Parameters of Peri-Implant Aesthetics

17

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Abstract

Aim: The goal of the following is intended to provide a comprehensive overview of state-of-the-art peri-implant tissue management. This should empower the clinician to choose the most suitable method of implant therapy for a particular patient depending on the clinical findings, the tissue type, and his/her own surgical experience.

Summary: Over the past 50 years, implantology has evolved from an experimental treatment modality into a safe and effective method in dentistry. Today, in addition to osseointegration, aesthetics play a more and more important role including both white and pink aesthetics. The latter is controlled by an elaborate soft tissue management. This starts at the stage of tooth extraction and is perpetuated to the point of recall in the maintenance treatment. However, preserving marginal peri-implant tissues is more than adding improved aesthetics to successful osseointegration; vice versa, a state-of-the-art soft tissue management contributes to maintaining overall functional health and stability in the long term.

Key learning points: It is understood that bone thickness is a major factor in dental implantology. In addition, the periodontal soft tissue biotype should be given attention, as it is decisive for peri-implant soft tissue *and* bone stability. For example, an implant requires around itself 3 mm of tissue height/thickness and 3 mm of attached gingiva to allow for the buildup of a sufficient biological width; an initially thin biotype tissue will even compromise the buccal plate thickness. As a rule, minimally invasive surgical methods should be employed as well as abutment/crown designs for maximally tender soft tissue manipulation.

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17.1 Introduction

Implant dentistry is a symbiosis between art and science.

The art is to visualize the end result of the patient's face, on the other hand, to enable to restore on implants in detail the same precise architecture of the bony structures, soft tissues, and teeth. The structures and aesthetics created in this way should also stay stable and perfectly functional in time.

This means that today, we do not talk about osseointegration success, we talk about aesthetic success.

The art of the tissue reconstruction is to be able to implement the information from the biology, literature, and technologies and constantly implement them into our daily workflow. The philosophy of the treatment should be as follows: Choose the most minimally invasive and effective procedures and techniques, which lead to the maximal aesthetic success.

The evaluation and classification of the aesthetic success of the treatment will be made today by the white aesthetic score (WES) and pink aesthetic score (PES) (Belser 2009) (Fig.17.1). The criteria of the pink aesthetic score were developed by Fürhauser et al. (2005), while the white aesthetic score was defined by Belser et al. (2009).

17.2 Tooth Extraction

Tooth extraction is a traumatic procedure often resulting in immediate destruction and loss of alveolar bone and surrounding soft tissues (Caplanis et al. 2005). The amount of the resorption and residual volume is depending on the general health situation, while the factors which influence the

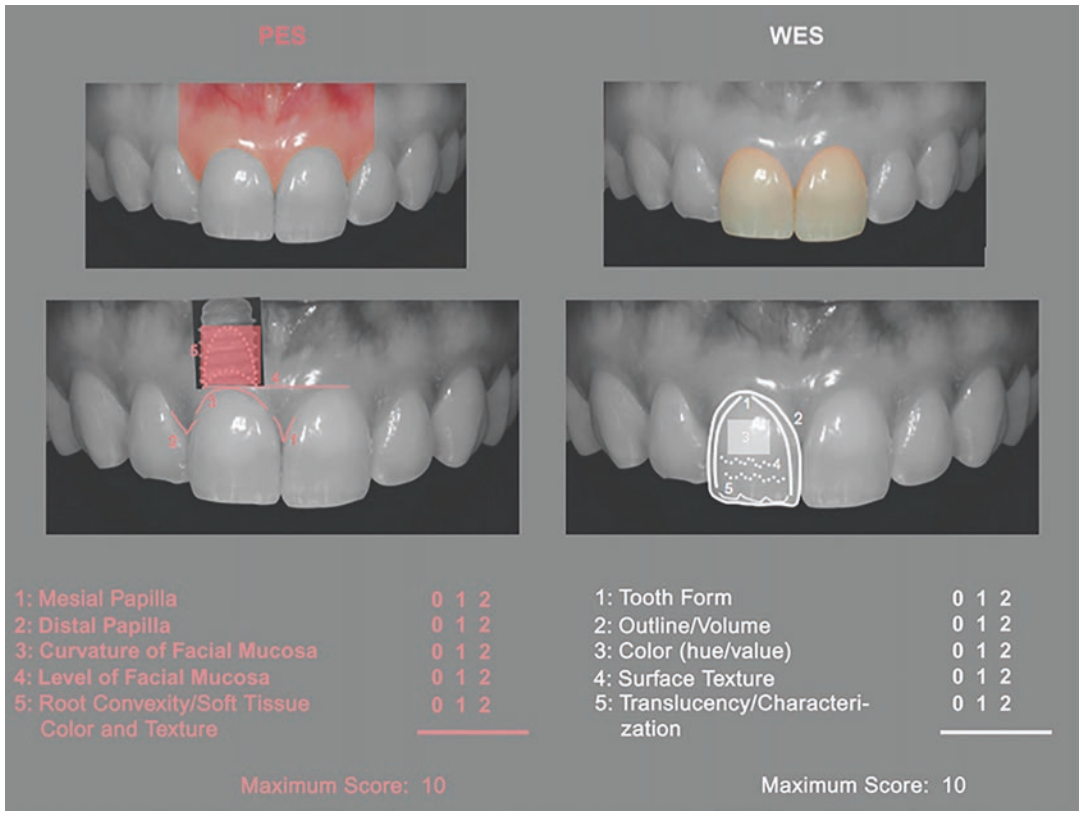

Fig. 17.1 The evaluation of the *pink* and *white* aesthetic score according to Fürhauser and Belser. The authors are showing that, under certain conditions, the volume and structure of the oral tissues stay stable in 95% of the cases in a range of 5–9 years (Buser et al. 2013)

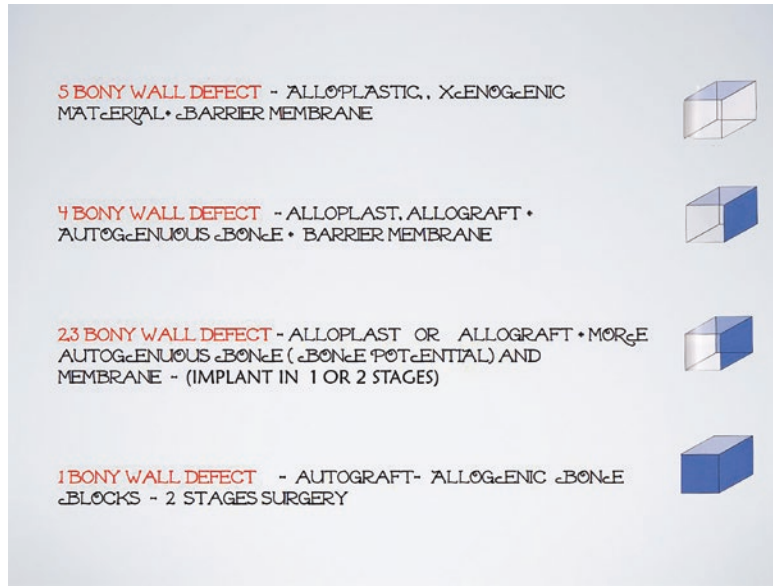

Fig. 17.2 Defect grafting philosophy

wound healing should be considered. A detailed dental history and thorough understanding of the pathology leading to the extraction are vital to the assessment and management of the extraction defect.

A detailed aesthetic analysis of the previous tooth should be performed, including photo and video documentations. This should reveal a variety of anomalies of the anatomical structure which are present.

The periodontal assessment should document the periodontal biotype; probing depths; amount of attached gingiva; recession; mobility; furcation involvement, as well as the presence of plaque, including the extent of inflammation; and bleeding on probing.

A subject of particular concern during the periodontal evaluation is the periodontal biotype.

Protective techniques are necessary to extract the tooth using microsurgical instruments (periotomes and other special extraction tools) and minimally invasive procedures, in order to save and protect all 8 of the major gingival fibers, which are needed for predictable healing.

Careful assessment of the extraction defect is therefore paramount to the success of aesthetic implant procedures. Extraction defect assessments can be made with or without flap reflection.

Following tooth extraction, a visual inspection of the socket bony walls is initially performed, whereas the buccal wall has the main importance for the aesthetic outcome.

The grafting of the socket/bone defect for a volume as well as for form maintenance should follow these rules.

The more bone that is initially missing:

- The more volume of bone graft has to be added.
- The more vascularization you have to promote into the graft.
- The more form maintenance has to be achieved through an appropriate membrane technique (Fig. 17.2).

17.3 Peri-Implant Tissue Histology and Modifications After Extraction

Clinical guidelines suggest that a minimal buccal alveolar bone thickness of 1–2 mm is required to maintain the tissue architecture following tooth extraction and implant placement (Vera et al. 2012). The buccal plate is a bundle bone which is connected to the tooth and therefore is prone to resorption after the extraction, and implant placement alone is able to maintain this bone.

It is generally accepted that the placement of an implant immediately after tooth extraction

fails to prevent the bone remodeling process that occurs mainly at the buccal bone plate after losing one tooth.

The studies which evaluate the impact of immediate implant placement on the bone healing dynamics have reported heterogeneous results, with a mean resorption (mm) of the buccal bone plate ranging from 0.5mm to 3.14mm. This high variability may be explained by the use of different preclinical models, different healing times, different implant diameters and their respective geometries, as well as varying surgical protocols. The aim is to have a minimum of resorption and volume loss of the tissues. Therefore, certain protocols are established.

17.3.1 Immediate Implant Placement and the Added Grafting Philosophy

Immediate implant placement is a well-documented procedure, with a high aesthetic success rate under certain conditions and parameters.

The skills and knowledge of the clinician are decisive for using these principles and techniques. If the skills and experience are not complete, the clinician should take one step back and choose a more conservative method (two-stage surgery, grafting, implant placement instead of immediate placement and loading).

17.3.2 Immediate Loading/ Immediate Restoration

Immediate loading/immediate restoration is a very predictable procedure, also well documented in the literature (Capelli et al. 2013; Misch et al. 2004; Schnitman et al. 1997; Tarnow et al. 1997; Misch 1998a, b; Wohrle 1998; Schwartz-Arad and Chaushu 1999).

According to the well-accepted immediate loading definition and to consensus conference results (Wang et al. 2006), immediate loading is defined on one/more implants in a single tooth restoration/partially edentulous situation as a provisional crown/bridge which is placed on an implant, in infra-occlusion. The immediate full-arch restoration is a provisional splinted bridge and the requisite diet limited to only soft food for the duration of osseointegration (8–10 weeks).

The conditions for an implant immediately placed in an extraction socket to be immediately loaded are:

- Primary stability (35 Ncm resistant to insertional torque).
- Ideal ISQ value.
- Three-fourths of the surface of the implant should be covered by bone.
- Grafting of the gap.

In clinical cases in which the distance between implant surface and the buccal plate is <4 mm, the combination of internal and external grafting (IEG) is recommended to maintain the volume and the contour of the ridge and achieve a successful aesthetic outcome.

The second-stage surgery is a predictable procedure.

On the path of a minimally invasive surgery, based on less surgical sessions, but aiming for a best aesthetic outcome, we can perform the following grafting and implant placement.

Today, the bone-grafting procedure, additionally to the implant, is tissue thickness typology oriented (Fig. 17.3).

17.3.3 Ideal Socket Situation

In thick tissue types, a flapless approach may be considered. Without raising the flap, this procedure is considered to be minimally invasive. Immediate implant placement and immediate loading can give a predictable aesthetic result. In thin tissue biotype (tissue thickness <2 mm), a connective tissue graft will be added in an envelope or tunneling technique (Fig. 17.4).

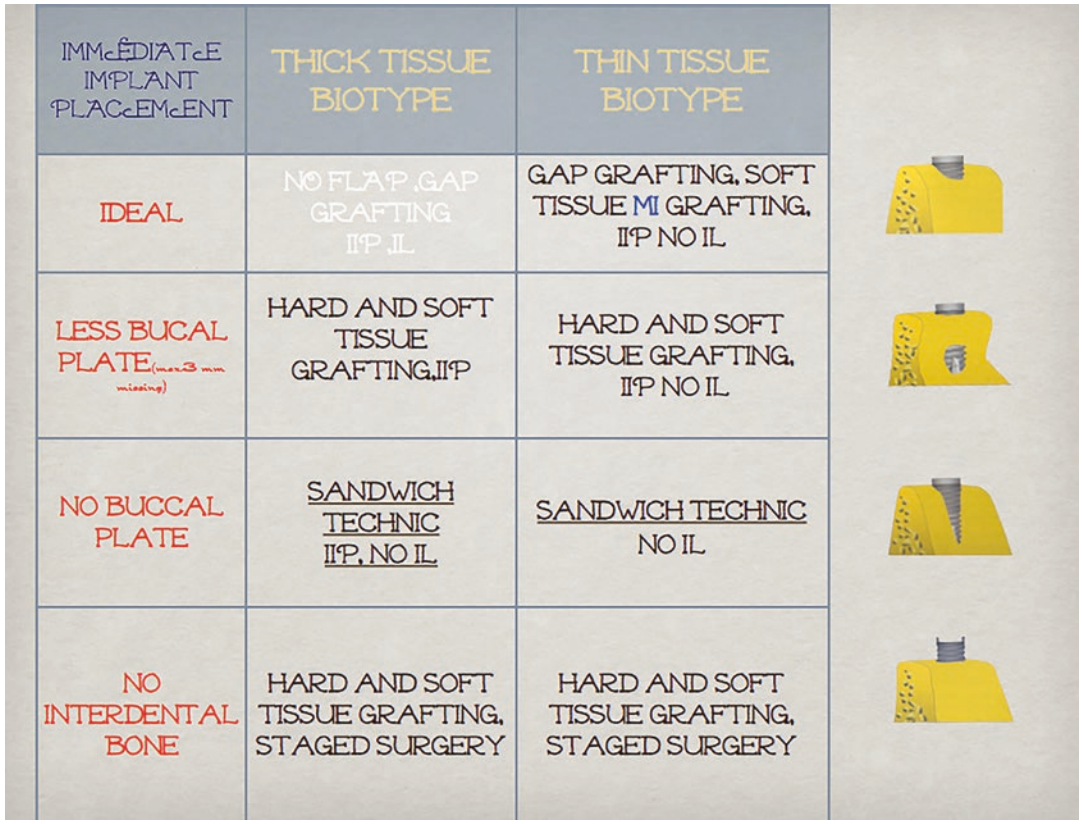

Fig. 17.3 *IP* immediate placement, *IL* immediate loading, *MI* minimally invasive. That is why the measurement of the thickness of the tissue prior to the surgery is an important step for the soft tissue grafting technique, long-term aesthetic, and tissue stability success of the implant treatment

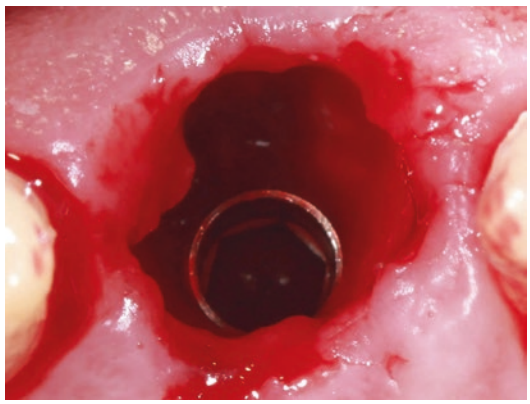

Fig. 17.4 Immediate implant placement in extraction socket. The position of the implant and thick tissue biotype gives the predictability to an aesthetic result

17.3.4 When 3–4 mm Buccal Bone Is Missing

Immediate implant placement is possible; however, immediate loading will not produce as predictable an aesthetic result, even in thick tissue phenology (Cabello et al. 2013).

Grafting both the gap between the implant fixture and the buccal plat of bone and the covering soft tissue are mandatory. The soft tissue grafting is recommended to be done with membranes which can at the same time protect the graft and keep it in form. A connective tissue won't be able to protect the graft; it will rather integrate partly with the grafting, partly with the flap (Fig. 17.5).

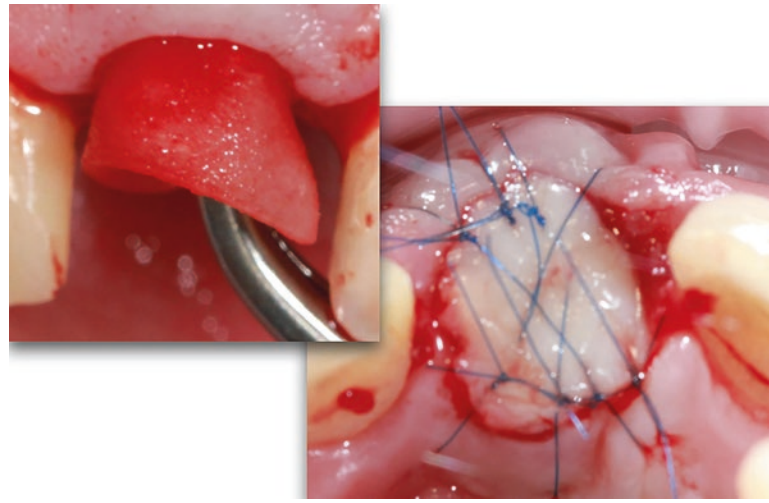

Fig. 17.5 Buccal defect of 3.4 mm will be grafted and covered by membrane, immediate implant placement is possible, and a closed healing will be a better solution for a more predictable aesthetic outcome. The inlay socket seal graft gives one of the best solutions to close the implant site, if more than 3 mm buccal plate is missing

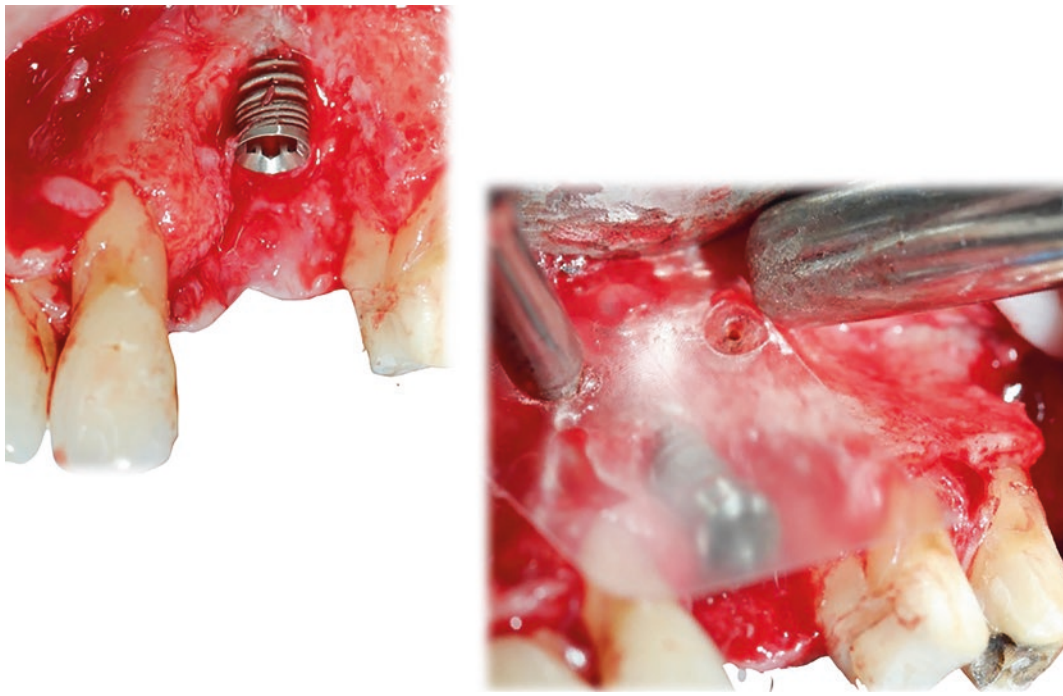

Fig. 17.6 Sandwich technique and a formed long-term stable membrane

When more than 3.4 mm of the buccal plate is missing, a simultaneous implant placement and bone grafting is performed which follows the sandwich technique. A stable membrane is required to maintain the space required for angiogenesis. This technique was first described by Hom-Lay Wang (Fu and Wang 2011) (Fig. 17.6).

17.3.5 Vertical Interdental Bone Loss

Currently, the literature shows that on average, until there is a maximum of 4 mm of bone loss, particulate material (synthetic, bovine, human) can be used for the vertical grafting, sometimes even simultaneously positioned with implant placement. This decision depends on the:

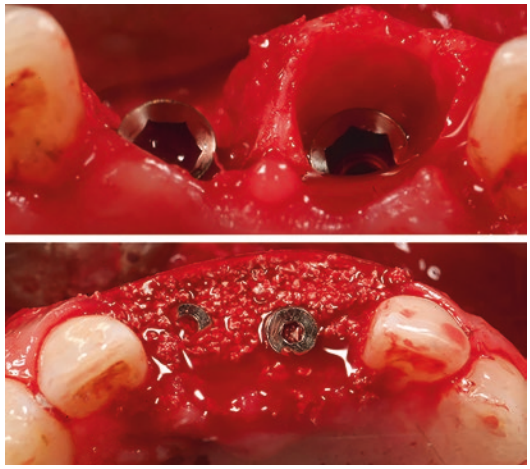

Fig. 17.7 Vertical and horizontal bone grafting with particulate material

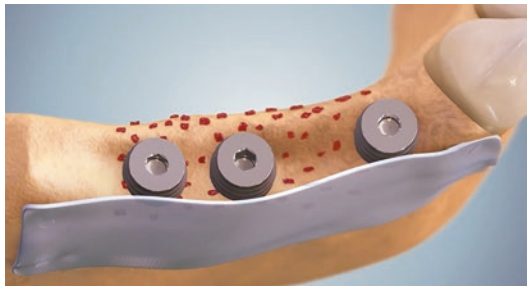

Fig. 17.8 Space maintenance quality of a membrane/bony wall

Fig. 17.9 Grafting with particulate material for enough bone potential (autogenous bone, growth factors, BMPs, vascularization has to be taken care of)

- Architecture of the defect
- Quality (bone potential) of the host bone
- Grafting envelope/space maintenance quality of the used membranes/techniques (Figs. 17.7, 17.8, and 17.9)

17.4 Peri-implant Tissue Reconstruction Techniques and Principles for Achieving Ideal Aesthetics

The structures to be maintained/rebuilt around implants are:

1. *Buccal plate thickness* and level of the interdental bone

   The buccal plate is a bundle bone connected to the tooth and will resorb horizontally and vertically with the extraction of the tooth (Araújo and Lindhe 2005). That is we try to maintain this bone by means of grafting of the gap with a non-resorbable material. The additional grafting of the soft tissues is performed in order to protect the bone resorption, by the formation of the biological width (Cochran et al. 1997).
2. *Soft tissue biotype*

   Linkevicius (Linkevicius et al. 2013) shows in contemporary studies what also Cochran pointed out in 1997. The tissues and dimension of these structures around teeth are very different than those around implants. The implant has a structure around it, specifically a peri-implant biological width. This is the composition of epithelial attachment, sulcus and connective tissue. And it extends to 3 mm, in average. When the tissues have a height/thickness of 3 mm, this soft tissue structure will be maintained, and the buccal plate will stay at the same level. If the initial tissues are with thin biotype (<2 mm), the biological width will be built on the cost of the bone loss. In conclusion, the tissue biotype is decisive for a peri-implant bone and soft tissue stability. Studies give evidence that the soft tissue biotype is essential for conserving aesthetic and functional stability of the peri-implant tissues. Any loss of more than 1 mm of tissue height/thickness causes a visual discolouration of the tissues (Linkevicius 2013).

In average, based on studies and literature, we can resume that an implant needs:

Three millimeters of tissue height
Three millimeters of tissue thickness

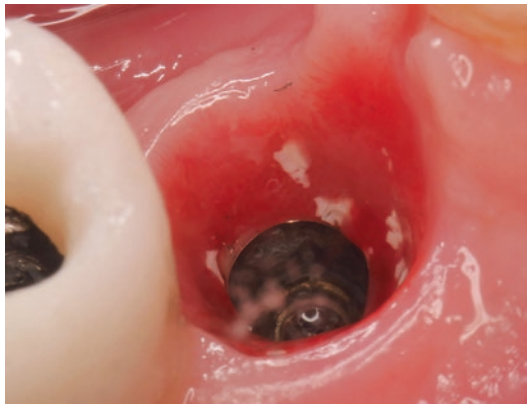

Fig. 17.10 Minimum 3–3.5mm tissue height

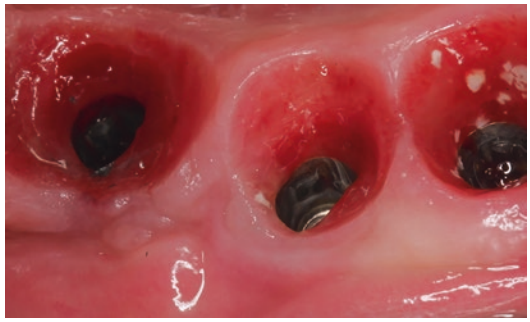

Fig. 17.11 Minimum 3 mm tissue thickness, otherwise there are discolorations

Three millimeters of attached gingiva around implants (Berglundh and Lindhe 1991, Hermann et al. 2007, Tarnow et al. 2000) (Figs.17.10, 17.11, and 17.12)

3. *Implant position*

Parameters of ideal implant positions, predicting an ideal aesthetic outcome are:

- Two millimeters from the buccal level of the tissues. Nevertheless, grafting the gap between the implant and the buccal plate with bone substitute and grafting the tissues with connective tissue graft/membrane soft tissues will give us a distance of 4 mm from the buccal plane, which seems to prevent the most tissue loss and to give the maximum of volume stability (Capelli et al. 2013) (Fig. 17.13).

Implant design is essential for many reasons and relates to various aspects.

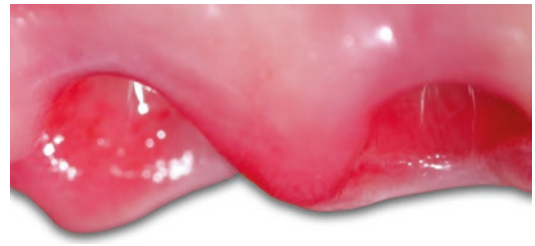

Fig. 17.12 We need at least 3 mm of attached gingiva around implants

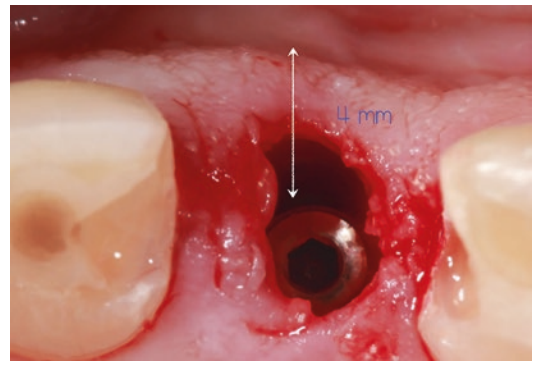

Fig. 17.13 Preventing the most tissue loss giving the maximum of volume stability (Capelli et al. 2013)

17.4.1 Collar Design

Older generations of implants showed a bone loss at the collar. In order to prevent bone and tissue loss, newer designs were implemented: rough surface on the shoulder of the implant, no polished collar, insertion technique under the level of the bone and special designs and textures at the collar of the implant or prosthetic parts (Norton 2013).

17.4.2 Platform Switching

A study of Hermann et al. (2001) shows that a micro-motion and bacterial endotoxins during masticatory forces may cause bone loss which occurs around implants. Platform switching/platform shifting design is employed to move the microgap from the position of the implant shoulder to a more medialized position. This seems to

be beneficial for the bone level maintenance. A minimal platform switching of 0.45 mm seems to be enough to have this positive effect. In platform switching design implant concepts, bone loss will be reduced from 1.4–1.6 to 0.6 mm; this is supported by several articles confirming this beneficial effect (Al-Nsour et al. 2012).

17.4.3 Implant Connection

It is well accepted that a rigid implant connection will avoid micro-motion, screw loosening and eventually bacterial colonization. Therefore, using designs with a rigid connection seems to contribute to the maintenance of the bone level (Schmitt et al. 2014; Mangano et al. 2014a, b).

17.4.4 Surgical Technique

The most predictable situation in terms of volume maintenance, where we have the highest expectance of a natural outcome of the restoration on implants similar to the natural teeth, includes immediate implant placement, immediate loading, grafting of the gap, grafting of the soft tissue and immediate restoration with a provisional crown, ideally screw-retained. This is a conclusion of a multicenter study (Fig. 17.14) (Chu et al. 2012).

In other situations, where we need to raise a flap or to create an access point to facilitate a bone or soft tissue graft, we stay as minimally invasive as possible, at the same time not compromising the success of the grafting. These approaches require a sound knowledge of the bony and tissue structures and processes, advanced surgical skills and the creativity to be minimally invasive and create maximal aesthetic results.

It is important to design and execute the flap elevation in such a manner that it will preserve the hard and soft tissue environment in the manner which it existed prior to the implant placement procedures.

Principles:

(a) Avoid vertical releasing incisions, if possible, in the aesthetic zone. Vertical incisions may create a depression in the tissues, which, because of the lack of elastic fibers, will not have the same appearance as the adjacent soft tissue structures.
(b) Prefer incisions which are out of either the aesthetic zone or innovative grafting techniques as tunneling technique versus the more common envelope technique.

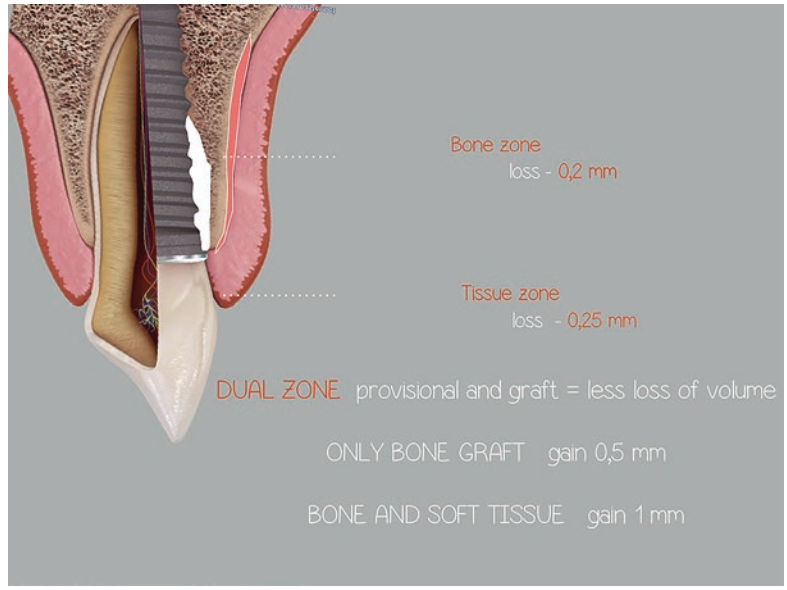

Fig. 17.14 Bone and soft tissue graft, provisional immediate restoration will avoid volume loss

(c) Prefer bone grafting methods which facilitate, with less invasive procedures (no secondary surgical field), less surgical sessions (simultaneously with implant placement) and the best aesthetic results. This is the art in contemporary implant dentistry.
(d) The suturing techniques and material selection are of primary importance. They give way to a traumatic suture using techniques that, advancing the flap coronally, facilitate to achieve the width and thickness as well as the height of the tissues required around implants in the first surgical session.

17.4.5 Provisional Abutment/ Provisional Crown

With every removal of the abutment, more than once, a certain volume of the surrounding structures will be lost (Rodríguez et al. 2013) through a destruction of the collagen fibers' adherence to the prosthetic collar. Therefore, techniques, procedures, or systems, which offer the possibility to avoid abutment disconnection using an individual final abutment from the very first or using the provisional abutment as a tool for impression coping or others, should be a criterion of choice. A concave profile of the running room, as well as a platform switching design of the provisional abutment, will create/maintain the tissue volume created (Fig. 17.15).

17.4.6 Final Abutment Design

It seems to have a decisive effect on the aesthetic success but also on the maintenance of the tissue volume, the papilla length, and the color. Many articles are confirming that a concave abutment design will conserve the tissue volume gained. Changing the emerging profile angle in the inter-implant space to a slight convex one, the papilla might gain 0.5 mm length. Several case studies show the possibility of gaining papilla length through manipulating and sculpting the gained peri-implant tissues and emergence profile of the final abutment and crown (Redemagni et al. 2009; Su et al. 2010; Lerner et al. 2012). The color of the abutment should be white, because according to a study, the human eye will notice the difference between a white and a black abutment (Fig. 17.16).

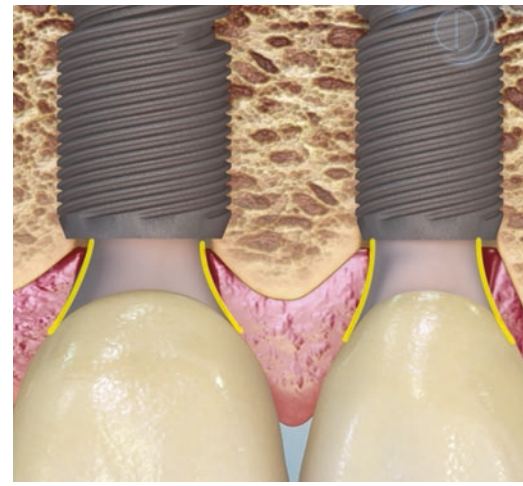

Fig. 17.15 Maintaining the tissue volume created using a concave profile of the running room

Fig. 17.16 *Black* or *white* abutment: The human eye will see the difference

17.4.7 Maintaining the Health and Volume of the Peri-implantary Tissues

Peri-implantitis is an inflammatory disease of the tissues surrounding the implant. This seems to be, today, the disease process which destroys through bacterial infection, inflammation, and subsequent bone loss the stability and health of the implant gingival and bony complex. Our purpose is to find solutions for preventing bone loss and infection. Cement in the sulcus around the restorative components (abutment and crown) seems to be one of the main reasons for this inflammatory process (Linkevicius et al. 2013). The solution and recommendation would be to place the cement margin at a maximal depth of 0.5 mm under the free gingival margin and cement using retraction cords in a manner similar to the cementation process of veneers. These will facilitate direct vision of residual retained cement in the sulcus environment.

The other option is a screw-retained restoration. This should be most preferred when the screw is not at a visible part of the tooth such as the incisal edge or on the direct facial surface.

In molar region, there are the same two options depending on the cleansability of the interdental spaces.

In the lateral zone, the maximal implant diameter is 4.3–5 mm. The mesio-distal dimension of the tooth is 10–12 mm. If the implant has been inserted deep enough in order to come out to an aesthetic gingival level, this will be the ideal situation to design the margin of the crown at an equigingival position (Fig. 17.17).

If the position of the implant is so near to the crestal bone, that an emergence profile would be too short to compensate the wide molar, then a screw-retained crown will be made in order to be able to clean professionally from time to time. This is preferred if the restoration has a ridge-lap modification to it.

Fig. 17.17 Design and margin of the crown in the lateral zone

The materials, which seem to have the best affinity to the gingiva, are zirconia and e.max ceramics, which are the materials of choice in all restorations (Yamane et al. 2013). There is no singular "aesthetic zone," rather we consider the whole oral environment as an aesthetic zone.

Conclusion

Creating the necessary peri-implant tissues requires a profound scientific knowledge and understanding of the structures and processes in charge. To create this environment, a comprehensive, fast, effective but at the same time an aesthetic surgical and prosthetic concept and treatment are necessary including the protection of the existing tissues.

You need:

- A stable and aesthetic volume of bone around implants
- A stable soft tissue environment, i.e., 3 mm gingival height, 3 mm gingival thickness, and 3 mm attached gingiva around implants
- Tender manipulation of the soft tissues by creating the provisional/final abutments/crowns to get to the end result

Maintaining the peri-implant tissues is the best opportunity for long-term aesthetic and functional health and stability of the implant and reconstruction (Case 17.1 (Figs. 17.18 and 17.19), Case 17.2 (Figs. 17.20 and 17.21)).

Case 17.1

Fig. 17.18 Peri-implant tissues created

Fig. 17.19 Final abutments and crowns

Case 17.2

Fig. 17.20 Adjacent implants, tissue requirements fulfilled

Fig. 17.21 Final aesthetic result pleasing the patient

References

Al-Nsour MM, Chan HL, Wang HL (2012) Effect of the platform-switching technique on preservation of peri-implant marginal bone: a systematic review. Int J Oral Maxillofac Implants 27(1):138–145

Araújo MG, Lindhe J (2005) Dimensional ridge alterations following tooth extraction. An experimental study in the dog. J Clin Periodontol 32(2):212–218

Belser UC, Grütter L, Vailati F, Bornstein MM, Weber HP, Buser D (2009) Outcome evaluation of early placed maxillary anterior single-tooth implants using objective esthetic criteria: a cross-sectional, retrospective study in 45 patients with a 2- to 4-year follow-up using pink and white esthetic scores. J Periodontol 80(1):140–151. doi:10.1902/jop.2009.080435

Berglundh T, Lindhe J (1991) Soft tissue barrier at implants and teeth. Clin Oral Implants Res 2:81–90

Buser D, Chappuis V, Bornstein MM, Wittneben JG, Frei M, Belser UC (2013) Long-term stability of contour augmentation with early implant placement following single tooth extraction in the esthetic zone: a prospective, cross-sectional study in 41 patients with a 5- to 9-year follow-up. J Periodontol 84(11):1517–1527. doi:10.1902/jop.2013.120635 Epub 2013 Jan 24

Cabello G, Rioboo M, Fábrega JG (2013) Immediate placement and restoration of implants in the aesthetic zone with a trimodal approach: soft tissue alterations and its relation to gingival biotype. Clin Oral Implants Res 24(10):1094–1100

Capelli M, Testori T, Galli F, Zuffetti F, Motroni A, Weinstein R, Del Fabbro M (2013) Implant-buccal plate distance as diagnostic parameter: a prospective cohort study on implant placement in fresh extraction sockets. J Periodontol 84(12):1768–1774. doi:10.1902/jop.2013.120474 Epub 2013 Mar 8

Caplanis N, Lozada JL, Kan JYK (2005) Extraction defect assessment, classification, and management. CDA J 33(11):853–863

Chu SJ, Salama MA, Salama H, Garber DA, Saito H, Sarnachiaro GO, Tarnow DP (2012) The dual-zone therapeutic concept of managing immediate implant placement and provisional restoration in anterior extraction sockets. Compend Contin Educ Dent 33(7):524–532 534

Cochran DL, Hermann JS, Schenk RK, Higginbottom FL, Buser D (1997) A histometric analysis of the implant-gingival junction around unloaded and loaded nonsubmerged implants in the canine mandible. J Periodontol 68:186–198

Fu JH, Wang HL (2011) Horizontal bone augmentation: the decision tree. Int J Periodontics Restor Dent 31(4):429–436

Fürhauser R, Florescu D, Benesch T, Haas R, Mailath G, Watzek G (2005) Evaluation of soft tissue around single-tooth implant crowns: the pink esthetic score. Clin Oral Implants Res 16(6):639–644

Hermann JS, Schoolfield JD, Schenk RK, Buser D, Cochran DL (2001) Influence of the size of the microgap on crestal bone changes around titanium implants. A histometric evaluation of unloaded non-submerged implants in the canine mandible. J Periodontol 72(10):1372–1383

Hermann F, Lerner H, Palti A (2007) Factors influencing the preservation of the peri-implant marginal bone. Implant Dent 11:162–169

Lerner H, Jacobson Z, Flax H (2012) Modified clinical approach for improved aesthetics in full-arch restoration. Cosmet Dent 4:34–37

Linkevicius T, Puisys A, Vindasiute E, Linkeviciene L, Apse P (2013) Does residual cement around implant-supported restorations cause peri-implant disease? A retrospective case analysis. Clin Oral Implants Res 24(11):1179–1184

Mangano C, Iaculli F, Piattelli A, Mangano F (2014a) Fixed restorations supported by Morse-taper connection implants: a retrospective clinical study with 10–20 years of follow-up. Clin Oral Implants Res 00:1–8. doi:10.1111/clr.12439

Mangano F, Macchi A, Caprioglio A, Sammons RL, Piattelli A, Mangano C (2014b) Survival and complication rates of fixed restorations supported by locking-taper implants: a prospective study with 1 to 10 years of follow-up. J Prosthodont 23(6):434–444. doi:10.1111/jopr.12152

Misch CE (1998a) Non-functional immediate teeth in partially edentulous patients: a pilot study of 10 consecutive cases using the Maestro Dental Implant System. Compendium 19:25–36

Misch CE (1998b) Non-functional immediate teeth. Dent Today 17:88–91

Misch CE, Hahn J, Judy KW, Lemons JE, Linkow LI, Lozada JL, Mills E, Misch CM, Salama H, Shaarawy M, Testori T, Wang H-L (2004) Workshop guidelines on immediate loading in implant dentistry. J Oral Implant 30(5):283–288

Norton M (2013) Primary stability versus viable constraint – a need to redefine. Int J Oral Maxillofac Implants 28(1):19–21

Redemagni M, Cremonesi S, Garlini G, Maiorana C (2009) Soft tissue stability with immediate implants and concave abutments. Eur J Esthet Dent 4(4):328–337

Rodríguez X, Vela X, Méndez V, Segalà M, Calvo-Guirado JL, Tarnow DP (2013) The effect of abutment dis/reconnections on peri-implant bone resorption: a radiologic study of platform switched and non-platform-switched implants placed in animals. Clin Oral Implants Res 24(3):305–311. doi:10.1111/j.1600-0501.2011.02317.x

Schmitt CM, Nogueira-Filho G, Tenenbaum HC, Lai JY, Brito C, Döring H, Nonhoff J (2014) Performance of conical abutment (Morse Taper) connection implants: a systematic review. J Biomed Mater Res A 102(2):552–574. doi:10.1002/jbmm.34709

Schnitman DA, Wohrle PS, Rubenstein JE, DaSilva JD, Wang NH (1997) Branemark implants immediately loaded with fixed prostheses at implant placement. Ten year results. Int J Oral Maxillofac Implants 12:495–503

Schwartz-Arad D, Chaushu G (1999) Full-arch restoration of the jaw with fixed ceramo-metal prosthesis: late implant placement. J Periodontol 70(1):90–94

Su H, González-Martín O, Weisgold A, Lee E (2010) Considerations of implant abutment and crown contour: critical contour and subcritical contour. Int Periodontics Restor Dent 30(4):335–343

Tarnow DP, Emtiag S, Classi A (1997) Immediate loading of threaded implants at stage one surgery in edentulous arches. Ten consecutive case reports with 1 to 5 year data. Int J Oral Maxillofac Implants 12:319–324

Tarnow DP, Cho SC, Wallace SS (2000) The effect of the interimplant distance on the height of the interimplant bone crest. J Periodontol 71:546–549

Vera C, De Kok IJ, Reinhold D, Limpiphipatanakorn P, Yap AK, Tyndall D, Cooper LF (2012) Evaluation of buccal alveolar bone dimension of maxillary anterior and premolar teeth: a cone beam computed tomography investigation. Int J Oral Maxillofac Implants 27(6):1514–1519

Wang HL, Ormianer Z, Palti A, Perel ML, Trisi P, Sammartino G (2006) Consensus conference on immediate loading: the single tooth and partial edentulous areas. Implant Dent 15:324–333

Wohrle P (1998) Single tooth replacement in the aesthetic zone with immediate provisionalization fourteen consecutive case reports. Pract Periodontics Aesthet Dent 9:1107–1114

Yamane K, Ayukawa Y, Takeshita T, Furuhashi A, Yamashita Y, Koyano K (2013) Bacterial adhesion affinities of various implant abutment materials. Clin Oral Implants Res 24(12):1310–1315. doi:10.1111/j.1600-0501.2012.02574.x