*This article original appeared in the 02/2017 issue of Dentista, a specialist magazine for the modern generation of oral health care professionals in the Netherlands. It has been translated from the original Dutch and is used with permission of the publisher.

'renewed' non-resorbable membranes Bone augmentation techniques

The non-resorbable d-PTFE membrane has been available for nearly twenty years. Yet in all that time it has received little attention (in the Netherlands), and not everyone is aware of the qualities of this membrane in GBR procedures. Melle Vroom and Lodewijk Gründemann have been successfully using the d-PTFE membrane in various bone augmentation techniques for several years.

> ince the discovery of guided tissue regeneration (GTR), of which guided bone regeneration (GBR) forms a part, the technique has become common procedure within the fields of implantology and periodontology. The GTR technique was first described at the start of the eighties by Newman and his colleagues. In the mid-eighties Nyman/Dahlin and colleagues proved the effectiveness of the GBR techniques in several experimental studies. The principle of GTR/ GBR techniques can be broadly described as: The closure of a space with the help of barrier membranes, which exclude epithelial cells and connective tissue cells and which stimulate bone regeneration on the alveolar ridge. This will provide more time for bone regeneration unimpeded by the negative impact on this process by epithelial cells.

e-PTFE membrane

The above mentioned experimental studies made use of non-resorbable *expanded polytetrafluoroethylene* (e-PTFE) membranes that functioned as a barrier. These membranes were applied with or without titanium reinforcement. The great regenerative potential of this membrane clearly Melle Vroom and Lodewijk Gründemann

emerged in various clinical studies. As long as unimpeded healing could take place, and the tissues remained primarily closed, (nearly) complete bone regeneration was possible.

However, a considerable disadvantage that was also described in various clinical studies was that upon exposure of the membrane, an inflammation often arose, which resulted in a (partial) failure. The explanation for this was that as soon as the membrane was exposed to the oral cavity, bacteria could migrate through the membrane. The commonly used e-PTFE membrane manufactured by the Gore® company was associated with the idea that in case of exposure the procedure had failed (purulent tissue underneath the membrane). The fact that studies showed that exposures regularly occur in GBR procedures (+/- 10-50 %) resulted in many clinicians becoming interested in resorbable membranes. In case of exposure of a resorbable membrane such a membrane would be resorbed and the edges of the wounds would close again. What is often under-emphasized is that the exposure that has occurred also has a negative impact on the total volume of the bone augmentation, especially in the area where the exposure has occurred.



Well-known resorbable membranes made of collagen are currently regarded as the standard option. However, it is interesting that comparative studies demonstrate that e-PTFE membranes show better results than resorbable membranes. Consequently, the e-PTFE membrane is mentioned in many regeneration studies as the 'gold standard'. However, due to the advantages of collagen membranes compared to the e-PTFE membranes, the further development of non-resorbable membranes was not given the attention it deserved.

d-PTFE membrane

It was nearly 20 years ago that a further developed non-resorbable membrane, a 'dense' PTFE membrane (d-PTFE), was marketed by the Osteogenics company under the brand name Cytoplast® (with or without titanium reinforcement). This d-PTFE membrane is manufactured by treating PTFE in such a way as to inhibit the penetration of bacteria through the surface, which was confirmed by a microbiological test. Besides, an additional modification was introduced on the surface of the d-PTFE membrane. It concerns little dimples that have been applied to the top of the surface of the membrane. These dimples allow for partial tissue ingrowth, which results in a reinforced connection between the inner side of the flap and the membrane. In case of a possible exposure, this limits epithelial ingrowth and the migration of bacteria alongside the membrane. A study in which e-PTFE vs. d-PTFE is used in vertical GBR procedures shows that both membranes lead to comparable results. The only difference mentioned in this study is the observation that d-PTFE membranes can be more simply removed.

It is noteworthy that this d-PTFE membrane, in our opinion, receives hardly any attention at many confer-

ences in Europe, while it has been used to obtain very good results. A possible explanation is that many clinicians associate the d-PTFE membrane with the e-PTFE membrane.

Various bone augmentation techniques using the d-PTFE membrane

Both authors have been applying the d-PTFE membrane in various GBR procedures for a number of years. It is interesting to note that this membrane can also be applied immediately after performing an extraction in order to preserve the shape of the alveolar process but also, if necessary, to repair it directly. During various clinical evening lectures and demonstrations, this technique seems to draw a lot of attention and sometimes causes surprised reactions. Below some of the various techniques and indications are illustrated on the basis of some clinical cases.

1. Bone augmentation immediately after extraction without wound closure

Tooth #3 (figure 1a) is unrestorable due to mesial caries, apically widened periodontal ligament, partial canal filling, distobuccal furcation grade 2 and a 4 mm buccal recession. The estimate is that after extracting #3, the alveolar process will resorb in such a way as to enable the placing of an implant only after performing a (local) sinus lift. Tooth #3 is extracted atraumatically, the inflamed tissue and remaining periodontal ligament is removed from the alveolus. A small flap is elevated only buccally with a vertical release located in the area of #2. No buccal releasing is done because the wound is purposely not primarily closed. The alveolus is filled with allogenic bone graft material and covered by a titanium reinforced d-PTFE membrane. Afterwards the flap is replaced in the original position and only the incision is sutured. A suture is solely applied over the membrane to stabilize the edges of the wounds and with no intention of closing them.

After one month the membrane is removed (figures 1b, 1c, 1d). It is remarkable how undisturbed the gingiva looks after one month (figure 1b). After removal of the membrane, the clearly formed osteoid matrix is visible (figure 1d).Three months later the osteoid matrix has epithelialized over the top and the shape of the alveolar process has been preserved (figure 1e).

After opening the tissue in order to place the implant, it is clearly visible that the shape of the alveolar process has been retained and the sharply cut edges illustrate that the bone has hardened (figure 1f, 1g). An 8 mm implant has been placed without perforating the sinus. After three months the crown is placed (figure 1i). A periapical X-ray shows a stable/improved bone level compared to the beginning (compare figure 1a with 1h). An X-ray of the same implant borne crown two years later shows a stable condition (figures 1j and 1k). The alveolar process has retained its shape.

2. Bone augmentation with wound closure

In conditions where there is insufficient bone present for placing an implant, and no tooth is present, the first step is to perform bone augmentation. An example of such a condition is shown in figure 2a. It concerns the position #10 where a lot of bone was lost due to endodontic problems and an apical root resection (figure 2a).

After applying bone graft material, a titanium reinforced d-PTFE membrane was applied that had been cut to size beforehand. Tension-free closure of the tissues was achieved by using releasing techniques especially in the buccal flap. During the healing period, the tissues remain primarily closed. Six months after the placement of the d-PTFE membrane, the tissues are opened and hard tissue is clearly visible in which shape the membrane has been applied.

The membrane has been enabled to retain this shape due to the titanium reinforcement (figure 2b). After removing the membrane, the amount of increased augmented bone can be seen (compare figure 2c to 2a).

The hard regeneration tissue is covered



by a very thin layer of soft tissue which is a normal result in the use of this type of membrane. A condition has been achieved in which the implant can be placed in adequate bone volume and also in the preferred prosthetic position.

The following case (figure 3a) clearly shows that d-PTFE membranes can show good results even in cases of more considerable bone defects. It concerns a young patient who lost teeth #7-#9 due to trauma. The patient wishes to have a fixed prosthesis and prefers an implant borne construction to a conventional bridge. The treatment plan includes the reconstruction of the alveolar process, and after a healing period, the placement of an implant in position 7 and 9, on which a three unit dental bridge will be constructed. The bone augmentation is performed with the help of bone graft material and the placement of a titanium reinforced d-PTFE membrane (fixated by one pin). After opening the tissues, it is clearly

visible that the alveolar process has a very narrow shape (figure 3a). The deficient ridge was reconstructed with allograft and a d-PTFE membrane as planned. There are no complications during the healing period and the tissues remain closed. After six months the tissues are opened and the membrane is removed (figures 3b, 3c). There is a thin soft layer present now as well. It is discernible that the alveolar process has recovered its proper shape (compare figure 3c to 3a). The implants are placed in a good position to function in the future as supports to a three unit bridge 12-21 (figure 3d).

3. GTR in cases of periodontal defects

As indicated above, the GTR technique was first described by Nyman and his colleagues at the start of the eighties. It concerned a technique which showed regeneration of the periodontal supportive tissues and surrounding elements; namely periodontal ligament, cementum, and bone. The conse-













quence was that the e-PTFE membrane was often applied in the treatment of periodontal defects. One disadvantage compared to resorbable membranes is that the e-PTFE membrane must be removed during a second surgical procedure. That is why the preferred option for many clinicians for this kind of treatment is resorbable membranes. In the case below, a GTR procedure using a d-PTFE membrane is described.

However, it is a procedure in which removal of the membrane in a second surgical procedure is unnecessary. The distal area of tooth #18 shows a lot of attachment loss (figures 4a, 4b). A decision is made to perform a GTR procedure distally of tooth #18. An incision is made distally, after which the tissue is shifted aside. The defect is elaborately cleaned and the granulation tissue removed. In addition, the root surface is cleaned. Afterwards bone substitute is applied and the defect is covered by a d-PTFE membrane which has been cut to size. A monofilament suture is put in the membrane, running in a circle around tooth #18 and remaining mesial supragingival. The suture is knotted at this location which keeps it within easy reach. The tissues are then distally sutured. Two weeks later, the sutures are removed, with the

exception of the circular suture. The membrane is removed four weeks after its placement by means of the circular suture. This suture is cut loose at first and then both ends are pulled. This results in an edge of the membrane coming out from underneath the tissue. After this, it is possible to remove the membrane from underneath the tissue by means of a pair of tweezers. A pocket probe can be helpful in breaking through the 'connection' between the membrane and the tissues. By applying this technique, it is no longer necessary to perform a second surgical procedure to remove the membrane (figure 4c). Two months after performing the GTR procedure, both the periapical X-ray and the clinical measurements show a lot of attachment gain (figures 4d, 4e). Twelve months later, both a clinically and radiologically stable condition is observable. (figure 4f).

Complications in the use of d-PTFE membranes

There is no single material or technique in GBR procedures that is without any complications. In the use of the d-PTFE membrane, we have observed fistulizing, or the emergence of a swelling, 2-3 months after placing the membrane in a few cases. If in such a situation the membrane is quickly removed, the swelling or fistula subsides quickly. It is remarkable that no matter what the size of the GBR area after such a complication, the performed bone augmentation still had a good result. In addition, another complication is the occurrence of an exposure in which the edge of the membrane is exposed and so a portal of entry arises. In such a case the occurrence of an inflammation in the augmentation area cannot be excluded and immediate membrane removal is necessary.

Conclusion

It seems as if 20 years after it was first marketed the d-PTFE membrane (Cytoplast®) is finally getting the attention and appreciation it deserves. The very interesting application directly after an extraction has certainly contributed to this. The results repeatedly achieved by the authors over a number of years with this type of membrane can be called good to excellent. Not unimportant, the achieved results also provide a lot of job satisfaction and a sense of achievement. Considering its wide applicability, the d-PTFE membrane can become the new standard option in many GBR procedures, in our opinion, and is frequently preferable to the use of resorbable membranes. The bibliography is available on request from the editor.

Published in Dentista, 02/2017.



Melle Vroom and Lodewijk Gründemann are both working as periodontists (NVvP = Dutch Union of Periodontists) and implantologists (NVOI = Dutch Union for Oral Implantology) in the Periodontal Practice Friesland (PPF) in Goutum/Leeuwarden, the Netherlands. They give lectures and provide hands-on training sessions on the use of d-PTFE membranes.

