



Soft Tissue Grafting Around Implants: Why, When, and How?

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Abstract

Purpose of Review This paper discusses the role of soft tissue grafting around dental implants. The aim of this review is to present pertinent literature on peri-implant soft tissue including its role, indications for augmentation, techniques used to enhance the quality and/or quantity of the soft tissue, and corresponding timing of those procedures.

Recent Findings Most reviewed soft tissue grafting studies in this paper were published in the last 5 years. However, the review also included older articles to mitigate the lack of recent randomized controlled trials or even case series on the reviewed soft tissue graft types. Soft tissue management with custom healing abutments or temporary restorations should be considered whenever possible. Soft tissue grafting to increase the width of keratinized mucosa (KM) seems to result in greater reduction of inflammation signs and a greater maintenance of crestal bone levels. The use of soft tissue grafts to increase soft tissue thickness tends to have a positive effect on maintaining crestal bone levels, especially when used to increase vertical thickness.

Summary Apically positioned flaps (APFs) in combination with free gingival grafts (FGGs), subepithelial connective tissue grafts (SCTGs), or xenogenic collagen matrix (XCM) can significantly increase the KM width. Grafts to enhance facial tissue thickness lack evidence to support their long-term impact on mucosal marginal levels. Nonetheless, soft tissue manipulation is frequently performed at second-stage surgery to improve the facial thickness and esthetics. No clear advantages for the timing of soft tissue grafting with regard to clinical outcomes can be delineated when grafting is performed to increase KM or tissue thickness in simultaneous or staged approaches. The decision and timing to treat soft tissue defects should be based on risk assessment at the site and patient levels.

Keywords Keratinized mucosa · Dental implants · Grafting · Free gingival graft · Subepithelial connective tissue graft · Tissue thickness · Soft tissue volume

Introduction

Replacing missing teeth with dental implants in partially or fully edentulous patients has become a routine treatment modality [1, 2]. While osseointegration remains the predominant parameter in recognizing the success of dental implants, other parameters related to implant fixtures, peri-implant soft tissue, prosthesis, and patient satisfaction have been introduced [3]. Following tooth extraction, soft and hard tissue alterations can occur as a result of the biological and clinical modifications of the alveolar ridge [4]. Due to these changes,

adequate treatment planning, including implant placement in the correct 3D position and reconstruction of lost soft and hard tissues, is recommended for reliable long-term implant success [5]. Despite various techniques suggested for bone grafting before implant placement [6], there are scenarios where soft tissue grafting can compensate for bone loss, provide better esthetic results, and achieve stable peri-implant soft tissue [7•].

Hard and soft tissue deficiencies around dental implants are common clinical findings that are caused by tooth extraction and resorptive ridge processes, periodontitis, endodontic infections, and trauma prior to implant placement, and by improper implant position, poor prosthetic design, peri-implantitis, and continued facial growth after implant placement [8]. As a result, complications such as poor esthetics, marginal bone loss, soft tissue inflammation, recession, and implant loss may arise [9–11]. While all implant locations in the mouth are prone to soft tissue deficiencies, there are distinctions in their occurrence and impact between implants placed in the esthetic zone and those placed in posterior areas.

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The most commonly encountered soft tissue discrepancies in the anterior zone include facial recession related to lack of buccal bone [12, 13], insufficient papilla height [14, 15], and gingival asymmetry between teeth and implants due to life-long skeletal changes [16]. In contrast, posterior implants typically present with lack of keratinized mucosa (KM) as the predominant soft tissue deficiency.

Soft tissue grafting around dental implants has been recommended to enhance functional, biological, and esthetic outcomes. Several techniques have been proposed to maintain and augment peri-implant soft tissue including various flap designs, graft materials, and suturing techniques. Two major indications include the increase of the KM width and the increase of soft tissue volume using autogenous or alternative-type grafts [17, 18•, 19•]. Furthermore, these grafting procedures are performed at different timepoints: (a) prior to implant placement, (b) at the time of implant placement, (c) at the time of second-stage surgery, (d) during implant bone healing, or (e) after implant restoration. The first four usually yield more predictable results when compared to grafting after implant loading as the latter is typically performed to repair an implant biologic or esthetic complication that might have a non-soft tissue–related etiology [20].

The aim of this review is to present pertinent literature on peri-implant soft tissue including its role, indications for augmentation, techniques used to change the quality and quantity of the soft tissue, and corresponding timing of those procedures.

Gingival Tissue and Peri-implant Mucosa

Despite similar clinical appearances, it is critical to highlight various histological differences that distinguish peri-implant mucosa from gingival tissues around teeth:

- Peri-implant mucosa has more collagen and less fibroblasts, when compared to gingival tissue [21, 22].
- The connective tissue length around implants varies between 1.1 and 1.7 mm [23]. The fiber bundles of the peri-implant mucosa run parallel to the implant or abutment surface without attaching to the implant, while periodontal fibers insert into the root via Sharpey's fibers and run perpendicular to the root surface [24]. Some human studies suggested direct attachment of collagen fibers into laser microgrooved implant surfaces [25, 26].
- Although the junctional epithelium is considered to be structurally similar around teeth and implants, it is approximately 2 mm long around implants whereas it averages 1 mm of length around teeth [23, 27].
- Supracrestal vascular topography around the implant is reduced and differently arranged compared to gingival tissues [24, 28]. Implants lack a periodontal ligament and the only vascular supply of the peri-implant soft tissue

originates from the suprapariosteal blood vessel and intraalveolar supply [24].

Collectively, these histological differences document that the peri-implant mucosa is less cellular and vascular than gingival tissue and that it confers a close adaptation to the collar of implant abutments and restorations rather than a functional attachment. Therefore, it is imperative that this peri-implant soft tissue attachment is not compromised by aggressing factors such as plaque-induced inflammation, thin phenotype, trauma from improper tooth brushing, reduced vestibular depth, and muscle pull at the marginal tissue.

Overall, probing depths around implants are greater than those around teeth [29]. There is no defined range of probing depth measurements compatible with peri-implant health and a stable peri-implant soft tissue [29]. Signs including edema, erythema, suppuration, and bleeding on probing and bone levels are considered in determining health from disease around dental implants.

Soft Tissue Grafting to Increase the Width of Keratinized Mucosa

Similar to keratinized gingiva, KM clinically extends from the mucosal margin to the mucogingival junction. It is frequently reduced at implant sites following tooth loss, especially at sites where advanced bone augmentation procedures have been performed, in which the mucogingival complex is coronally displaced to achieve tension-free closure at time of ridge reconstruction.

Overall, inconclusive evidence exists regarding the need for an adequate KM width to facilitate proper oral hygiene and maintain long-term implant health. KM width ≥ 2 mm was shown to have a favorable effect on overall tissue health, plaque and bleeding scores [30–32], and long-term maintenance of implants [33]. On the contrary, the maintenance of peri-implant bone level [34], risk for peri-implant disease [35], and implant health and soft tissue stability [36] did not seem influenced by the amount of KM. However, a recent systematic review [7•] and a consensus report [37] favored soft tissue grafting to increase KM width resulting in greater reduction of inflammation signs and a greater maintenance of crestal bone levels.

Types of Soft Tissue Grafts

Various techniques have been presented in periodontal plastic surgeries to widen the zone of KM around dental implants with different success rates. These techniques include apically positioned flap/vestibuloplasty, free gingival graft (FGG), subepithelial connective tissue graft (SCTG), acellular dermal matrix (ADM), and xenogenic bilayer collagen matrix (XCM) [38].

Autogenous grafts (i.e., FGG and SCTG), harvested from the patient's palate, are considered the gold standard in soft tissue augmentation procedures with the most predictable results [38]. It was clearly shown that these grafts were able to transplant the characteristics of the palatal tissue to the recipient site, owing to the genetic information carried by the connective tissue inducing epithelial keratinization [39]. To compensate for FGG shrinkage and achieving optimal outcomes, there is always a tendency to harvest larger grafts which is associated with significant patient morbidity. Minimally invasive techniques such as the “strip gingival autograft” were introduced to limit the volume of harvested grafts where two thin strips of FGGs are harvested and placed parallel to each other leaving exposed periosteum between these strips at the recipient site [40]. As a result, a significant decrease in patient morbidity along with widening the KM zone is achieved. Despite various advantages for FGG, unfavorable esthetic outcomes, donor site morbidity, limited graft amount, increased hemorrhage risk from donor sites, and unpleasant patient experience are all considered drawbacks for using autogenous grafts.

Xenogenic collagen matrix (XCM) was recently introduced as a viable alternative for autogenous grafts in soft tissue augmentation procedures [41]. It consists of types I and III collagen in two layers, a superior thin layer that is cell occlusive and a porous thick layer that is placed on the periosteum of the recipient site to aid in cell ingrowth, tissue integration, and stabilization of the blood clot [42–44].

Another alternative for autogenous grafting is the acellular dermal matrix (ADM) allograft that is derived from human skin. ADM, originally used for treating burn wounds [45], is an epithelium free, freeze-dried matrix containing types I and III collagen bundles where elastic fibers are its main components [46, 47]. ADM acts as a bioactive scaffold that integrates in host tissue and permits the migration of fibroblasts and epithelial and endothelial cells through vascular channels of the recipient sites [48]. Since its initial use, ADM has been widely used in dental practice, in particular for soft tissue grafting of gingival recession [49] or to change the quality of peri-implant/teeth mucosa [50].

Table 1 summarizes available studies that evaluated KM increase using various types of grafts. The majority of investigations included the use of autogenous tissue as a control group in mostly equivalence studies to advocate for an alternative graft type, i.e., ADM or XCM. It is noteworthy that greater KM increase was consistently found with autogenous grafting in the reviewed studies.

The timing of soft tissue augmentation for KM increase seems to vary depending on the clinical situation and clinician preferences. It is uncommonly performed prior to implant placement, in particular prior to ridge augmentation procedures to improve the volume of soft tissue and KM width in preparation for the subsequent treatment phases. However, this approach has been proposed by some clinicians [51, 52].

Studies comparing outcomes of soft grafting before and after implant placement are lacking. Figure 1 illustrates a case of FGG prior to ridge augmentation and implant placement.

The following sections will discuss those grafting techniques according to the timing at which they are performed.

Grafting at Time of Second-Stage Surgery

Irrespective of the graft type, the recipient bed is prepared with a split-thickness flap design with a horizontal incision at the MGJ and two vertical incisions outlining the mesial-distal extension of the graft. The flap is apically positioned (APF) and sutured. The graft is trimmed to allow appropriate adaptation to recipient site without interfering with flap margins or any movement caused by lips and cheeks. An example of KM augmentation at time of implant uncover is illustrated in Fig. 2.

FGG is considered to be the gold standard for augmentation of the KM width around implants; however, it is less desirable in esthetic areas due to poor blending characteristics in color and texture with adjacent gingival tissue. A range of KM width gain between 3.35 and 8.93 mm has been reported with FGG [41, 53, 54].

When comparing three grafting techniques at time of implant uncover, i.e., (a) APF without a graft material, (b) roll flap, and (c) APF combined with SCTG, the mean KM gain was 4.63 mm, 1.35 mm, and 4.10 mm respectively [55]. The ability to displace KM with an APF, with or without additional FGG or SCTG, to the facial aspect of an implant is prevalent in the maxilla where keratinized tissue is readily available in the palate, whereas the use of FGG or SCTG in the mandible is far more common [18•].

Another treatment modality to establish an adequate band of KM at the time of uncover is APF in combination with XCM after relocating and securing the existing KM apically to XCM. This technique was shown to result in a mean of 4.81 mm of KM after 3 months with comparable histological findings between native and regenerated KM biopsies [56]. A similar concept was applied by harvesting a 2–3-mm FGG strip from the palate and suturing it at the apical extension along with XCM covering the coronal aspect of the recipient site [44]. A mean KM width of 6.33 mm was reported with a 43% shrinkage rate of the grafted area at 6 months. The authors theorized that the FGG strip acts as a barrier and provides a source of keratinization. In a 5-year study, an average KM width gain of 8.4 mm and 6.15 mm was reported using APF with FGG and XCM respectively. The reported shrinkage from time of grafting was 40.65% for FGG and 52.89% for XCM [54].

A systematic review concluded that either a vestibuloplasty or an APF combined with FGG or XCM achieved acceptable results for KM increase whereas only a combination of APF with either FGG or XCM yielded acceptable results in the mandible at time of implant uncover [18•].

Table 1 Summary of studies on soft tissue grafting to increase KM

Authors	Study design	Study aims + outcome measures	Control group (n)	Test group (n)	Conclusions
Tunkel et al. 2013 [55]	Case series	Compare the results (KM width and/or soft tissue thickness) using three different techniques of stage-two surgery	ARF (stage 2) Patients <i>n</i> = 14 Implants <i>n</i> = 36	RF (stage 2) Patients <i>n</i> = 10 Implants <i>n</i> = 23 ARF + CT (stage 2) Patients <i>n</i> = 8 Implants <i>n</i> = 19	Tissue thickness deficient → RF or APF recommended KM deficient → APF or APF + CT recommended If both deficient → APF + CT recommended
Basegmez et al. 2012 [57]	RCT	Compare the efficacy of two techniques (FGG vs VP) for increasing the amount of KM around loaded implants	VP Patients <i>n</i> = 32 Implants <i>n</i> = 32	FGG Patients <i>n</i> = 32 Implants <i>n</i> = 32	Mean KM gain: VP (1.15 mm) FGG (2.36 mm) - Less postoperative relapse and PD values for FGG group
Park JB. 2006 [117]	Case series	Evaluate the efficacy of ADM to achieve increased peri-implant keratinized mucosa around loaded implants	No control group	ADM (already loaded implants) Patients <i>n</i> = 10 Implants <i>n</i> = 26	Mean KM gain: - 2.2 mm at 6 months - 50% shrinkage of grafted area at 6 months
Basegmez et al. 2013 [58]	RCT	Compare the efficacy of two techniques (FGG vs ADM) for increasing the amount of keratinized mucosa around loaded implants	FGG Patients <i>n</i> = 18 Implant <i>n</i> = 36	ADM Patients <i>n</i> = 18 Implants <i>n</i> = 36	- Mean KM gain: FGG: 2.57 mm ADM: 1.58 mm - Less relapse for FGG group - FGG is more effective and ADM is recommended when donor site to be avoided.
Schmitt et al. 2016 [54]	Prospective clinical trial	Evaluate the efficacy of a xenogeneic collagen matrix as a substitute for soft tissue grafting around uncovered dental implants and compared to FGG	FGG Patients <i>n</i> = 21 Implants <i>n</i> = 74	XCM Patients <i>n</i> = 27 Implants <i>n</i> = 102	Mean KM gain: FGG: 8.4 mm XCM: 6.15 mm Shrinkage between time of grafting and 5 years: 40.65% FGG vs 52.89% XCM XCM had less surgical time, more esthetic results, and less morbidity.
Lorenzo et al. 2012 [59]	RCT	Evaluate the efficacy of a xenogeneic collagen matrix to augment the keratinized tissue around uncovered implants and compared to CTG	CTG Patients <i>n</i> = 12 Implants NR	XCM Patient: 10 Implant: NR	Mean KM gain at 6 months: CTG: 2.75 mm XCM: 2.8 mm Both groups had similar esthetic results. XCM had less surgical time, less morbidity.
Urban et al. 2015 [44]	Case series	Evaluate the efficacy of a combination of strip FGG and XCM to regenerate KM at the time of uncover	No control group	Strip graft + XCM	Mean KM gain at 12 months was 6.33 mm with less shrinkage 43%. Minimal morbidity reported and good esthetic outcomes
Jiang et al. 2019 [56]	Case series	Evaluate the efficacy of APF combined with XCM to regenerate KM in posterior mandible pat the time of uncover	No control group	APF + XCM Patients <i>n</i> = 6 Implants <i>n</i> = 18	Mean KM gain at 3 months: APF + XCM = 4.81 mm Minor morbidity Histological analysis showed similar architecture to native KM.

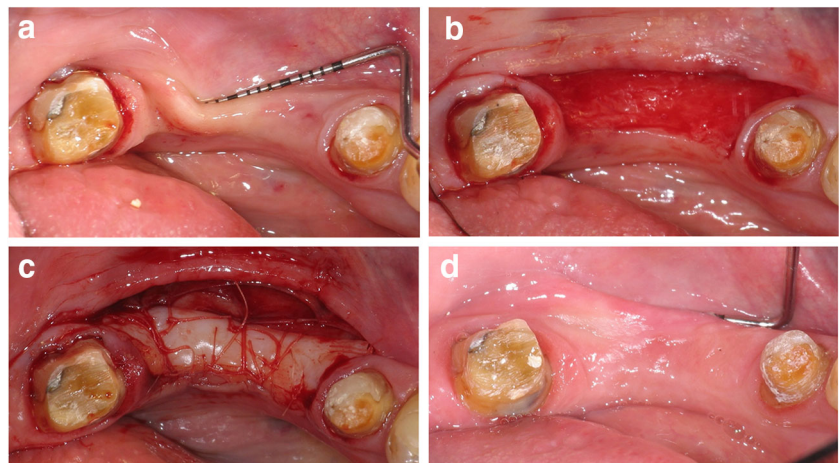
RCT randomized controlled trial, ARF apically repositioned flap, VP vestibuloplasty, RF roll flap, CT connective tissue, FGG free gingival graft, ADM acellular dermal matrix, XCM xenogeneic collagen matrix, KM keratinized mucosa, PD probing depth, NR not reported

Grafting Around Healed and Loaded Implants

As previously mentioned, soft tissue augmentation after implant loading is more challenging because the soft tissue

defect may be related to other complications. Among all techniques to increase peri-implant KM, the application of FGG seems to be the treatment of choice with mean gains ranging between 2.36 and 2.57 mm [57, 58]. A statistically significant

Fig. 1 FGG prior to ridge augmentation and implant placement. **a** Lack of KM on crestal and buccal aspects of edentulous ridge no. 18–19, **b** split-thickness APF preparation, **c** FGG secured to adjacent tissue and periosteum with sutures, and **d** wide band of KM is noted after 12 weeks



advantage was shown for combining vestibuloplasty and FGG versus vestibuloplasty alone in terms of KM increase (2.36 mm and 1.15 mm respectively) [57].

When evaluating alternatives to autogenous grafts, a 2.3-mm mean gain of KM width was reported with the use of APF in combination with either SCTG or XCM [59]. Another study used a combination of APF and CTG instead of FGG and found a significant gain in KM width (mean 2.3 mm) [59]. Similar esthetic results were reported in both groups with more favorable pain perception outcomes with XCM [59].

Similarly, ADM use was reported in the treatment of mucogingival defects around uncovered or loaded implants. In a pilot study, a mean gain of 2.2 mm at 6 months and a significant decrease in plaque index was reported [60]. However, limitations of this study were the small number of subjects and the lack of a control group; thus, those results should be interpreted carefully. When compared to FGG, ADM achieved significantly lesser KM gain (2.57 mm for FGG vs 1.58 mm for ADM) at 6 months after grafting [58].

In this study, ADM shrinkage was considered a drawback, yet the indication to use ADM or other substitutes to autogenous grafts may be justified by decreasing patient morbidity.

In summary, the use of APF in combination with either FGG, SCTG, or XCM achieved comparable and significant increase in KM width [19•]. Nevertheless, according to available evidence, the amount of KM gained with FGG and XCM was significantly greater than ADM [19•]. Overall, surgical intervention after restoring the implants seems to be more challenging and has a higher level of complications [20]. Figure 3 represents a KM augmentation procedure after loading of implant prosthesis.

Soft Tissue Grafting to Increase Soft Tissue Volume

Graft type selection for volume augmentation is largely similar to that in procedures to increase KM width. One difference is that most autogenous grafts used for this application tend to

Fig. 2 FGG at time of implant uncover. **a** Initial presentation of mandibular posterior right sextant. Note absence of KM around tooth no. 29 and ridge, **b** APF and periosteal bed preparation, **c** FGG sutured around uncovered implants site no. 30 and tooth no. 29, and **d** 4 months healing after FGG

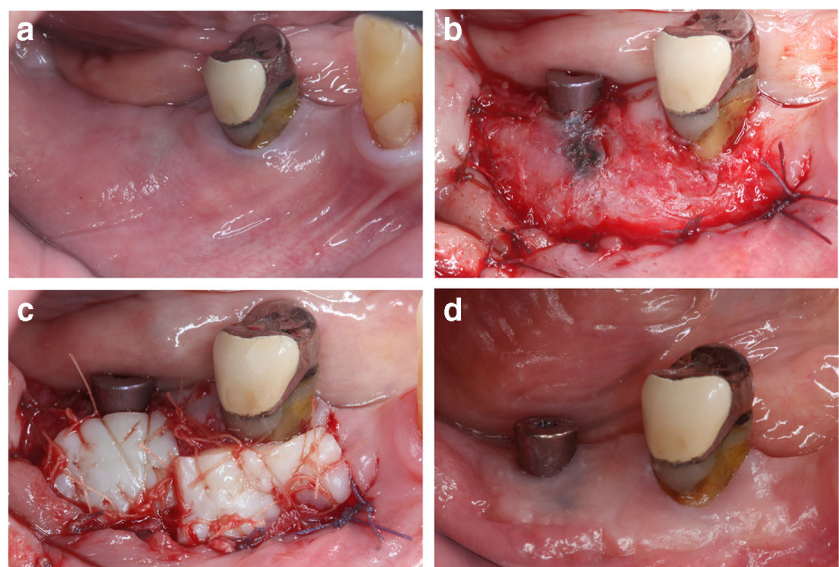
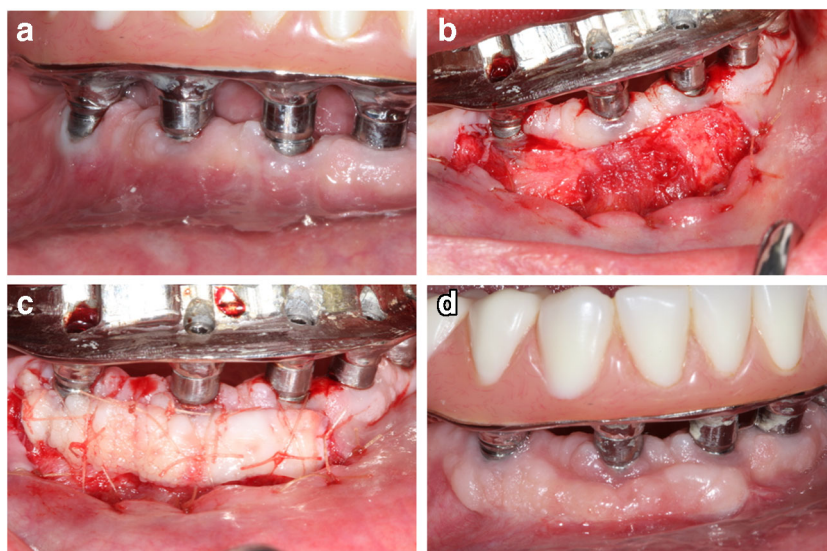


Fig. 3 FGG after implant loading. **a** Initial presentation of minimal tissue thickness and KM width at implants supporting mandibular fixed detachable prosthesis, **b** APF and periosteal bed preparation, **c** FGG sutured around uncovered implants, and **d** 6 months healing after FGG



be SCTGs as they are typically combined with a bilaminar technique.

From a treatment indication standpoint, there are largely three clinical situations for soft tissue augmentation to increase soft tissue volume: phenotype modification and/or recession coverage, papillary reconstruction, and increase of vertical tissue thickness.

Increasing peri-implant tissue thickness has not been shown to influence clinical parameters such as plaque control, probing depth, and bleeding on probing in a recent systematic review [7•]. However, implants with augmented tissue thickness were found to maintain marginal bone levels better than thinner non-grafted sites in the same review which recommends soft tissue thickness augmentation [7•].

It has been advocated that the typical “saucerization” of peri-implant bone level happens both horizontally and vertically and is considered to be related to the establishment of the biologic width around implants, especially in thin mucosal tissue < 2 mm prior to abutment connection [61].

Initial peri-implant bone remodeling is widely reported in the healing phase and its amount seems to depend on implant design, location of implant-abutment interface, and prosthetic connection [62–64]. Tissue-level implant designs allow for a vertical shift of the implant-abutment interface owing to their transmucosal portion and have also been shown to have minimal bone loss during the first year of loading [65]. For bone-level implants, platform switching is currently a standard feature in the design of implant-abutment interface. Its concept is to horizontally displace the micro-gap between implant and abutment in a medial direction, and has been shown to minimize crestal bone remodeling when compared to regular-matched platforms [66–70]. It is noteworthy that platform switching of implants was not found to have less marginal bone loss in other randomized trials [71, 72]. Other factors have been proposed to influence crestal bone loss including

submerged implant polished collars and vertical soft tissue thickness. The positive effect of platform switching designs on the amount of crestal remodeling was challenged in the presence of thin soft tissue defined as < 2 mm [73, 74]. When investigating vertical and horizontal mucosal thickness around implants, it was reported that a thin peri-implant tissue phenotype was associated with more bone loss (average = 1.76 mm) [73] compared to thick peri-implant phenotype (average bone loss = 1.18 mm) [74]. A systematic review demonstrated that there is a short-term advantage for implants placed in initially thicker peri-implant soft tissue (≥ 2 mm). Implants that were crestally and supracrestally placed had 0.35 mm and 1.29 mm less bone remodeling, respectively, when placed in thicker soft tissue height. Hence, soft tissue augmentation to increase tissue thickness at time of implant placement may be considered to minimize marginal bone loss [75•].

From a timeline standpoint, these soft tissue grafting procedures may be performed at time of implant placement, at time of second stage implant surgery, or after implant loading.

It is noteworthy that a recent systematic review did not demonstrate any significant impact for the intervention timing of soft tissue grafting procedures on clinical outcomes when performed to increase KM or tissue thickness in simultaneous or staged approaches [76]. Nonetheless, the following sections will discuss the available evidence and techniques to augment soft tissue volume at different stages of implant therapy (Table 2).

Grafting at Time of Implant Placement

Soft tissue grafting during implant placement may be performed for tissue phenotype modification in anterior cases, to increase the vertical soft tissue thickness in posterior cases

Table 2 Summary of studies on soft tissue grafting to increase tissue thickness and volume

Authors	Study design	Study aims + outcome measures	Control group (n)	Test group (n)	Conclusions
Wiesner et al. 2010 [118]	RCT (split-mouth)	Evaluate SCTG in augmenting peri-implant soft tissue at premolar and molar implant sites (PES, vertical soft tissue thickness)	Implant placement alone Patients: 10 Implants: 10	Implant placement + SCTG Patients: 10 Implants: 10	1.3 mm thicker soft tissue (vertically) in test group after 1 year of loading No difference in bone levels between groups Significantly greater PES in test group
Yoshino et al. 2014 [90]	RCT	Compare gingival margin level after immediate implant placement with or without SCTG (Facial gingival level, Papilla index)	IIPP + no soft tissue grafting Patients: 10 Implants: 10	IIPP + SCTG Patients: 10 Implants: 10	0.70 mm of recession in control group vs 0.25 mm in test group after 1 year 50% papilla fill in 75% of test sites vs 80% of control sites
Migliorati et al. 2015 [91]	RCT	Evaluate ridge alterations after immediate implant placement with or without soft tissue grafting (gingival tissue thickness, keratinized mucosa, PES)	IIPP + no soft tissue grafting Patients: 23 Implants: 23	IIPP + SCTG Patients: 24 Implants: 24	Control: 10% loss in thickness and 18% in height after 2 years Test: 35% gain in thickness and 11% loss in height PES of 8 in test group vs 6.65 in control group
Bienz et al. 2017 [119]	Retrospective case-control study	Evaluate volumetric changes at implant sites with and without soft tissue grafting (ridge width, buccal mucosal level)	No soft tissue grafting during submerged implant healing Patients: 10 Implants: 10	SCTG during submerged implant healing (3–4 months after implant placement) Patients: 8 Implants: 8 SCTG grafting to treat implant recession Patients: 10 Implants: 10	Minimal volumetric and linear changes in the 2 groups over 5 years Average recession coverage of 75% after 1 month Final recession coverage of 66% after 6 months
Burkhardt et al. 2008 [98]	Prospective cohort study	Evaluate healing outcome of soft tissue dehiscence coverage at implant site (recession coverage)		SCTG grafting to treat implant recession Patients: 13 Implants: 13	Complete recession coverage in 62% of cases (8 cases) Mean soft tissue recession coverage: 86% VAS score increased significantly from 3.6 to 8.1 at the 5-year follow-up
Rocuzzo et al. 2019 [99]	Prospective study	Evaluate healing outcome of soft tissue dehiscence coverage at implant site (recession coverage, VAS score)		SCTG grafting to treat implant recession Patients: 19 Implants: 19	5-year follow-up: 79% of cases achieved a complete coverage and the mean coverage was 99.2% Statistical significant increase of soft tissue thickness (0.3 mm) and of KM width (0.5 mm) from 1-year to 5-year post-operative
Zuchelli et al. 2018 [101]	Prospective cohort study	Evaluate healing outcome of soft tissue dehiscence coverage. Buccal soft tissue thickness, PES/WES)		SCTG at facial of provisionalized implant Patients: 35 Implants: 35	Statistical significant PES/WES score between baseline and 5-year Soft tissue gain immediately after CTG: 1.07 mm Soft tissue gain at 1 year: 0.97 mm No differences between thin and thick phenotypes
De Bruyckere et al. 2015 [103]	Case series	Evaluate the horizontal stability (thickness) of a connective tissue graft place at time of implant provisionalization (buccal soft tissue thickness)	IIPP + no soft tissue grafting		
	Prospective study				

Table 2 (continued)

Authors	Study design	Study aims + outcome measures	Control group (n)	Test group (n)	Conclusions
Cosyn et al. 2016 [100]		Evaluate the 5-year clinical and esthetic outcome of immediate implant placement with or without SCTG (mid-facial recession depth, papillary recession depth)	Patients: 13 Implants: 13	IIPP + SCTG grafting to increase peri-implant mucosal thickness (3 months after implant placement) Patients: 5 Implants: 5	Recession of test group: 0.21 mm at 1 year and 0.5 mm at 5 year Recession of control group: 0.23 mm at 1 year and 0.63 mm at 5 years Papillae filled after 1 year in both groups
Hutton et al. 2018 [92]	RCT	Determine the clinical efficacy of ADM in the augmentation of the peri-implant mucosal thickness (soft tissue thickness, KM width)	IIPP + SCTG Patients: 10 Implants: 10	IIPP + ADM Patients: 10 Implants: 10	Thickness increase was measured at 1, 3 and 5 mm from mucosal margin and ranged from 0.05 to 1.45 mm after 16 weeks. No statistical significant differences in the achieved peri-implant thickness and KM width between groups
Anderson et al. 2014 [102]	RCT	Compare the efficacy of CTG and ADM for correcting esthetic discrepancies associated with definitively restored implant crowns (soft tissue thickness, recession coverage)	SCTG (already loaded) Patients: 7 Implants: 7	ADM (already loaded) Patients: 6 Implants: 6	Tissue thickness: 1.75 mm (ADM) vs 1.00 mm (SCTG) Concavity correction: 2.17 mm decrease (ADM) vs 1.86 mm (SCTG) Recession coverage: 40% (SCTG) vs 28% (ADM)
Schallhorn et al. 2015 [104]	Case series	Evaluate clinical outcomes at implant sites treated using XCM at previously loaded implants (soft tissue thickness, KM width)		XCM Patients: 27 Implants: 35 (3 patients lost but did not mention number of implants lost)	XCM resulted in significantly increased soft tissue thickness and a potential of KM increase but results varied between subjects and implant sites
Nemcovsky et al. 2000 [97]	Case series	Evaluate a surgical procedure performed at implant uncurey for papilla reconstruction (papilla index score)		Papilla augmentation procedure Patients: 32 Implants: 36	Mean increase in the PIS at the 6-month follow-up was 1.07 PIS increased in 89% of the papillae In 51 papilla (71%), there was an increase of 1 PIS unit and 13 (18%) of 2 PIS units between both measurements.
Linkevicius et al. 2015 [74]	Prospective clinical trial	Evaluate crestal bone levels after soft tissue thickening with ADM (crestal bone levels)	Thin tissue Patients: 34 Implants: 34 Thick tissue Patients: 34 Implants: 34	Thin (thickened tissue with ADM) Patients: 35 Implants: 35	Implants in thin mucosal tissue experienced early crestal bone loss (1.65 mm mesially and 1.81 mm distally). Implants in thick mucosal tissue experienced minimal early crestal bone loss (0.44 mm mesially and 0.47 distally). Thickening of mucosal tissue around implants limited early crestal bone loss (0.31 mm mesially and 0.34 distally).
Linkevicius et al. 2020 [80]	Randomized clinical trial (2 years)	Evaluate and compare crestal bone levels and vertical soft tissue thickness between subcrestal (– 1.5 mm) and crestal (with 2-mm tenting healing	Subcrestal implant placement Patients: 32 (total) Implants: 20	Crestal implant placement + soft tissue tenting over 2-mm healing abutments	Control group had 0.18 mm of bone loss. Test group had 0.51 mm of bone loss.

Table 2 (continued)

Authors	Study design	Study aims + outcome measures	Control group (n)	Test group (n)	Conclusions
		abutments) implant placement (crestal bone levels, vertical tissue thickness)		Patients: 32 (total) Implants: 20	Vertical tissue thickness significantly increased in the test group (mean of 1.8 mm). Vertical thickness changes were not assessed in the control group.

RCT randomized controlled trial, *SCTG* subepithelial connective tissue graft, *IIP* immediate implant placement, *IIPP* immediate implant placement and provisionalization, *PES* pink esthetic score, *KM* keratinized mucosa, *VAS* visual analog scale, *ADM* acellular dermal matrix, *XCM* xenogeneic collagen matrix

(Fig. 4) or to achieve soft tissue coverage at sites of immediately placed and non-loaded implants.

The concept of vertical thickening of the peri-implant mucosa at time of implant placement has been based on animal histological study [61] and advocated by clinical studies [73, 74, 75, 77–80] to minimize crestal bone remodeling. Initially, subepithelial connective tissue grafts were reported as means to increase vertical tissue thickness without demonstrating an influence on the amount of bone remodeling [81]. The use of acellular dermal matrix (ADM) allografts has been proposed in a double-layer approach to create a 2–3-mm increase in thickness, requiring periosteal releasing incisions and coronal advancement of buccal and lingual flaps for tension-free closure over graft, and reporting increase in tissue thickness and less bone remodeling [77]. Similarly, the use of collagen xenograft matrix was supported by a clinical and histological study in the increase of tissue thickness and tissue integration [82].

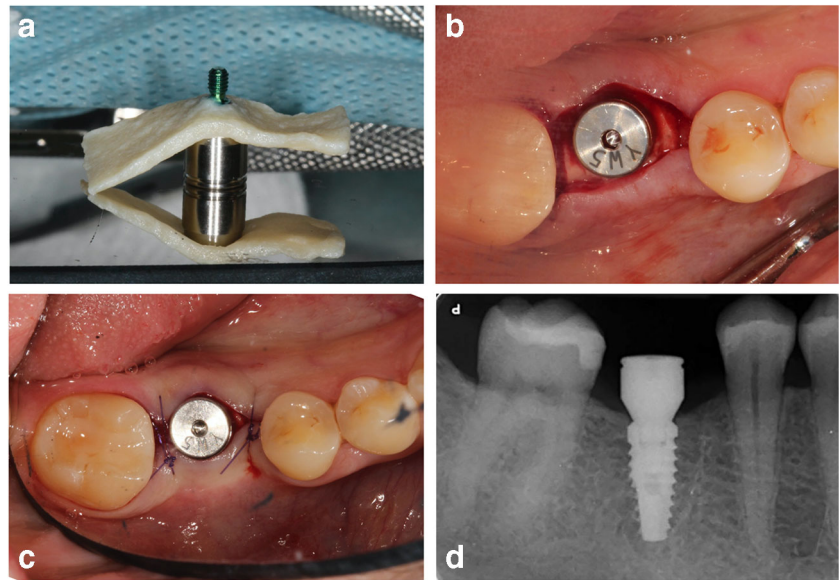
Several techniques have been proposed to achieve soft tissue closure over immediately placed and non-loaded implants, including the use of FGG [83, 84], CTG [85], or pedicle split- or full-thickness palatal flaps [86–89] to seal the socket orifice during implant healing. While these grafting procedures dramatically improve the soft tissue volume, their effect on implant survival or esthetic outcomes long term has not been evaluated.

Tissue phenotype modification using facial soft tissue grafting at sites of immediate implants has been performed to minimize the risk of future recession and tissue translucency in the presence of thin bone and soft tissue. Most techniques describe minimally invasive procedures using sulcular incisions and a pouch preparation to insert the graft on the facial of the ridge. SCTG has been supported in randomized controlled studies in minimizing future recession [90], increasing facial thickness and improving esthetic outcomes [91]. In a short-term study, ADM was found to increase facial thickness similarly to SCTG [92]. While these grafts enhance the facial tissue thickness and ridge contour, conclusive evidence to support their influence on mid-facial mucosal margin positions is lacking [93].

Grafting at Time of Second-Stage Surgery

Many clinicians find it opportune to augment or manipulate the peri-implant soft tissue at time of implant uncover, especially in anterior sites. In maxillary sites, adequate palatal tissue thickness is readily available to be used in different versions of pedicle flaps to augment the facial tissue thickness and tissue height. Studies supporting these approaches are mostly short-term case series that document improvement in papilla fill and facial convex profile (CPF [94]) using a palatal roll flap [95] and facial tissue thickness using a roll envelope flap or an apically positioned flap with SCTG [55]. A trap

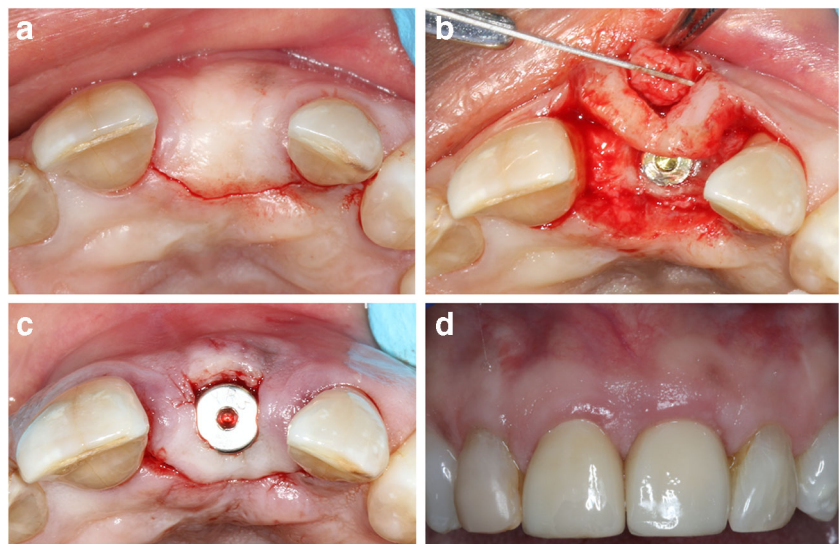
Fig. 4 Vertical tissue thickening with ADM at time of implant placement. **a** Preparation of ADM graft using healing abutment, **b** positioning of graft secured with abutment at implant no. 30 and extending over buccal and lingual aspects of ridge, **c** flap adaptation around abutment with sutures, and **d** final radiograph demonstrating abutment fit



door technique was also suggested for single or multiple implants incorporating a roll flap for tissue thickening, although no outcome measures could be assessed [96]. A palatal split envelope flap technique for papillary reconstruction of anterior and premolar single implants showed a consistent improvement in papilla fill using the Jemt index [15] in a case series [97]. However, in the absence of the osseous framework and adherence to prosthetic principles, predictable techniques to reconstruct missing papillae do not exist. Minimal or no information is provided about the effect of these grafts on the mucosal margin level.

Despite the relatively weak evidence to support advantages of grafting at second-stage implant surgery, soft tissue manipulation at the edentulous sites is frequently performed to improve the facial thickness and esthetics (Fig. 5).

Fig. 5 Roll flap at implant second stage surgery. **a** Palatal incision for full-thickness flap preparation to uncover implant no. 9 using the Tinti & Parma-Benfenati technique, **b** de-epithelialization of inner flap in preparation to roll it to facial aspect of abutment and implant, **c** primary closure and increased facial tissue thickness are achieved, and **d** final implant restoration after 2 years. Note thicker tissue appearance on facial aspect



Grafting Around Healed and Loaded Implants

Soft tissue volume augmentation following implant loading is generally performed to treat conditions such as recession, thin phenotype leading to graying of the mucosa or discomfort upon performing oral hygiene, or gingival asymmetry resulting from continued facial growth (Fig. 6).

The treatment of recessions has been mostly described with SCTG and coronally advanced flaps [98–101]. The vast majority of these studies are case series of a limited number of patients. Nonetheless, 6-month recession mean coverage of 66% of moderate recessions was reported, with an advantage recorded for thicker flaps at baseline [98]. Shallow recession defects appear to be more responsive to this therapy after 5 years with an 86% mean and 50% complete coverage

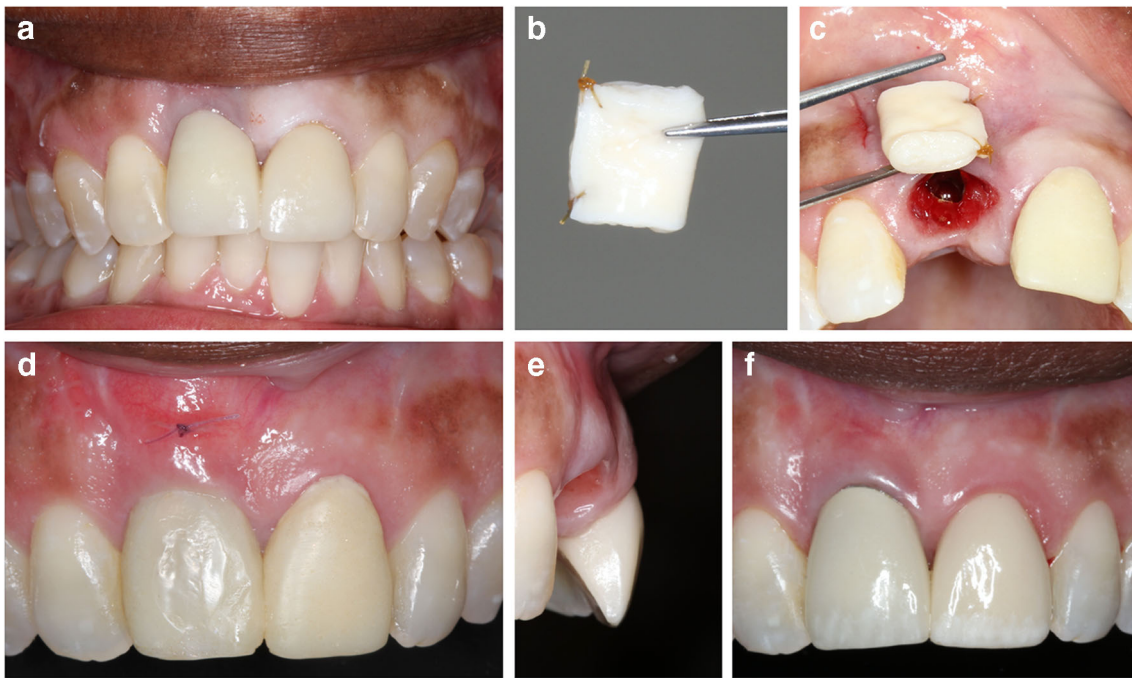


Fig. 6 Correction of gingival line asymmetry with ADM. **a** Initial presentation of implant no. 8 placed >20 years ago. Note uneven margins evident due to high smile line. **b, c** Double-layer ADM to maximize graft thickness in preparation for insertion into facial tunnel.

d Healing at 2 weeks. Note coronal advancement of mucosal margin. **e** Final contour showing convex profile of tissue, and **f** 1 year follow-up after delivery of new implant restoration

respectively [99]. In another 5-year case series, the removal of the implant prosthesis and its replacement with a supra-mucosal provisional restoration with a narrow transmucosal abutment was deemed critical for the success of the soft tissue grafting to predictably repair moderate recession defects, leading to 99.2% mean and 79% complete coverage, respectively, and a mean tissue thickness of 2.6 mm [101].

The use of ADM in the treatment of implant recessions has been limited and provided limited coverage (28%) in a 6-month study when compared to SCTG (40%) [102]. On the other hand, ADM achieved greater gain of tissue thickness than SCTG (1.75 mm vs 1.00 mm) [102]. It is noteworthy that the soft tissue deficiencies treated in that study were combination of recession, thin tissue, and concavity defects, which renders any comparisons inconclusive. Finally, the use of XCM to specifically treat implant recession defects has not been well documented in the literature.

The increase of mucosal thickness is usually achieved as a collateral objective of using a graft to increase either KM width or recession coverage. However, tissue thickness increase may be an independent treatment objective in cases of thin phenotype and esthetic concerns. A prospective 5-year study did not find a significant influence of tissue thickening with SCTG on the level of mucosal margin when compared to non-grafted sites [100]. The stability of tissue thickening with SCTG at time of provisionalization was demonstrated in a 1-year case series (mean of 0.97 mm) irrespective of baseline tissue phenotype [103].

When XCM was used in a case series to improve facial contour or mucosal graying, it achieved a mean 0.7-mm increase in thickness with no significant changes to mucosal contour or color after 6 months [104].

A systematic review concluded that both a split-thickness flap (STF) and coronally advanced flap (CAF) in combination with SCTG achieved a significant coverage of recession defects. On the other hand, STF + XCM and CAF + AMD did not produce significant coverage [19].

Soft Tissue Management with Implant Restorations

The predictability of long-term implant maintenance and the esthetic outcomes of implant restorations greatly depends on an optimal 3D implant position and an adequate implant restoration.

An ideal implant restoration is one that resembles the missing natural tooth in all dental and gingival aspects. Since implants typically have a narrower diameter than teeth, it becomes imperative to use information provided by an ideal surgical guide allowing for an optimal apico-coronal implant position and the subsequent fabrication of an adequate transmucosal portion of the implant restoration. Implant provisionalization plays an important transitional role and results in the shaping of the peri-implant soft tissue following a proper emergence profile [105–108]. Specifically, a temporary crown at an anterior immediate implant aims to maintain the existing soft tissue architecture in addition to its esthetic

benefits. [109, 110]. Soft tissue management via restorative approaches needs to be considered, sometimes in lieu of or in conjunction with soft tissue augmentation, whenever possible. When immediate temporization of an implant is not feasible or indicated, available preliminary information seems to favor the use of custom healing abutments to improve the soft tissue management and esthetic outcomes [111, 112].

Furthermore, the choice of abutment material was shown to influence soft tissue esthetics from a tissue color perspective [113–115]. Zirconia or gold abutments are generally recommended when peri-implant soft tissue thickness is less than 2 mm due to their greater colorimetric performances in comparison to titanium.

Conclusions

The role and clinical condition of the peri-implant mucosa can be easily overlooked in treatment planning in implant dentistry. Failure to recognize existing or to anticipate future soft tissue deficiencies may jeopardize the success of dental implants. Implant success is no longer simply defined by the Albrektsson criteria [116] but has additional components that assess the peri-implant soft tissue health, prosthesis, and patient satisfaction.

In light of the available evidence, the authors of this review conclude and propose the following:

- A minimal KM band or its absence seems to be less tolerated around implants than natural teeth. Due to its relative controversy, increasing KM width around implants may need to be evaluated on an individual basis. Subjects that demonstrate sub-optimal levels of plaque control due to challenging access for hygiene, dexterity shortcomings, or chronic inflammatory signs at mucosal margins may be good candidates for grafting. In addition, patients who undergo advanced ridge reconstruction procedures for implant site preparation may benefit from a bound-down peri-implant mucosa that seems to be more protective than alveolar mucosa. Risk assessment remains key in evaluating benefits and risks for each patient.
- Soft tissue volume increase is either performed vertically to thicken the supracrestal tissue attachment minimizing crestal bone remodeling, or horizontally to thicken the tissue phenotype to mask future esthetic failures or to treat existing defects on healed and restored implants. Increasing horizontal tissue thickness to mitigate future complications is not well supported with evidence whereas vertical thickening seems to be supported in the literature. However, additional studies by other investigators are recommended to validate this conclusion. The success of soft tissue grafting to treat defects on healed and loaded implants seems to be inconsistent due to potential

multifactorial etiologies. Nonetheless, clinical situations requiring soft tissue corrections may be inevitable to avoid further complications leading to implant loss.

- Timing of soft tissue grafting varies depending on the indication and clinician preferences. Procedures to increase KM are more commonly performed around healed and loaded implants or at second-stage surgery. It is recommended that a risk assessment is performed at the treatment planning phase to incorporate KM augmentation if deemed indicated. Soft tissue thickening seems to occur more often at time of second-stage surgery or implant placement.
- The implant position remains an imperative influencing factor on the health and/or appearance of the soft tissue. An implant placed too superficially or too facially may cause esthetic complications especially in thin phenotypes. An implant placed too deep may lead to biologic complications and affect the health of hard and soft tissues. The authors recommend a careful and multidisciplinary approach in treatment planning for implant site development, placement, provisionalization, permanent restoration, and maintenance.

Compliance With Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article is a review of published studies and does not contain any reports with human or animal subjects performed by any of the authors for the purpose of this article.

References

Papers of particular interest, published recently, have been highlighted as:

- Of importance

1. Esposito M, Ardebili Y, Worthington HV. Interventions for replacing missing teeth: different types of dental implants. The Cochrane database of systematic reviews. 2014;7:CD003815. <https://doi.org/10.1002/14651858.CD003815.pub4>.
2. Del Fabbro M, Testori T, Kekovic V, Goker F, Tumedei M, Wang HL. A systematic review of survival rates of osseointegrated implants in fully and partially edentulous patients following immediate loading. *J Clin Med*. 2019;8(12). <https://doi.org/10.3390/jcm8122142>.
3. Pappaspyridakos P, Chen CJ, Singh M, Weber HP, Gallucci GO. Success criteria in implant dentistry: a systematic review. *J Dent Res*. 2012;91(3):242–8. <https://doi.org/10.1177/0022034511431252>.
4. Araujo MG, Lindhe J. Dimensional ridge alterations following tooth extraction. An experimental study in the dog. *J Clin Periodontol*. 2005;32(2):212–8. <https://doi.org/10.1111/j.1600-051X.2005.00642.x>.

5. Rocuzzo M, Gaudio L, Bunino M, Dalmaso P. Long-term stability of soft tissues following alveolar ridge preservation: 10-year results of a prospective study around nonsubmerged implants. *Int J Periodontics Restorative Dent*. 2014;34(6):795–804. <https://doi.org/10.11607/prd.2133>.
6. Araújo MG, Lindhe J. Ridge preservation with the use of Bio-Oss collagen: a 6-month study in the dog. *Clin Oral Implants Res*. 2009;20(5):433–40. <https://doi.org/10.1111/j.1600-0501.2009.01705.x>.
7. Thoma DS, Naenni N, Figuero E, Hämmerle CHF, Schwarz F, Jung RE, et al. Effects of soft tissue augmentation procedures on peri-implant health or disease: a systematic review and meta-analysis. *Clinical oral implants research*. 2018;29(Suppl 15):32–49. <https://doi.org/10.1111/clr.13114> **This review highlights the rationale for increasing vertical soft tissue thickness and width of keratinized mucosa equipped with best available evidence.**
8. Hämmerle CHF, Tamow D. The etiology of hard- and soft-tissue deficiencies at dental implants: a narrative review. *J Periodontol*. 2018;89(Suppl 1):S291–303. <https://doi.org/10.1002/JPER.16-0810>.
9. Chappuis V, Araújo MG, Buser D. Clinical relevance of dimensional bone and soft tissue alterations post-extraction in esthetic sites. *Periodontol 2000*. 2017;73(1):73–83. <https://doi.org/10.1111/prd.12167>.
10. Pjetursson BE, Asgeirsson AG, Zwahlen M, Sailer I. Improvements in implant dentistry over the last decade: comparison of survival and complication rates in older and newer publications. *The International journal of oral & maxillofacial implants*. 2014;29 Suppl:308–324. doi:<https://doi.org/10.11607/jomi.2014suppl.g5.2>.
11. 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. <https://doi.org/10.1111/j.1600-0501.2012.02547.x>.
12. Benic GI, Mokti M, Chen C-J, Weber H-P, Hämmerle CHF, Gallucci GO. Dimensions of buccal bone and mucosa at immediately placed implants after 7 years: a clinical and cone beam computed tomography study. *Clin Oral Implants Res*. 2012;23(5):560–6. <https://doi.org/10.1111/j.1600-0501.2011.02253.x>.
13. 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(2):253–7. <https://doi.org/10.1111/clr.12586>.
14. Zetu L, Wang H-L. Management of inter-dental/inter-implant papilla. *J Clin Periodontol*. 2005;32(7):831–9. <https://doi.org/10.1111/j.1600-051X.2005.00748.x>.
15. Jemt T. Regeneration of gingival papillae after single-implant treatment. *The International journal of periodontics & restorative dentistry*. 1997;17(4):326–33.
16. Daftary F, Mahallati R, Bahat O, Sullivan RM. Lifelong craniofacial growth and the implications for osseointegrated implants. *The International journal of oral & maxillofacial implants*. 2013;28(1):163–9. <https://doi.org/10.11607/jomi.2827>.
17. Thoma DS, Zeltner M, Hilbe M, Hämmerle CH, Hüsler J, Jung RE. Randomized controlled clinical study evaluating effectiveness and safety of a volume-stable collagen matrix compared to autogenous connective tissue grafts for soft tissue augmentation at implant sites. *J Clin Periodontol*. 2016;43(10):874–85. <https://doi.org/10.1111/jcpe.12588>.
18. Bassetti RG, Stähli A, Bassetti MA, Sculean A. Soft tissue augmentation procedures at second-stage surgery: a systematic review. *Clinical oral investigations*. 2016;20(7):1369–87. <https://doi.org/10.1007/s00784-016-1815-2> **This study reviews most effective grafts and techniques to augment keratinized mucosa and tissue thickness at time of implant uncover.**
19. Bassetti RG, Stähli A, Bassetti MA, Sculean A. Soft tissue augmentation around osseointegrated and uncovered dental implants: a systematic review. *Clinical oral investigations*. 2017;21(1):53–70. <https://doi.org/10.1007/s00784-016-2007-9> **This study reviews most effective grafts and techniques to augment keratinized mucosa and tissue thickness around healed and loaded implants.**
20. Bassetti M, Kaufmann R, Salvi GE, Sculean A, Bassetti R. Soft tissue grafting to improve the attached mucosa at dental implants: a review of the literature and proposal of a decision tree. *Quintessence Int*. 2015;46(6):499–510. <https://doi.org/10.3290/j.qi.a33688>.
21. Berglundh T, Lindhe J, Ericsson I, Marinello CP, Liljenberg B, Thomsen P. The soft tissue barrier at implants and teeth. *Clin Oral Implants Res*. 1991;2(2):81–90. <https://doi.org/10.1034/j.1600-0501.1991.020206.x>.
22. Abrahamsson I, Zitzmann NU, Berglundh T, Linder E, Wennerberg A, Lindhe J. The mucosal attachment to titanium implants with different surface characteristics: an experimental study in dogs. *J Clin Periodontol*. 2002;29(5):448–55. <https://doi.org/10.1034/j.1600-051x.2002.290510.x>.
23. Tomasi C, Tessarolo F, Caola I, Wennström J, Nollo G, Berglundh T. Morphogenesis of peri-implant mucosa revisited: an experimental study in humans. *Clin Oral Implants Res*. 2014;25(9):997–1003. <https://doi.org/10.1111/clr.12223>.
24. Berglundh T, Lindhe J, Jonsson K, Ericsson I. The topography of the vascular systems in the periodontal and peri-implant tissues in the dog. *J Clin Periodontol*. 1994;21(3):189–93. <https://doi.org/10.1111/j.1600-051x.1994.tb00302.x>.
25. Nevins M, Camelo M, Nevins ML, Schupbach P, Kim DM. Connective tissue attachment to laser-microgrooved abutments: a human histologic case report. *The International journal of periodontics & restorative dentistry*. 2012;32(4):385–92.
26. Geurs NC, Geisinger ML, Vassilopoulos PJ, O'Neal SJ, Haigh SJ, Reddy MS. Optimizing connective tissue integration on laser-ablated implant abutments. *Clin Adv Periodontics*. 2016;6(3):153–9. <https://doi.org/10.1902/cap.2016.150068>.
27. Oh T-J, Yoon J, Misch CE, Wang H-L. The causes of early implant bone loss: myth or science? *J Periodontol*. 2002;73(3):322–33. <https://doi.org/10.1902/jop.2002.73.3.322>.
28. Moon IS, Berglundh T, Abrahamsson I, Linder E, Lindhe J. The barrier between the keratinized mucosa and the dental implant. An experimental study in the dog. *J Clin Periodontol*. 1999;26(10):658–63. <https://doi.org/10.1034/j.1600-051x.1999.261005.x>.
29. Berglundh T, Armitage G, Araújo MG, Avila-Ortiz G, Blanco J, Camargo PM, et al. Peri-implant diseases and conditions: consensus report of workgroup 4 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. *J Periodontol*. 2018;89(Suppl 1):S313–s8. <https://doi.org/10.1002/jper.17-0739>.
30. Rocuzzo M, Grasso G, Dalmaso P. Keratinized mucosa around implants in partially edentulous posterior mandible: 10-year results of a prospective comparative study. *Clin Oral Implants Res*. 2016;27(4):491–6. <https://doi.org/10.1111/clr.12563>.
31. Bouri A Jr, Bissada N, Al-Zahrani MS, Faddoul F, Nouneh I. Width of keratinized gingiva and the health status of the supporting tissues around dental implants. *Int J Oral Maxillofac Implants*. 2008;23(2):323–6.
32. Schrott AR, Jimenez M, Hwang JW, Fiorellini J, Weber HP. Five-year evaluation of the influence of keratinized mucosa on peri-implant soft-tissue health and stability around implants supporting full-arch mandibular fixed prostheses. *Clin Oral Implants Res*.

- 2009;20(10):1170–7. <https://doi.org/10.1111/j.1600-0501.2009.01795.x>.
33. Kim BS, Kim YK, Yun PY, Yi YJ, Lee HJ, Kim SG, et al. Evaluation of peri-implant tissue response according to the presence of keratinized mucosa. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2009;107(3):e24–8. <https://doi.org/10.1016/j.tripleo.2008.12.010>.
 34. Chung DM, Oh TJ, Shotwell JL, Misch CE, Wang HL. Significance of keratinized mucosa in maintenance of dental implants with different surfaces. *J Periodontol.* 2006;77(8):1410–20. <https://doi.org/10.1902/jop.2006.050393>.
 35. Roos-Jansåker AM, Renvert H, Lindahl C, Renvert S. Nine- to fourteen-year follow-up of implant treatment. Part III: factors associated with peri-implant lesions. *J Clin Periodontol.* 2006;33(4):296–301. <https://doi.org/10.1111/j.1600-051X.2006.00908.x>.
 36. Wennström JL, Derks J. Is there a need for keratinized mucosa around implants to maintain health and tissue stability? *Clin Oral Implants Res.* 2012;23(Suppl 6):136–46. <https://doi.org/10.1111/j.1600-0501.2012.02540.x>.
 37. Giannobile WV, Jung RE, Schwarz F. Evidence-based knowledge on the aesthetics and maintenance of peri-implant soft tissues: Osteology Foundation Consensus Report Part 1-Effects of soft tissue augmentation procedures on the maintenance of peri-implant soft tissue health. *Clin Oral Implants Res.* 2018;29(Suppl 15):7–10. <https://doi.org/10.1111/clr.13110>.
 38. Scheyer ET, Sanz M, Dibart S, Greenwell H, John V, Kim DM, et al. Periodontal soft tissue non-root coverage procedures: a consensus report from the AAP Regeneration Workshop. *J Periodontol.* 2015;86(2 Suppl):S73–6. <https://doi.org/10.1902/jop.2015.140377>.
 39. Karring T, Lang NP, Loe H. The role of gingival connective tissue in determining epithelial differentiation. *J Periodontol Res.* 1975;10(1):1–11.
 40. Han TJ, Takei HH, Carranza FA. The strip gingival autograft technique. *Int J Periodontics Restorative Dent.* 1993;13(2):180–7.
 41. Schmitt CM, Tudor C, Kiener K, Wehrhan F, Schmitt J, Eitner S, et al. Vestibuloplasty: porcine collagen matrix versus free gingival graft: a clinical and histologic study. *J Periodontol.* 2013;84(7):914–23. <https://doi.org/10.1902/jop.2012.120084>.
 42. Nevins M, Nevins ML, Kim SW, Schupbach P, Kim DM. The use of mucograft collagen matrix to augment the zone of keratinized tissue around teeth: a pilot study. *Int J Periodontics Restorative Dent.* 2011;31(4):367–73.
 43. Sanz M, Lorenzo R, Aranda JJ, Martin C, Orsini M. Clinical evaluation of a new collagen matrix (Mucograft prototype) to enhance the width of keratinized tissue in patients with fixed prosthetic restorations: a randomized prospective clinical trial. *J Clin Periodontol.* 2009;36(10):868–76. <https://doi.org/10.1111/j.1600-051X.2009.01460.x>.
 44. Urban IA, Lozada JL, Nagy K, Sanz M. Treatment of severe mucogingival defects with a combination of strip gingival grafts and a xenogeneic collagen matrix: a prospective case series study. *Int J Periodontics Restorative Dent.* 2015;35(3):345–53. <https://doi.org/10.11607/prd.2287>.
 45. Wainwright D, Madden M, Luterman A, Hunt J, Monafa W, Heimbach D, et al. Clinical evaluation of an acellular allograft dermal matrix in full-thickness burns. *J Burn Care Rehabil.* 1996;17(2):124–36. <https://doi.org/10.1097/00004630-199603000-00006>.
 46. Cummings LC, Kaldahl WB, Allen EP. Histologic evaluation of autogenous connective tissue and acellular dermal matrix grafts in humans. *J Periodontol.* 2005;76(2):178–86. <https://doi.org/10.1902/jop.2005.76.2.178>.
 47. Scarano A, Barros RR, Iezzi G, Piattelli A, Novaes AB Jr. Acellular dermal matrix graft for gingival augmentation: a preliminary clinical, histologic, and ultrastructural evaluation. *J Periodontol.* 2009;80(2):253–9. <https://doi.org/10.1902/jop.2009.080326>.
 48. Jhaveri HM, Chavan MS, Tomar GB, Deshmukh VL, Wani MR, Miller PD Jr. Acellular dermal matrix seeded with autologous gingival fibroblasts for the treatment of gingival recession: a proof-of-concept study. *J Periodontol.* 2010;81(4):616–25. <https://doi.org/10.1902/jop.2009.090530>.
 49. Allen EP. AlloDerm: an effective alternative to palatal donor tissue for treatment of gingival recession. *Dent Today.* 2006;25(1):48. **50-2 quiz 2.**
 50. Wei PC, Laurell L, Geivelis M, Lingen MW, Maddalozzo D. Acellular dermal matrix allografts to achieve increased attached gingiva. Part 1. A clinical study. *J Periodontol.* 2000;71(8):1297–305. <https://doi.org/10.1902/jop.2000.71.8.1297>.
 51. Bhatavadekar NB, Gharpure AS. Sequential ridge augmentation protocol for hard and soft tissue grafting in alveolar ridge deficiencies: a proposed evidence-based algorithm. *J Oral Implantol.* 2018;44(2):153–60. <https://doi.org/10.1563/aaid-joi-D-17-00165>.
 52. Kadkhodazadeh M, Amid R, Kermani ME, Mirakhori M, Hosseinpour S. Timing of soft tissue management around dental implants: a suggested protocol. *Gen Dent.* 2017;65(3):50–6.
 53. Stimmelmayer M, Stangl M, Edelhoff D, Beuer F. Clinical prospective study of a modified technique to extend the keratinized gingiva around implants in combination with ridge augmentation: one-year results. *Int J Oral Maxillofac Implants.* 2011;26(5):1094–101.
 54. Schmitt CM, Moest T, Lutz R, Wehrhan F, Neukam FW, Schlegel KA. Long-term outcomes after vestibuloplasty with a porcine collagen matrix (Mucograft®) versus the free gingival graft: a comparative prospective clinical trial. *Clin Oral Implants Res.* 2016;27(11):e125–e33. <https://doi.org/10.1111/clr.12575>.
 55. Tunkel J, de Stavola L, Khoury F. Changes in soft tissue dimensions following three different techniques of stage-two surgery: a case series report. *The International journal of periodontics & restorative dentistry.* 2013;33(4):411–8. <https://doi.org/10.11607/prd.0616>.
 56. Jiang X, Lin Y. Gain of keratinized mucosa around implants in the posterior mandible by a modified apically positioned flap and xenogeneic collagen matrix. *Int J Periodontics Restorative Dent.* 2019;39(5):721–7. <https://doi.org/10.11607/prd.4176>.
 57. Basegmez C, Ersanli S, Demirel K, Bölükbaşı N, Yalcin S. The comparison of two techniques to increase the amount of peri-implant attached mucosa: free gingival grafts versus vestibuloplasty. One-year results from a randomised controlled trial. *European journal of oral implantology.* 2012;5(2):139–45.
 58. Basegmez C, Karabuda ZC, Demirel K, Yalcin S. The comparison of acellular dermal matrix allografts with free gingival grafts in the augmentation of peri-implant attached mucosa: a randomised controlled trial. *European journal of oral implantology.* 2013;6(2):145–52.
 59. Lorenzo R, García V, Orsini M, Martin C, Sanz M. Clinical efficacy of a xenogeneic collagen matrix in augmenting keratinized mucosa around implants: a randomized controlled prospective clinical trial. *Clin Oral Implants Res.* 2012;23(3):316–24. <https://doi.org/10.1111/j.1600-0501.2011.02260.x>.
 60. Park J-B. Increasing the width of keratinized mucosa around endosseous implant using acellular dermal matrix allograft. *Implant Dent.* 2006;15(3):275–81. <https://doi.org/10.1097/01.id.0000227078.70869.20>.
 61. Berglundh T, Lindhe J. Dimension of the periimplant mucosa. Biological width revisited. *J Clin Periodontol.* 1996;23(10):971–3. <https://doi.org/10.1111/j.1600-051x.1996.tb00520.x>.
 62. Brogini N, McManus LM, Hermann JS, Medina R, Schenk RK, Buser D, et al. Peri-implant inflammation defined by the implant-abutment interface. *J Dent Res.* 2006;85(5):473–8. <https://doi.org/10.1177/154405910608500515>.

63. Hermann JS, Cochran DL, Nummikoski PV, Buser D. Crestal bone changes around titanium implants. A radiographic evaluation of unloaded nonsubmerged and submerged implants in the canine mandible. *J Periodontol*. 1997;68(11):1117–30. <https://doi.org/10.1902/jop.1997.68.11.1117>.
64. Ekelund JA, Lindquist LW, Carlsson GE, Jemt T. Implant treatment in the edentulous mandible: a prospective study on Brånemark system implants over more than 20 years. *Int J Prosthodont*. 2003;16(6):602–8.
65. Karoussis IK, Brägger U, Salvi GE, Bürgin W, Lang NP. Effect of implant design on survival and success rates of titanium oral implants: a 10-year prospective cohort study of the ITI Dental Implant System. *Clin Oral Implants Res*. 2004;15(1):8–17. <https://doi.org/10.1111/j.1600-0501.2004.00983.x>.
66. Caricasulo R, Malchiodi L, Ghensi P, Fantozzi G, Cucchi A. The influence of implant-abutment connection to peri-implant bone loss: a systematic review and meta-analysis. *Clin Implant Dent Relat Res*. 2018;20(4):653–64. <https://doi.org/10.1111/cid.12620>.
67. Hsu YT, Lin GH, Wang HL. Effects of platform-switching on peri-implant soft and hard tissue outcomes: a systematic review and meta-analysis. *Int J Oral Maxillofac Implants*. 2017;32(1):e9–e24. <https://doi.org/10.11607/jomi.5140>.
68. Santiago JF Jr, Batista VE, Verri FR, Honório HM, de Mello CC, Almeida DA, et al. Platform-switching implants and bone preservation: a systematic review and meta-analysis. *Int J Oral Maxillofac Surg*. 2016;45(3):332–45. <https://doi.org/10.1016/j.ijom.2015.11.009>.
69. Lazzara RJ, Porter SS. Platform switching: a new concept in implant dentistry for controlling postrestorative crestal bone levels. *The International journal of periodontics & restorative dentistry*. 2006;26(1):9–17.
70. Trammell K, Geurs NC, O'Neal SJ, Liu P-R, Haigh SJ, McNeal S, et al. A prospective, randomized, controlled comparison of platform-switched and matched-abutment implants in short-span partial denture situations. *The International journal of periodontics & restorative dentistry*. 2009;29(6):599–605.
71. Enkling N, Jöhren P, Klimberg V, Bayer S, Mericske-Stern R, Jepsen S. Effect of platform switching on peri-implant bone levels: a randomized clinical trial. *Clin Oral Implants Res*. 2011;22(10):1185–92. <https://doi.org/10.1111/j.1600-0501.2010.02090.x>.
72. Enkling N, Jöhren P, Katsoulis J, Bayer S, Jervøe-Storm PM, Mericske-Stern R, et al. Influence of platform switching on bone-level alterations: a three-year randomized clinical trial. *J Dent Res*. 2013;92(12 Suppl):139s–45s. <https://doi.org/10.1177/0022034513504953>.
73. Linkevicius T, Apse P, Grybauskas S, Puisys A. Influence of thin mucosal tissues on crestal bone stability around implants with platform switching: a 1-year pilot study. *J Oral Maxillofac Surg*. 2010;68(9):2272–7. <https://doi.org/10.1016/j.joms.2009.08.018>.
74. Linkevicius T, Puisys A, Steigmann M, Vindasiute E, Linkeviciene L. Influence of vertical soft tissue thickness on crestal bone changes around implants with platform switching: a comparative clinical study. *Clin Implant Dent Relat Res*. 2015;17(6):1228–36. <https://doi.org/10.1111/cid.12222>.
75. Suárez-López Del Amo F, Lin GH, Monje A, Galindo-Moreno P, Wang HL. Influence of soft tissue thickness on Peri-implant marginal bone loss: a systematic review and meta-analysis. *J Periodontol*. 2016;87(6):690–9. <https://doi.org/10.1902/jop.2016.150571> **This study reviews best evidence on the influence of vertical tissue thickness on crestal bone remodeling.**
76. Lin C-Y, Chen Z, Pan W-L, Wang H-L. Impact of timing on soft tissue augmentation during implant treatment: a systematic review and meta-analysis. *Clin Oral Implants Res*. 2018;29(5):508–21. <https://doi.org/10.1111/clr.13148>.
77. Puisys A, Linkevicius T. The influence of mucosal tissue thickening on crestal bone stability around bone-level implants. A prospective controlled clinical trial. *Clin Oral Implants Res*. 2015;26(2):123–9. <https://doi.org/10.1111/clr.12301>.
78. Linkevicius T, Apse P, Grybauskas S, Puisys A. The influence of soft tissue thickness on crestal bone changes around implants: a 1-year prospective controlled clinical trial. *Int J Oral Maxillofac Implants*. 2009;24(4):712–9.
79. Linkevicius T, Linkevicius R, Alkimavicius J, Linkeviciene L, Andrijauskas P, Puisys A. Influence of titanium base, lithium disilicate restoration and vertical soft tissue thickness on bone stability around triangular-shaped implants: a prospective clinical trial. *Clin Oral Implants Res*. 2018;29(7):716–24. <https://doi.org/10.1111/clr.13263>.
80. Linkevicius T, Puisys A, Linkevicius R, Alkimavicius J, Gineviciute E, Linkeviciene L. The influence of submerged healing abutment or subcrestal implant placement on soft tissue thickness and crestal bone stability. A 2-year randomized clinical trial. *Clin Implant Dent Relat Res*. 2020. <https://doi.org/10.1111/cid.12903>.
81. Wiesner G, Esposito M, Worthington H, Schlee M. Connective tissue grafts for thickening peri-implant tissues at implant placement. One-year results from an explanatory split-mouth randomised controlled clinical trial. *European journal of oral implantology*. 2010;3(1):27–35.
82. Puisys A, Zukauskas S, Kubilius R, Barbeck M, Razukevicius D, Linkeviciene L, et al. Clinical and histologic evaluations of porcine-derived collagen matrix membrane used for vertical soft tissue augmentation: a case series. *Int J Periodontics Restorative Dent*. 2019;39(3):341–7. <https://doi.org/10.11607/prd.4097>.
83. 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(4):289–96.
84. Jung RE, Siegenthaler DW, Hämmerle CH. Postextraction tissue management: a soft tissue punch technique. *Int J Periodontics Restorative Dent*. 2004;24(6):545–53.
85. Covani U, Marconcini S, Galassini G, Cornolini R, Santini S, Barone A. Connective tissue graft used as a biologic barrier to cover an immediate implant. *J Periodontol*. 2007;78(8):1644–9. <https://doi.org/10.1902/jop.2007.060461>.
86. Nemcovsky CE, Moses O. Rotated palatal flap. A surgical approach to increase keratinized tissue width in maxillary implant uncovering: technique and clinical evaluation. *The International journal of periodontics & restorative dentistry*. 2002;22(6):607–12.
87. Goldstein M, Boyan BD, Schwartz Z. The palatal advanced flap: a pedicle flap for primary coverage of immediately placed implants. *Clin Oral Implants Res*. 2002;13(6):644–50. <https://doi.org/10.1034/j.1600-0501.2002.130611.x>.
88. Romanos AH, Geurs NC, Abou-Arrej RV. Pedicle connective tissue graft with novel palatal tunneling. *Clinical Advances in Periodontics*. 2013;3(4):191–8. <https://doi.org/10.1902/cap.2013.120125>.
89. Abou-Arrej RV, Geurs NC, Romanos AH. Autogenous options for soft-tissue management of extraction sockets in the anterior maxilla. *Clinical Advances in Periodontics*. 2013;3(4):259–68. <https://doi.org/10.1902/cap.2013.120126>.
90. Yoshino S, Kan JYK, Rungcharassaeng K, Roe P, Lozada JL. Effects of connective tissue grafting on the facial gingival level following single immediate implant placement and provisionalization in the esthetic zone: a 1-year randomized controlled prospective study. *The International journal of oral & maxillofacial implants*. 2014;29(2):432–40. <https://doi.org/10.11607/jomi.3379>.
91. Migliorati M, Amorfini L, Signori A, Biavati AS, Benedicenti S. Clinical and aesthetic outcome with post-extractive implants with or without soft tissue augmentation: a 2-year randomized clinical

- trial. *Clin Implant Dent Relat Res.* 2015;17(5):983–95. <https://doi.org/10.1111/cid.12194>.
92. Hutton CG, Johnson GK, Barwacz CA, Allareddy V, Avila-Ortiz G. Comparison of two different surgical approaches to increase peri-implant mucosal thickness: a randomized controlled clinical trial. *J Periodontol.* 2018;89(7):807–14. <https://doi.org/10.1002/JPER.17-0597>.
 93. Lee CT, Tao CY, Stoupe J. The effect of subepithelial connective tissue graft placement on esthetic outcomes after immediate implant placement: systematic review. *J Periodontol.* 2016;87(2):156–67. <https://doi.org/10.1902/jop.2015.150383>.
 94. Belser UC, Grütter L, Vailati F, Bornstein MM, Weber H-P, 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(1):140–51. <https://doi.org/10.1902/jop.2009.080435>.
 95. Man Y, Wang Y, Qu Y, Wang P, Gong P. A palatal roll envelope technique for peri-implant mucosa reconstruction: a prospective case series study. *Int J Oral Maxillofac Surg.* 2013;42(5):660–5. <https://doi.org/10.1016/j.ijom.2013.01.008>.
 96. Tinti C, Parma-Benfenati S. Minimally invasive technique for gingival augmentation around dental implants. *Int J Periodontics Restorative Dent.* 2012;32(2):187–93.
 97. Nemcovsky CE, Moses O, Artzi Z. Interproximal papillae reconstruction in maxillary implants. *J Periodontol.* 2000;71(2):308–14. <https://doi.org/10.1902/jop.2000.71.2.308>.
 98. Burkhardt R, Joss A, Lang NP. Soft tissue dehiscence coverage around endosseous implants: a prospective cohort study. *Clin Oral Implants Res.* 2008;19(5):451–7. <https://doi.org/10.1111/j.1600-0501.2007.01497.x>.
 99. Rocuzzo M, Dalmasso P, Pittoni D, Rocuzzo A. Treatment of buccal soft tissue dehiscence around single implant: 5-year results from a prospective study. *Clin Oral Investig.* 2019;23(4):1977–83. <https://doi.org/10.1007/s00784-018-2634-4>.
 100. Cosyn J, Eghbali A, Hermans A, Vervaeke S, De Bruyn H, Cleymaet R. A 5-year prospective study on single immediate implants in the aesthetic zone. *J Clin Periodontol.* 2016;43(8):702–9. <https://doi.org/10.1111/jcpe.12571>.
 101. Zucchelli G, Felice P, Mazzotti C, Marzadori M, Mounssif I, Monaco C, et al. 5-year outcomes after coverage of soft tissue dehiscence around single implants: a prospective cohort study. *Eur J Oral Implantol.* 2018;11(2):215–24.
 102. Anderson LE, Inglehart MR, El-Kholy K, Eber R, Wang H-L. 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(4):416–25. <https://doi.org/10.1097/ID.000000000000122>.
 103. De Bruyckere T, Eghbali A, Younes F, De Bruyn H, Cosyn J. Horizontal stability of connective tissue grafts at the buccal aspect of single implants: a 1-year prospective case series. *J Clin Periodontol.* 2015;42(9):876–82. <https://doi.org/10.1111/jcpe.12448>.
 104. Schallhorn RA, McClain PK, Charles A, Clem D, Newman MG. Evaluation of a porcine collagen matrix used to augment keratinized tissue and increase soft tissue thickness around existing dental implants. *The International journal of periodontics & restorative dentistry.* 2015;35, 99(1):–103. <https://doi.org/10.11607/prd.1888>.
 105. González-Martín O, Lee E, Weisgold A, Veltri M, Su H. Contour management of implant restorations for optimal emergence profiles: guidelines for immediate and delayed provisional restorations. *Int J Periodontics Restorative Dent.* 2020;40(1):61–70. <https://doi.org/10.11607/prd.4422>.
 106. Furze D, Byrne A, Alam S, Wittneben JG. Esthetic outcome of implant supported crowns with and without peri-implant conditioning using provisional fixed prosthesis: a randomized controlled clinical trial. *Clin Implant Dent Relat Res.* 2016;18(6):1153–62. <https://doi.org/10.1111/cid.12416>.
 107. Wittneben JG, Buser D, Belser UC, Brägger U. Peri-implant soft tissue conditioning with provisional restorations in the esthetic zone: the dynamic compression technique. *Int J Periodontics Restorative Dent.* 2013;33(4):447–55. <https://doi.org/10.11607/prd.1268>.
 108. Belser U, Buser D, Higginbottom F. Consensus statements and recommended clinical procedures regarding esthetics in implant dentistry. *Int J Oral Maxillofac Implants.* 2004;19(Suppl):73–4.
 109. De Rouck T, Collys K, Wyn I, Cosyn J. Instant provisionalization of immediate single-tooth implants is essential to optimize esthetic treatment outcome. *Clin Oral Implants Res.* 2009;20(6):566–70. <https://doi.org/10.1111/j.1600-0501.2008.01674.x>.
 110. Block MS, Mercante DE, Lirette D, Mohamed W, Ryser M, Castellon P. Prospective evaluation of immediate and delayed provisional single tooth restorations. *J Oral Maxillofac Surg.* 2009;67(11 Suppl):89–107. <https://doi.org/10.1016/j.joms.2009.07.009>.
 111. Ruales-Carrera E, Pauletto P, Apaza-Bedoya K, Volpato CAM, Özcan M, Benfatti CAM. Peri-implant tissue management after immediate implant placement using a customized healing abutment. *J Esthet Restor Dent.* 2019;31(6):533–41. <https://doi.org/10.1111/jerd.12512>.
 112. Perez A, Caiazzo A, Valente NA, Toti P, Alfonsi F, Barone A. Standard vs customized healing abutments with simultaneous bone grafting for tissue changes around immediate implants. 1-year outcomes from a randomized clinical trial. *Clin Implant Dent Relat Res.* 2020;22(1):42–53. <https://doi.org/10.1111/cid.12871>.
 113. Lops D, Stellini E, Sbricoli L, Cea N, Romeo E, Bressan E. Influence of abutment material on peri-implant soft tissues in anterior areas with thin gingival biotype: a multicentric prospective study. *Clin Oral Implants Res.* 2017;28(10):1263–8. <https://doi.org/10.1111/clr.12952>.
 114. Jung RE, Sailer I, Hämmerle CH, Attin T, Schmidlin P. In vitro color changes of soft tissues caused by restorative materials. *Int J Periodontics Restorative Dent.* 2007;27(3):251–7.
 115. Ioannidis A, Cathomen E, Jung RE, Fehmer V, Husler J, Thoma DS. Discoloration of the mucosa caused by different restorative materials - a spectrophotometric in vitro study. *Clin Oral Implants Res.* 2017;28(9):1133–8. <https://doi.org/10.1111/clr.12928>.
 116. Albrektsson T, Zarb G, Worthington P, Eriksson AR. The long-term efficacy of currently used dental implants: a review and proposed criteria of success. *Int J Oral Maxillofac Implants.* 1986;1(1):11–25.
 117. Park J. Increasing the width of keratinized mucosa around endosseous implant using acellular dermal matrix allograft. *Implant Dent.* 2006;15(3):275–81.
 118. Wiesner G, Esposito M, Worthington H, Schlee M. Connective tissue grafts for thickening peri-implant tissues at implant placement. One-year results from an explanatory split-mouth randomized controlled clinical trial. *Eur J Oral Implantol.* 2010;3(1):27–35.
 119. Bienz SP, Jung RE, Sapata VM, Hämmerle CHF, Hüsler J, Thoma DS. Volumetric changes and peri-implant health at implant sites with or without soft tissue grafting in the esthetic zone, a retrospective case-control study with a 5-year follow-up. *Clin Oral Implants Res.* 2017;28(11):1459–65. <https://doi.org/10.1111/clr.13013>.