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Peri-implant buccal soft tissue dehiscences: A narrative review on current knowledge and management

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ABSTRACT

Peri-implant buccal soft tissue dehiscences (BSTD) not only impact the aesthetic appearance of the implant-restorations but also pose a threat to the long-term survival of the implants. This comprehensive narrative review aims to provide a concise overview of the epidemiology, classification, risk indicators, current surgical and prosthetic therapeutic approaches of peri-implant BSTD. Although BSTD is a common finding, the different study design, case definitions and follow-up periods difficult the estimation of a representative prevalence. Implants placed too buccal and thin peri-implant phenotype are viewed as the major factors associated with the occurrences of BSTD. The most reported and scientifically-supported surgical technique is coronally advanced flap plus connective tissue graft, although other surgical techniques have been evaluated in the long-term. Further randomized clinical trials are needed to assess the efficacy of each surgical technique in the management of BSTD.

1. Background of peri-implant buccal soft tissue dehiscences (BSTD)

To rehabilitate partially or fully edentulous patients, implant therapy is considered a predictable and successful option. However, despite its long-term function, other factors need to be considered to define therapeutic success such as hard and soft tissue stability, esthetics and patients reported outcomes [1,2].

Peri-implant soft tissue plays a critical role in both health and esthetics; therefore, three distinct components of its phenotype need to be taken into account: the keratinized mucosa width, the mucosal thickness and the supracrestal tissue height [3]. Recent evidence has shown that a band of keratinized tissue of at least 2 mm acts as a protective factor [3-6] and its coral pink color provides higher esthetic results [3]. A thicker mucosal thickness is related with greater interproximal bone stability [3,7] and from an esthetic point of view its coronal portions plays a major role since a minimum thickness is required to prevent tissue discoloration due to the transparency of the abutment. Furthermore, in a cross-sectional study [8], it was seen that there is lower risk of midfacial mucosa recession in those cases with thick mucosa [8].

Currently, there is still a lack of agreement among clinicians when it comes to defining localized mucosal recessions around implants. This is due to the absence of a defined landmark (as it is the CEJ in teeth) that serves as a reference for the normal position of the mid-bucal peri-implant mucosa [9,10]. Peri-implant buccal soft tissue dehiscence (BSTD) is known as the exposure of the prosthetic components and/or the implant due to the apical shift of the peri-implant mucosal margin after implant loading [2,3,11]. It has also been reported as mid-facial recession, soft-tissue defect, mucosal recession or peri-implant soft tissue recession. This tissue migration may compromise the esthetic results due to the increased crown height compared to the adjacent sites [9,10].

It is worth mentioning that a classification of BSTD around implants cannot be based on similar methods of grading gingival recession on teeth, since the peri-implant mucosa significantly differs from the periodontal soft tissue apparatus [1]. Therefore, BSTD should be defined on multiple factors such interproximal attachment level, height of the papillae, position and extension of the PSTD, bucco-lingual position of the implant and the level of implant-supported crown margin related to the contralateral or adjacent teeth.

The most well-known classification of peri-implant BSTD is the one described by Zuchelli et al. [1]. This classification system has been tested among different skill-level practitioners and has shown reproducible and consistent assessments among examiners [12]. The classification is defined by:

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- **Class I**: soft tissues align correctly with the adjacent teeth, yet the implant or abutment's color becomes apparent through the soft tissues due to insufficient keratinized tissue thickness.
- **Class II**: soft tissue margin of the implant restoration is situated more apically than that of the corresponding natural tooth. Simultaneously, the implant-supported crown is positioned palatally to the "imaginary curve" formed by the profile of the natural teeth at the soft tissue margin level.
- **Class III**: soft tissue margin is located more apically and the crown profile is facial to the "imaginary curve," and the implant head is positioned more palatally.
- **Class IV**: soft tissue margin is located more apically and the implant head is located more facially to the straight imaginary line connecting the adjacent teeth's profile.
- Classes II and III can further be subdivided into three distinct subtypes.
  - **Subtype a**: both mesial and distal papillae tips are positioned 3 mm coronally to the ideal soft tissue margin.
  - **Subtype b**: at least one papilla tip is less than 3 mm coronally to the ideal margin.
  - **Subtype c**: at least one papilla being at the same level or more apically compared to the ideal height of the soft tissue margin of the implant-supported prosthesis

2. Epidemiology of BSTD

The occurrence of peri-implant BSTD is not a rare finding [1,7]. Its prevalence and/or incidence has been reported in different studies and its values vary depending on the inclusion of implants affected by peri-implantitis, the study design, case definition of BSTD used and its follow-up.

A cross-sectional study by Romandini et al. [11] reported that the prevalence of soft tissue dehiscence was 12 % when no peri-implantitis implants were included, and it increased up to 26.7 % when implants affected by this condition were also analyzed. These reported values tend to be higher in longitudinal studies, in which the incidence moves between 0 and 61 % according to the last DGI/SEPA/Osteology Workshop [10]. Cosyn et al. observed during a 5-year follow-up study that the incidence increased throughout the observation period [13], whereas Bengazi et al. noticed that the apical displacement took place during the first 6 months after the placement of the prosthesis [14]. This early soft tissue recession was suggested to be related with a modeling process of the peri-implant soft tissues for its adaptation to adequate biological dimensions. The incidence values of soft tissue dehiscences were of 17, 64 % and 57 % respectively [14], different to the data published by Schroot et al., who reported an incidence of 75 % and related it with a keratinized mucosa width <2 mm [15]. Nevertheless, in a randomized clinical trial where soft tissue dehiscence was assessed according to the International Congress of Oral Implantologists (ICOI) criteria [16], the reported value was rather low (6.3 %) when compared to the studies above-mentioned.

To establish a specific value for the prevalence of BSTD around implants is complex since the comparison of studies with different methodologies might be biased. Furthermore, the limited sample size of some of these studies affects statistical power, especially if small changes such as mid-facial recessions are to be detected.

3. Risk factors/indicators of BSTD

Implant malposition, thin peri-implant soft tissue, lack of keratinized mucosa (KM) width and thin peri-implant buccal bone are risk factors/indicators associated with the occurrence of BSTD. The extent to which these parameters influence the stability of peri-implant soft tissues is still a matter of debate. For a better interpretation of this section, it is worth mentioning that reviewed studies [2,13,17-24] exhibited different (i) methodological designs (i.e., case-control, retrospective, cross-sectional); (ii) sample sizes; (iii) case definitions of BSTD; (iv) methods of outcome assessments and (v) implant and restorative protocols.

3.1. Implant malposition

The proper 3D installation of dental implants is crucial for achieving long-term success and maintaining optimal soft tissue health. Buser et al. advised that the ideal implant positioning consisted in placing the implant shoulder 1 to 2 mm palatal to the emergence line of the adjacent teeth [17]. Implant malposition, particularly in the buccal region, can significantly predispose the occurrence of BSTD (Fig. 1). When implants are positioned too far toward the buccal aspect, it may lead to inadequate thickness of the surrounding soft tissues – thus compromising their ability to resist mechanical and microbial challenges [2]. This insufficient soft tissue support can eventually result in BSTD, exposing the implant threads and potentially compromising the esthetic outcome [1]. A classical retrospective cohort study by Cosyn et al. found that buccally positioned implants presented with 17.2 times more risk of midfacial soft tissue recession [13]. Similarly, in a recent case control study that assessed implant position by means of cone beam computer tomography (CBCT), implants that were placed >1 mm outside the bony envelope exhibited significantly higher likelihood of BSTD (odds ratio (OR)$=$ 34.65) [2]. A cross-sectional epidemiological study by Romandini et al. also identified buccally proinclined implants as a risk indicator for PBSDT (OR$=$ 8.1) [18].

3.2. Thin peri-implant soft tissue

The thickness of peri-implant mucosa has also been identified as a critical factor influencing BSTD around dental implants (Fig. 2). A prospective clinical study by Kan et al. reported that substantial differences in mean facial gingival changes at 1-year post-implant placement between sites with thick and thin biotypes (-0.25 mm vs. -0.75 mm, respectively) [19]. This discrepancy was further accentuated in the latest follow-up assessment (-0.56 mm vs. -1.50 mm, respectively) [19]. In a cross-sectional study evaluating the factors affecting soft tissue level around anterior maxillary implants [20], it was observed that thin peri-implant biotypes were 18.8 times significantly more prone to midfacial soft tissue recession. Recently, Tavelli et al. identified a significant inverse correlation between mucosal thickness (assessed through ultrasonography) at 1 and 3 mm from the mucosal margin and BSTD - thus corroborating the notion that a thin mucosa can weaken the stability of the peri-implant mucosal [21].

3.3. Lack of keratinized mucosa width

The clinical significance of an adequate band of KM around dental implants has been extensively explored, while still leading to controversial findings in the literature. A 10-year follow-up cohort study by Roccuzzo et al. observed that implants surrounded by KM and alveolar mucosa presented with 0.16 ± 0.39 mm and 2.08 ± 0.71 mm marginal soft tissue recession, respectively [22]. In addition, Sanz-Martin et al. found that those implants sites buccally surrounded with KM > 2 mm displayed a protective effect against the occurrence of BSTD [2]. More recently, Tavelli et al. further established a significant correlation between a reduced KM width with the occurrence of BSTD [21].

3.4. Reduced height and width of peri-implant buccal bone

The influence of buccal bone thickness (BBT) and buccal bone dehiscences (BBD) on the development of BSTD is not well understood. A cross-sectional study by Tavelli et al. observed that implants with vertical buccal bone resorption - but not horizontal thickness - were negatively associated with the stability of the peri-implant mucosal margin [21]. Each millimeter of additional buccal bone dehiscence increased

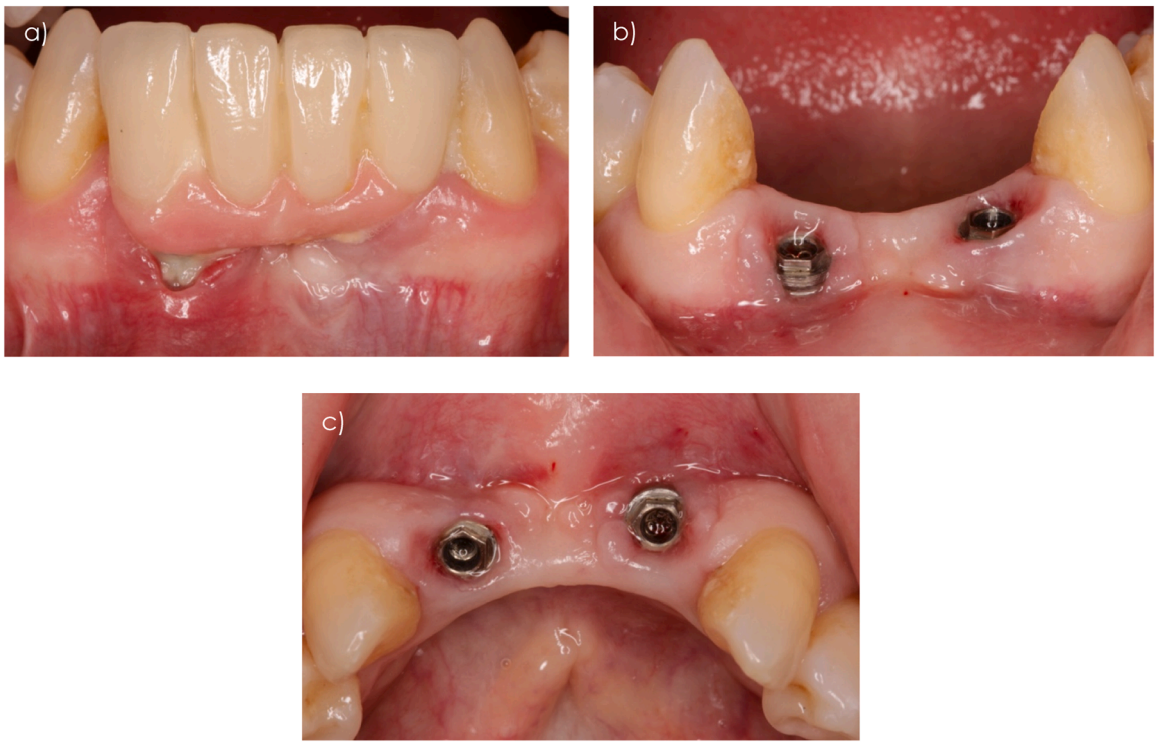

Fig. 1. A 35-year-old patient referred discomfort when brushing her anterior lower sextant. The clinical scenario revealed (a) plaque accumulation, mucosal inflammation and lack of keratinized mucosa in implant #4.2 and (b) 3 mm high BSTD. (c) Note that the implant #4.2 was buccally malpositioned in comparison to #3.2.

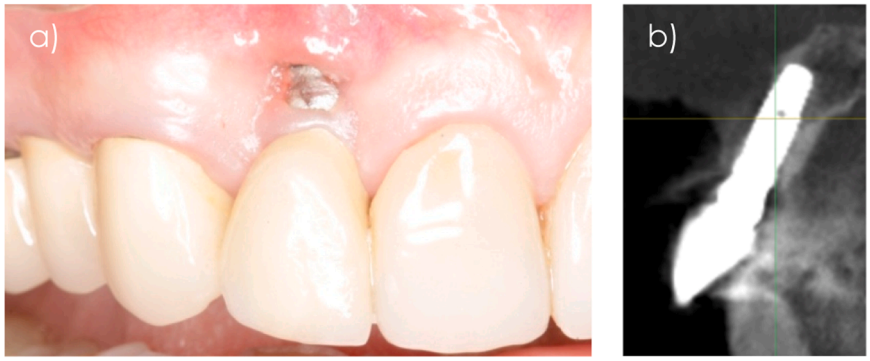

Fig. 2. A 54-year-old patient referred aesthetic demand on implant positioned in #1.2. The clinical and radiographic scenario revealed (a) BSTD of 1 mm, mucosal fenestration, lack of apical keratinized mucosa and thin peri-implant soft tissue thickness. (c) Note in the 3D radiograph the excessive emergence of the prosthetic abutment that leads to muccoal fenestration.

the odds of BSTD by a factor of 41 % [21]. Conversely, a 9 year-follow up case series with 12 single implants placed in the maxillary incisors without bone augmentation of the bone dehiscence revealed that all the implants had a mean of 3.8 mm of buccal bone dehiscences - with stable mucosal tissue and fair aesthetics [23]. Similarly, a recent randomized clinical trial evaluated single implants installed in narrow ridges and bone dehiscences < 5 mm treated with guided bone regeneration (GBR) or spontaneous healing [24]. The GBR group exhibited bone regeneration with a reduced bone dehiscence defect at re-entry, whereas in the spontaneous healing group the bone dehiscence remains. As interest, there were no significant differences in the position of the peri-implant mucosal margin between groups at 18 months follow-up [24]. A case-control study by Sanz-Martin found that the first bone to implant contact (fBIC) was significantly higher in the BSTD group (4.85 mm) when compared to the control group (2.15 mm) [2]. This finding evidenced that control groups displayed bone dehiscences without the presence of BSTD. In summary, it seems reasonable to affirm that the presence of a buccal bone dehiscences plays a less important role in the development of BSTD whenever implants are placed withing the alveolar housing.

3.5. *Summary of scientific evidence*

A systematic review and meta-analysis was performed for the DGI/SEPA/Osteology Workshop (2022) which included 24 articles [25]. BSTD was defined as an apical migration of the peri-implant soft tissues of $\geq$1 mm from the baseline examination (final restoration) or in comparison with the adjacent or contralateral natural tooth. The main findings were: (i) patients at a higher risk of developing BSTD were significantly associated with buccally malpositioned implants (OR= 14.37 [4.58, 45.14]) and thin biotype (OR= 2.85 [1.40, 5.8]); (ii) sites without connective tissue graft (CTG) augmentation had a higher

probability of mucosal dehiscence (OR= 9.00 [3.11, 26.02); and (iii) buccal bone thickness < 1 mm and immediately placed implants were not significantly associated with greater BSTD [25].

4. Surgical and prosthetic approaches for the treatment of BSTD

The treatment approach for peri-implant BSTD depends largely on the specific type of dehiscence presented by the patient. As previously stated, Zucchelli et al. proposed a recent classification outlining four classes and three subcategories of PSTD at single implant sites [1]. Their classification is based on the position of the implant-supported crown, interproximal soft tissue dimensions, and offers treatment recommendations [1].

Traditional surgical methods address PSTD by combining a coronally advanced flap (CAF) with connective tissue grafts (CTG), acellular dermal matrix (ADM), or collagen matrix (CM) [26-29]. However, various other surgical, prosthetic, and combined techniques have been documented in case reports or case series [30-34], demonstrating differing levels of success in managing aesthetic and tissue height concerns around implants. These encompass different methods from envelope techniques to modified approaches, showcased in Table 1.

Different surgical modalities have been explored to approach BSDT. Zucchelli et al. (2013) introduced the so-called surgical-prosthetic approach, which involved removing the prosthetic crown a month before surgery, adjusting and polishing the abutment, and using temporary restorative crowns to aid soft tissue healing. Positive results were achieved in terms of complete dehiscence coverage (75 %), aesthetic improvements, and tissue enhancement over time [35]. The success of the technique lays in the enlargement of the interdental tissues, which provided better support for the graft and surgical papillae. However, this method extends treatment duration and costs. Burkhardt et al. and Roccuzzo et al. utilized CAF and CTG, reporting varying degrees of success in complete dehiscence coverage, from 66 % at 6 months to 58 % at 10 years, respectively [27,36]. Burkhardt et al. noted challenges in achieving total coverage around implants, possibly due to using deep palate CTG, richer in fatty and granular tissue [36] compared to de-epithelialized free gingival grafts, which contain denser and more stable collagen fibers [37].

Additional methods have showcased effectiveness in varying scenarios including the envelope technique with SCTG envelope technique with SCTG, pouch flap with collagen matrix [29], and partially epithelialized connective tissue grafts (PECTGs). The latest, aimed to augment keratinized tissue height and thickness, achieved significant recession coverage in 88 % of 22 implants at a 5-year follow-up, with 64 % exhibiting complete coverage [33].

Several studies have been conducted comparing graft materials suc as CTG, ADM combined with. A randomized clinical trial conducted by Anderson et al. revealed no statistical significance differences in outcomes between the two groups were observed (23% vs 40 % of recession coverage) [38]. However, the control group displayed smoother healing [38]. A case report using triangular-shaped incision for CAF combined with ADM showed partial dehiscence coverage of a 3 mm baseline recession [30].

In conclusion, despite the promising results observed across various

Table 1
Surgical techniques in the treatment of peri-implant BSTD.

Author (year)	Type of study	Follow up (months)	Patients/ sites (n)	Intervention	BSTD type	Complete BSTD coverage (%)	Mean BSTD coverage (% or mm)	STT gain (% or mm)	KM gain (mm)	Esthetic VAS score
Anderson et al. (2014)	RCT	6	Control group: 7	Control group: CAF + SCTG	NR	NR	Control group: 40 %	Control group: 63 %	NR	NR
			Test group: 6	Test group: CAF + ADM			Test group: 23 %	Test group: 105 %		
Burkhardt et al. (2008)	PS	6	10	CAF + CTG	NR	NR	66 % ± 18 %	NR	−0.2 ± 1.1 mm	NR
Cosyn et al. (2012)	PS	3 and 9	2	Envelope (pouch) technique + CTG	NR	NA	66 % and 75 %	NR	NR	NR
Frisch et al. (2020)	CS	72	22	Repositioned flap + PECTG	NR	64 % of sites	1.98 ± 0.93 mm	NR	2.02 ± 1.05 mm	NA
Lee et al. (2015)	CR	12	1/1	Modified VISTA technique (envelope-tunnel flap) + CTG	NR	NR	NR	NR	NR	NR
Mareque-Bueno S. (2011)	CR	6	1/1	CAF + ADM	NR		NR	NR	1 mm	NA
Roccuzzo et al. (2023)	PS	120	16/16	Envelope technique + *U*-shape CTG from tuberosity	NR	58 % of sites	89.6 % ± 17.1 %	NR	NR	8.9 ± 0.9
Schallhorn et al. (2015)	PS	6	NA	Pouch flap + collagen matrix	NR	NR	−0.1 ± 0.7 mm	0.7 ± 0.8 mm	0.7 ± 1.2 mm	NR
Schoenbaum et al. (2018)	CR	5	1/1	Prosthetic approach	NR	100 % of sites	NR	NR	NR	NR
Ueno et al. (2015)	CR	9	2/2	Semilunar coronary positioned flap + SCTG	NR	100 % of sites	2.5 mm	2 mm	2 mm	NA
Yang et al. (2021)	CR	36	1/1	Digital prosthetic/tunnel flap + SCTG	NR	NR	2.4 mm	2.9 mm	NR	NA
Zucchelli et al. (2013)	PS	12	20	Surgical–prosthetic approach (abutment modification and CAF + CTG)	NR	75 % of sites	−2.62 ± 0.81 mm	1.58 ± 0.21 mm	0.57 ± 0.41 mm	8.0
Zucchelli et al. (2018)	PS	72	19	Surgical–prosthetic approach (abutment modification and CAF + CTG)	NR	79 % of sites	99.2 %	1.8 mm (1.6–2.1 mm)	1.0 mm (0.5–2.0 mm)	8.75 ± 1.02

RCT: randomized clinical trial; CS: case series; CR: case report; KM, keratinized mucosa; PS: prospective study; SCTG: subepithelial connective tissue graft; NR: not reported; CTG: connective tissue graft; CAF: coronally advanced flap; BSTD: peri-implant buccal soft tissue dehiscence; ADM, acellular dermal matrix; VISTA, vestibular incision supraperiosteal tunnel access; PECTG, partially epithelialized connective tissue graft N/A, not appliable; NR: not reported.

approaches, the need for larger studies with longer follow-ups and standardized outcome measures is crucial to establish their efficacy definitely. Additionally, there is a lack of randomized controlled trials assessing these surgical approaches and biomaterials, limiting definitive conclusions about their effectiveness. The existing trials often have small sample sizes and short follow-up periods, thus requiring more comprehensive investigations.

5. Future perspectives

Upcoming research on this field should be focused in conducting:

- Studies that follow a uniform case definition of BSTD to better estimate its prevalence and understand its predisposing factors.
- Studies that evaluate the influence of prosthetic/abutment emergence profile/design on the occurrence of BSTD.
- Studies that evaluate the contribution of the thickness of the buccal bone on the occurrence of BSTD.
- RCT studies that evaluate the efficacy of BSTD coverage (with complete BSTD as the primary outcome) after comparing different surgical techniques, CTG harvesting sites and procedures as well as soft tissue substitutes.
- Studies that evaluate patient-reported outcomes after BSTD therapy.

6. Conclusion

Peri-implant BSTD are relatively frequent conditions that may have an impact on patient's aesthetics and long-term peri-implant health. Based on the available scientific evidence, buccal malposition is the factor with the strongest association with buccal mucosal recession, while coronally advanced flap plus connective tissue graft is the most reported surgical technique to treat this condition. However, further studies are needed to elucidate on the etiology and effective therapy of peri-implant BSTD.

Declaration of competing interest

None.

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