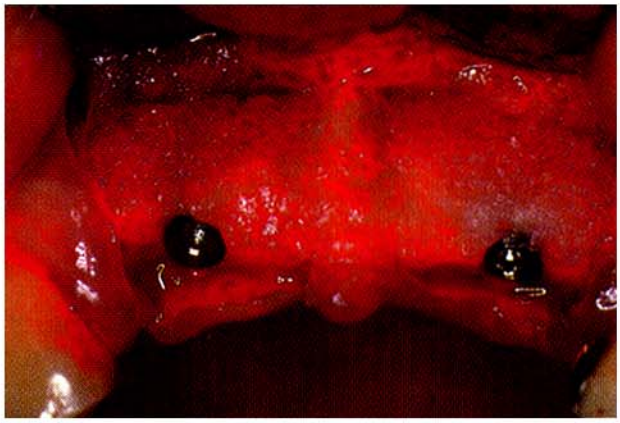

FIGURE 7: In order to prevent post surgical bone resorption and possible subsequent implant exposure, an osseous ridge augmentation has been incorporated with the first stage implant surgery. An allograft has been placed where the additional new host bone is desired.

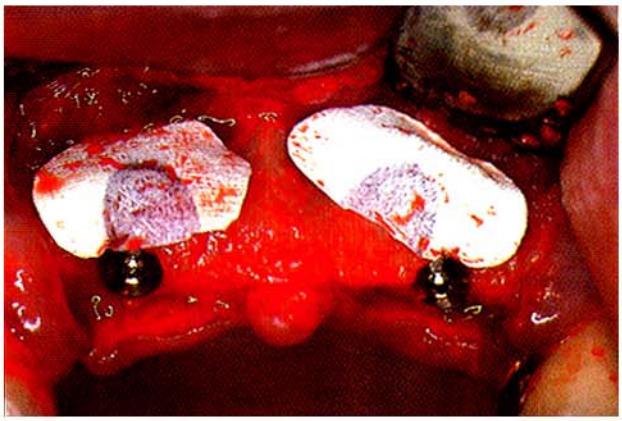

FIGURE 8: A GTAM has been trimmed and placed over the allograft. In this case the GTAM will be held in place by the implant cover screws and the overlying flap which will be sutured to achieve primary closure.

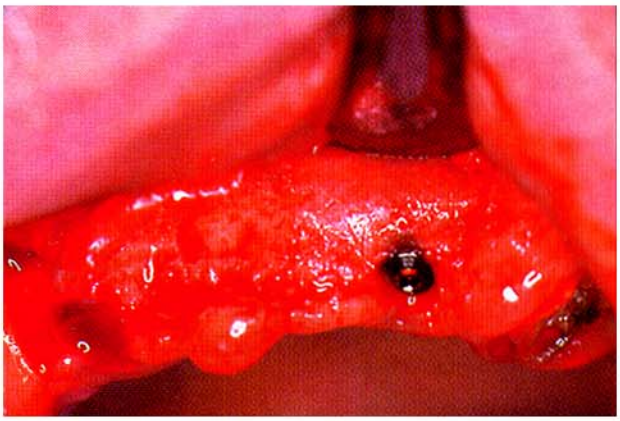

FIGURE 9: Six months after GTAM placement significant osseous augmentation is evident on the labial aspect of the implant. The allograft has been resorbed and replaced by host bone (compare to Figure 6).

Implants Into Extraction Sockets; Advantages and Case Reports", in Oral Health, July 1992, pp. 19-26[7] and 2) "Immediate Placement of Dental Implants into Extraction Sockets; Surgical Related Difficulties", in Oral Health, July 1993, pp. 23-33[8].

III. OSSEOUS DEFICIENCIES ENCOUNTERED AFTER INITIAL IMPLANT PLACEMENT (REPAIR OF "AILING" IMPLANTS)

Osseous defects associated with repair of "ailing" implants in this article, refers to treating implants that are no longer sterile and where bone loss has occurred long after initial implant placement. In these situations the implant surface must be "decontaminated" as part of the overall treatment technique.

Initially the etiology of the bone loss must be determined in order to be able to formulate a proper treatment plan. In the situation where the osseous defect is present at initial placement, one should expect that new bone formation will not take place unless GTR is carried out at the first stage surgery[7]. Peri-implant bone loss occurring after initial implant placement may be caused by a microbiological etiology[9] or a stress-occlusal related etiology[10]. In these latter two situations, the etiologies must be resolved prior to carrying out a regenerative procedure. Following is a protocol for treatment of "ailing" implants as proposed by Meffert[11]. a) debride the osseous defect and implant surface with plastic instruments, b) detoxify the implant surface c)

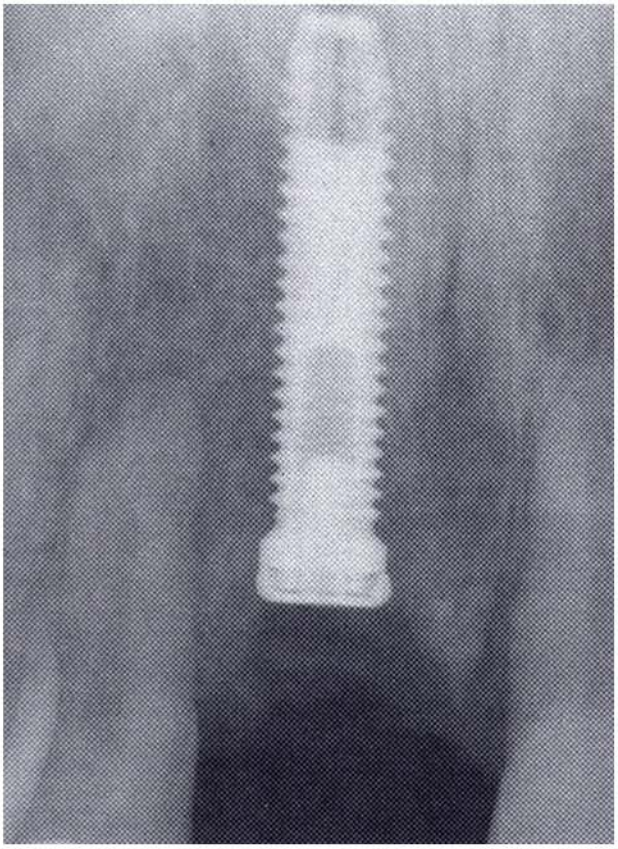

FIGURE 10: This radiograph was taken shortly after initial placement of a 15 mm. self tapping implant. A residual space is evident between the extraction socket wall and implant surface. See Figure 11 for the corresponding clinical view and Figure 13 for the 8 month follow-up radiograph.

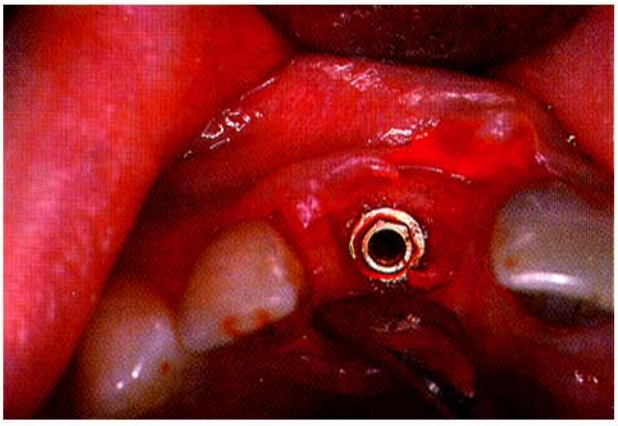

FIGURE 12: Complete bone fill of the peri-implant space is evident at the second stage surgical procedure which has been carried out 6 months after the initial placement as seen in Figure 11. With immediate implants the GTR technique is very predictable and it is not uncommon for bone to "grow over" the implant.

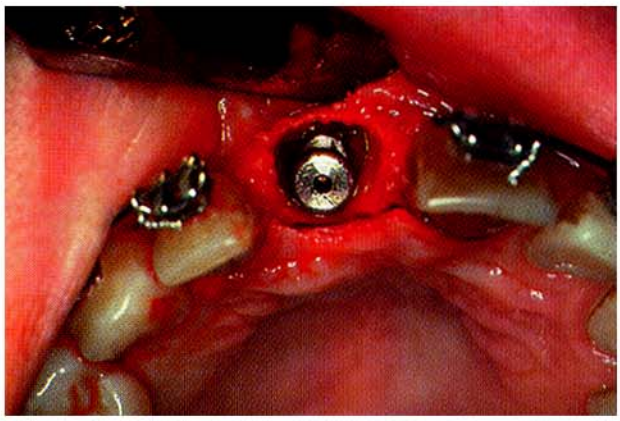

FIGURE 11: Initial placement of the implant immediately into the fresh extraction socket has resulted in a peri-implant space in the coronal third of the implant. A GTAM will be placed in a saddlelike fashion over the surgical site. See Figure 10 for the corresponding radiograph.

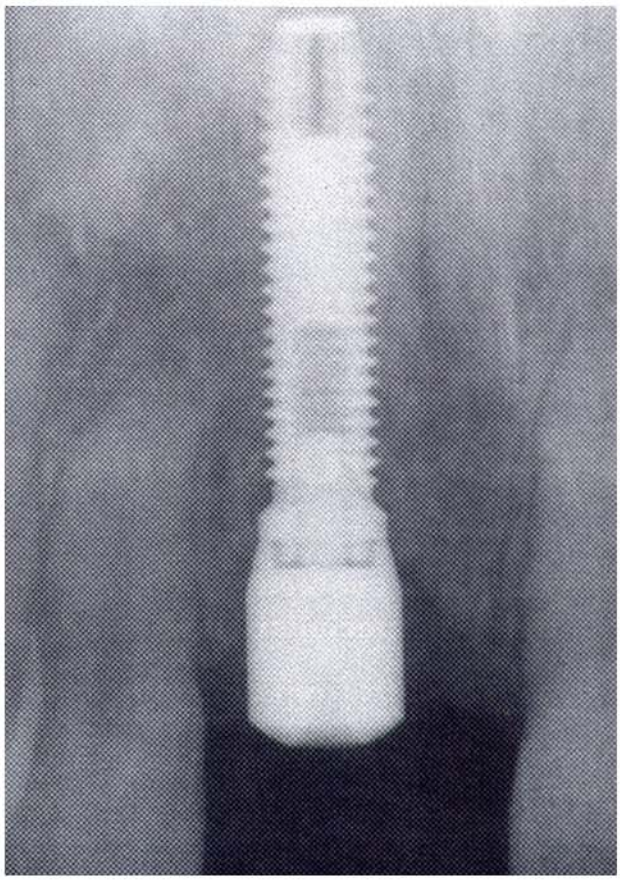

FIGURE 13: Taken 6 months after initial placement and at the time of the placement of the healing abutment, this radiograph demonstrates bone regeneration of the peri-implant space (compare to 6 months earlierradiographically in Figure 10, and clinically in Figure 11).

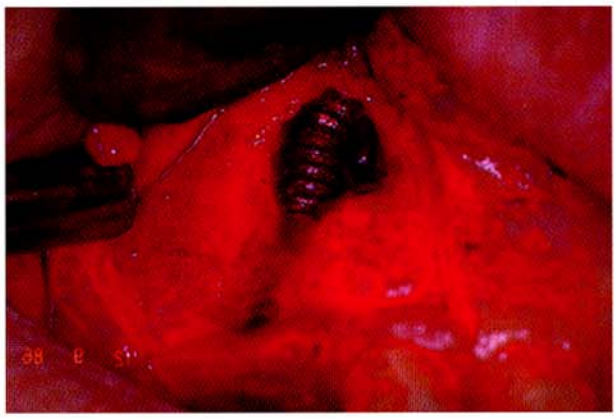

FIGURE 14: The buccal view of the implant in position #14 illustrates a large fenestration involving the apical ⅔rds of the implant. The etiology is likely from an endodontic complication on the adjacent natural cuspid tooth. Clinically the implant was immobile and integrated in the coronal third.

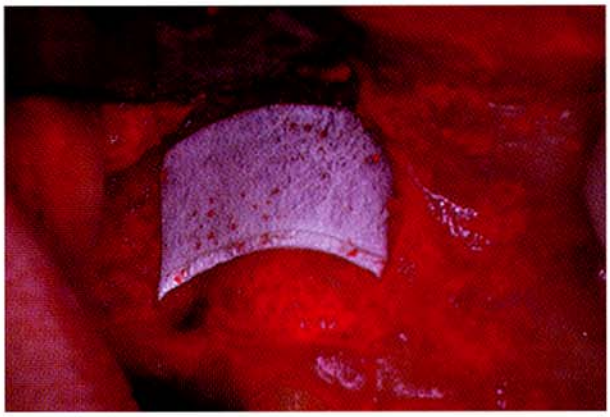

FIGURE 15: After curetting out the granulation tissue, the implant was "detoxified" and an allograft was condensed into the defect. A modified GTR barrier was placed over the defect (GTAM was not available at that time). The barrier was secured only by the overlying flap once primary closure was achieved.

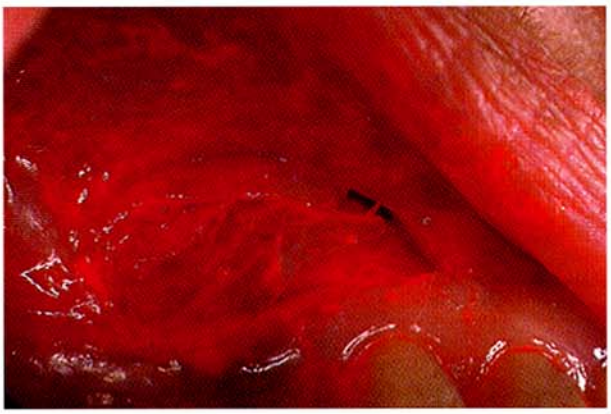

FIGURE 16: The surgical re-entry procedure was carried out 11 months after the initial procedure as seen in Figures 14 and 15. The barrier was removed but was tenaciously adherent to the tissues. This was due to its biocompatability and relatively long retention period i.e. 11 months.

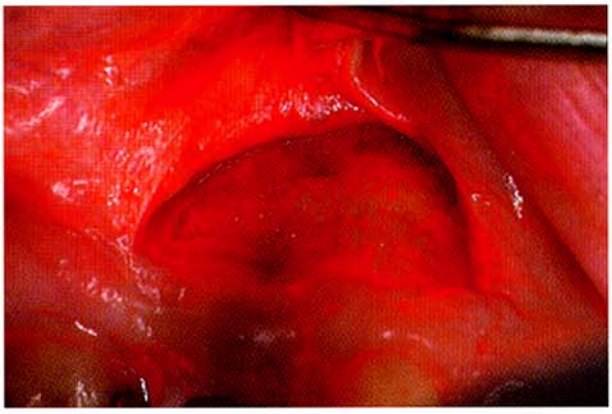

FIGURE 17: Upon removal of the barrier it was evident that excellent bone regeneration had taken place. Clinically and radiographically to date there have been no signs or symptoms indicating any pathosis over a follow-up period of 5 years.

consider filling the osseous defect with an appropriate autograft, allograft or alloplast, d) adapt a barrier membrane e.g. GTAM to promote GTR, e) achieve primary flap closure, f) avoid transmucosal loading.

The protocol for detoxification of the implant surface and osseous grafting, varies depending on the type of implant surface and clinical situation. According to Meffert[11] the protocol is as follows;

i) Detoxify a hydroxylapatite implant surface with citric acid PH 1.0, 40%) for 30-60 seconds, then irrigate. If the hydroxylapatite surface is pitted or discoloured, remove the hydroxylapatite completely, then treat as a metallic implant.

ii) Detoxify a metallic implant surface with tetracycline paste (250 mg and saline)

iii) Consider osseous grafting with an autograft or allograft if the implant surface is clean and detoxified with the objective of attaining regeneration and "re-osseointegration". If the implant surface cannot be properly cleaned and detoxified, consider an alloplast (e.g. hydroxylapatite) with the objective of achieving a biocompatible fill.

Successful re-osseointegration (i.e. achieving new bone osseointegration on a previously non-sterile exposed implant surface) has been reported[12]. These claims however, have largely been based on clinical and radiographic evaluations but not confirmed histologically. Indeed animal histological studies that have been carried out under more ideal controlled conditions, have reported that at best only a small degree of re-osseointegration has been seen at the apical portion of the defects[13,14]. In the opinion of this author, the predictability of achieving reos-seointegration is questionable but can be improved if healing takes place in a "closed environment" (see Figures 14, 15, 16, and 17)

SUMMARY

This article has discussed and illustrated various applications of GTR associated with dental implants. At present, in the opinion of this author, the material of choice for these procedures is GTAM. Other barriers are currently available while still more are under development. It is not within the scope of this article to include a comprehensive discussion of all available materials but it is noteworthy that resorbable membranes such as GUIDOR (Butler) show promise.

At present the predictability of the various GTAM techniques discussed in this article, in the experience of the author are as follows:

a) There is good predictability with immediate implant placement in extraction sockets.

b) There is fairly good predictability regenerating localized osseous ridge deformities prior to implant placement.

c) There is fairly good predictability regenerating new bone at dehiscences and/or fenestration defects that are associated around initial implant placements.

d) There is poorer predictability regenerating new bone i.e. "re-osseointegration" around "ailing" i.e. contaminated implants.

BIBLIOGRAPHY

1. Nyman S., Gottlow J., Karring T. et al: "The Regenerative Potential of the Periodontal Ligament: An Experimental Study in the Monkey". J. Clin. Periodontol. 9:257,1982.
2. Nyman S., Lindhe J., Karring T. et al: "New Attachment Following Surgical Treatment of Human Periodontal Disease", J. Clin. Periodontol 9:290, 1982.
3. Gottlow J., Nyman S., Lindhe J. et al, "New Attachment Formation in the Human Periodontium by Guided Tissue Regeneration", J. Clin. Periodontol, 14:819, 1987.
4. Buser D., Bragger V., Lang, N.P. et al. "Regeneration and Enlargement of Jaw Bone Using Guided Tissue Regeneration", Clin. Oral Implant Res. 1:22, 199.
5. O'Brien, T.P., Hinrichs, J.E., Schaffer, E.M., "The Prevention of Localized Ridge Deformities Using Guided Tissue Regeneration", J. of Periodontol., V65, #l,p. 17,Jan.94.
6. Dahlin C., Andersson L., and Lindhe A., "Bone Augmentation at Fenestrated Implants by an Osteopromotive Membrane Technique. A Controlled Clinical Study", Clin. Oral Impl. Res., 2:159-165, 1991.
7. Arlin, M.L., "Immediate Placement of Osseointegrated Dental Implants into Extraction Sockets: Advantages and Case Reports", Oral Health, July 1992, pp. 19-26.
8. Arlin, M.L., "Immediate Placement of Dental Implants into Extraction Sockets: Surgically-Related Difficulties", Oral Health, July 1993, pp. 23-33.
9. Mombelli, A., Van Oosten, M.A.C., Schurch E., Lang, N.P., "The Microbiota Associated with Successful or Failing Osseointegrated Titanium Implants", Oral Microbiol. Immunol., 2:145-151, 1987.
10. Becker W., Becker B.E., Newman M.G., Nyman S., "Clinical and Microbiological Findings That May Contribute to Implant Failure", Int. J. Oral Maillofac. Implants, 5:31-38, 1990.
11. Meffert, R.M., "Treatment of the Ailing, Failing Implant", California Dental Assoc. Journal, Vol.20, #6, June 1992.
12. Mellonig, J.T., and Triplett, R.G., "Guided Tissue Regeneration an Endosseous Dental Implants", Int. J. Periodont. Res. Dent., 13:109-119, 1993.
13. Grunder, V., Hurzeter, M.B., Schupbach, P. and Strub, J.R., "Treatment of Ligature Induced Periodontitis Using Guided Tissue Regeneration: A Clinical and Histological Study in the Beagle Dog", Int. J. Oral Maxillofac. Impl., 8:282-293, 1993.
14. Jovanovic, S.A., Kenney, E.B., Carranza, .A., Donath, K., "The Regenerative Potential of Plaque Induced Peri-Implant Bone Defects Treated by a Submerged Membrane Technique: An Experimental Study", Int. J. Oral Maxillofac. Implants, 8:13-18, 1993.

Self Study Questionnaire

1. **The first publications describing the Guided Tissue Regeneration Technique were carried out in humans.**
   True or False

2. **The "barrier membrane" function in the technique of "Guided Tissue Regneration" functions only to exclude saliva and plaque from invading the wounds.**
   True or False

3. **"GTAM" stands for Gore Tex Ridge Augmentation Material**
   True or False

4. **Three different applications of GTAM as it relates to Dental Implants include bone dehiscenses, fenestrations and immediate extraction socket placements.**
   True or False

5. **One might choose to carry out "Guided Tissue Regneration" after a difficult extraction site or with an osseous ridge defect in order to augment the bone to a sufficient size to accommodate an endosseous implant.**
   True or False

6. **GTAM is indicated after placing an implant into a fresh extraction socket on a routine basis.**
   True or False

7. **GTAM may be indicated when encountering osseous dehiscense around an implant at initial placement because periostium alone cannot regenerate new bone.**
   True or False

8. **Bone loss around implants can be caused by plaque-induced inflammation and/or non-physiological forces.**
   True or False

9. **It is less predictable to regenerate bone around an "ailing" (ie. non-sterile) implant because one cannot predictably "detoxify" the implant surface.**
   True or False

10. **The predictability of achieving osseous regeneration around an "ailing" implant can be greatly improved if the patient is placed on a systemic antibiotic.**
    True or False