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# Esthetics in periodontics and implantology

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From ancient times, people have recognized the importance of physical appearance and attractiveness. Greek art dealt with the concept of beauty by carefully studying the 'divine proportion' associated with esthetics and harmony in the fields of architecture, sculpture, music, and the human body and face, and the rules of golden proportions also help present-day societies to define ideal beauty. In 1978, Levin (84) applied the principles of golden proportions to teeth and the anterior esthetic region. Mass media and fashion magazines portray esthetics as being associated with health and social success. Facial attractiveness plays a particularly important role in modern society as it can influence not only self-esteem but also social opportunities, professional performance and employment prospects (41, 56). However, the novelist, Margaret Wolfe Hungerford, wrote in 1878 that 'beauty is in the mind of the beholder' and 'each mind perceives a different beauty', pointing out the difficulty of defining the concept of 'beauty'.

The smile is an important focal point of people's attention and a key feature of the overall esthetic appearance of a person. The eyes of a person, in a face-to-face situation, initially observe the eyes and, immediately afterwards, the mouth and the smile of the other person (56, 99). Accordingly, facial esthetics and a beautiful smile have become major reasons for many patients to request orthodontic and other types of dental treatment. The American Academy of Cosmetic Dentistry, in 2013 and 2015, reported that 86–89% of dental patients sought treatment to improve physical attractiveness and self-esteem (4). The reasons cited for dental treatment included fixing a previously failed cosmetic treatment, upcoming events (such as a wedding), restorative or health-related events (such as accident or injury) and desire to look and feel younger (4).

The creation of excellent esthetics requires an analysis of patients in their entirety. The esthetics of the smile has to be contextualized within the harmony and esthetics of the entire face, and the smile's visual impact cannot be associated exclusively with the beauty of one or more teeth. Analyzing and understanding the global facial esthetics may lead to modification of teeth, tissues or the smile itself by esthetic dentistry, orthodontics, corrective surgery, etc. As stated by Morley & Eubank (103), the smile is part of facial esthetics, macroesthetics, microesthetics and gingival esthetics. Facial esthetics addresses how the lips and the soft tissue frame the smile in different positions of speech, smiling and laughter. Macroesthetics deals with the relationship between the teeth and the surrounding tissue, including the facial characteristics of the patient. Microesthetics considers the anatomy, the color and the location of teeth in the dental arch. Gingival esthetics includes the entire gingival tissue surrounding the teeth. In sum, factors of importance in smile esthetics are the midline of the face, the smile line, the appearance of soft tissue, black interdental spaces and the size, the shape, the position and the color of teeth. Importantly, the various components of an 'ideal smile' should be evaluated not in isolation but in combination with each other (103, 105).

Garber & Salama (49) proposed that the essentials of a smile are the relationships between teeth, lip framework and gingival scaffold. The dental factor includes tooth color, position and shape or silhouette. The lip framework entails the lip form and the frame of a smile, termed the esthetic zone, and three levels of lip lines were defined – high, medium or low – based on the amount of tooth coverage by the upper lip. The gingival scaffold addresses restoration and maintenance of the health and integrity of the periodontal tissues. However, from an esthetic perspective, the

smile determinants described above are not always sufficient. An irregular gingival margin, despite being healthy, may appear unesthetic, and restoration of the harmony and continuity of the free gingival margin may be important esthetically (49). Rotundo et al. (121) presented a method to measure and evaluate the esthetics of a smile using intrarater and inter-rater agreement analysis. The method, termed the Smile Esthetic Index, assessed 10 variables, including the smile line, facial midline, tooth alignment, tooth deformity, tooth dyschromia, gingival dyschromia, gingival recession, gingival excess, gingival scars and diastema/missing papillae (121). Based on smile frontal-view pictures, examiners with different clinical experience found the Smile Esthetic Index to constitute a useful method to assess smile esthetics and to be helpful in treatment planning of plastic surgery (121).

In the past few decades, as the esthetically pleasing smile has become a key element of periodontal and implant therapy, surgical techniques have been developed to improve esthetic outcome and functional restoration. This volume of *Periodontology 2000* provides clinical recommendations and technical aspects of periodontal and implant surgical procedures applied to the esthetic zone. Experienced researchers and clinicians from different subdisciplines of periodontology summarize the developments and the most recent knowledge on the following: gingival recession treatment with or without papilla elevation; clinical crown lengthening in the natural dentition and in a restorative context; periodontal regeneration around natural teeth; and soft-tissue augmentation in edentulous areas. Similarly, experts in different areas of implant science address esthetic outcomes with single and multiple implant rehabilitation, alveolar ridge preservation, implant positioning and immediate implant placement in the esthetic zone. Horizontal and vertical bone augmentation and coverage of periimplant soft-tissue dehiscence are also discussed.

## Periodontal plastic surgery

Mucogingival therapy is a general term for periodontal treatment that corrects defects in morphology or in the position and/or amount of soft tissue and underlying bone around teeth and implants (5). The concept of mucogingival therapy has changed over time. When Friedman, in 1957, introduced the term 'mucogingival surgery', it included all surgical procedures designed to preserve or improve healthy soft tissue (maintenance of attached gingiva, removal of aberrant frena or muscle attachments and increase in depth of the vestibulum), without consideration of esthetics (44, 45, 51, 52, 78, 107, 122). Later on, the concept of mucogingival developed into 'periodontal plastic surgery' (93) and became accepted by the international scientific community in 1996 to mean surgical procedures performed to prevent or correct anatomic, developmental, traumatic or disease-induced defects of gingiva, alveolar mucosa or bone (101, 102, 148). Surgery was performed for the purpose of gingival augmentation, root coverage, correction of esthetic defects around implants, crown lengthening, gingival preservation at ectopic tooth eruption, removal of aberrant frena, prevention of alveolar ridge collapse and augmentation of the edentulous ridge.

## Patient perception of the root-coverage procedure: what is the most suitable surgical technique?

Buccal gingival recession can cause esthetic concern and root sensitivity, and occurs primarily in patients with a high level of oral hygiene (5). Mounssif et al. (106), in this volume of *Periodontology 2000*, describe surgical techniques to achieve complete root coverage, reduction of gingival recession or increased keratinized tissue, using photographs (16, 23, 31, 69, 70, 119, 146) or an outcome rating scale (36, 151, 155, 157) to evaluate color match, tissue texture, contour and contiguity and keloid scar tissue. The treatment decision depended almost exclusively on the knowledge and clinical experience of the dentists, as well as on financial considerations (109). Patients' esthetic perception and true treatment need are often underestimated in professional practice and are barely discussed in the periodontal literature (109). However, a recent consensus of the European Federation of Periodontology has emphasized the need for clinical trials with patient-centered outcome (true end point) as well as objective clinical outcome (surrogate end point), especially because patient esthetic evaluation can be at variance with the professional judgement (72); patients tend to concentrate on color and contour of gingiva rather than on the amount of root coverage achieved. Stefanini et al. (134), in this volume of *Periodontology 2000*, propose a decision-making strategy for treatment of gingival recession that includes selection of a surgical technique that can achieve both complete root coverage and blending of tissue color and texture of the treated area with that of the adjacent soft tissues. Coronally advanced flap + connective tissue graft for single tooth

recessions and the modified coronally advanced tunnel technique for multiple teeth recessions are the recommended surgical methods. The treatment decision must also consider anatomic factors, such as the presence of noncaries cervical lesion(s), interdental clinical attachment loss, interdental soft-tissue loss, buccal displacement of the root, degree of keratinized tissue and gingival thickness, as well as patient esthetic request and the need to minimize patient morbidity. Patient morbidity can be assessed using an easily administered visual analogue scale (114). The main concern of patients regarding periodontal plastic surgery seems to be the second surgical site (palatal donor site). Surgical harvesting techniques using primary wound closure, smaller and thinner connective tissue grafts (156) or substitute materials (allograft or xenograft) can help minimize postoperative pain and discomfort. Shorter surgical intervention time and use of analgesics seem also to reduce postoperative complications.

## Esthetic treatment of gummy smile and altered passive eruption

The American Academy of Periodontology has identified altered passive eruption as a mucogingival deformity around teeth (8). Altered eruption can cause gummy smile, which implies a visible exposure of gingiva of > 2 mm from the inferior rim of the upper lip (111). The correction of excessive gingival display can be important for the esthetics of the smile and for patient self-esteem (43, 71). Mele et al. (95) describe, in this volume of *Periodontology 2000*, two main types, each with two subgroups, of altered passive eruption. Types 1 and 2 differ in keratinized tissue height, and subgroups A and B differ in the distance between the cemento–enamel junction and the alveolar bony crest. Type 1 displays keratinized tissue that extends apically beyond the cemento–enamel junction; and type 2 displays less keratinized tissue with the mucogingival junction located coronally to, or at, the level of the cemento–enamel junction (38). Subgroup A specifies the distance between the cemento–enamel junction and the alveolar bone crest to be great enough to allow for connective tissue attachment on the root cementum; subgroup B has the bony crest located at, or coronally to, the cemento–enamel junction and provides no space for connective tissue attachment (38).

The etiopathogenesis and treatment of altered passive eruption warrant further studies. No data are available on changes in clinical crown length after 20 years of age, and thus it is unknown when altered passive eruption has run its course. Altered passive eruption can be diagnosed on periapical radiographs using a long-cone parallel technique and a radiopaque reference point (e.g. the gutta-percha endodontic point at the level of the soft-tissue margin), and the diagnosis of altered passive eruption is usually made when the distance between the tip of the gutta-percha point and the cemento–enamel junction exceeds 3 mm. Gummy smile is treated with gingivectomy to expose the hidden tooth anatomy or by apically repositioned full-thickness flap, with or without osseous resective surgery (49). The need to reduce bony thickness to change the relationship between the bony crest and the cemento–enamel junction in adjacent teeth favors apically positioned flap surgery with bone recontouring. The postsurgical distance between the cemento–enamel junction and the bone crest should not exceed 1–2 mm (20, 35, 120, 150). Surgical treatment of altered passive eruption can markedly improve patient appearance and smile, but research is lacking on the reasons why patients request treatment for altered passive eruption and on patients' perception of the treatment outcome.

## Crown lengthening for esthetic reasons: surgical and restorative concepts

Clinical crown lengthening is a common surgical procedure in periodontal practice. A recent survey by the American Academy of Periodontology found that approximately 10% of all periodontal surgical procedures were performed to gain clinical crown length. Several studies have addressed crown lengthening in the posterior area, but crown lengthening for esthetic reasons in the anterior area has received relatively little attention. Marzadori et al. (90) identified only a few controlled clinical trials on esthetic crown lengthening (10, 17, 47, 55, 112) and no systematic review, which complicates clinical decision making. Surgical and prosthetic procedures for esthetic crown lengthening need to consider the vestibular and palatal flap design, the amount of ostectomy and osteoplasty, and flap suturing. The surgical procedures include thinning of soft and hard tissues to minimize rebound of soft tissue and placement of a provisional restoration during healing to ensure the proper esthetic outcome. Tooth preparation and provisional relining are usually performed 3 weeks following surgery.

## Simplified procedures for treatment of intraosseous defects in esthetic areas: why, when and how

Treatment of deep intraosseous defects aims to improve the prognosis of the affected teeth, preferably through regeneration of the lost periodontal tissues. In esthetically sensitive areas, however, the preservation (or improvement) of pre-existing esthetics is just as important as the regenerative goals, and combining these two therapeutic end points can be challenging. Over the years, 'simplified' treatments of intraosseous defects have appeared that promised easily performed surgical techniques with less postsurgical pain and discomfort, fewer adverse outcomes and lower cost. 'Simplified' surgical procedures, such as the single flap approach and its variants (37, 142, 154), involve elevation of a single flap on the buccal or oral aspect, leaving the tissues on the lingual/palatine side intact. The article by Trombelli et al. (143), in this volume of *Periodontology 2000*, lends support to nonsurgical treatment of infrabony pockets with moderate depth, but not of deep infrabony defects. The single flap approach, performed either as a stand-alone treatment or in combination with regenerative devices, can achieve similar clinical attachment gain or probing-depth reduction as traditional papilla-preservation techniques. Simplified surgical techniques seem also to result in minimal esthetic impairment (i.e. post-treatment gingival recession) and a more tolerable postoperative course compared with conventional surgical (double-flap) techniques. Despite these encouraging results, research data on histologic, esthetic and long-term outcomes after 'simplification' surgery are still not available.

## Esthetics of soft-tissue augmentation in edentulous areas

The loss of teeth can create functional and esthetic defects in the edentulous area, such as deformities of hard and soft tissues in both apicocoronal and buccolingual directions, which may complicate prosthetic rehabilitation in esthetically sensitive areas. Although prosthetic devices, such as apicocoronal extended pontic or gingival-like porcelain, may be acceptable from a functional standpoint, they often look artifical and this is readily apparent on smiling. Reconstructive plastic surgery aimed at restoring the alveolar ridge to its former dimensions has therefore become a treatment of great importance. Marzadori et al. (89) describe, in this volume of *Periodontology 2000*, five surgical techniques for soft-tissue augmentation: onlay grafts; inlay grafts; combination onlay–inlay grafts; roll technique; and pouch procedures with connective tissue grafts (1, 64, 80, 81, 97, 123, 126–128, 152). In highly demanding esthetic areas, the pouch technique is preferred for soft-tissue augmentation because of its potential for primary wound healing and for maintaining color and surface characteristics of the surrounding tissues. Onlay, inlay and combination grafts are less suitable choices because of poor esthetic outcome and high resorption rates of the exposed graft. High-priority research is to develop surgical techniques, such as the 'connective tissue platform technique' (152), that can provide soft-tissue correction and primary wound healing in a one-stage approach, even with severe apicocoronal and buccolingual defects. Development of connective tissue substitutes to reduce morbidity from harvesting soft-tissue grafts from a donor site is also an important research topic. Current systems for morphologic and metric assessment of tissue changes postsurgery lack reproducibility, but three-dimensional detection shows encouraging results (141). However, the high cost of three-dimensional devices and exposure to radiation (in the case of cone-beam computed tomography) limit their use in clinical practice.

## Esthetic surgery without papilla incision in periodontics and implantology

The mucogingival techniques for treatment of soft-tissue defects are continually evolving. While early studies have concentrated on quantitative measurement of root coverage or changes in keratinized tissue (117), recent research takes into account patient satisfaction along with qualitative esthetic criteria of success, such as tissue color, texture and contour (93). The esthetic requirements and the need for blood-supply preservation and wound stability have led to the development of tunneling flap techniques in periodontal and peri-implant plastic surgery. Zuhr et al. (161), in this volume of *Periodontology 2000*, discuss how tunneling surgery with an incision-free flap elevation, avoiding visible surface incisions, can produce rapid and uneventful wound healing and high-quality esthetic outcomes. The major obstacle seems to be the treatment of single, deep, gingival recessions. Although originally developed for treating gingival

recessions (3, 9, 113, 149), the versatility of the tunneling flap technique makes it useful also for minor (e.g. surgical thickening of thin buccal gingiva or peri-implant mucosa), moderate (e.g. alveolar ridge preservation following tooth extraction with or without immediate implants, as well as implant second-stage surgery) and extensive (e.g. soft-tissue ridge augmentation either with implants or for pontic site development) soft-tissue reconstructions (11, 58, 158, 159). The tunneling technique has undergone several changes over the years (3, 11, 113, 149, 157, 160) that have resulted in improved flap design but also in a more demanding and technique-sensitive procedure, which even can require advanced surgical training and specifically designed microsurgical instruments. The tunneling flap procedure has shown excellent short-term results for treatment of gingival recession-type defects but long-term data are still missing and its utility in other clinical applications is essentially unknown.

## Esthetics with single-tooth replacement

The outcome of treatment with a single implant in the esthetic area was traditionally assessed solely by physical tissue measures, but esthetic assessment and patient-reported outcomes have become an integral part of the final evaluation of implant therapy (79). The ideal esthetic outcome includes perfect integrations of the treated area with the surrounding tissues and of the prosthetic crown with the natural dentition (94). Stefanini et al. (133), in this volume of *Periodontology 2000*, evaluate indices to determine the esthetic outcome. Early esthetic indices took into account only aspects relating to the soft tissues but, later on, more complex indices (which included both soft tissues and prosthetic aspects) were developed. It is still not clear which esthetic index performs best in implant research (7, 14), but the pink/white esthetic score is frequently used (13, 48). The dentist's esthetic assessment should ideally agree with the patient's evaluation, but studies have reported a discrepancy and the reason for this is unclear (40).

## Alveolar ridge preservation: does it improve the final esthetic outcome?

Tooth extraction can be expected to be followed by alveolar bone loss, structural and compositional changes of the overlaying soft tissues and morphological alterations of the alveolar ridge (124). These tissue changes can complicate implant placement (19), and tooth extraction in the esthetic zone can lead to challenging therapeutic decision-making. As described by Jung et al., in this volume of *Periodontology 2000* (61), treatment planning ideally starts before tooth extraction and includes three therapeutic options: (i) spontaneous tissue healing; (ii) immediate implant placement; or (iii) preservation of the alveolar ridge to counteract changes in soft and hard tissue. Alveolar ridge preservation is associated with three time-points of healing: (i) the soft tissues (soft-tissue preservation following 6–8 weeks of healing after tooth extraction); (ii) the hard and soft tissues (preservation of hard and soft tissue following 4–6 months of healing after tooth extraction); and (iii) the hard tissues (hard-tissue preservation following > 6 months of healing after tooth extraction) (30). Soft-tissue preservation techniques aim to improve the quantity and quality of soft tissues and are performed at the time of tooth extraction with a flapless approach or with a minimal coronal-flap advancement. Subepithelial connective tissue graft, free gingival graft, soft-tissue substitute or a resorbable membrane may be used to enhance wound closure (12, 62, 132, 135–137). Hard-tissue preservation techniques are typically used for ankylosed teeth with a vertical soft-tissue deficiency, teeth with soft-tissue recessions and teeth with lack of keratinized tissue. The hard-tissue preservation technique employs a variety of biomaterials (59, 74, 138, 147) but because of the 6- to 8-week healing period, only minimal new-bone formation can be expected within the extraction socket at the time of complete soft-tissue closure (86). Accordingly, the bone-substitute materials serve mainly as a space-maintaining device for the biomaterial or the soft-tissue graft. A combination of soft- and hard-tissue preservation techniques is used in patients in whom tooth extraction has caused both soft- and hard-tissue deficits. More recent combination techniques for soft- and hard-tissue preservation employ a minimally invasive, nonflapped approach with a healing period of 4–6 months. These so-called socket seal techniques, which combine biomaterials placed at the bony level with autogenous soft-tissue grafts or soft-tissue substitutes placed at the soft-tissue level (62, 86, 87, 96), are indicated for treatment of small buccal bony defects (in which < 50% of the buccal bony plate is missing), with or without soft-tissue defects, for sites having implant placement 4–6 months later or for pontic sites. A prolonged healing period before implant placement is recommended for sites with severe loss of the buccal bone plate

(> 50%), and alveolar ridge preservation is performed using a bone substitute covered with a membrane followed by flap advancement to achieve complete or partial wound closure, a bone substitute followed by a coronal advancement or rotation of the flap to obtain full wound closure or a bone-substitute material without wound closure (39, 145). Research is warranted to determine the long-term performance of alveolar ridge preservation in sites with large alveolar defects and missing buccal bony plates and for implant treatment performed with and without alveolar ridge preservation.

## Placement of implants in the esthetic area

The survival rate of the implant fixture was, for many years, the sole measurement of therapeutic success, but as implant treatment matured, patients started demanding good esthetics as well. As discussed in this volume of *Periodontology 2000* by Testori et al. (140), implant treatment in the esthetic area raises questions regarding the timing of implant placement and whether the best approach is immediate, early or late placement following tooth extraction (53, 76). Patients prefer immediate implant placement as it is less traumatic and involves fewer surgical procedures, and implants may be reliably placed even in infected sites (139). However, immediate implant placement is technique sensitive and requires experienced operators. In choosing the type of implant treatment, the soft tissue and bony anatomy are obviously important, but altered passive eruption and root morphology of adjacent teeth, and even skeletal growth (110), can also be important decision-making criteria. The abutment design may also influence esthetic outcome. Restorative abutments were traditionally made with a wide horizontal preparation finish, but new prosthetic concepts have led to the design of abutments with a vertical (shoulder-less) finishing line (125). Shoulder-less abutments provide more space for soft-tissue growth and allow for the long axis of the implant to aim at the incisal edge of the future restoration, improving the opportunity to create a restorative crown with a cervical contour that resembles more closely a natural tooth. Novel diagnostic methods to guide three-dimensional positioning of implants and innovative abutment morphology may soon give rise to new implant treatments that are simple, less invasive and produce highly esthetic outcomes (125).

## How do we improve the esthetic outcome with immediate implant placement and provisionalization?

One of the most desirable features of immediate implant placement and provisionalization is the preservation of existing osseous and gingival architectures (50, 66–68, 108). As described by Kan et al. (65), the esthetic success of immediate implant placement and provisionalization is related to patient factors (relationship between hard and soft tissues, the gingival biotype and/or the sagittal root position in the alveolar bone) and therapeutic factors (the three-dimensional position and angulation of the implant, the abutment contour and/or the provisional restoration) (67, 73). The flapless procedure reduces discomfort and is usually combined with guided implant surgery templates but should be performed only by skilled clinicians (85). Studies show the importance of filling the gap between the implant and the alveolus to prevent bone resorption after tooth extraction (24), and soft-tissue augmentation is suggested when the patient presents a thin biotype (83). The success in terms of esthetics of immediate implant placement depends on the combination of all the different factors described above. Risks of mucosal recession are widely described in the literature (104) and this type of surgery should be performed adhering to a strict clinical protocol and only by clinicians with proper expertise. The future of this technique is strongly linked to the accuracy and precision of the diagnostic devices and their capability to guide and simplify implant surgery.

## Esthetic treatment of bony ridge defects

In recent years, the focus in implantology has moved from osseointegration (2), which of course is still fundamental to achieve proper implant integration, to esthetic and functional aspects of implant treatment (15). The prosthetic portion of implant-supported rehabilitation then becomes the central point in implant placement and in guiding successive therapeutic steps (28, 34). According to Chiapasco & Casentini (32), a prosthetic-driven approach to implantology provides clear definition of the size and the shape of ridge defects and helps select the best reconstructive technique. Different classes of ridge defects and their most appropriate treatment can be defined in a three-dimensional radiograph. In classes I and II, which have

the the lowest degree of ridge defects, implant placement is usually combined with soft- and hard-tissue augmentation but can otherwise proceed immediately (19, 60, 98). Classes III and IV show a higher degree of ridge atrophy, which requires bone grafting and delayed implant placement (33, 131, 144). Research is needed to determine which type of treatment of ridge defects provides the best long-term successful outcome.

## Esthetic outcome with vertical ridge augmentation

Implant placement in the esthetic zone often needs complex treatment planning. Vertical alveolar ridge deficiencies are probably the most demanding cases because ridge reconstruction is often necessary before implant placement and prosthetic rehabilitation. Rocchietta et al. (115), in this volume of *Periodontology 2000*, review several techniques used to obtain vertical alveolar bone gain but guided bone regeneration remains the most common and best-documented reconstructive method. Guided bone regeneration allows a three-dimensional reconstruction, which is crucial for correct implant placement and final esthetics, and it has fewer drawbacks than other techniques. However, although widely used in clinical practice, the vertical guided bone regeneration technique is highly operator-dependent with a steep learning curve (116). Emphasis must also be given to a proper analysis of the hard- and soft-tissue alterations following tooth loss, and to patient expectations and desire. Several indices exist for classification of the esthetic outcomes of implant-supported restorations, and interest in patient perception of implant treatment is steadily increasing (92). Unfortunately, treatment of severe bone atrophy has not attracted similar research interest.

## Soft-tissue dehiscence around implant: how do we solve this esthetic problem?

Implant treatment after tooth loss, irrespective of whether this is delayed, early or immediate implant placement and loading (29, 42), can create various biologic or biomechanic complications (54, 63), but the greatest problem esthetically may be the buccal dehiscence, which can result in an oversized prosthetic crown and/or implant/abutment exposure. Several anatomic/predisposing and pathologic/precipitating factors can cause apical shift of tissue around implants (46). Unlike recession in the natural dentition, no definition and no classification exist for soft-tissue dehiscence around implants, probably because of the lack of a reference point, such as the cemento–enamel junction (21, 100). Mazzotti et al. (91) describe, in this volume of *Periodontology 2000*, various treatments of buccal soft-tissue dehiscence with implants, which can be grouped in mucogingival surgery with or without prosthetic support and guided bone regeneration. Treatment of soft-tissue dehiscence with implants has been assessed in case report series (77, 88, 129, 130, 153), and in longitudinal (18, 118, 153) and retrospective (82) studies, but only in one randomized controlled trial (6). The overall conclusion is that mucogingival treatment of soft-tissue dehiscence with implants produces less tissue coverage compared with treatment of gingival recession with natural teeth. Nevertheless, proper prosthetic management, before and after mucogingival surgery, seems to improve soft-tissue coverage, approximating that reported for teeth (22, 25). Evaluation of treatment efficacy of soft-tissue dehiscence around implants should employ objective measures in order for readers to confirm and compare study data (104).

## Concluding remarks

The main goals of plastic surgery treatment around teeth and implants are rehabilitation of function and satisfying patients' esthetic demands. Numerous studies have reported on plastic surgery techniques and surgical outcomes (surrogate end points), and esthetic results have been evaluated by dentists in some trials, but very few studies have taken into account patient needs and requests (true end points) (57). The esthetic judgment of clinicians may not always be consistent with patient satisfaction, as patients tend to rate the cosmetic results more favorably than the clinicians (14, 26, 27, 72, 75). The few studies available on patient satisfaction concern treatment of gingival recession or single implant placement. No adequate and validated assessment questionnaires exist to quantitate patient satisfaction in respect to esthetics, psychological difficulty and morbidity following plastic surgery around teeth and implants. Assessment of such outcome criteria by dentists and patients might provide better insight into important aspects of periodontal and implant treatments and might also improve the dentist–patient relationship.

## References


1. Abrams L. Augmentation of the deformed residual edentulous ridge for fixed prosthesis. *Compend Contin Educ Gen Dent* 1980: **1**: 205–213.
2. Adell R, Eriksson B, Lekholm U, Branemark PI, Jemt T. Long-term follow-up study of osseointegrated implants in the treatment of totally edentulous jaws. *Int J Oral Maxillofac Implants* 1990: **5**: 347–359.
3. Allen AL. Use of the supraperiosteal envelope in soft tissue grafting for root coverage. I. Rationale and technique. *Int J Periodontics Restorative Dent* 1994: **14**: 216–227.
4. American Academy of Cosmetic Dentistry. State of the industry, 2013. 2015.
5. American Academy of Periodontology. *Glossary terms of periodontology*. Chicago, IL: American Academy of Periodontology, 2001.
6. Anderson LE, Inglehart MR, El-Kholy K, Eber R, Wang HL. Implant associated soft tissue defects in the anterior maxilla: a randomized control trial comparing subepithelial connective tissue graft and acellular dermal matrix allograft. *Implant Dent* 2014: **23**: 416–425.
7. Annibali S, Bignozzi I, La Monaca G, Cristalli MP. Usefulness of the aesthetic result as a success criterion for implant therapy: a review. *Clin Implant Dent Relat Res* 2012: **14**: 3–40.
8. Armitage GC. Development of a classification system for periodontal diseases and conditions. *Ann Periodontol* 1999: **4**: 1–6.
9. Aroca S, Keglevich T, Nikolidakis D, Gera I, Nagy K, Azzi R, Etienne D. Treatment of class III multiple gingival recessions: a randomized-clinical trial. *J Clin Periodontol* 2010: **37**: 88–97.
10. Arora R, Narula SC, Sharma RK, Tewari S. Evaluation of supracrestal gingival tissue after surgical crown lengthening: a 6-month clinical study. *J Periodontol* 2013: **84**: 934–940.
11. Azzi R, Etienne D, Takei H, Fenech P. Surgical thickening of the existing gingiva and reconstruction of interdental papillae around implant-supported restorations. *Int J Periodontics Restorative Dent* 2002: **22**: 71–77.
12. Barone A, Borgia V, Covani U, Ricci M, Piattelli A, Iezzi G. Flap versus flapless procedure for ridge preservation in alveolar extraction sockets: a histological evaluation in a randomized clinical trial. *Clin Oral Implants Res* 2015: **26**: 806–813.
13. Belser UC, Grutter L, Vailati F, Bornstein MM, Weber HP, Buser D. 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* 2009: **80**: 140–151.
14. Benic GI, Wolleb K, Sancho-Puchades M, Hammerle CH. Systematic review of parameters and methods for the professional assessment of aesthetics in dental implant research. *J Clin Periodontol* 2012: **39** (Suppl. 12): 160–192.
15. Boardman N, Darby I, Chen S. A retrospective evaluation of aesthetic outcomes for single-tooth implants in the anterior maxilla. *Clin Oral Implants Res* 2016: **27**: 443–451.
16. Bouchard P, Etienne D, Ouhayoun JP, Nilveus R. Subepithelial connective tissue grafts in the treatment of gingival recessions. A comparative study of 2 procedures. *J Periodontol* 1994: **65**: 929–936.
17. Bragger U, Lauchenauer D, Lang NP. Surgical lengthening of the clinical crown. *J Clin Periodontol* 1992: **19**: 58–63.
18. Burkhardt R, Joss A, Lang NP. Soft tissue dehiscence coverage around endosseous implants: a prospective cohort study. *Clin Oral Implants Res* 2008: **19**: 451–457.
19. Buser D, Martin W, Belser UC. Optimizing esthetics for implant restorations in the anterior maxilla: anatomic and surgical considerations. *Int J Oral Maxillofac Implants* 2004: **19** (Suppl): 43–61.
20. Cairo F, Graziani F, Franchi L, Defraia E, Pini Prato GP. Periodontal plastic surgery to improve aesthetics in patients with altered passive eruption/gummy smile: a case series study. *Int J Dent* 2012: 1–6.
21. Cairo F, Nieri M, Cincinelli S, Mervelt J, Pagliaro U. The interproximal clinical attachment level to classify gingival recessions and predict root coverage outcomes: an explorative and reliability study. *J Clin Periodontol* 2011: **38**: 661–666.
22. Cairo F, Nieri M, Pagliaro U. Efficacy of periodontal plastic surgery procedures in the treatment of localized facial gingival recessions. A systematic review. *J Clin Periodontol* 2014: **41** (Suppl. 15): S44–S62.
23. Cairo F, Rotundo R, Miller PD, Pini Prato GP. Root coverage esthetic score: a system to evaluate the esthetic outcome of the treatment of gingival recession through evaluation of clinical cases. *J Periodontol* 2009: **80**: 705–710.
24. Capelli M, Testori T, Galli F, Zuffetti F, Motroni A, Weinstein R, Del Fabbro M. Implant-buccal plate distance as diagnostic parameter: a prospective cohort study on implant placement in fresh extraction sockets. *J Periodontol* 2013: **84**: 1768–1774.
25. Chambrone L, Sukekava F, Araujo MG, Pustiglioni FE, Chambrone LA, Lima LA. Root coverage procedures for the treatment of localised recession-type defects. *Cochrane Database Syst Rev* 2009: **15**: CD007161.
26. Chang M, Odman PA, Wennstrom JL, Andersson B. Esthetic outcome of implant-supported single-tooth replacements assessed by the patient and by prosthodontists. *Int J Prosthodont* 1999: **12**: 335–341.
27. Chang M, Wennstrom JL, Odman P, Andersson B. Implant supported single-tooth replacements compared to contralateral natural teeth. Crown and soft tissue dimensions. *Clin Oral Implants Res* 1999: **10**: 185–194.
28. Chen ST, Beagle J, Jensen SS, Chiapasco M, Darby I. Consensus statements and recommended clinical procedures regarding surgical techniques. *Int J Oral Maxillofac Implants* 2009: **24** (Suppl): 272–278.
29. Chen ST, Buser D. Clinical and esthetic outcomes of implants placed in postextraction sites. *Int J Oral Maxillofac Implants* 2009: **24** (Suppl): 186–217.
30. Chen ST, Wilson TG Jr, Hammerle CH. Immediate or early placement of implants following tooth extraction: review of biologic basis, clinical procedures, and outcomes. *Int J Oral Maxillofac Implants* 2004: **19** (Suppl): 12–25.
31. Cheung WS, Griffin TJ. A comparative study of root coverage with connective tissue and platelet concentrate grafts: 8-month results. *J Periodontol* 2004: **75**: 1678–1687.
32. Chiapasco M, Casentini P. Horizontal bone-augmentation procedures in implant dentistry: prosthetically guided regeneration. *Periodontol 2000* 2018: **77**: 213–240.

33. Chiapasco M, Casentini P, Zaniboni M. Bone augmentation procedures in implant dentistry. *Int J Oral Maxillofac Implants* 2009: **24** (Suppl): 237–259.
34. Chiapasco M, Ferrini F, Casentini P, Accardi S, Zaniboni M. Dental implants placed in expanded narrow edentulous ridges with the Extension Crest device. A 1–3-year multicenter follow-up study. *Clin Oral Implants Res* 2006: **17**: 265–272.
35. Chu SJ, Karabin S, Mistry S. Short tooth syndrome: diagnosis, etiology, and treatment management. *J Calif Dent Assoc* 2004: **32**: 143–152.
36. Cortellini P, Tonetti M, Baldi C, Francetti L, Rasperini G, Rotundo R, Nieri M, Franceschi D, Labriola A, Prato GP. Does placement of a connective tissue graft improve the outcomes of coronally advanced flap for coverage of single gingival recessions in upper anterior teeth? A multi-centre, randomized, double-blind, clinical trial. *J Clin Periodontol* 2009: **36**: 68–79.
37. Cortellini P, Tonetti MS. Improved wound stability with a modified minimally invasive surgical technique in the regenerative treatment of isolated interdental intrabony defects. *J Clin Periodontol* 2009: **36**: 157–163.
38. Coslet JG, Vanarsdall R, Weisgold A. Diagnosis and classification of delayed passive eruption of the dentogingival junction in the adult. *Alpha Omegan* 1977: **70**: 24–28.
39. Darby I, Chen S, De Poi R. Ridge preservation: what is it and when should it be considered. *Aust Dent J* 2008: **53**: 11–21.
40. De Bruyn H, Raes S, Matthys C, Cosyn J. The current use of patient-centered/reported outcomes in implant dentistry: a systematic review. *Clin Oral Implants Res* 2015: **26** (Suppl. 11): 45–56.
41. Dion K, Berscheid E, Walster E. What is beautiful is good. *J Pers Soc Psychol* 1972: **24**: 285–290.
42. Esposito M, Grusovin MG, Polyzos IP, Felice P, Worthington HV. Interventions for replacing missing teeth: dental implants in fresh extraction sockets (immediate, immediate-delayed and delayed implants). *Cochrane Database Syst Rev* 2010: **8**: CD005968.
43. Flores-Mir C, Silva E, Barriga MI, Lagravere MO, Major PW. Lay person's perception of smile aesthetics in dental and facial views. *J Orthod* 2004: **31**: 204–209.
44. Friedman N. Mucogingival surgery: the apically repositioned flap. *J Periodontol* 1962: **3**: 328–340.
45. Friedman N. Mucogingival surgery. *Tex Dent J* 1957: **75**: 358–362.
46. Fu JH, Su CY, Wang HL. Esthetic soft tissue management for teeth and implants. *J Evid Based Dent Pract* 2012: **12**: 129–142.
47. Fugazzotto PA. Periodontal restorative interrelationships: the isolated restoration. *J Am Dent Assoc* 1985: **110**: 915–917.
48. Furhauser R, Florescu D, Benesch T, Haas R, Mailath G, Watzek G. Evaluation of soft tissue around single-tooth implant crowns: the pink esthetic score. *Clin Oral Implants Res* 2005: **16**: 639–644.
49. Garber DA, Salama MA. The aesthetic smile: diagnosis and treatment. *Periodontol 2000* 1996: **11**: 18–28.
50. Garber DA, Salama MA, Salama H. Immediate total tooth replacement. *Compend Contin Educ Dent* 2001: **22**: 210–216.
51. Goldman HM. The topography and role of the gingival fibers. *J Dent Res* 1951: **30**: 331–336.
52. Hall WB. The current status of mucogingival problems and their therapy. *J Periodontol* 1981: **52**: 569–575.
53. Hammerle CH, Chen ST, Wilson TG Jr. Consensus statements and recommended clinical procedures regarding the placement of implants in extraction sockets. *Int J Oral Maxillofac Implants* 2004: **19** (Suppl): 26–28.
54. Heitz-Mayfield LJ, Needleman I, Salvi GE, Pjetursson BE. Consensus statements and clinical recommendations for prevention and management of biologic and technical implant complications. *Int J Oral Maxillofac Implants* 2014: **29** (Suppl): 346–350.
55. Herrero F, Scott JB, Maropis PS, Yukna RA. Clinical comparison of desired versus actual amount of surgical crown lengthening. *J Periodontol* 1995: **66**: 568–571.
56. Hofel L, Lange M, Jacobsen T. Beauty and the teeth: perception of tooth color and its influence on the overall judgment of facial attractiveness. *Int J Periodontics Restorative Dent* 2007: **27**: 349–357.
57. Hujoel PP. Endpoints in periodontal trials: the need for an evidence-based research approach. *Periodontol 2000* 2004: **36**: 196–204.
58. Hurzeler MB, von Mohrenschildt S, Zuhr O. Stage-two implant surgery in the esthetic zone: a new technique. *Int J Periodontics Restorative Dent* 2010: **30**: 187–193.
59. Jambhekar S, Kernen F, Bidra AS. Clinical and histologic outcomes of socket grafting after flapless tooth extraction: a systematic review of randomized controlled clinical trials. *J Prosthet Dent* 2015: **113**: 371–382.
60. Jensen SS, Terheyden H. Bone augmentation procedures in localized defects in the alveolar ridge: clinical results with different bone grafts and bone-substitute materials. *Int J Oral Maxillofac Implants* 2009: **24** (Suppl): 218–236.
61. Jung RE, Ioannidis A, Hämmerle CHF, Thoma DS. Alveolar ridge preservation in the esthetic zone. *Periodontol 2000* 2018: **77**: 165–175.
62. Jung RE, Philipp A, Annen BM, Signorelli L, Thoma DS, Hammerle CH, Attin T, Schmidlin P. Radiographic evaluation of different techniques for ridge preservation after tooth extraction: a randomized controlled clinical trial. *J Clin Periodontol* 2013: **40**: 90–98.
63. Jung RE, Zembic A, Pjetursson BE, Zwahlen M, Thoma DS. Systematic review of the survival rate and the incidence of biological, technical, and aesthetic complications of single crowns on implants reported in longitudinal studies with a mean follow-up of 5 years. *Clin Oral Implants Res* 2012: **23** (Suppl. 6): 2–21.
64. Kaldahl WB, Tussing GJ, Wentz FM, Walker JA. Achieving an esthetic appearance with a fixed prosthesis by submucosal grafts. *J Am Dent Assoc* 1982: **104**: 449–452.
65. Kan JYK, Rungcharassaeng K, Deflorian M, Weinstein T, Wang H-L, Testori T. Immediate implant placement and provisionalization of maxillary anterior single implants. *Periodontol 2000* 2018: **77**: 197–212.
66. Kan JY, Roe P, Rungcharassaeng K, Patel RD, Waki T, Lozada JL, Zimmerman G. Classification of sagittal root position in relation to the anterior maxillary osseous housing for immediate implant placement: a cone beam computed tomography study. *Int J Oral Maxillofac Implants* 2011: **26**: 873–876.
67. Kan JY, Rungcharassaeng K. Immediate placement and provisionalization of maxillary anterior single implants: a

surgical and prosthodontic rationale. *Pract Periodontics Aesthet Dent* 2000: **12**: 817–824.
68. Kan JY, Rungcharassaeng K, Lozada J. Immediate placement and provisionalization of maxillary anterior single implants: 1-year prospective study. *Int J Oral Maxillofac Implants* 2003: **18**: 31–39.
69. Kerner S, Katsahian S, Sarfati A, Korngold S, Jakmakjian S, Tavernier B, Valet F, Bouchard P. A comparison of methods of aesthetic assessment in root coverage procedures. *J Clin Periodontol* 2009: **36**: 80–87.
70. Kerner S, Sarfati A, Katsahian S, Jaumet V, Micheau C, Mora F, Monnet-Corti V, Bouchard P. Qualitative cosmetic evaluation after root-coverage procedures. *J Periodontol* 2009: **80**: 41–47.
71. Kerosuo H, Hausen H, Laine T, Shaw WC. The influence of incisal malocclusion on the social attractiveness of young adults in Finland. *Eur J Orthod* 1995: **17**: 505–512.
72. Kim SM, Choi YH, Kim YG, Park JW, Lee JM, Suh JY. Analysis of the esthetic outcome after root coverage procedures using a comprehensive approach. *J Esthet Restor Dent* 2014: **26**: 107–118.
73. Kois JC, Kan JYK. Predictable peri-implant gingival aesthetics: surgical and prosthodontic rationales. *Pract Proced Aesthet Dent* 2001: **13**: 691–698.
74. Kotsakis G, Chrepa V, Marcou N, Prasad H, Hinrichs J. Flapless alveolar ridge preservation utilizing the "socket-plug" technique: clinical technique and review of the literature. *J Oral Implantol* 2014: **40**: 690–698.
75. Kourkouta S, Dedi KD, Paquette DW, Mol A. Interproximal tissue dimensions in relation to adjacent implants in the anterior maxilla: clinical observations and patient aesthetic evaluation. *Clin Oral Implants Res* 2009: **20**: 1375–1385.
76. Kuchler U, Chappuis V, Gruber R, Lang NP, Salvi GE. Immediate implant placement with simultaneous guided bone regeneration in the esthetic zone: 10-year clinical and radiographic outcomes. *Clin Oral Implants Res* 2016: **27**: 253–257.
77. Lai YL, Chen HL, Chang LY, Lee SY. Resubmergence technique for the management of soft tissue recession around an implant: case report. *Int J Oral Maxillofac Implants* 2010: **25**: 201–204.
78. Lang NP, Loe H. The relationship between the width of keratinized gingiva and gingival health. *J Periodontol* 1972: **43**: 623–627.
79. Lang NP, Zitzmann NU, Working Group 3 of the VEWoP. Clinical research in implant dentistry: evaluation of implant-supported restorations, aesthetic and patient-reported outcomes. *J Clin Periodontol* 2012: **39** (Suppl. 12): 133–138.
80. Langer B, Calagna L. The subepithelial connective tissue graft. *J Prosthet Dent* 1980: **44**: 363–367.
81. Langer B, Calagna LJ. The subepithelial connective tissue graft. A new approach to the enhancement of anterior cosmetics. *Int J Periodontics Restorative Dent* 1982: **2**: 22–33.
82. Le B, Borzabadi-Farahani A, Nielsen B. Treatment of labial soft tissue recession around dental implants in the esthetic zone using guided bone regeneration with mineralized allograft: a retrospective clinical case series. *J Oral Maxillofac Surg* 2016: **74**: 1552–1561.
83. Lee CT, Tao CY, Stoupel J. The effect of subepithelial connective tissue graft placement on esthetic outcomes after immediate implant placement: systematic review. *J Periodontol* 2016: **87**: 156–167.
84. Levin EI. Dental esthetics and the golden proportion. *J Prosthet Dent* 1978: **40**: 244–252.
85. Lin GH, Chan HL, Bashutski JD, Oh TJ, Wang HL. The effect of flapless surgery on implant survival and marginal bone level: a systematic review and meta-analysis. *J Periodontol* 2014: **85**: 91–103.
86. Lindhe J, Cecchinato D, Donati M, Tomasi C, Liljenberg B. Ridge preservation with the use of deproteinized bovine bone mineral. *Clin Oral Implants Res* 2014: **25**: 786–790.
87. Mardinger O, Vered M, Chaushu G, Nissan J. Histomorphometrical analysis following augmentation of infected extraction sites exhibiting severe bone loss and primarily closed by intrasocket reactive soft tissue. *Clin Implant Dent Relat Res* 2012: **14**: 359–365.
88. Mareque-Bueno S. A novel surgical procedure for coronally repositioning of the buccal implant mucosa using acellular dermal matrix: a case report. *J Periodontol* 2011: **82**: 151–156.
89. Marzadori M, Stefanini M, Mazzotti C, Ganz S, Sharma P, Zucchelli G. Soft-tissue augmentation procedures in edentulous esthetic areas. *Periodontol 2000* 2018: **77**: 111–122.
90. Marzadori M, Stefanini M, Sangiorgi M, Mounssif I, Monaco C, Zucchelli G. Crown lengthening and restorative procedures in the esthetic zone. *Periodontol 2000* 2018: **77**: 84–92.
91. Mazzotti C, Stefanini M, Felice P, Bentivogli V, Mounssif I, Zucchelli G. Soft-tissue dehiscence coverage at peri-implant sites. *Periodontol 2000* 2018: **77**: 256–272.
92. McGrath C, Lam O, Lang N. An evidence-based review of patient-reported outcome measures in dental implant research among dentate subjects. *J Clin Periodontol* 2012: **39** (Suppl. 12): 193–201.
93. McGuire MK, Scheyer ET, Gwaltney C. Commentary: incorporating patient-reported outcomes in periodontal clinical trials. *J Periodontol* 2014: **85**: 1313–1319.
94. Meijer HJ, Stellingsma K, Meijndert L, Raghoebar GM. A new index for rating aesthetics of implant-supported single crowns and adjacent soft tissues–the Implant Crown Aesthetic Index. *Clin Oral Implants Res* 2005: **16**: 645–649.
95. Mele M, Felice P, Sharma P, Mazzotti C, Bellone P, Zucchelli G. Esthetic treatment of altered passive eruption. *Periodontol 2000* 2018: **77**: 65–83.
96. Meloni SM, Tallarico M, Lolli FM, Deledda A, Pisano M, Jovanovic SA. Postextraction socket preservation using epithelial connective tissue graft vs porcine collagen matrix. 1-year results of a randomised controlled trial. *Eur J Oral Implantol* 2015: **8**: 39–48.
97. Meltzer JA. Edentulous area tissue graft correction of an esthetic defect. A case report. *J Periodontol* 1979: **50**: 320–322.
98. Milinkovic I, Cordaro L. Are there specific indications for the different alveolar bone augmentation procedures for implant placement? A systematic review. *Int J Oral Maxillofac Surg* 2014: **43**: 606–625.
99. Miller AG. Role of physical attractiveness in impression formation. *Psychol Sci* 1970: **19**: 231–234.

100. Miller PD Jr. A classification of marginal tissue recession. *Int J Periodontics Restorative Dent* 1985: **5**: 8–13.
101. Miller PD Jr. Regenerative and reconstructive periodontal plastic surgery. Mucogingival surgery. *Dent Clin North Am* 1988: **32**: 287–306.
102. Miller PD Jr. Root coverage grafting for regeneration and aesthetics. *Periodontol 2000* 1993: **1**: 118–127.
103. Morley J, Eubank J. Macroesthetic elements of smile design. *J Am Dent Assoc* 2001: **132**: 39–45.
104. Morton D, Chen ST, Martin WC, Levine RA, Buser D. Consensus statements and recommended clinical procedures regarding optimizing esthetic outcomes in implant dentistry. *Int J Oral Maxillofac Implants* 2014: **29** (Suppl): 216–220.
105. Moskowitz ME, Nayyar A. Determinants of dental esthetics: a rational for smile analysis and treatment. *Compend Contin Educ Dent* 1995: **16**: 1164–1166.
106. Mounssif I, Stefanini M, Mazzotti C, Marzadori M, Sangiorgi M, Zucchelli G. Esthetic evaluation and patient-centered outcomes in root-coverage procedures. *Periodontol 2000* 2018: **77**: 19–53.
107. Nabers CL. Repositioning the attached gingiva. *J Periodontol* 1954: **25**: 38–39.
108. Nemcovsky CE, Moses O, Artzi Z. Interproximal papillae reconstruction in maxillary implants. *J Periodontol* 2000: **71**: 308–314.
109. Nieri M, Pini Prato GP, Giani M, Magnani N, Pagliaro U, Rotundo R. Patient perceptions of buccal gingival recessions and requests for treatment. *J Clin Periodontol* 2013: **40**: 707–712.
110. Op Heij DG, Opdebeeck H, van Steenberghe D, Quirynen M. Age as compromising factor for implant insertion. *Periodontol 2000* 2003: **33**: 172–184.
111. Peck S, Peck L, Kataja M. The gingival smile line. *Angle Orthod* 1992: **62**: 91–100; discussion 1–2.
112. Perez JR, Smukler H, Nunn ME. Clinical evaluation of the supraosseous gingivae before and after crown lengthening. *J Periodontol* 2007: **78**: 1023–1030.
113. Raetzke PB. Covering localized areas of root exposure employing the "envelope" technique. *J Periodontol* 1985: **56**: 397–402.
114. Reips UD, Funke F. Interval-level measurement with visual analogue scales in Internet-based research: VAS Generator. *Behav Res Methods* 2008: **40**: 699–704.
115. Rocchietta I, Ferrantino L, Simion M. Vertical ridge augmentation in the esthetic zone. *Periodontol 2000* 2018: **77**: 241–255.
116. Rocchietta I, Fontana F, Simion M. Clinical outcomes of vertical bone augmentation to enable dental implant placement: a systematic review. *J Clin Periodontol* 2008: **35**: 203–215.
117. Roccuzzo M, Bunino M, Needleman I, Sanz M. Periodontal plastic surgery for treatment of localized gingival recessions: a systematic review. *J Clin Periodontol* 2002: **29** (Suppl. 3): 178–194.
118. Roccuzzo M, Gaudioso L, Bunino M, Dalmasso P. Surgical treatment of buccal soft tissue recessions around single implants: 1-year results from a prospective pilot study. *Clin Oral Implants Res* 2014: **25**: 641–646.
119. Rosetti EP, Marcantonio RA, Rossa C Jr, Chaves ES, Goissis G, Marcantonio E Jr. Treatment of gingival recession: comparative study between subepithelial connective tissue graft and guided tissue regeneration. *J Periodontol* 2000: **71**: 1441–1447.
120. Rossi R, Benedetti R, Santos-Morales RI. Treatment of altered passive eruption: periodontal plastic surgery of the dentogingival junction. *Eur J Esthet Dent* 2008: **3**: 212–223.
121. Rotundo R, Nieri M, Bonaccini D, Mori M, Lamberti E, Massironi D, Giachetti L, Franchi L, Venezia P, Cavalcanti R, Bondi E, Farneti M, Pinchi V, Buti J. The Smile Esthetic Index (SEI): A method to measure the esthetics of the smile. An intra-rater and inter-rater agreement study. *Eur J Oral Implantol* 2015: **8**: 397–403.
122. Ruben MP. A biologic rationale for gingival reconstruction by grafting procedures. *Quintessence Int Dent Dig* 1979: **10**: 47–55.
123. Scharf DR, Tarnow DP. Modified roll technique for localized alveolar ridge augmentation. *Int J Periodontics Restorative Dent* 1992: **12**: 415–425.
124. Schropp L, Wenzel A, Kostopoulos L, Karring T. Bone healing and soft tissue contour changes following single-tooth extraction: a clinical and radiographic 12-month prospective study. *Int J Periodontics Restorative Dent* 2003: **23**: 313–323.
125. Scutella F, Weinstein T, Lazzara R, Testori T. Buccolingual implant position and vertical abutment finish line geometry: two strictly related factors that may influence the implant esthetic outcome. *Implant Dent* 2015: **24**: 343–348.
126. Seibert JS. Reconstruction of deformed, partially edentulous ridges, using full thickness onlay grafts. Part I. Technique and wound healing. *Compend Contin Educ Dent* 1983: **4**: 437–453.
127. Seibert JS. Reconstruction of deformed, partially edentulous ridges, using full thickness onlay grafts. Part II. Prosthetic/periodontal interrelationships. *Compend Contin Educ Dent* 1983: **4**: 549–562.
128. Seibert JS, Louis JV. Soft tissue ridge augmentation utilizing a combination onlay-interpositional graft procedure: a case report. *Int J Periodontics Restorative Dent* 1996: **16**: 310–321.
129. Shibli JA, d'Avila S. Restoration of the soft-tissue margin in single-tooth implant in the anterior maxilla. *J Oral Implantol* 2006: **32**: 286–290.
130. Shibli JA, d'avila S, Marcantonio E Jr. Connective tissue graft to correct peri-implant soft tissue margin: a clinical report. *J Prosthet Dent* 2004: **91**: 119–122.
131. Simion M, Fontana F, Rasperini G, Maiorana C. Vertical ridge augmentation by expanded-polytetrafluoroethylene membrane and a combination of intraoral autogenous bone graft and deproteinized anorganic bovine bone (Bio Oss). *Clin Oral Implants Res* 2007: **18**: 620–629.
132. Sisti A, Canullo L, Mottola MP, Covani U, Barone A, Botticelli D. Clinical evaluation of a ridge augmentation procedure for the severely resorbed alveolar socket: multicenter randomized controlled trial, preliminary results. *Clin Oral Implants Res* 2012: **23**: 526–535.
133. Stefanini M, Felice P, Mazzotti C, Mounssif I, Marzadori M, Zucchelli G. Esthetic evaluation and patient-centered outcomes in single-tooth implant rehabilitation in the esthetic area. *Periodontol 2000* 2018: **77**: 150–164.
134. Stefanini M, Marzadori M, Aroca S, Felice P, Sangiorgi M, Zucchelli G. Decision making in root-coverage procedures for the esthetic outcome. *Periodontol 2000* 2018: **77**: 54–64.

135. Stimmelmayr M, Allen EP, Reichert TE, Iglhaut G. Use of a combination epithelized-subepithelial connective tissue graft for closure and soft tissue augmentation of an extraction site following ridge preservation or implant placement: description of a technique. *Int J Periodontics Restorative Dent* 2010: **30**: 375–381.
136. Stimmelmayr M, Guth JF, Iglhaut G, Beuer F. Preservation of the ridge and sealing of the socket with a combination epithelialised and subepithelial connective tissue graft for management of defects in the buccal bone before insertion of implants: a case series. *Br J Oral Maxillofac Surg* 2012: **50**: 550–555.
137. Tal H. Autogenous masticatory mucosal grafts in extraction socket seal procedures: a comparison between sockets grafted with demineralized freeze-dried bone and deproteinized bovine bone mineral. *Clin Oral Implants Res* 1999: **10**: 289–296.
138. Ten Heggeler JM, Slot DE, Van der Weijden GA. Effect of socket preservation therapies following tooth extraction in non-molar regions in humans: a systematic review. *Clin Oral Implants Res* 2011: **22**: 779–788.
139. Testori T, Zuffetti F, Capelli M, Galli F, Weinstein RL, Del Fabbro M. Immediate versus conventional loading of post-extraction implants in the edentulous jaws. *Clin Implant Dent Relat Res* 2014: **16**: 926–935.
140. Testori T, Weinstein T, Scutellà F, Wang H-L, Zucchelli G. Implant placement in the esthetic area: criteria for positioning single and multiple implants. *Periodontol 2000* 2018: **77**: 176–196.
141. Thoma DS, Benic GI, Zwahlen M, Hammerle CH, Jung RE. A systematic review assessing soft tissue augmentation techniques. *Clin Oral Implants Res* 2009: **20** (Suppl. 4): 146–165.
142. Trombelli L, Scabbia A, Tatakis DN, Calura G. Subpedicle connective tissue graft versus guided tissue regeneration with bioabsorbable membrane in the treatment of human gingival recession defects. *J Periodontol* 1998: **69**: 1271–1277.
143. Trombelli L, Simonelli A, Minenna L, Vecchiatini R, Farina R. Simplified procedures to treat periodontal intraosseous defects in esthetic areas. *Periodontol 2000* 2018: **77**: 93–110.
144. Urban IA, Nagursky H, Lozada JL, Nagy K. Horizontal ridge augmentation with a collagen membrane and a combination of particulated autogenous bone and anorganic bovine bone-derived mineral: a prospective case series in 25 patients. *Int J Periodontics Restorative Dent* 2013: **33**: 299–307.
145. Vignoletti F, Matesanz P, Rodrigo D, Figuero E, Martin C, Sanz M. Surgical protocols for ridge preservation after tooth extraction. A systematic review. *Clin Oral Implants Res* 2012: **23** (Suppl. 5): 22–38.
146. Wang HL, Bunyaratavej P, Labadie M, Shyr Y, MacNeil RL. Comparison of 2 clinical techniques for treatment of gingival recession. *J Periodontol* 2001: **72**: 1301–1311.
147. Weng D, Stock V, Schliephake H. Are socket and ridge preservation techniques at the day of tooth extraction efficient in maintaining the tissues of the alveolar ridge? *Eur J Oral Implantol* 2011: **4**: 59–66.
148. Wennstrom JL. Mucogingival therapy. *Ann Periodontol* 1996: **1**: 671–701.
149. Zabalegui I, Sicilia A, Cambra J, Gil J, Sanz M. Treatment of multiple adjacent gingival recessions with the tunnel subepithelial connective tissue graft: a clinical report. *Int J Periodontics Restorative Dent* 1999: **19**: 199–206.
150. Zucchelli G. Altered passive eruption. In: *Mucogingival esthetic surgery*. Berlin: Quintessence Publishing Co. Inc., 2013: 749–793.
151. Zucchelli G, Marzadori M, Mounssif I, Mazzotti C, Stefanini M. Coronally advanced flap + connective tissue graft techniques for the treatment of deep gingival recession in the lower incisors. A controlled randomized clinical trial. *J Clin Periodontol* 2014: **41**: 806–813.
152. Zucchelli G, Mazzotti C, Bentivogli V, Mounssif I, Marzadori M, Monaco C. The connective tissue platform technique for soft tissue augmentation. *Int J Periodontics Restorative Dent* 2012: **32**: 665–675.
153. Zucchelli G, Mazzotti C, Mounssif I, Mele M, Stefanini M, Montebugnoli L. A novel surgical-prosthetic approach for soft tissue dehiscence coverage around single implant. *Clin Oral Implants Res* 2013: **24**: 957–962.
154. Zucchelli G, Mazzotti C, Tirone F, Mele M, Bellone P, Mounssif I. The connective tissue graft wall technique and enamel matrix derivative to improve root coverage and clinical attachment levels in Miller Class IV gingival recession. *Int J Periodontics Restorative Dent* 2014: **34**: 601–609.
155. Zucchelli G, Mele M, Mazzotti C, Marzadori M, Montebugnoli L, De Sanctis M. Coronally advanced flap with and without vertical releasing incisions for the treatment of multiple gingival recessions: a comparative controlled randomized clinical trial. *J Periodontol* 2009: **80**: 1083–1094.
156. Zucchelli G, Mounssif I, Mazzotti C, Montebugnoli L, Sangiorgi M, Mele M, Stefanini M. Does the dimension of the graft influence patient morbidity and root coverage outcomes? A randomized controlled clinical trial. *J Clin Periodontol* 2014: **41**: 708–716.
157. Zucchelli G, Mounssif I, Mazzotti C, Stefanini M, Marzadori M, Petracci E, Montebugnoli L. Coronally advanced flap with and without connective tissue graft for the treatment of multiple gingival recessions: a comparative short- and long-term controlled randomized clinical trial. *J Clin Periodontol* 2014: **41**: 396–403.
158. Zuhr O, Hurzeler MB. Management of extraction sockets. In: *Plastic-esthetic periodontal and implant surgery*. New Malden, UK: Quintessence Publishing, 2012: 513–607.
159. Zuhr O, Hurzeler MB. Replacement of missing teeth. In: *Plastic-esthetic periodontal and implant surgery*. New Malden, UK: Quintessence Publishing, 2012: 609–798.
160. Zuhr O, Fickl S, Wachtel H, Bolz W, Hurzeler MB. Covering of gingival recessions with a modified microsurgical tunnel technique: case report. *Int J Periodontics Restorative Dent* 2007: **27**: 457–463.
161. Zuhr O, Rebele SF, Cheung SL, Hürzeler MB. Surgery without papilla incision: tunnelling flap procedures in plastic periodontal and implant surgery. *Periodontol 2000* 2018: **77**: 123–149.