RESEARCH ARTICLE

Reconstruction of a Horizontal and Vertical Bone defect using The Cortical Lamina Technique

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Abstract

For many years guided bone regeneration has been a challenge in oral and implant surgery. Many techniques and devices have been used in trying to regenerate and reconstruct resorbed edentulous ridges. The literature in the field is scarce due to the impossibility to perform RCT on such lesions, therefore the judgement of the international community is based on case reports and retrospective studies.
In the last ten years a new device has proved to be quite successful and predictable on top of showing a very low morbidity, a membrane made of xenogeneic collagenated bone with features that are very different from any other material used in the past.
This paper will show the application of the cortical lamina technique where a vertical and horizontal defect was corrected and successfully restored.

Key Words: Bone Regeneration, Bone Grafting, Ridge Augmentation, Cortical Lamina

Introduction

Tooth extraction very often represents a traumatic experience, not only because is somehow mutilating the patient, but also because ignites a phenomenon of bone and soft tissue remodeling that can be from moderate to severe.

Schropp and al. 2003 evaluated the changes happening after single tooth extraction by radiographic evaluation and by comparison of the stone casts before and after. Surprisingly they reported volumetric variations reaching up to 50% of the original bone shape [1].

Van der Veijden et al. in 2009 carried on a systematic review of the papers discussing ridge alterations and reported averages of 3.87 mm in width and 1.67 mm in height [2]. This could be quite significant when dealing with teeth extraction in the esthetic zone. Another and more recent systematic review done by Tan et al. in 2012 evaluated more recent papers on alveolar hard and soft-tissue modifications, they reported 29-63% variation in horizontal shape and 11-22% variation in vertical volume within 6 months after the removal of teeth [3]

Such changes represent a serious challenge for the dentist because not all clinicians have the experience and the capabilities to restore the original ridge and soft tissue shape.

Wang and Al-Shammari in 2002 classified the defects resulting from tooth extraction describing three different kind of defects, horizontal, vertical and combined vertical and horizontal [4].

From a clinical point of view the clinicians focus of research was on trying to find the best surgical option to treat these lesions, the most recent systematic review performed by Sanz-Sanchez et al. in 2015 pointed out how the treatment of horizontal lesions by means of a xenograft protected by a bio-absorbable membrane seems to be the most predictable option [5].

Less clear is the real value of surgical techniques when we are talking about vertical and combined defects, Simion, one of the pioneers of vertical bone augmentation, in 2008 published a systematic review on the topic concluding that at that time the generalizability of the surgical approach was quite limited [6].

Esposito et al. 2009 in a systematic review evaluating the efficacy of horizontal and vertical bone augmentation procedures drew some interesting conclusions, most of the studies on the topic are trials with few patients and often a short follow up. There is a variety of procedures available for bone augmentation but it is unclear which one are the most effective. He considers short implants as a very good option when speaking about the posterior resorbed mandible. Of the many techniques described to address this area the complications are probably the most known thing [7].

One of the most popular techniques for vertical ridge augmentation utilized the combination of Bovine derived anorganic bone with autogenous bone chips and the use of titanium reinforced dense PTFE membranes. This was considered for many years a standard procedure, and in 2014 Urban et al. reported an average gain of 5.45 mm (sd. 1.93) on 19 patients treated with this technique [8].

The use of PTFE membranes proved to be very tricky and their early exposure one of the weak links of the technique. Fontana and al. 2011r described seven different kind of complications, four in the healing phase based on the degree of exposure and exudate and three surgical (flap damage, neurological and vascular) [9].

A very recent publication by Gallo et al. 2019 described the management of 80 complications (exposures and infections) related to the use of these membranes. In their paper they described how these complications (exposure and subsequent infection) occurred in 43,75% of the cases in the anterior maxilla and 20% in the lower left mandible. The authors reported also a very useful information, majority of the complications appeared before the second month after surgery [10].

The use of d-PTFE membranes represents still a viable option for the resolution of the horizontal and vertical bony defects, but the high incidence of complications suggested the

research of new bio-materials less prone to show this kind of complication.

THE CORTICAL LAMINA

The cortical lamina (Tecnoss, Coazze, Italy) is a membrane made of collagenated porcine cortical bone, at the Sem image (fig.1)one can see how it could be compared to a semi permeable membrane as it shows holes and channels on its surface that can clearly favor the re-vascularization of the grafted area both from flap side and from grafted site

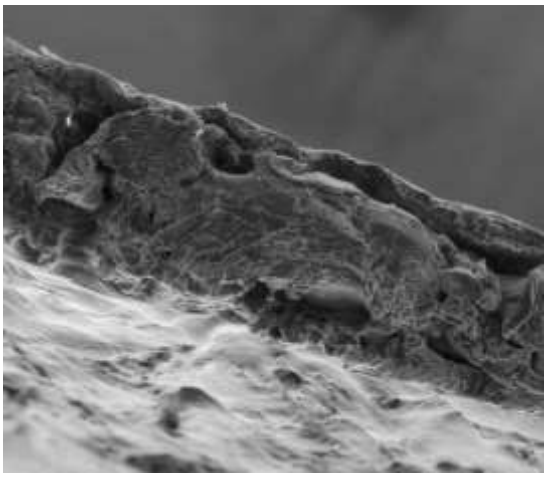

Fig.1 SEM image of cortical lamina

The lamina is produced in three different versions: a Curved lamina (fig.2) very stiff but very elastic that is 35 mm x 15 mm with thickness of 1mm, and can be easily adjust to the local anatomy of defects. The suggestion is to use it dry trying to take advantage of its stiffness to maximize its 'dome' effect. Lamina must be stabilized using pins or screws (fig.2).

Fig.2 Curved lamina

A soft lamina (fig.3) that is very rigid and shaped like a square in size 30 x 30 mm with thickness of 0.6 mm. This version needs to be hydrated with warm sterile water for 5 min in order to gain flexibility and to be cut and adjusted over grafted defects. It behaves and should be used as a collagen membrane to protect the grafted areas but has the benefits of being made of bone. Because of its elasticity and flexibility needs to be anchored to the bone by means of pins.

Fig.3 The soft lamina works like any resorbable membrane

The third version of the lamina is the 'bone layer' type that represents a piece of cortical bone used to replace one or more of the wall's defect similarly to what described by Khoury with autogenous cortical bone [11]. The advantage of using this version of the lamina is to spare the patient the necessity of a donor site, saving time and reducing the morbidity and post-operative pain and swelling (fig.4).

Fig.4 The bone layer lamina

REVIEW OF THE LITERATURE

The first evidence of the use of the cortical lamina on humans was published by Pagliani et al. 2012 in a multi-center study they reported efficacy of the lamina in protecting grafted defects over implants [12].

Wachtel and al. 2104 published a chapter on the book Bone Biomaterial and Beyond (EDRA) reporting excellent clinical outcomes on a large number of cases treated with the cortical lamina functioning as membrane when treating horizontal defects [13].

Happe and Slotte in another chapter of the same book reported a number of cases where the lamina was utilized to treat horizontal defects in the esthetic zone with excellent biological and esthetic results [14].

Rossi et al. 2016 carried out a clinical and histological study on humans, a series of patient was first treated in posterior resorbed mandible by means of collagenated porcine bone grafts (GenOs, Tecnoss, Coazze, Italy) mixed with the patient's own blood clot covered with the curved lamina. After healing periods of 6/8 months implants were placed in the regenerated bone only after biopsies were taken.

All implants succeeded in reaching osseointegration and up to one year after loading showed no modification at the crestal level. Biopsies demonstrated that the areas augmented with the cortical lamina presented new live bone [15].

CASE PRESENTATION

A female patient 45 years old presented for consultation with a failing bridge in the lower left quadrant. Once the bridge was removed, the third molar was deemed hopeless and the residual edentulous ridge showed a combined horizontal and vertical defect (fig. 5-6). Patient was sent to the radiologist to take a CBCT to further explore the anatomy of the area, the radiograph (fig.7) showed a severely resorbed edentulous ridge distal to the second bicuspid with a thickness of 2-3 mm. The day of surgery the patient was anesthetized with Articaine 1:200.000 and after a mid-crestal incision full thickness flaps were raised from the buccal and lingual aspect to expose the underlying bone (fig.8). The ridge was very thin and corticalized, therefore with a small carbide bur the ridge was perforated 1. To recall cells from the marrow spaces to re-vascularize the bone graft 2. To guaranty some kind of roughness in order to give stability to the bone graft (fig.9). Once the flaps were opened some of the forming blood clot was isolated and collected into a dappen dish where the bone graft was later added (GenOs, Tecnoss, Coazze, TO, Italy) the collagenated porcine xenograft mixed with the autogenous blood clot provided a 'sticky bone' that well adapted to the area needing augmentation (fig.10). It became immediately evident how different the ridge looked after the bone graft was placed on its buccal side. The cortical lamina was removed from its sterile package, cut in the proper size and shaped to adapt like a dome to protect the grafted area and to configure a new shape and volume to the ridge (fig.11). Rx in figures (12-13) show the area before and after the graft. Ten days after the lamina was installed the sutures were removed and one can notice the significant difference in ridge size and shape (fig.14). Postoperatively the patient did not report any complication and discomfort.

The case here presented was part of a case series where the volumetric changes were recorded by a software SLT, and later evaluated by another software (Solid Works) providing the exact variations in all three dimensions (fig.15-16)
After six months two dental implants, 4 mm in diameter, were placed in the now wider ridge (fig.17-18-19-20) and later restored with individual ceramic fused to metal crowns (fig.21-22-23). One can notice how the now wide ridge provides a good balance between the soft tissue and the restorations and how the emergence profile of the crowns provides a very bio-mimetic effect.

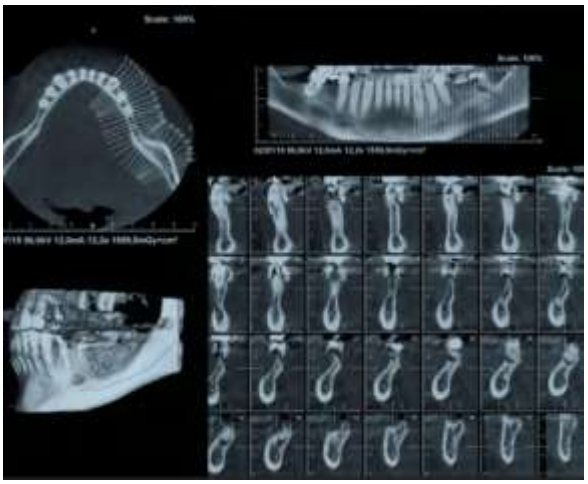

Fig.7 CBCT of the lower jaw

Fig.5 Lateral view

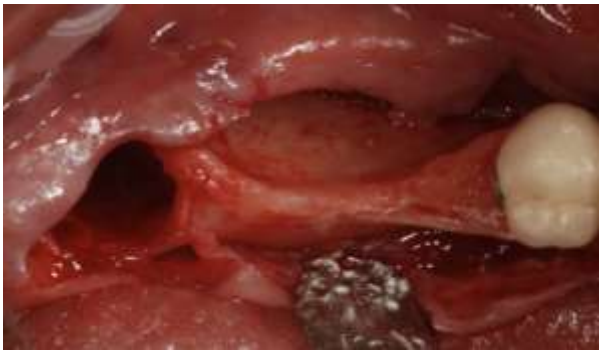

Fig.8 Open flap shows a very thin ridge

Fig.6 Occlusal view

Fig.9 Ridge was very thin and vertical

Fig.10 The bone graft in place

Fig.11 The cortical lamina in place

Fig.12 Rx before extraction and graft

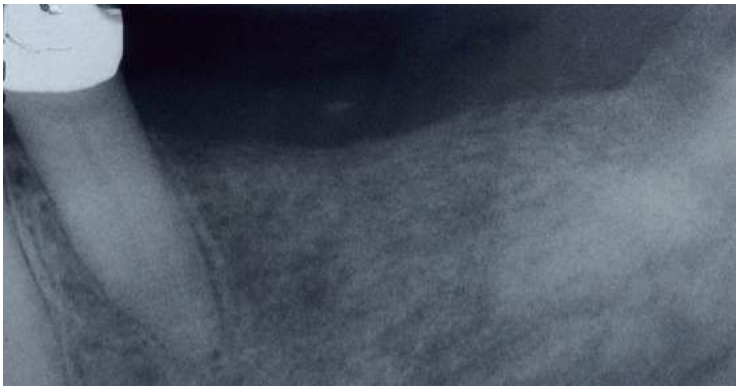

Fig.13 Rx after extraction and graft

Fig.14 Healing at 3 weeks

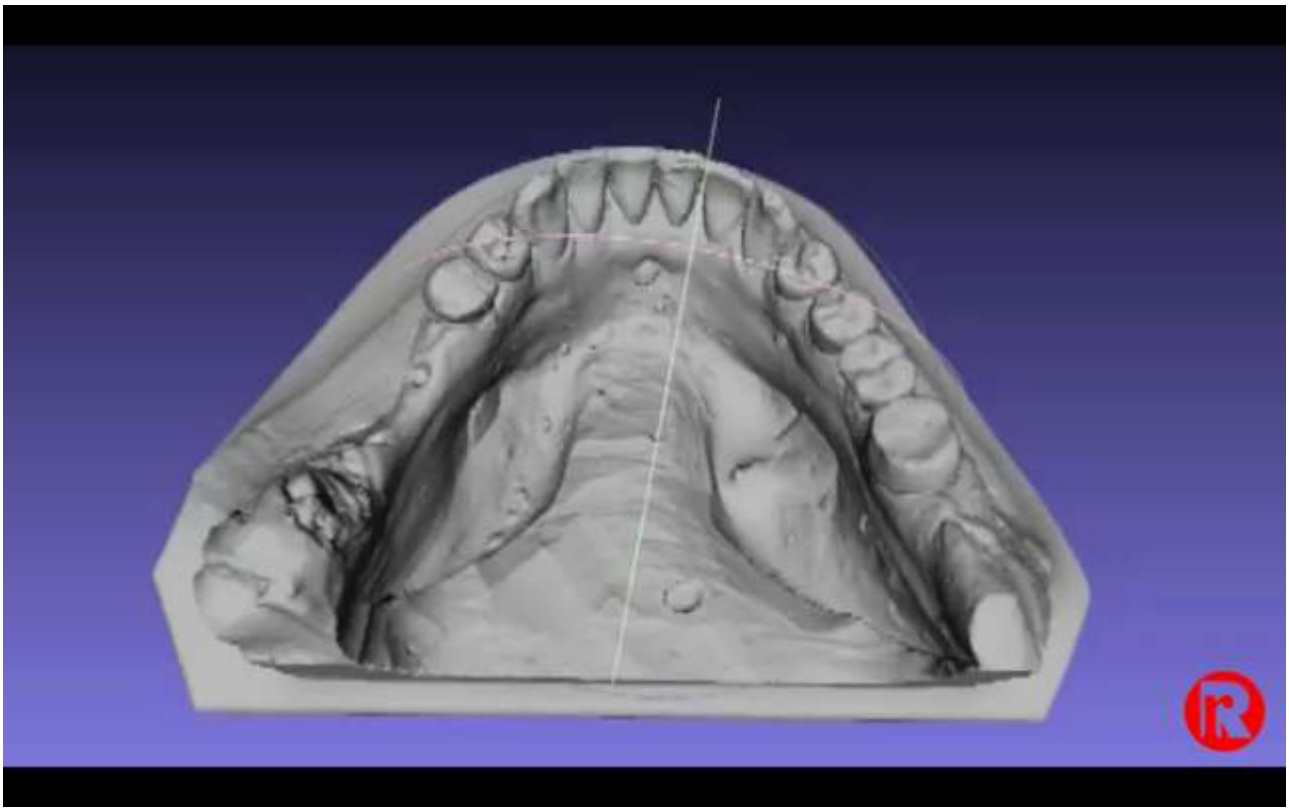

Fig.15 The initial stone cast

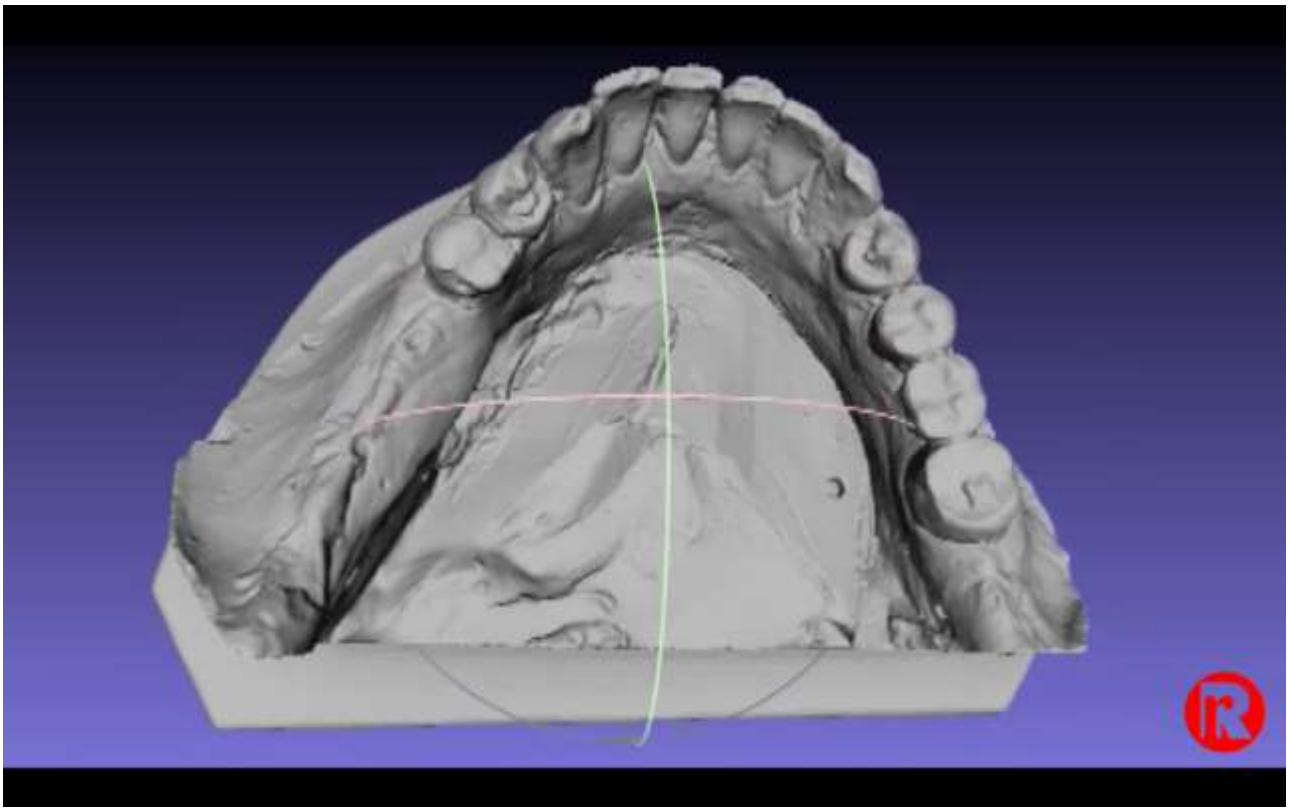

Fig.16 The stone cast after ridge augmentation

Fig.17 The ridge at the time of implant surgery

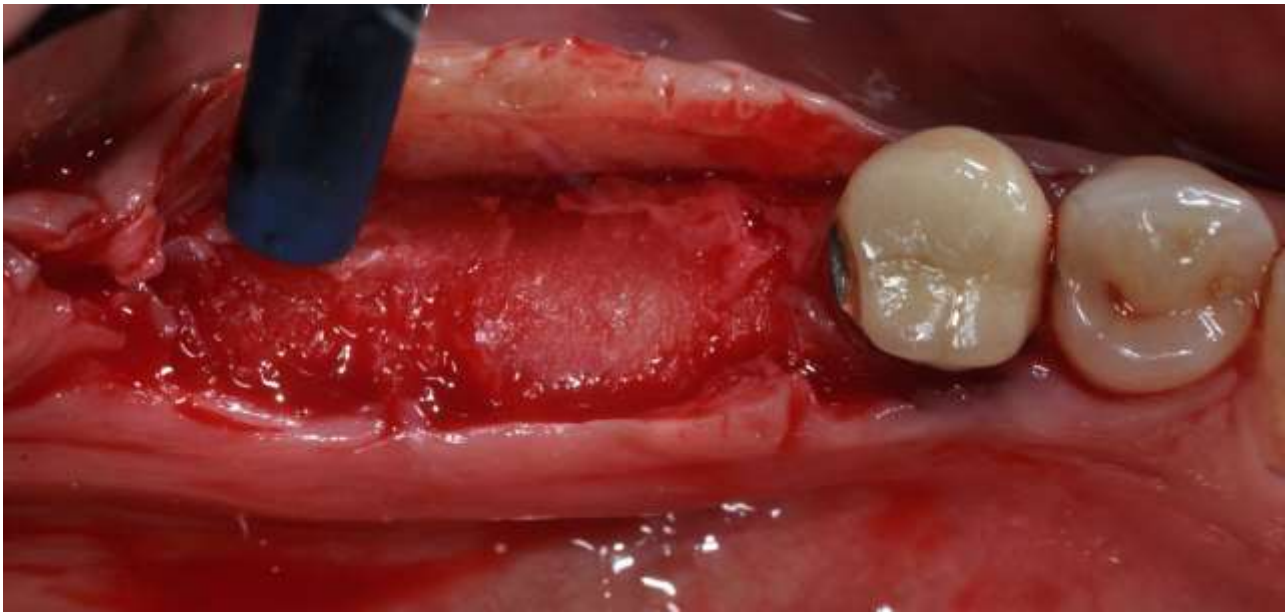

Fig.18 The new expanded ridge

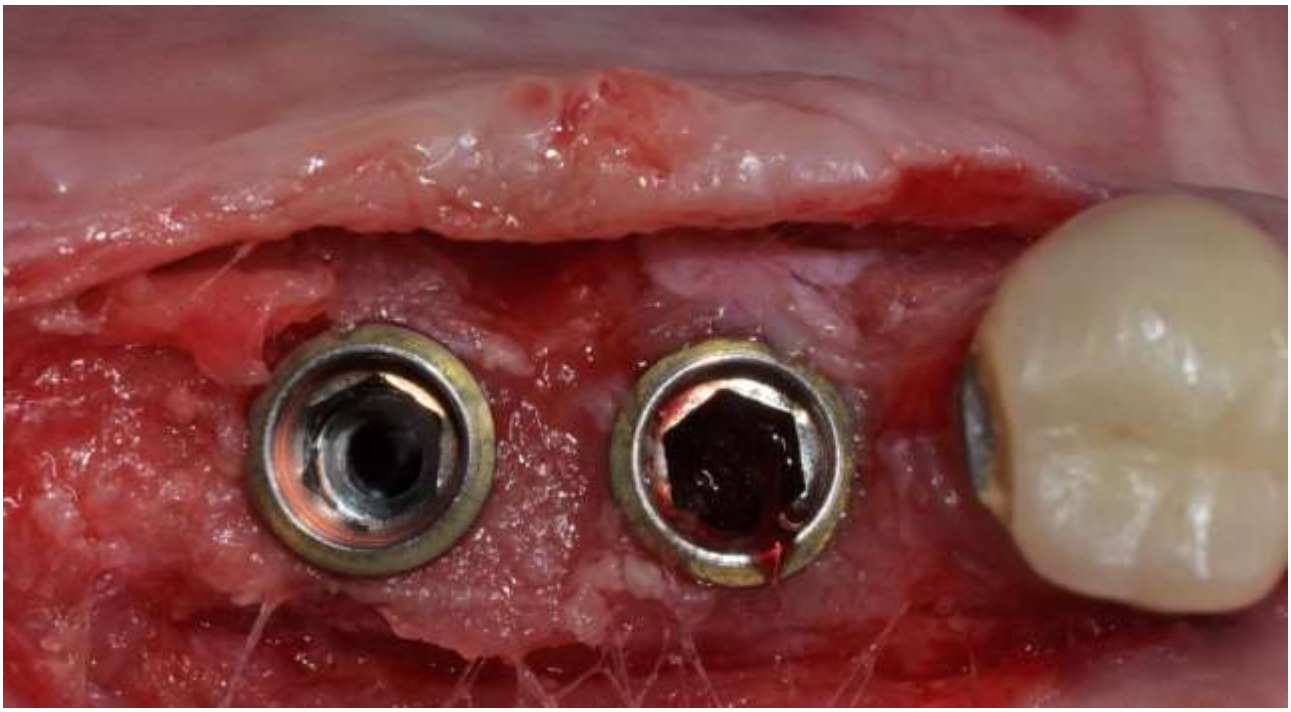

Fig.19 the two implants in place

Fig.20 The handling of the soft tissue

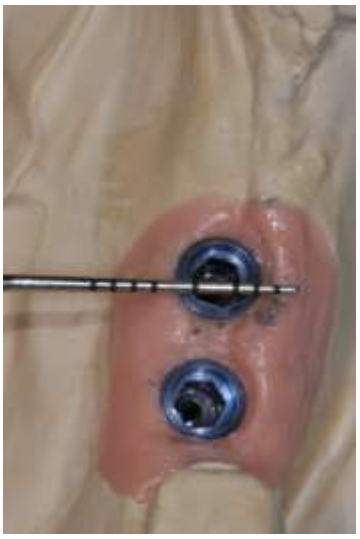

Fig.21 The cast showing the new ridge width

Fig.22 The very natural esthetics of the two crowns

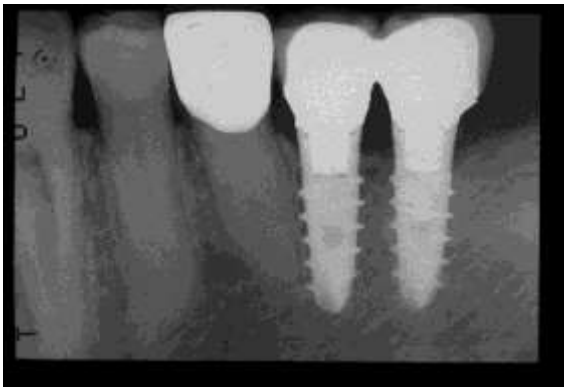

Fig.23 The radiograph showing good osseointegration

DISCUSSION

The successful treatment of vertical and horizontal bony lesions has always been a real challenge for the clinicians. The posterior mandible represents an anatomical area where often complications arise. The way the bone resorbs and the way this atrophy manifests, is one of the reasons why there is such a high percentage of failure in this area [10]. Esposito and al . 2009 [7] after a systematic review done on behalf of Cochrane, suggested the use of short implants in the posterior resorbed mandible noting that complications are a frequent finding in these areas.

The use of PTFE membranes has been for many years one of the solutions for the problem, nevertheless complications leading to an early exposure of the membrane was a well described complication [10], and this event was often leading to a failure of the procedure and to the need of a new surgical procedure. The cortical lamina technique represents a big step forward because uses a membrane that is made of cortical bone.

When we speak about complications or early exposure it is a completely different pattern of healing. The cortical lamina when exposed to saliva and oral enzymes, depending on individual situations, either hydrolyzes and slowly melts or remains exposed while the soft tissue granulate around it. The morbidity of the procedure is very low and the rate of complications reported minimal. While the lamina slowly resorbs the bone graft underneath still remains protected and rarely ends up in an untreatable ridge.

CONCLUSIONS

The Cortical lamina technique shows promising results in solving otherwise complex cases of horizontal, vertical or combined ridge augmentation. Many ongoing studies will soon provide further confirmation of its usefulness for patients and clinicians.

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