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Review Article

Systematic assessment of soft tissue level and bone level dental implants

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A R T I C L E I N F O

Keywords:
Dental implant
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Level implant

A B S T R A C T

Objective: To systematically review the literature to compare soft tissue level implants vs. bone level implants, depending on mesiodistal edentulous space, aesthetic requirements, type of prosthetic restoration, connection-reconnection of the abutment, and denture space.
Methods: Medline (Pubmed) and Scopus were electronically and hand searched for any publications that evaluated STL and BL implants in relation to any advantages or disadvantages in clinical situations.
Results: Overall, 1098 articles were identified, of which 48 were selected for review. 7 of them were systematic reviews, 8 were randomized controlled trials (RCTs), and 33 were non-RCTs (5 case control studies, 4 cohort studies, and 24 other types of non-RCTs)
Conclusions: All current implant approaches offer good results in terms of marginal bone loss and survival rates. Due to the fact that in different clinical situations, one or another type of implant may offer additional advantages, the choice between soft tissue level or bone level implant must be based on the particular characteristics of each case.

1. Introduction

Current challenges in implant dentistry involve achieving predictable long-term results in any clinical situation, especially when there are high aesthetic requirements. Currently, treatment with implants offers predictable long-term results in replacing all types of dental deficiencies, single or multiple, becoming the most appropriate therapeutic alternative to removable dentures and fixed prostheses. Over the years, continuous variations in implant design have been proposed, with modifications varying considerably to achieve the best possible results in terms of the degree of osseointegration. Nevertheless, all such innovations, which often lack solid evidence, complicate clinical decision making. The maintenance of stable bone levels over time remains the gold standard when evaluating success in implantology, but currently the final objective in implant treatment is based not only on achieving good results in bone integration, but also in reaching aesthetic and predictable contours of the soft tissues; thus, making the aesthetic component an inherent part of oral rehabilitation. During the early years of implant science, the most commonly used implants were two-piece; these components were placed on the bone crest during the first phase of the surgical procedure, allowing submerged healing during the period of osseointegration with the aim of minimizing implant failure. However, a second surgical procedure was necessary during the prosthodontic phase. Resorption of the bone crest after 1 year of prosthetic loading was a common occurrence in this type of implant, with a marginal bone loss of not more than 1.5 mm in the first year and 0.2 mm in each successive year. Changes around the neck of the implant were assumed to be due to establishing biological width [1]. It has also been suggested that inflammation and micromotion in the gap between the implant and the abutment also play a role in marginal bone loss and the consequent soft tissue recession [2]. More recently, implants have been designed at the soft tissue level, requiring only one surgical stage. This has decreased morbidity and shortened the treatment period, with a similar success rate for the initial approach [3]. This type of implant has a rough surface designed to facilitate osseointegration and a polished coronal part that facilitates the adaptation of soft tissues. Multiple studies have established that the supracrestal position of the implant causes less marginal bone reaction compared with implants placed at the epicrestal level [4]. The main drawback of this type of implant is the possible exposure of the polished neck, especially in aesthetic areas with a fine biotype. In recent decades, the concept of platform switching appeared serendipitously [5]. It was observed that, when restoring bone level implants with prosthetic attachments of smaller diameter, the loss of peri-implant crestal bone was minimized. In this way, with the advent

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of the switching platform concept, it was possible to place the shoulder of the implant at the level of the crestal bone with minimal and predictable marginal bone resorption. Thus, such an approach offers obvious aesthetic advantages by allowing the neck of the implant to be hidden [6]. Currently, most systems offer two types of implants: soft tissue level (STL) implants are typically placed transmucosally in a single surgical phase, while bone level (BL) implants are placed at the epicrestal level with a narrow platform abutment that aims to maintain levels of the peri-implant bone crest. Both types of implants promise good results in the medium and long term and are versatile, allowing for immediate loading of any type of prosthetic restoration, screwed or cemented. Despite wide use of BL and STL implants during past decades, the results have not been evaluated with an evidence-based approach. There are few systematic reviews or meta-analyses in this regard, the most recent one finding no differences between the two approaches [2]. Although most studies report no differences in marginal bone loss or survival rates between the two systems, and in fact, find the two to be interchangeable, other factors may identify superior performance for one system over the other. Currently there are specific indications for each type of implant, thus, STL would be indicated for the posterior sector and for prostheses, while BL would be the implant indicated for aesthetic requirements. However, this is an overly simplistic approach and other factors may be taken into account.

The aim is to compare soft tissue level vs. bone level implants indications through a systematic review of the literature. Few studies have analyzed the advantages and disadvantages of each implant system depending on the different clinical situations. In this context, a clinical guide could be useful for making decisions for implant planning.

2. Materials and methods

This systematic review was performed according to the PRISMA statement (Supplementary Table S1). Focused questions: what is the difference between STL and BL implants depending on other clinical situations regardless of bone availability? The question to answer is in relation to the two implant systems: which type is more advantageous than the other in the different clinical situations mentioned? The PICO question is based on P: partially or totally edentulous patients who have received treatment with both types of implants; I: STL implant placed supracrestally in one-stage surgery receiving any type of fixed or removable restoration; C: BL implant placed epicrestally in two surgical stages that receive any type of fixed or removable restoration; O: beneficial effects in terms of promoting osseointegration, shortening treatment times, facilitating procedures, superior utility in some type of restoration, avoiding adverse effects (such as non-osseointegration and peri-implantitis), and desirable economic factors.

2.1. Study design

Before beginning the systematic review, the authors developed a protocol designed along the general lines of the review for each of the study sections. In this way, an independent review was established comparing the favorable effects, advantages, and disadvantages of the STL and BL implants, depending on various aspects, such as dimensions of the edentulous space, aesthetics, connection-reconnection of the abutments, type of prosthetic restoration, and available prosthetic space. It also includes the search strategy of each section, inclusion and exclusion criteria, screening, and quality assessment technique. This paper focuses on BL and STL implant systems from the same manufacturer (Straumann AG, Basel, Switzerland); however, these findings are applicable to other commercial implants, in which the diameter and length vary slightly.

2.2. Search strategy

An electronic search was performed in two databases (Medline via PubMed and Scopus), looking for studies published before July 2020, only in English, and using MESH terms and keywords. The MESH terms included *dental implants* and the following keywords/search terms and their combinations: *STL transmucosal, submerged, nonsubmerged, one stage, one piece, one-part, single part, BL submucosal, submerged, two stage, two pieces,* and *two parts*. These search terms were completed with specific keywords for each of the topics specifically: Mesiodistal edentulous space: edentulous gap, edentulous space, implant diameter, mesiodistal size, interimplant distance, and jumping distance. Filters were for dental journals, clinical trials, and reviews were applied. Aesthetics: Implant aesthetic(s), failures, emergence profile. Filters for dental journals, clinical trial, and review were applied. Type of prosthetic restoration: Implant restoration, implant rehabilitation, overdenture, single tooth replacement, fixed partial denture, prosthetic planning. Filters for dental journals, clinical trial, and review were applied. Connection-reconnection: Abutment disconnection, connection, reconnection, disconnection. Filters for dental journals, clinical trial, and review were applied. Denture space; Vertical restorative space, interridge space, denture space, prosthetic space, restorative space, interarch space. Filters for dental journal. In addition, a hand search and expert opinions were sought using articles and references retrieved from the electronic search and peer-reviewed journals.

2.3. Screening

2.3.1. Inclusion criteria

These included publication in the peer-reviewed literature of studies in partially or totally edentulous patients with fixed or removable implant restorations through STL or BL implants in the English language and animal or human clinical studies evaluating BL or STL implants about focused questions. Clinical studies: *Randomized clinical trials, controlled trials, cohort studies/case series, and case control studies*. Additionally, in vitro *studies, review articles, and textbooks* were included for review. Follow-up time: at least 6 months after functional loading.

2.3.2. Exclusion criteria

Studies in patients with medical conditions that may affect implant therapy (*diabetes mellitus, cancer,* and *drugs*). Studies using STL and BL implants for other nondental uses (*orthodontic anchor, maxillofacial prosthesis*). Studies with multiple interventions, i.e., *ridge augmentations* and/or *sinus lift*. Studies describing *peri-implantitis treatments* and those that report immediate loading.

2.4. Eligibility criteria

The number of studies published on each of the topics is variable. In all cases, a sequential screening process was performed independently and secondarily by two of the authors (L.L. and B.R.) to increase the relevance of the data obtained. In a first step based on the title and abstract, studies not focused on the topic and duplicate studies were eliminated. Then, eligibility for full-text assessment and, finally, selection of studies was performed according to the inclusion and exclusion criteria. The primary outcome was any advantage or disadvantage about STL or BL implants. The excluded articles, together with the reasons, are referenced in Supplementary Table S2.

2.5. Quality assessment

The risk of bias was evaluated for the selected articles. The included systematic reviews were assessed for quality, using AMSTAR 2, whose checklist aims to assess the overall confidence in the results of a systematic review. AMSTAR 2 is composed of 16 items scored *yes, partial yes, no*, and *meta-analysis*. Of the 16 items, seven are considered critical domains:

– protocol registered before commencement of the review (Item 2);

- adequacy of the literature search (Item 4);
- justification for excluding individual studies (Item 7);
- risk of bias of included individual studies (Item 9);
- appropriateness of meta-analytical methods (Item 11);
- consideration of risk of bias when interpreting the results (Item 13);
- assessment of presence and likely impact of publication bias (Item 15) [7].

The overall confidence in the results of the systematic reviews proposed by the AMSTAR 2 tool was defined as:

1. High (no, or one noncritical weakness: the systematic review provides an accurate and comprehensive summary of the results);
2. Moderate (more than one noncritical weakness but no critical flaws: the systematic review provides an accurate summary of the results);
3. Low (one critical flaw, with or without noncritical weakness: the systematic review may not provide an accurate or comprehensive summary of the results);
4. Critically low (more than one critical flaw, with or without noncritical weakness: the review should not be relied on to provide an accurate nor comprehensive summary of the results).

A pair of reviewers (B.R., L.L.) performed the AMSTAR 2 assessment; disagreements were resolved by discussion or arbitration with a third reviewer (S.D.).

The Cochrane Collaboration's "Risk of Bias" was used to assess the included randomized controlled trials (RCTs) as recommended by the *Cochrane Handbook for Systematic Reviews of Interventions*. For each study, a cumulative score was estimated and the overall risk of bias was evaluated for the included RCTs. A low risk of bias was assigned to studies that fulfilled all criteria. A moderate risk of bias was assigned to studies in which at least one criterion was only partially fulfilled. A high risk of bias was assigned to studies in which one or more criteria were not fulfilled (Higgins JPT, Green S eds. *Cochrane Handbook for Systematic Reviews of Interventions,* Version 5.1.0. updated March 2011. The Cochrane Collaboration, 2011. www.handbook.cochrane.org).

Finally, quality appraisal for nonrandomized studies (cohort and case series studies) was executed according to the Newcastle-Ottawa Scale (NOS) [8]. The NOS calculates the study quality based on three major components: selection, comparability, and outcome for cohort and case series studies. It assigns a maximum of four stars for selection, a maximum of three stars for outcome, and a maximum of two stars for comparability. According to that quality scale, a maximum of nine stars/points can be given to a study. In the analysis, the studies are defined as high quality: 7–9; medium quality: 4–6; low quality: 1–3.

Pooling of data in a meta-analysis was not possible due to heterogeneity and low number of RCTs. Therefore, a qualitative analysis was made.

3. Results

Overall, 1098 articles were identified, of which 48 were selected for review (Table 1). 7 of them were systematic reviews, 8 were randomized controlled trials (RCTs), and 33 were non-RCTs (5 case control studies, 4

Table 1
Flow chart of the selection strategy used in the systematic review.

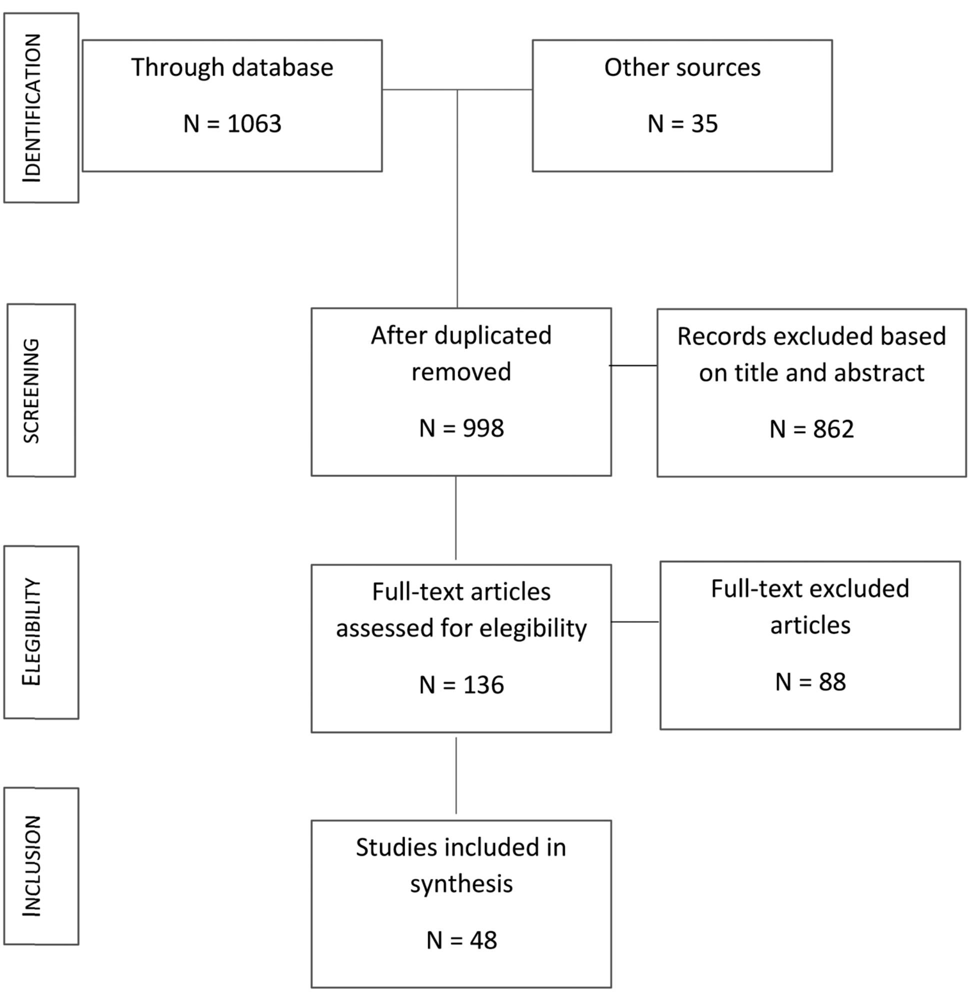


Table 2
Summary assessment of risk of bias for systematic reviews.

		Staubli *et al.* (2017)	Koutouzis et al. (2017)	Saleh et al. (2018)	Vouros *et al.* (2012)	Stietzel *et al.* (2015)	Assaf *et al.* (2017)	Sadowsky (2007)
1. Did the research questions and inclusion criteria for the review include the components of PICO?		Green	Green	Green	Green	Green	Green	Red
2.Did the report of the review contain an explicit statement that the review methods were established prior the conduct of the review and did the report justify any significant deviations from the protocol?		Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
3.Did the review authors explain their selection of the study designs for inclusions in the review?		Green	Yellow	Green	Green	Green	Green	Green
4.Did the review authors use a comprehensive literature search strategy?		Yellow	Yellow	Green	Yellow	Yellow	Yellow	Red
5.Did the review authors perform study selection in duplicate?		Green	Green	Green	Green	Green	Green	Red
6. Did the review authors perform data extraction in duplicate?		Green	Green	Green	Green	Green	Green	Red
7. Did the review authors provide a list of excluded studies and justify the exclusions?		Red	Red	Green	Red	Yellow	Red	Red
8. Did the review authors describe the included studies in adequate detail?		Green	Green	Green	Green	Green	Green	Green
9. Did the review authors use a satisfactory technique for assessing the risk of bias (RoB) individual studies that were included in the review?		Red	Green	Green	Green	Green	Green	Red
10. Did the review authors report on the sources of funding for the studies included in the review?		Red	Green	Green	Red	Red	Red	Red
11.If meta-analysis was performed did the review authors use appropriate methods for statistical combination of results?		Red	Green	Green	Green	Green	Red	Red
12.If meta-analysis was performed did the review authors assess the potential impact of RoB in individual studies on the results of the meta-analysis or other evidence synthesis?		Red	Green	Green	Green	Green	Red	Red
13.Did the review authors account for RoB in individual studies when interpreting/discussing the results of the review?		Red	Green	Green	Green	Green	Green	Red
14.Did the review authors provide a satisfactory explanation for, and discussion of, any heterogeneity observed in the results of the review?		Red	Green	Green	Green	Green	Green	Red
15.If they performed quantitative synthesis did the review authors carry out an adequate investigation of publication bias (small study bias) and discuss its likely impact of the results of the review?		Red	Green	Green	Green	Green	Red	Red
16.Did the review authors report any potential sources of conflict of interest, including any funding they received for conducting the review?		Green	Green	Green	Green	Green	Red	Red

Red= No; Yellow= Partial Yes; Green= Yes

Red = No; Yellow = Partial Yes; Green = Yes.

Table 3
Summary assessment of risk of bias for RCT's using Cochrane Collaboration's.

	Random Sequence Generation	Allocation Concealed	Blinding Participants/ Personnel	Blinding Outcome Assessment	Incomplete Outcome Data	Selective Reporting	Other Bias
Grandi et al. [34]	Low	High	Low	High	Low	Low	Low
Sanz et al. *(2013)*	Low	Low	Low	Low	Low	Low	Low
Ebler et al. *(2015)*	Low	Low	Unclear	Unclear	Low	Low	*
Bressan et al. [33]	Low	Low	Low	Low	Low	Low	Low
Esposito et al. [35]	Low	Low	Low	Low	Low	Low	-
Gamper et al. [25]	Low	Low	High	High	Low	Low	+
Barbisan de Souza et al. *(2018)*	Low	Low	Low	Low	Low	Low	**
Praça et al. *(2019)*	Low	Low	Low	Low	Low	Low	Low

[*] Ebler et al. (2015) blinding participants/personnel was not reported.
[+] Gamper et al. (2017) blinding outcome assessment was not reported.
[**] Barbisan de Souza et al. (2018) blinding outcome assessment was not possible.

cohort studies, and 24 other types of non-RCTs).

Regarding the risk of bias and quality of studies, in the case of systematic reviews, the overall confidence was high for one, moderate for one, low for two, and critical for three systematic reviews (Table 2). For the eight RCTs analyzed, the risk of bias was low for four and high for the other four (Table 3). In the case of non-RCTs, the five case control studies were of medium quality and the four cohort studies showed a high quality (Tables 4a, 4b).

Table 4a
Summary assessment of case-control studies.

Author (year)	Selection				Comparability		Outcome			Total
	Is the case definition adecuate?	Representativeness of the cases	Selection of controls	Definition of controls	Study controls for previous injury	Study controls for age	Ascertainment of exposure	Same for cases and controls	Non-response rate	
Abrahamsson et al. [28]	�	0	�	�	0	0	�	0	�	Fair
Grossberg [19]	�	�	0	0	�	0	�	0	0	Poor
Canullo & Rasperini [20]	�	0	�	�	0	0	�	�	�	Poor
Rodríguez-Ciruana et al. [10]	�	�	0	0	�	0	�	0	0	Poor
Lago et al. (2017)	�	�	0	0	�	0	�	0	0	Poor

Table 4b
Summary assessment for cohort studies.

Author (year)	Selection				Comparability		Outcome			Total
	Representativeness of the exposed cohort	Selection of external control	Ascertainment of exposure	Outcome of interest not present at start	Main factor	Additional factor	Assessment of outcome	Follow-up long enough	Adequacy of follow-up	
Tarnow (2000)	�	�	�	�	�	0	�	�	�	8/9
Kumar (2014)	�	�	�	�	�	0	�	�	�	8/9
Andreassi (2016)	�	�	�	�	�	0	�	�	�	8/9
Meijndert (2020)	�	0	�	�	�	0	�	�	�	7/9

3.1. Mesiodistal edentulous space

Regarding the mesiodistal distance, the size of the edentulous gap may be a factor in the choice of the type of implant [9,10]. In most implant systems, although the diameter of the intraosseous part is identical, the coronal part presents differences, including the widest STL implant. For a single implant, if the mesiodistal distance is close to 15 mm, the possibility of excessive embrasures is high. This also occurs with most standard implants having a diameter of 4.1 mm. STL implants always minimize this inconvenience and improve the possible food packing and interproximal hygiene. At a distance of 7–9 mm, a BL implant allows maintaining 1.5-mm bone walls on each side. Similarly, if the distance is around 20 mm, the placement of two implants can be subject to the same considerations. Regardless of bone availability, the size of the gap can be adapted to the different diameters of the implants. If the distance is around 15 mm, two BL implants would be indicated, whereas if it is greater than 15 mm, two STL implants would be more suitable [11]. A narrow implant with a shoulder diameter of 3.5 mm (STL) or 3.3 mm (BL) is generally used to replace the lateral incisor, particularly in areas between 5.0 and 5.5 mm [12], but it can be useful in other areas with reduced dimensions [13,14].

3.2. Aesthetics

Although there seems to be no difference in marginal bone loss between STL and BL implants [2], the use of platform switching in BL implants can improve the stability of soft tissues [6]. Regardless of the thickness of the mucosa, BL implants allow a more appropriate aesthetic management [14,15]. Since the transmucosal polished neck of the STL implants is at least 1.8 mm, higher mucosal thicknesses are required so that either the neck does not become visible or the subcrestal placement of the implant can be performed, with the risk of greater bone loss during the formation of biological width [16]. Placing the neck of the implant at the correct depth has important aesthetic implications [17], since it allows the use of healing caps with an adequate emergency profile and substitution of the prosthetic part in the event of marginal tissue recession [12,18–20].

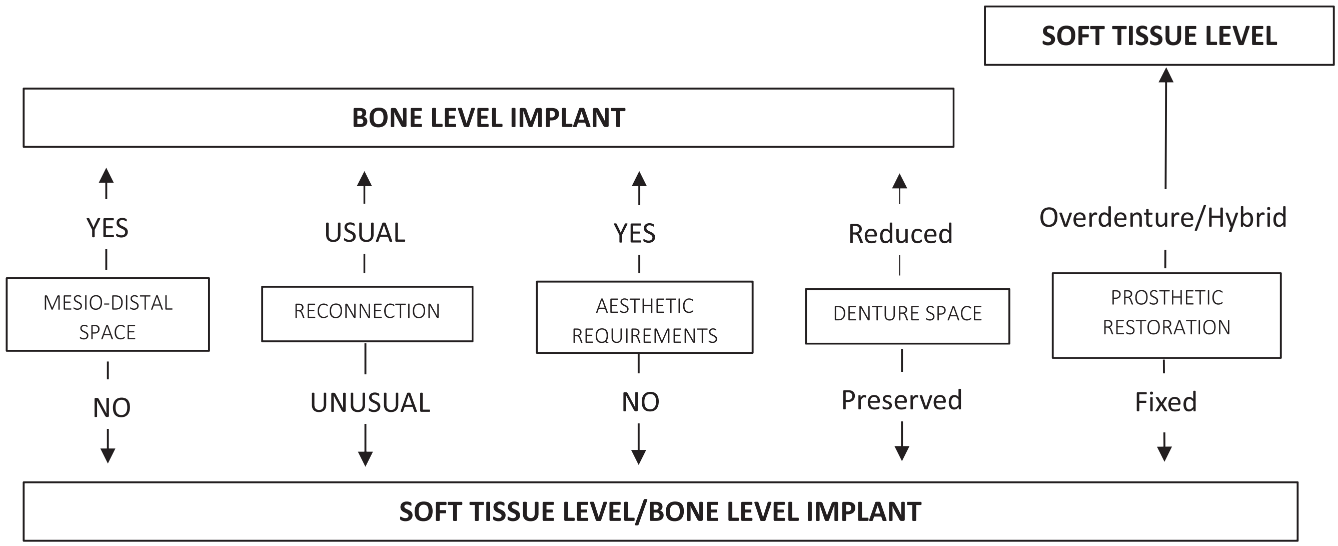
3.3. Type of prosthetic restoration

In general, when the planned prosthetic restoration is an overdenture or a fixed detachable prosthesis, the most suitable implant appears to be an STL implant. Since, in this type of restoration, it is feasible that the mucosa could be subjected to loads by the prosthesis. However, in a bone level implant, due to the apical position of the microgap, an anaerobic environment exists that could favor a more pathogenic bacterial composition, leading to peri-implantitis [18]. Another related aspect is the type of union between the abutment and the prosthetic restoration and whether it is cemented or screwed in. Retaining the restoration involves positioning the shoulder of the implant to facilitate an adequate emergence profile and adequate soft tissue architecture [12]. The two-piece bone-level implant is placed at the level of the bone crest, which is usually restored by means of screw-retained crowns because the unseen coronal margin can hinder correct seating of the crown, resulting in excess cement being left to damage the tissue [21]. In contrast, the STL implant offers more favorable characteristics for a cemented restoration, the margin is far from the bone crest, removal of the cement is feasible, the cemented crown is technically simpler to manufacture, and it offers better occlusal aesthetics and less maintenance [22]. In this way, although both implant systems render similar outcomes [23–25], prosthetic management may vary depending on the anterior or posterior location of the implant and whether or not it is submerged [26,27].

3.4. Connection-reconnection

Abrahamsson et al. [28] reported on the influence of connecting and reconnecting implant abutments on the health of the peri-implant

Table 5
Clinical decision-making flow chart.



tissues, as well as on the apical migration of the connective tissue of the mucosal barrier; similar observations were reported by Canullo et al. [29,30]. More recently, Becker et al. [31] suggested that repeatedly reconnecting the abutments may be associated with dimensional changes of the peri-implant tissues. Although there is no clear evidence on the effect of this repetition at the marginal peri-implant bone levels [32,36], the most recent meta-analysis suggests it is necessary to choose the implant type during the planification protocol phase [37]. Indeed, the need to repair overdentures over time is constant. In this situation, STL offers advantages since it outdistances implant abutment junction. Similarly, in the case of fixed detachable prostheses, it is customary to disconnect the prosthesis during routine check-ups to assess the soft tissues [38–40]. Thus, move implant abutment junction away from the bone will favor maintenance of the bone level.

3.5. Denture space

Evaluating available restorative space is necessary during the diagnostic phase. Regardless of the type of restoration, fixed, fixed detachable, or removable, failure to consider this factor before the placing the implants can lead to structurally weakened prosthesis, invasion of the resting space, aesthetic difficulties, and compromised retention and stability of the prosthesis [41–44]. In case of overdentures, this aspect is more dramatic. A minimum vertical space of 13 or 14 mm is recommended for an overdenture supported by bars and 10–12 mm for individual attachments [45]. In the case of locator attachments, a minimum vertical space of 8.5 mm is required, corresponding to 1.8 mm to the polished neck of the implant, 1.5 mm from the height of the shortest attachment, 3.2 mm for the patrix part, and 2 mm of acrylic resin on the attachment [46]. The limitation of minimal available space may involve such complications as alveoplasty, increasing the vertical dimension of the occlusion, altering the occlusal plane, or selecting inappropriate attachments [46–48]. In cases of partial edentulism, if the space between the arches is limited by extrusion of the antagonists, the BL implant allows more space for the abutment and the prosthetic restoration. In such cases, the low height of the abutment offers little retention and should be screw-mounted. In general, the implant at the level of the tissues offers 1.8 mm less space, which is the minimum height of the polished portion of the implant neck.

4. Discussion

Historically, evaluation of an implant system was based mainly on maintaining stable bone levels over time. However, current systems are a great improvement over the initial losses of 1.5 mm for the first year. A systematic review [2], revealed that both implant systems sustain acceptable levels of bone loss. Also, the implant survival rates are similar. Another evaluation by Andreassi et al. [49], found no differences in the parameters studied (survival rate, success rate, such as bone resorption around the implant neck) between the two implant systems. Although many studies that have found statistically significant differences in peri-implant marginal bone loss, this difference may not be clinically significant [17]. A recent example is the study by Hadzik et al. [50] which found less marginal bone loss in the BL implant than in STL implants; however, this difference was less than 0.5 mm, which is not relevant clinically. At this point, it does not seem that bone loss is the key factor when choosing between one type of implant over the other. Each individual case has different characteristics, and the best implant for each situation must be determined on a case-by-case basis. A flow chart can be made to determine where an STL or BL implant offers advantages, or where either approach would be sufficient in specific clinical situations (Table 5). In this way, the clinician should follow a train of thought that will lead him or her to analyze the factors that indicate the best approach. In conclusion, all current implant approaches offer excellent results in terms of marginal bone maintenance and survival and success rates. Thus, the choice of one approach over another is based on the particular characteristics of each case. It is necessary to point out the heterogeneity of the studies reviewed and that prospective randomized studies are scarce. Therefore, the possible external evidence has a high risk of bias that should be taken into account when considering the conclusions of this review.

5. Conclusions

All current implant approaches offer good results in terms of marginal bone loss and survival and success rate. The choice between BL or STL must be based on the particular characteristics of each case.

Declaration of Interests

We declare no conflicts of interest.

Acknowledgment

None.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ajoms.2023.02.007.

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