BY Hadi Antoun and Pierre Cherfane

Immediate implant placement and provisionalization after tooth extraction: Rationale

Complete restoration of dentogingival harmony is the primary objective of any restorative treatment, particularly when the dental root is to be extracted and replaced by an implant. The predictability and reliability of esthetic outcomes remains a challenge because of pronounced changes in the hard and soft tissues following a simple extraction (Atwood,1963; Carlsson et al, 1966).

Alveolar Resorption

The phenomenon of resorption occurs with regard to height and to thickness, and also affects the soft tissues. Schropp et al (2003) studied the consequences of the extraction of a single tooth (premolar or molar) without prosthetic treatment in humans. They observed a 50% change in the width of the bony ridge, two thirds of which occured in the 3 months following extraction. Resorption in the vertical direction is less pronounced, from 0.8 to 4.5 mm according to various authors (Camargo et al, 2000; Iasella et al, 2003; Schropp et al, 2003). It is more pronounced in cases of multiple extractions than in cases of simple extraction. Cardaropoli et al (2005) and Araujo et al (2005) showed that, in dogs, the healing process led to more marked resorption of the buccal wall than of the lingual or palatal walls at 8 weeks following extraction. The degree of bone resorption was proportional to the width of the bone wall. The thinner it was, the more it resorbed. This is often the case with the anterior buccal wall (Bragger et al, 1988). Can this resorption be prevented by immediate implant placement?

Immediate extraction implantation and esthetic evaluation

Immediate implant placement in a newly empty alveolus and provisionalization with a crown is an alternative to conventional treatment proposed to improve esthetic results and the comfort of the patient and to reduce treatment times. Since Schulte et al (1978), many authors have listed the advantages of immediate extraction implantation (IEI) (Wagenberg and Froum, 2006), then immediate temporization (Ganales and Wismeijer, 2004). IEI must also be able to preserve gingival and bone architecture for an immediate and optimal esthetic outcome (Mayfield, 1999; Chen et al, 2004), particularly when it is carried out flapless. A provisional crown helps to guide the soft tissues during healing, resulting in favorable gingival architecture. Jemt (1999) shows that the use of a provisional crown allows for faster restoration of the peri-implant soft tissues than healing abutments, although the volume of papillae is identical after 2 years.

Various studies of the healing sequences of the alveolus show that while bone resorption is not prevented by immediate placement of an implant, this does not compromise osseointegration and allows for an esthetic and stable result in certain conditions. Success rates for these treatments can be equivalent to those for conventional techniques. However, favorable situations should be assessed according to precise criteria, and require a procedure that will be presented here in detail through a clinical case report.

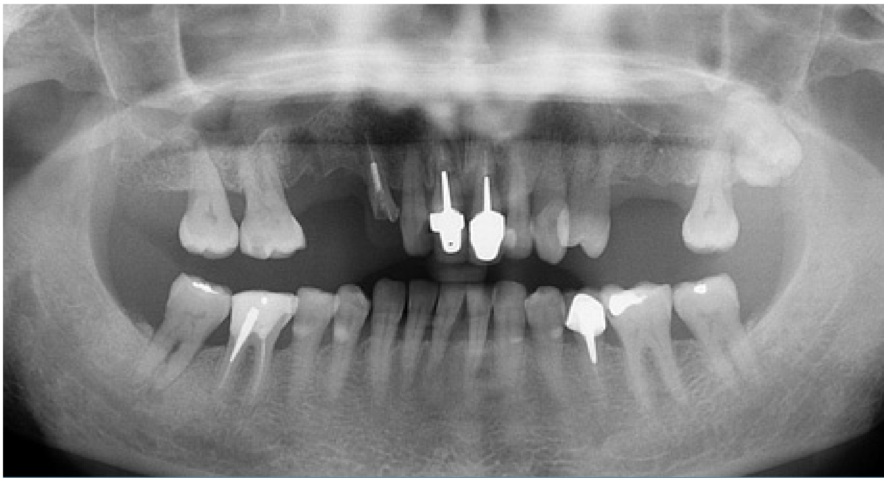

Fig. 1 Initial panoramic radiograph showing posterior maxillary partial edentulism. The patient also presented chronic periodontitis, which was treated with root debridement and surfacing.

that the loading of implants had a positive effect on bone maturation.

Most authors conclude that there is an equivalent success rate versus conventional treatments (Ericsson et al, 2000; Testori et al, 2003). However, other studies have shown a higher failure rate with single teeth that increases in posterior areas (Del Fabro et al, 2002).

Biomechanical factors linked to temporization methods are often held responsible.

It would therefore be justified with regard to edentulism in the esthetic area, where conditions are favorable, to adopt immediate flapless extraction implantation and to place provisional restorations immediately if primary stability is sufficient.

In addition, the creation of a flap causes trauma to the bony surface by separating it from its periosteum, which results in bone remodeling at the exposed areas. A study by Blanco (2008) compared extraction sites with immediate narrow-diameter implants (3.3 mm) placement, with flap or flapless procedures, in dogs. The histometric results were significant: less bone resorption of the buccal wall occurred when flapless surgery was performed (0.8 mm compared to 1.4 mm with a flap). A more recent study confirmed that resorption may be reduced by avoiding the flap elevation during IEI (Fickl et al, 2008).

It is recommended for these immediate surgical and restorative procedures that the occlusal scheme avoid any contact during closing and above all during lateral excursive movements (Testori et al, 2003). Excessive micromovements – greater than 100 microns for implants with rough surfaces and 30 microns for implants with a smooth surface – that occur during bone healing in the bone/implant contact area can lead to fibrous healing and failure (Szmukler-Moncler et al, 2000). If primary stability is insufficient, bone remodeling is carried out in a progressive manner in stages of osteoblastic or osteoclastic activity in equilibrium, which results in the implant remaining stable during the entire osseointegration period (Schnitman et al, 1997). Schenk (1994) also showed

Clinical case and procedure

1. Case presentation

Mrs S.L. wished to replace some lost teeth in the posterior maxillary area **Fig. 1**. Two implants placed on each side enabled immediate esthetic restorations with provisional crowns; 6 months later the provisional crowns were replaced with porcelain-fused-to-metal restorations fastened to screwretained abutments **Fig. 2 - 5**.

In the light of her positive experience during this first phase of treatment, the patient wanted to improve the esthetic appearance of her central incisors **Fig. 6**. The replacement of the old crowns on 11 and 21 as well as a crown lengthening to position the margins more apically seemed unavoidable. The age of the restorations, the presence of periodontal lesions, the teeth mobility (grade 2), the unfavorable crown-to-root ratio, and the post lengths guided the indication for teeth extractions and implant restorations.

The clinical examination showed that the buccal table was intact at the related teeth, confirming the treatment option. The preimplantation radiographic study confirmed sufficient bone volume, indicating the feasibility of IEI **Fig. 7**.

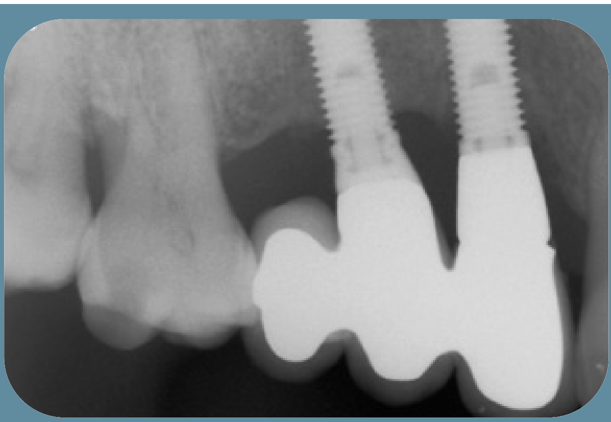

Fig. 2 and 3 Porcelain-fused-to-metal prosthesis bonded onto a Procera zirconia abutment on 13 and a titanium abutment on 14. The seating of 4-mm-diameter NobelSpeedy implants (Nobel Biocare) on 13 and 14 was carried out in line with the available bone volume; 15 is a cantilever unit.

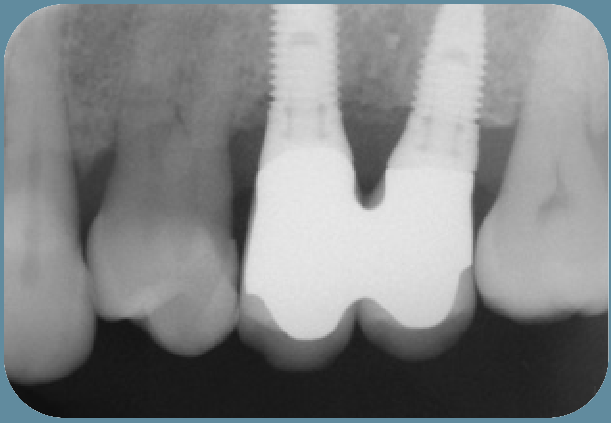

Fig. 4 and 5 Two twin porcelain-fused-to-metal crowns were bonded onto individualized titanium abutments. Note the stability of the marginal bone level after 2 years.

Fig. 6 View of the anterior maxillary area showing its unsightly appearance, and in particular the restorations on 11 and 21. Note also the uneven levels of the necks.

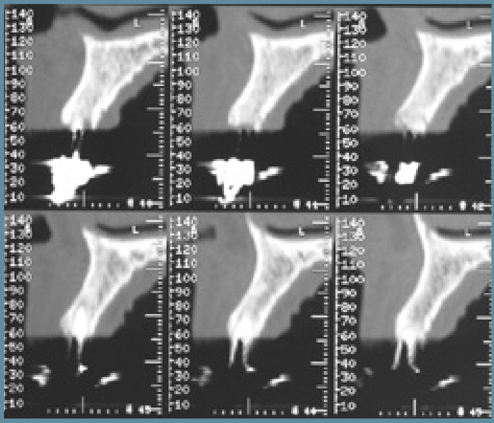

Fig. 7 Coronal cross-sections of a CT scan show bone volume that would allow implants to be placed on the day of extraction.

Fig. 8 Piezoelectric inserts (Mectron) were used to dissect the periodontal ligament fibers and to assist in tooth luxation for an atraumatic extraction.

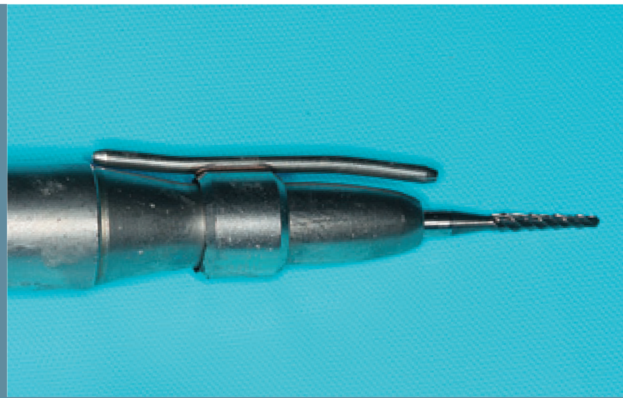

Fig. 9 A fissure bur (Komet) mounted on a handpiece allowed the roots to be cut longitudinally in the buccolingual direction and extracted without exerting pressure on the buccal wall.

Fig. 10 The fragments of roots and the crowns were extracted without damaging the bone walls, in particular the buccal wall, which was often very thin.

Fig. 11 and 12 The alveoli were irrigated with povidone-iodine (Betadine 10%, Meda Pharma SAS) to decontaminate the sites, which might have retained some bacterial load, increasing the potential for reinfection.

2. Atraumatic extraction and socket preparation

After piezoelectric inserts **Fig. 8** were used to dissect the alveolodental ligament, one of the roots was presectioned using a fissure carbide bur mounted on a handpiece **Fig. 9**. The extractions could thus be carried out atraumatically **Fig. 10**. A Lucas curette enabled the removal of all soft tissue remnants on the socket walls; this was followed by abundant irrigation using a povidone-iodine solution (Betadine® green) **Fig. 11, 12**.

3. Drilling procedure

Drilling of the implant site was done through the palatal wall. The guide drill engaged the palatal wall of the alveolus at the level of its apical third, giving it a buccal inclination so as not to slip and avoiding the alveolar long axis **Fig. 13a**. The drilling axis was gradually straightened up until an ideal direction vis-à-vis the future prosthetic emergence was obtained **Fig. 13b**. The recommended orientation stays between the incisal edge and the cingulum of this tooth. Enlargement of the site was carried out using drills of increasing diameter, in accordance with the bone density.

Fig. 13a Guide drill engaging the palatal wall along a buccal axis, thus avoiding it slipping.

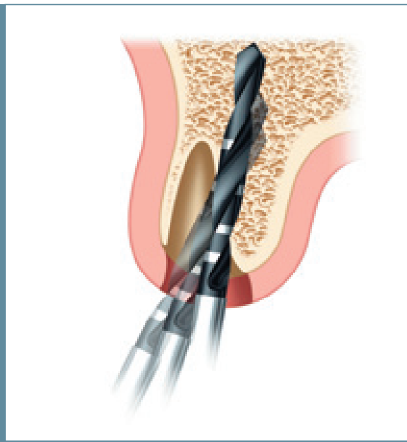

Fig. 13b Gradual straightening of the drill until the ideal axis for the future restoration was achieved.

Fig. 14 A NobelActive implant 4.3 mm in diameter and 13 mm in length (Nobel Biocare) was placed on a punch-handle to be inserted directly into the internal connection of the implant.

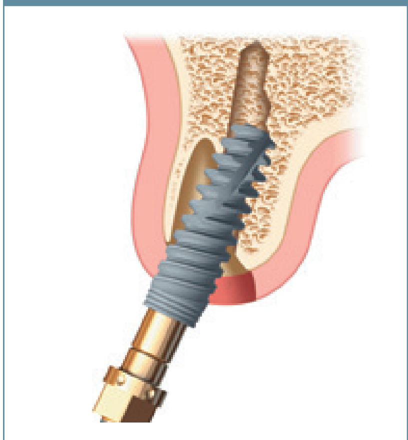

Fig. 15 Placement of the implant in an initially buccal direction, then the axis was straightened until the final position was obtained.

Fig. 16 A manual handle allows accurate adjustment of the final implant position and direction.

4. Placement of NobelActive™ implants

Once the drilling diameter was achieved, the first NobelActive™ implant was attached to the specific implant driver that fitted into the internal hexagon Fig. 14. Its placement was begun with an initial buccal angulation and engaging it in the osteotomy hole Fig. 15; the action was completed by seeking out the ideal axis and seating. The self-cutting properties of the apical part allow maintenance of the ideal predetermined prosthetic axis that could be slightly modified. If placement of the implant had been carried out against the palatal wall in an underdimensioned drill hole, a classical selftapping implant would have a tendency to slip buccally, despite an ideal drilling axis, compromising the final esthetic outcome.

In addition, the possibility of seating this type of implant using a manual handle Fig. 16 enabled the implant axis to be directed more easily and palatal pressure to be exerted, ensuring self-tapping through the palatal wall and thus ensuring ideal placement of the implant. This procedure was repeated in the same way for the adjacent implant.

5. Bone filling and connective tissue enhancement

The diameter of the implant is often smaller than the diameter of the alveolus, creating a crater around the implant, predominantly in the buccal situation. This crater is not incompatible with osseointegration, most probably when this distance is not greater than 1.5 mm. However, regardless of the size of this crater, we recommend filling it with a bovine-derived hydroxyapatite bone substitute (Bio-Oss, Geistlich), a very slow-resorbing material, to maintain the best esthetic buccal contour and to partly compensate for the resorption of the buccal bone wall Fig. 17, 18. In addition, we routinely employ a buccal subepithelial connective tissue graft Fig. 19 in a mucous membrane envelope of split thickness to enhance the resistance of the cervical region to possible recession. This is an adequate approach when facing a thin periodontal biotype. The tuberosity is preferred as the donor site, when possible; alternatively, the palate also constitutes an appropriate and frequently recommended donor site Fig. 20.

6. Placement of provisional abutments and provisional crowns placement

The provisional Quick Temp titanium abutments (Nobel Biocare) were torque-tightened to the implants at 35 Ncm Fig. 21 - 23. A previously prepared provisional acrylic denture is relined on the specific abutment caps Fig. 24. Note the practical tip for optimal seating of the provisional restoration on the abutments by means of acrylic wings as well as the subcontour, designed to favor peri-implant tissue thickening and reduce the risk of recession Fig. 25, 26.

7. Healing and evaluation of the soft tissue environment

A minimum of 3 to 4 months was required before moving on to the final phase. This time was necessary to achieve soft/hard tissue healing and stabilization Fig. 27, 28. Note the preservation of the bone level between the implants and the adjacent teeth at the dental side, and in particular the preservation of the interimplant bone peak, which is more difficult to

Fig. 17 and 18 The alveolus is filled with a low-resorption hydroxyapatite of bovine origin (Bio-Oss, Geistlich), to maintain the best esthetic contour.

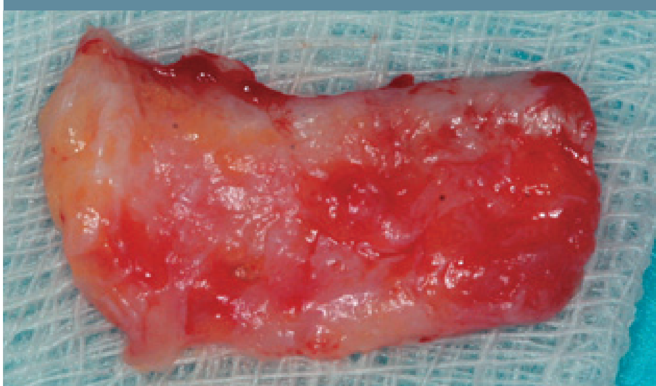

Fig. 19 The connective graft taken from the palate enabled the soft tissues to be thickened buccally, to compensate for an eventual bone resorption and to minimize the risk of recession.

Fig. 20 The palate was the donor site for the connective tissue graft.

Fig. 21 Two provisional tapered abutments (Quick Temp for multiunit provisional cemented solutions) were tightened to the implants on 11 and 21 respectively, at 35 Ncm torque. The cap acted as support for relining the provisional crowns.

Fig. 22 Postoperative view of the implant sites with connected provisional tapered abutments and connective tissue grafts within the inner buccal aspect of a split-thickness flap.

Fig. 23 Postoperative retroalveolar radiograph showing the two implants in place together with the tapered abutments. Note the platform switching between the abutments and the implant collars, as well as the concavity of these abutments, thus ensuring a thicker mucous membrane crimp seal around the implant collars.

Fig. 24 Two provisional crowns were prepared beforehand; two additional wings attached to these shells enabled them to be optimally positioned during relining.

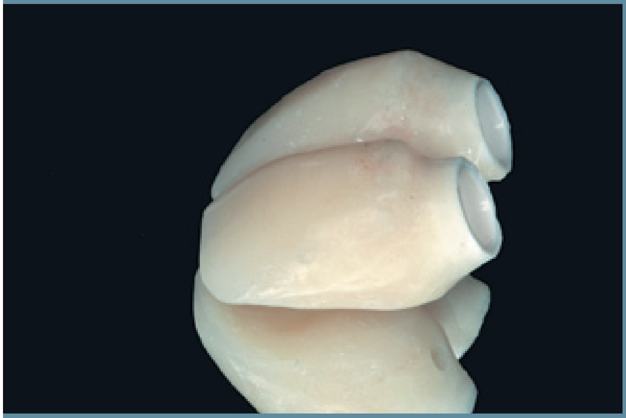

Fig. 25 The two provisional crowns after trimming and polishing.

Fig. 26 Clinical situation on the day the implants were placed. The patient has thus been able to benefit from immediate provisional crowns without having to use a removable prosthesis and wait for healing to have a fixed restoration.

Fig. 27 Healing after 6 months and maturation of the soft tissues. Note the stability of the marginal gingival level compared to the initial stage 6 months previously.

Fig. 28 Retroalveolar radiograph after 6 months showing the stability of the marginal bone level around the implant collars and in particular between the implants. The bone peak is well-maintained; it is the only guarantee of maintaining or restoring the papilla between 11 and 21.

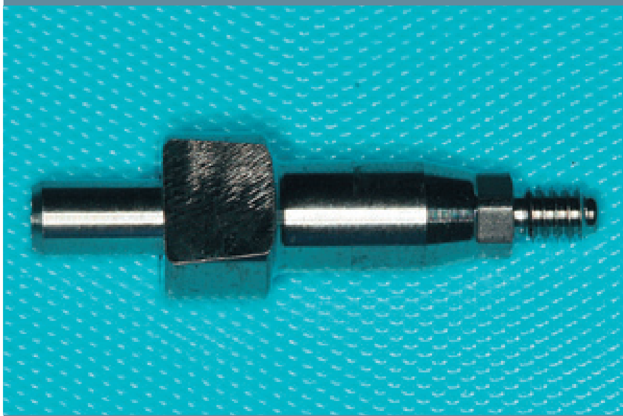

Fig. 29 and 30 The impression copings in place and the control radiograph showing their full insertion. Their form respects the bone morphology that has been guided by the provisional abutments.

Fig. 31 and 32 Two Procera® Zirconia (Nobel Biocare) substructures were created and tried in. Note their similar form and the texture of the peri-implant mucosa.

Fig. 33 Occlusal view of try-in.The emergence of the implants together with their axis enabled two screw-retained crowns to be created directly on the implants. The buccal curve has been well maintained despite the postextraction bone and soft tissue remodeling process.

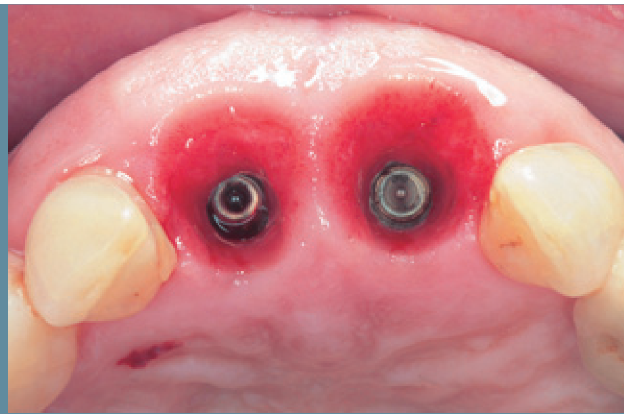

Fig. 34 The provisional crowns allowed the emergence profile around the implants to be worked on and prepared right from the first day.

maintain following extraction of two adjacent teeth. Osseointegration of the implant is clinically confirmed before moving on to the usual restorative phase, which could be performed earlier to improve soft tissue adhesion. The use of a titanium or zirconia scalloped abutment considerably improves the issue health instead of acrylic resin. The advent of the TiUnite surface is also an asset in favor of accelerated bone healing and improved toleration of micromovements following immediate esthetic procedures.

8. Final restorations

An implant-level impression **Fig. 29, 30** was made to produce the master model, from which two individualized Procera® (Nobel Biocare) zirconia substructures were fabricated **Fig. 31 - 34**. Composite restorations on the adjacent teeth were done to adjust a relatively small mesiodistal space. Direct porcelain veneering on the zirconia Procera substructures provides one-piece screw-retained all-ceramic crowns, eliminating multiple assemblies and cementations **Fig. 35**. In addition to the risk of cement encapsulation in the implant sulcus, the retrievability of the restorations represents a very positive advantage of this approach. After biscuit try-in and final glazing **Fig. 36**, the crowns were directly tightened to the implants at 35 Ncm torque **Fig. 37 - 41**.

9. Follow-up and maintenance

An occlusal adjustment was carried out just after the crown placement on the implants; group anterior guidance was sought, then checked after 2 weeks. The patient was then followed up at 3 months and at 1-year intervals thereafter.

Discussion and rationale

The choice of this implant design for this clinical situation was particularly appropriate for several reasons:

- The self-cutting properties of the apical threads enabled maintenance of the preestablished ideal prosthetic axis.
- The condensing properties obtained through the decreasing depth of the threads between the apical and cervical parts of the implant gave it the possibility of primary stability with a low bone height, which is often the case with immediate extraction implantations.
- The diameter of the implant neck being smaller than the body allowed the bone thickness on the periphery to be managed better, in particular buccally, which favors maintenance of the esthetic outcome in the long term.
- The connection of the implant abutments was set back in relation to the exterior collar of the implant

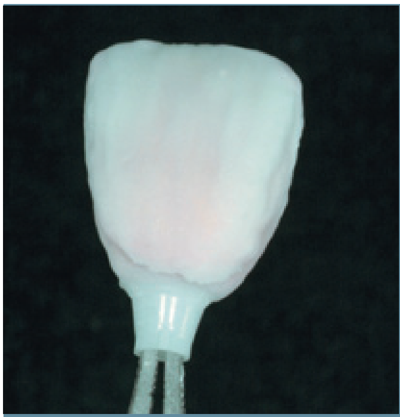

Fig. 35 The porcelain was veneered directly to the zirconia substructures (Ceralor Laboratory, Mr Jean-Marc Étienne).

Fig. 36 Fitting of the biscuit and occlusal view showing soft tissue stability in the horizontal direction.

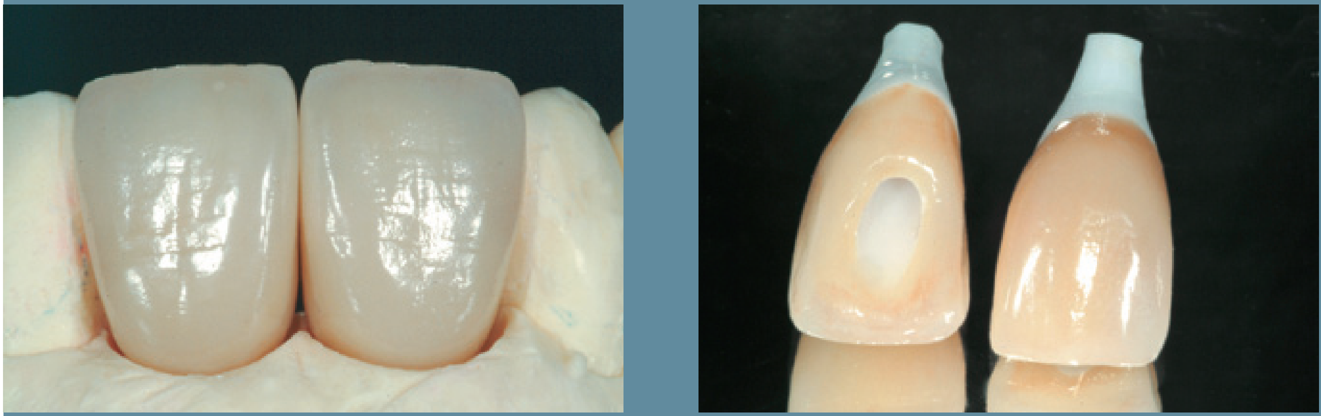

Fig. 37 and 38 Finishing of the crowns in the laboratory. Note their texture and the zirconia tapered and hexagonal connection (Ceralor Laboratory, Mr Jean-Marc Étienne).

and therefore moved toward the center of the implant. The microgap and associated inflammatory infiltrate were also displaced away from the bone, significantly reducing bone resorption (Cappiello et al, 2008). In addition, according to Berglundh and Lindhe (1996), a narrower abutment would enable more biological space to be generated, and would thus limit the bone resorption necessary for the creation of a stable epithelial connective tissue attachment.

- The tapered internal connection enabled the gap at the level of the joint to be reduced, as well as the bacterial colonization associated with it. Germs inducing an immune reaction that is the origin of the chronic inflammatory infiltrate observed in connection with microgap may trigger the activation of osteoclasts (Cochran et al, 2009). This phenomenon is more significant because interventions in esthetic areas encourage submergence of the implant (Buser and Von Arx, 2000). In addition, the combination of an internal cone with an internal hexagon allows for even better stabilization of this joint and facilitation of the abutment seating.

- The stability of this connection seems to guarantee peripheral tissue preservation. Thus the rigidity of this connection should result in an improved response by the tissues. It is therefore essential from a practical point of view, and more particularly in the presence of a thin biotype, to tighten the healing abutments or prosthetic abutments correctly at the implant placement stage. This involves systematic tightening with a torque wrench.

Fig. 39 and 40 The ceramic screw-retained crowns are in place directly on the implants; note the soft tissue contour as well as the integration of the restorations.

Fig. 41 Radiographic check showing the stability of the bone level, notably with respect to the adjacent teeth and in particular between the implants, where the bone peak is clearly maintained.

It is also important to inform the patient that in the case of unscrewing he/she should point this out as quickly as possible, and to remedy this problem as soon as possible to limit the bone loss that could result from this.

- The type of abutments that present concavity at the cervical level seems to favor the creation of a thicker epithelial connective tissue cuff, which is clearly able to provide the necessary connective tissue.

The various factors mentioned here lead to the conclusion that the crestal bone is deemed to be better preserved with this type of implant and associated abutments than with collar forms and more traditional implant abutments. The achievement of stability of esthetic results seems to be better guaranteed in the case of two adjacent implants. This situation is often the most difficult to manage in esthetic areas because the reproduction of the papillae between the implants is very uncertain.

Conclusion

Immediate extraction implantation and immediate esthetic provisionalization with regard to the central incisors enabled us to manage the temporization phase in a neat manner for our patient. We avoided the discomfort of a provisional removable prosthesis for her, as well as the social inconvenience that this could have caused her. This approach allows several treatment phases, which would have meant more chair time and a longer overall treatment time, to be reduced to a single stage. This was an advantage for both the patient and the clinician. The immediate esthetic provisionalization also provides appropriate management of the emergence profiles for a faster soft tissue contouring. In short, the use of NobelActive™ implants in this type of situation seems particularly well indicated with possible ideal seating and overall form, as well as a connection favoring improved bone and soft tissue healing at the cervical level, compared to more classical implant designs. Controlled studies with greater scope should confirm these results.

Thanks

to Dr Dora Dely Daly for her help in preparing this work.

REFERENCES

1. *Antoun H, Guillot AE. Extraction, implantation, temporisation immédiates dans les secteurs esthétiques. Revue de la littérature. J Parodont implant orale 2007;26:303-320.*
2. *Araujo MG, Sukekava F, Wennstrom JL, Lindhe J. Ridge alterations following implant placement in fresh extraction sockets: an experimental study in the dog. J Clin Periodontol 2005;32:645-652.*
3. *Atwood D. Post-extraction changes in adult mandible as illustrated by micrograph of midsagittal section and serial cephalometric roentgenograms. J Prosthet Dent 1963;13:810-824.*
4. *Berglundh T, Lindhe J. Dimension of the periimplant mucosa. Biological width revisited. J Clin Periodontol 1996;23(10):971-3.*
5. *Blanco J, Nunez V, Aracil L, Munoz F, Ramos I. Ridge alterations following immediate implant placement in the dog: flap versus flapless surgery. J Clin Periodontol 2008;35:640-648.*
6. *Bragger U, Pasquali L, Komman KS. Remodeling of interdental alveolar bone fater periodontal flap procedures assessed by means of computer assisted densitometric image analysis (CADIA). J Clin Periodontol 1988;15:558-564.*
7. *Buser D, Von Arx T. Surgical procedures in partially edentulous patients with ITI implants. Clin Oral Implants Res 2000;11. Suppl 1:83-100. Review.*
8. *Camargo PM, Lekovic V, Weinlaender M, et al. Influence of bioactive glass on changes in alveolar process dimensions after exodontia. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2000;905:581-586.*
9. *Cappiello M, Luongo R, Di Iorio D, Bugea C, Cocchetto R, Celletti R. Evaluation of peri-implant bone loss around platform-switched implants. Int J Periodont Rest Dent 2008;28(4):347-55.*
10. *Cardaropoli G, Araujo M, Havacibara R, Sukekava F, Lindhe J. Healing of extraction sockets and surgically produced – augmented and non-augmented – defect in the alveolar ridge. An experimental study in the dog. J Clin Periodontol 2005;32:435-440.*
11. *Carlsson H, Thilander H, Hedegard H. Histologic changes in the upper alveolar process after extractions without insertion of an immediate full denture. Acta Odontol Scand 1966;65:22-43.*
12. *Cochran DL, Bosshardt DD, Grize L, Higginbottom FL, Jones AA, Jung RE, Wieland M, Dard M. Bone response to loaded implants with non-matching implant-abutment diameters in the canine mandible. J Periodontol 2009;80(4):609-17.*
13. *Del Fabbro M, Testori M, Francetti L, et al. A meta-analysis on survival rate of immediately loaded implants. Clin Oral Impl Res 2002;13:XXIV (abstract n° 60).*
14. *Ericsson I, Nilson H, Lindhe T, Nilner K, Randow K. Immediate functional loading of Brånemark single tooth implants. Clinical Oral Implant Research 2000;11:26-33.*
15. *Fickl S, Zuhr O, Wachtel H, Bolz W, Huerzeler M. Tissue alterations after tooth extraction with and without surgical trauma: a volumetric study in the beagle dog. J Clin Periodontol 2008;35(4):356-63.*
16. *Ganales J, Wismeijer D. Early and immediately restored and loaded dental implants for single-tooth and partial-arch applications. Int J Oral Maxillofac Impl 2004;19:92-102.*
17. *Iasella JM, Greenwell H, Miller RL, et al. Ridge preservation with freezedried bone allograft and a collagen membrane compared to extraction alone for implant site development: A clinical and histologic study in humans. J Periodontol 2003;74:990-999.*
18. *Jemt T. Restoring the gingival contour by means of provisional resin crowns after single-implant treatment. Int J Periodont Rest Dent 1999;19:20-29.*
19. *Schenk RK. Bone regeneration: biologic basis. Guided Bone Regeneration in Implant Dentistry. Quintessence 1994:49-100.*
20. *Schnitman PA, Wohrle PS, Rubenstein JE, Da Silva JD, Wang NH. Ten year for Brånemark implants immediately loaded with fixed prostheses at implant placement. Int J Oral Maxillofac Implants 1997;12:495-503.*
21. *Schropp L, Wenzel WE A, Kostopoulos L, Karring T. Bone healing and soft tissue contour following single tooth extraction: a clinical and radiographic 12-month prospective study. Int J Periodont Rest Dent 2003;23:313-323.*
22. *Schulte W, Kleineikenscheidt H, Linder K, Schareyka R. The Tübingen immediate implant in clinical studies. Dtsch Zahnärztl Zeitschr 1978;33:348-359.*
23. *Szmukler-Moncler S, Piatelli A, Favero GA et al. Considerations preliminary to the application of early and immediate loading protocols in dental implantology. Clin Oral Implants Res 2000;11:12–25.*
24. *Testori T, Bianchi F, Del Fabbro M, Szmukler–Moncler S, Francetti L, Weinstein RL. Immediate non occlusal loading vs. Early loading in partially edentulous patients. Pract Proced Aesthet Dent 2003;15:787-794.*
25. *Wagenberg B, Froum SJ. A Retrospective Study of 1925 Consecutively Placed Immediate Implants from 1988 to 2004. Int J Oral Maxillofac Implants 2006;21:71-80.*

Hadi Antoun - Pierre Cherfane

11 bis, avenue Mac-Mahon
75017 Paris - France
E-mail : hadi@antoun.fr