



GRADUATION PROJECT

Degree in Dentistry

BONE-LEVEL VS TISSUE-LEVEL IMPLANT INDICATION, A SYSTEMATIZED REVIEW.

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RESUMEN

Introducción: Los implantes dentales pueden colocarse a diferentes alturas con respecto a la cresta alveolar. Los implantes bone-level se insertan hasta que su plataforma se sitúa por debajo de la cresta ósea, mientras que los implantes tissue-level se colocan más coronalmente, a nivel de los tejidos blandos, y presentan un cuello transmucoso; **Objetivos:** El objetivo principal fue comparar su rendimiento biológico, estético y funcional. Los objetivos secundarios fueron evaluar su estabilidad e integración según diversos parámetros como su localización, forma o tipo de prótesis utilizada, así como formular recomendaciones sobre las situaciones clínicas en las que se recomienda cada tipo de implante; **Metodología:** Se formuló una pregunta PICO y se realizó una revisión de la literatura de los últimos 10 años a través de diferentes bases de datos como MEDLINE (PubMed), Scopus y Dentistry & Oral Sciences Source (EBSCO). La búsqueda se centró en humanos, ensayos clínicos aleatorizados y estudios de cohorte prospectivos o retrospectivos; **Resultados:** Los artículos fueron seleccionados según criterios de inclusión y exclusión. 75 artículos fueron evaluados mediante lectura completa y 8 fueron incluidos en el análisis de datos, para comparar los resultados de los implantes bone-level y tissue-level en diferentes situaciones clínicas; **Conclusiones:** Los implantes tissue-level mostraron resultados predecibles, particularmente en sectores posteriores, donde las cargas oclusales son mayores. Los implantes bone-level mostraron una mayor variabilidad en términos de pérdida ósea marginal, pero presentaron mejores resultados estéticos y en el manejo de los tejidos blandos, especialmente cuando se combinan con un pilar con platform switching.

PALABRAS CLAVE

Odontología, Implantología, Implantes bone-level, Implantes tissue-level, Indicaciones

ABSTRACT

Introduction: Dental implants can be placed at different heights relative to the alveolar bone. Bone-level implants are inserted until their platform is located under the bone crest level, whereas tissue-level implant platforms are located more coronally, at the soft tissue level, and have a transmucosal neck. It is important to determine the differences and indications of each of these implants; **Objectives:** The primary objective was to evaluate their biological, aesthetic and functional performance. The secondary objectives were to evaluate their stability and integration according to various parameters such as their location, shape or type of prosthesis used, as well as formulating recommendations on the clinical situations where each type of implant is indicated; **Methods:** A PICO question was formulated, and a literature review from the last 10 years has been performed through various databases such as MEDLINE (PubMed), Scopus and Dentistry & Oral Sciences Source (EBSCO). The research focused on humans, by analyzing randomized controlled trials and prospective or retrospective cohort studies; **Results:** Articles were selected according to inclusion and exclusion criteria, 75 articles were assessed for full reading and 8 have been included in the qualitative data analysis, to compare the outcomes of bone-level and tissue-level implants in different situations; **Conclusions:** Tissue-level implants had good predictable results, particularly in posterior sectors where occlusal loads are higher. Bone-level implants showed a higher variability in terms of marginal bone loss but had better outcomes in terms of aesthetic results and soft tissues management, particularly when combined with a platform switching abutment.

KEYWORDS

Dentistry, Implantology, Bone-level implants, Tissue-level implants, Indications

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1. INTRODUCTION

1.1 Modern implantology: a mix between biology and engineering

Dental implantology has a central role in modern oral rehabilitation. It allows to restore the function and aesthetics of missing teeth by replacing them with different types of prosthesis, which are placed on osseointegrated implants, generally made of titanium and acting as artificial roots in order to replace the missing ones (1).

As it can be observed around natural teeth, there is a supracrestal tissue attachment around implants, in a similar but weaker way to how the biological width acts (1–3). It helps to protect the bone underneath against bacteria and food detritus, and contributes to maintain a good peri implant health (1–4). This observed tissue attachment is desirable and can depend on various factors such as the implant collar geometry, the soft tissue thickness and the type of prosthetic connection used (5–7).

Since the discovery of osseointegration by Brånemark in 1952, the evaluation of implants success used to depend on their direct and stable integration in the alveolar bone, the marginal bone loss was the gold standard evaluation criteria. However, the patients and health professionals expectations evolved with time: the success rate can no longer be only assessed by the survival of the implant, but also by the long term stability of the soft tissues, as well as the aesthetic integration (8,9). These criteria led to the development of different implant designs and systems, with various materials, shapes, lengths, structures, type of connection or surgical protocols being used. Most of the brands offer the option to place these implants at the bone or the tissue level (1,2,10,11). The choice between these two positions became a very important topic, as it directly influences the bone preservation, soft tissues health, aesthetics and the long term success of the implant (9). Both systems present advantages, limits and specific indications depending on the clinical situation.

1.2 Two different approaches to the implant collar position

The main difference resides in the position of the interface between the implant and the abutment, this parameter might look negligible but it is an essential factor for the peri-implant tissues stability (1). The choice needs to be done according to each situation: anatomical area, gingival biotype, functional limits, aesthetics desired, or economical aspect (5,6,12).

1.2.1. Biological aspects

The micro gap between the implant and the abutment can be a source of micro movements, as well as bacterial infiltration. If it is located close to the bone crest as in bone-level implants, it can increase the initial marginal bone loss (1,4). It is important to distinguish the early bone remodeling after the implant placement, which is physiological and desirable, and the marginal bone loss (4,13,14). In tissue-level implants, this junction is located further from the bone crest, which can reduce the crestal inflammation and favorize bone stability (14).

1.2.2. Mechanical aspect

The force transmission is also different on these two types of implants. Tissue-level implants are recognized to disperse more efficiently the vertical forces thanks to their integrated collars, giving them a higher stability; bone-level implants allow higher aesthetic parameters and better prosthetic adaptation but require a more precise management of the forces applied in order to avoid bone resorption (2,4,13).

1.2.3. Tissue-level implants characteristics

Tissue-level implants have been developed to ensure biological protection. They usually present a polished transmucosal collar and the implant-abutment junction is located on top of the bone crest, in the gingival mucosa (1,10). This position allows more distance between the bacterial micro leakage area and the bone tissue, and limits the inflammation as well as the bone resorption risk (2,13). These implants are known to be surgically easy to handle as most of them are placed with a one stage surgery, but also to be mechanically reliable and to have an excellent longevity, particularly in posterior sectors where the aesthetic is less critical (1,15).

1.2.4. Bone-level implants features

Bone-level implants, however, have this junction located at the level of the bone crest, or slightly under it. This choice aims to obtain a better integration of the soft tissues, particularly in aesthetic areas, as they allow a more natural transition between the implant and the abutment (1,4,8,16). Nevertheless, this proximity of the junction and the bone crest implies a very high surgical precision to respect the biological width. The outcome can be improved by using conical internal connection implants (9). This design also allows to apply the platform switching technique, which consists in using an abutment narrower than the implant collar to preserve the marginal bone. The difference of diameter creates an internal displacement of the junction,

in order to create a micro gap in the implant-abutment junction further away from the bone crest by moving it towards the center of the implant (1,2,4,13,15).

1.3 Current situation: absence of consensus

Over the last decade, numerous studies have tried to determine which type of implant provides the best tissue stability. However, the results obtained are not consensual.

Historically, tissue-level implants were mostly used in the last decades because of their relative simplicity and excellent long term stability (1). But with the increase in aesthetic demand, bone-level implants have been preferred more recently and are considered the norm in various protocols, due to the use of platform switching technique and conical internal connections, helping to have a better control on the marginal bone loss (2,9). Some systematic reviews report a slightly smaller marginal bone loss around bone-level implants, particularly when platform switching technique is applied (2,4).

However, other studies are highlighting the increased biological resistance and the long term stability of tissue-level implants, due to their transmucosal conception and the distance between the micro gap and the bone (1,4,13). Both types of implants have a high survival rate, often around 90% after 10 years. The main differences between these implants are found in the bone crest morphology and aesthetic criteria (1,4,8).

The literature is still very heterogeneous: the implants systems diversity, different surgical protocols, follow up periods and different measurement criteria make the general interpretation harder and almost impossible to get a clear consensus (1,8,13,14,16).

2. OBJECTIVES

2.1 Primary objective

The main objective of this systematized review is to analyze the clinical indications of bone-level and tissue-level implants, by comparing their biological, aesthetic and functional performance.

2.2 Secondary objectives

More specifically, the aim of this study is to evaluate the marginal bone stability associated with each type of implant according to their position and the type of connection used, as well as to assess the soft tissues health and aesthetic results obtained. Finally, this study aims to provide precise clinical indications to know when to use each type of implant, and to formulate recommendations to select the best treatment option, based on recent literature.

3. MATERIAL AND METHODS

3.1 Type of study

This study is a systematized review of literature about bone-level and tissue-level implants indication. This review follows the PRISMA recommendations to ensure scientific rigor, reproducibility and transparency of the methodology (17).

3.2 PICO question

The formulated PICO question is: In adult patients treated with dental implants (P), how do bone-level (I) and tissue-level implants (C) differ in their indications and specificities in terms of peri-implant bone stability and integration, biological response and aesthetic outcomes (O)?

3.3 Search strategy

A systematic search was performed in different digital medical databases, accessed through the online library of the Universidad Europea de Madrid: MEDLINE (PubMed), Scopus, and Dentistry & Oral Sciences Source (EBSCO). The first search was conducted on the 3rd of October 2025. The research equation used in MEDLINE was: MH "Dental Implants" AND (bone level implants OR subcrestal implants OR equicrestal implants OR crestal implants) AND (Tissue level implants OR transmucosal implants OR supracrestal implants) AND (outcome OR results).

The one used in Scopus was: (TITLE-ABS-KEY (bone level implants OR crestal level implants) AND TITLE-ABS-KEY (tissue level implants OR supracrestal implants) AND TITLE-ABS-KEY (marginal bone loss OR crestal bone changes OR results OR outcome OR indications)) AND PUBYEAR > 2014 AND PUBYEAR < 2026 AND (LIMIT-TO (SUBJAREA , "DENT")) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "re")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (OA , "all")).

Finally, the equation for the database Dentistry & Oral Sciences Source was: ("bone level implants" OR "equicrestal" AND "tissue level implants") AND ("marginal bone loss" OR "peri-implant bone").

For each database, filters have been used such as publication time limited to the last 10 years, full-text articles available and human adults. Additionally, a manual search has been conducted to identify further possible articles.

3.3.1 Inclusion criteria

This review includes articles published in the last 10 years (2015-2025), comparing directly bone-level and tissue-level implants on adult humans (>18-year-old), without uncontrolled systemic conditions. These publications had to evaluate at least one of these criteria: marginal bone loss, aesthetic result, tissue integration, biological or clinical complications, or indications. They also had to be randomized controlled trials or cohort studies.

3.3.2 Exclusion criteria

Articles older than 10 years, narrative reviews, studies without quantitative data, in vitro and animal studies have been excluded, as well as studies not comparing directly both types of implants, and without a comparison group. Finally, publications not containing full text access and isolated report cases were excluded. Systematic reviews and meta-analysis were also excluded from the data extraction.

3.4 Selection process

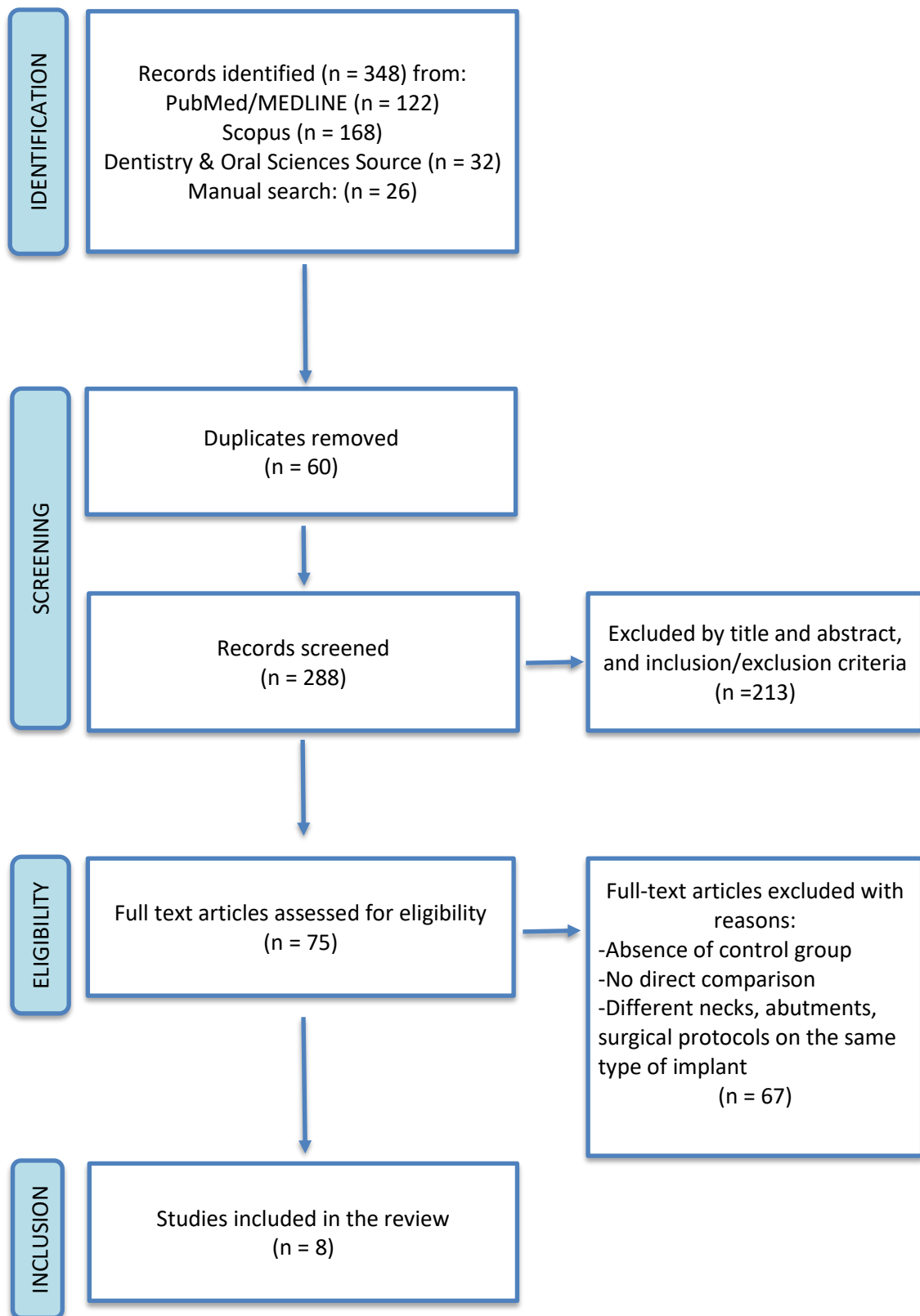


Figure 1. PRISMA 2020 flowchart (17).

4. RESULTS

Overall, the research strategy allowed to identify 348 articles for this study. After removing duplicates and reading titles and abstracts, 75 references with full texts have been read and assessed. According to the inclusion and exclusion criteria, 8 studies were included in the results table. The principal reasons for exclusion were mainly the absence of control groups and therefore direct comparisons between both types of implants, the lack of standardization of surgical procedures and too many implants differences within the groups.

The studies included were composed of 4 randomized clinical trials, 1 prospective cohort study and 3 retrospective studies.

The total number of patients was 1045, for 2408 implants placed, with follow-up periods going from 9 months to 11 years, allowing an analysis of the early bone remodeling and medium/long-term stability under functional loads, as well as soft tissue behavior. Among these implants, 646 have been placed at bone-level (BL) and 1762 at tissue-level (TL). The survival rate of these implants had a range between 87 and 100 %.

Most bone-level implants were characterized by internal connections, straight necks and placed with platform switching abutments; whereas the tissue-level implants had polished or micro machined integrated transmucosal necks and were used with platform matching abutments. The analyzed implant systems mainly use grade IV pure titanium or a grade V titanium alloy, with treated surfaces (coated, machined, chemically modified, SLA: sand-blasted, large grit, acid-etched), which limit the variability of the implant surface in the comparison between bone-level and tissue-level implants.

Table 1. Data extracted from the studies included.

Authors, Year, Type of study	N (patients and implants type)	Sector, Follow-up, survival rate, prosthesis type, and loading	Evaluation method	Bone results	Soft tissue/biological results
Shen <i>et al.</i> , 2022, (18) Retrospective cohort study	151 patients, all undergoing a simultaneous Guided Bone Regeneration (GBR) procedure with Bio-Oss and covered with Bio-Guide Bone-level implants (BL): 128 implants, Straumann AG Tissue-level implants (TL): 104 implants, Straumann AG	Posterior, mandible < 36 months to > 72 months BL: 98,8% TL: 95,8% Implant- supported fixed prostheses Conventional loading	Periapical X-rays, using paralleling technique	<u>Alveolar bone crest-implant platform distance: (mean $\pm$ Standard deviation (SD)):</u> At placement: BL: 1,70 $\pm$ 0,98 mm TL: 1,84 $\pm$ 0,99 mm On the second stage surgery: BL: 1,24 $\pm$ 0,93 mm TL: 1,19 $\pm$ 0,94 mm On the last follow-up visit: BL: 0,82 $\pm$ 1,05 mm TL: 0,73 $\pm$ 0,86 mm <u>Δ Marginal bone loss (median (min; max)):</u> BL: 0,81 mm (-0,84; 3,51) TL: 1,03 mm (-0,87; 3,45)	<u>Losses due to peri implantitis:</u> BL: 1 TL: 3

Lago <i>et al.</i> , 2019, (19) Split mouth Randomized controlled trial (RCT)	35 patients	Posterior	Periapical X-rays, using paralleling technique	<u>Changes in implant-bone distance at 1 year (mean and [IC 95%]):</u>	<u>Pocket probing depths (mean ± SD):</u>
	BL: 50 implants, Bone level type model (Institut Straumann AG) TL: 50 implants, Standard Plus Type model (Institut Straumann AG)	Up to 3 years Partial fixed protheses supported by 2 implants Conventional loading		BL: Mesial: 0,07 mm [0,00-0,14] Distal: 0,09 mm [0,01-0,17] TL: Mesial: 0,17 mm [0,02-0,31] Distal: 0,15 mm [0,02-0,28] <u>Changes in implant-bone distance at 3 years (mean and [IC 95%]):</u> BL: Mesial: 0,11 mm [0,03-0,19] Distal: 0,19 mm [0,07-0,31] TL: Mesial: 0,17 mm [0,03-0,30] Distal: 0,20 mm [0,07-0,33]	BL: Initial: 1,7 ± 0,7 mm At 3 years: 2,2 ± 0,6 mm TL: Initial: 2,2 ± 0,4 mm At 3 years: 2,4 ± 0,5 mm
Morón-Conejo <i>et al.</i> , (20) 2023, RCT	25 patients BL: 19 implants, 0.8 mm height straight and machined rim, 3.4 mm internal hex prosthetic	Posterior 12 months 100%	Periapical X-rays, using paralleling technique	<u>Changes in implant-bone distance at 12 months (mean and [IC 95%]):</u> BL: Mesial: 0,52 ± 1,46 mm	<u>Contour thickness of the gingival margin (GM) at 12 months:</u> Buccal GM: BL: 0,65 ± 0,42 mm

	connection (Premium SP, Sweden & Martina)	Conventional loading		Distal: $0,39 \pm 1,18$ mm	TL: $1,96 \pm 2,69$ mm
	TL: 19 implants, 2.8 mm convergent transmucosal neck and an ultrathin threaded micro surface (UTM), 3.4 mm internal hex prosthetic connection (Premium SP, Sweden & Martina)			TL: Mesial: $0,16 \pm 0,92$ mm Distal: $0,17 \pm 0,91$ mm	Lingual GM: BL: $1,580 \pm 2,804$ mm TL: $0,584 \pm 0,373$ mm
Lago <i>et al.</i> , 2018, (21) RCT	100 patients BL: 102 implants, Bone level type model (Institut Straumann AG), with smaller diameter abutments TL: 100 implants, Standard Plus Type model (Institut Straumann AG), with matching abutments	Posterior 5 years BL: 87% TL: 95,8% Conventional loading	Periapical X-rays, using paralleling technique	<u>Marginal bone level changes (mean $\pm$ SD):</u> From 0 to 1 year: BL: $-0,03 \pm 0,74$ mm TL: $0,26 \pm 0,55$ mm From 0 to 5 years: BL: $-0,20 \pm 0,75$ mm TL: $0,61 \pm 0,73$ mm	Probing depth reduction for both types of implants, but no measures available

Aydogmus <i>et al.</i> , (22) 2025, Retrospective cohort study	53 patients	Posterior	Panoramic radiographs	<u>Marginal bone loss (mean $\pm$ SD):</u> BL: 1,59 $\pm$ 0,72 mm TL: 1,37 $\pm$ 0,60 mm	<u>Failures:</u> 4 BL (2 in posterior maxilla and 2 in posterior mandible) <u>Pain, mobility, exudation:</u> only observe around the 4 failed BL implants
	BL: 31 implants placed in 22 patients, 6 months after autogenous onlay bone augmentation	5 years BL: 87% TL: 95,8%			
	TL: 48 implants placed in 31 patients, 6 months after autogenous onlay bone augmentation	Conventional loading			
Rammelsberg <i>et al.</i> , (23) 2016, Prospective cohort study	630 patients	Anterior, posterior, maxilla, mandible	Visual assessment	<u>Marginal bone loss > 2mm, without inflammation:</u> 6 cases <u>Severe complications involving bone loss:</u> 62 implants	<u>Peri implantitis:</u> 29 cases <u>Severe biological complications:</u> 4% <u>Survival rate according to the type of restoration:</u> -Single crowns 97% -Fixed partial dentures: 95,5% -Removable partial dentures: 97% -tooth-implant support: 96%
	BL: 104 implants Straumann, 120 implants Nobel Biocare Replace	9 months to 11 years,			
	TL: 1345 implants, Straumann	94 to 97 % at 5 years Type of restorations: 557 single crowns, 594 fixed partial dentures and 418 removable partial dentures Conventional loading			

Hadzik <i>et al.</i> , 2017, (24) RCT	13 patients BL: 16 implants, OsseoSpeed TX, Astra Tech, 4mm x 8mm, subgingival healing abutment, Platform switching abutment TL: 16 implants, RN SLActive®, Straumann, 4,1mm x 8mm, transgingival healing abutment	Posterior, lateral aspect of the mandible 36 weeks 100% Conventional loading	Periapical X-rays, using paralleling technique	<u>Marginal bone loss at 12 weeks (mean ± SD):</u> BL: 0,19 ± 0,1 mm TL: 0,53 ± 0,2 mm <u>Marginal bone loss at 36 weeks:</u> BL: 0,29 ± 0,2 mm TL: 0,57 ± 0,3 mm	Higher primary and secondary stability for BL implants
Pera <i>et al.</i> , 2023, (25) Retrospective cohort study	38 patients BL: 76 implants, Syra or Shelta implants, Sweden & Martina, connected to straight or angulated abutments TL: 80 implants, Prama, Sweden & Martina, connected to angulated abutments	Anterior and posterior, 1 year follow-up BL: 97,37% TL: 100% Immediate loading and full arch restoration	Periapical X-rays, using paralleling technique	<u>Marginal bone loss at 1 year (mean):</u> BL: Mesial: 1,412 mm Distal: 1,264 mm TL: Mesial: 1,165 mm Distal: 1,222 mm	<u>Probing depths:</u> BL: 2,155 mm TL: 2,066 mm <u>Plaque index (score):</u> BL: 1,892 TL: 1,938 <u>Bleeding on probing (number of bleeding sites):</u> BL: 0,905 TL: 1,7

4.1 Peri implant marginal bone loss or bone to implant distance

4.1.1 Early bone remodeling (0-6 months)

The data extracted from the articles converge towards the existence of an early marginal bone remodeling, observed around both types of implants during the first months after placement (18,19,24). The studies indicate that this loss is less important around bone-level implants during the first months, followed by a progressive stabilization, with a loss observed between 0,19 mm and 0,29 mm (18,21,22,24). Around tissue-level implants, these values ranged between 0,53 mm and 0,57 mm (24). Most of the studies differences in terms of bone loss in the early stage after placement were not statistically significant between both types of implants, but a study conducted in 2018 by Lago *et al.*, reported a significant statistical difference in favor of tissue-level implants, which had a lower marginal bone loss when used with platform matching abutments (21). However, Hadzik *et al.*, (2017), found that the marginal bone loss around short bone-level implants placed in the lateral aspect of the mandible was significantly lower compared to short tissue-level implants (24).

4.1.2 Medium- to long-term evolution (6-36 months)

This criterion is the main value used in the studies to assess the performance of the different implant types. Most of the articles show bone stabilization after the initial resorption, and even a reduction in the bone to implant distance at 3 years after placement (18,24,25).

For bone-level implants, the average marginal bone loss was comprised between -0,03 mm and 1,59 mm after 12 months, with an average loss of 0,532 mm. Tissue-level implants showed a less variable marginal bone loss, with measurements going from 0,17 mm to 1,19 mm at 12 months, and an average loss of 0,65 mm (18–22,25). On the longer term, bone-level implants showed a slightly better bone stability, with a more homogenous and lower marginal bone loss, with a mean loss of 0,15 mm at 3 years after placement, compared to a loss of 0,185 mm for tissue-level implants (19,21,22). A statistically significant difference has been reported by Lago *et al.*, (2019), as the marginal bone loss around tissue-level implants in this study was in average lower between baseline and 3 years after placement compared to the bone-level implants placed, following the same inclusion and exclusion criteria, as well as surgical protocol (19).

4.1.3 Long-term evolution (>5 years)

Both types of implants showed acceptable levels of stability, as it can be observed in Figure 2. However, tissue-level implants had a lower variability of the marginal bone loss values with a range comprised between 0,61 mm and 1,37 mm at 5 years, and an average bone loss of 0,856 mm. In comparison, bone-level implants had bone loss values ranging between -0,20 mm and 1,59mm, and a mean bone loss of 0,217 mm (19,22). Lago *et al.*, (2018), reported a significant difference between both groups after a 5-year follow-up.

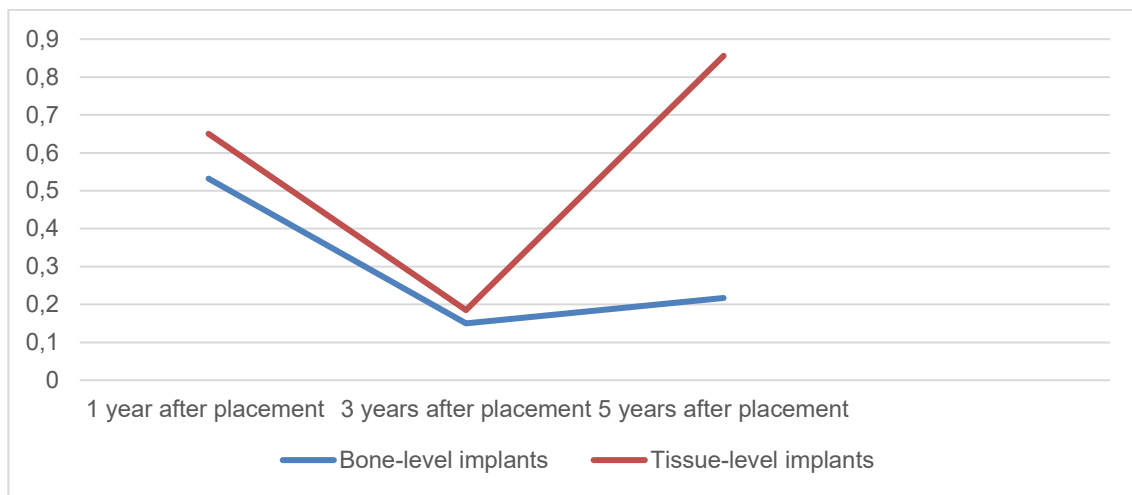


Figure 2. Mean marginal bone changes (in mm) at various times after placement (18–22,24,25).

4.2 Soft tissue behavior

According to these studies, soft tissues behave differently according to the type of implant they surround. The parameters analyzed were not the same in all the studies, but most of them measured the probing depths, gingival bleeding, plaque indexes or gingival contour levels and thicknesses (19,20,23,25).

For the probing depths, no statistically significant differences were found, with similar values for both types of implants, with a slightly better result around tissue-level implants (19,21,25) .

Bone-level implants were associated with better gingival contour management, as well as a more predictable behavior of the papillae, which contributed to particularly good aesthetic outcomes, but without statistically significant results (19–21). They allow a higher emergence profile personalization but have lower values in terms of soft tissue stability (20,22). With bone-level implants, gingival recessions and height changes of the mucosal level were more frequently reported in patients with a thin gingival biotype (20). On the other side, tissue-level implants had a lower association with peri-implant inflammation, but had similar mucosal stability with

probing depth values ranging from 2,066 mm at 1 year to 2,4 mm at 3 years, compared to bone-level implants (2,155 mm at 1 year to 2,2 mm at 3 years) (20,21,25). Their biological tolerance was also higher in the long term (19–21). The survival rates between both types of implants were similar, above 95% in most cases, with similar plaque indexes (25). There was a statistically significant difference for the bleeding on probing measures, by being more important around tissue-level implants (25).

4.3 Mechanical aspect

No statistically significant difference was found in terms of mechanical complications between both types of implants, even if the position influences the loading repartition on the underlying bone (20–23).

Rammelsberg *et al.*, in 2017, did not report any significant statistical difference between the type of restoration (single or plural restorations, bridges, removable or fixed partial dentures) and the survival (23). For posterior plural restorations, the results were similar in most of the studies, but with a small significant difference in favor of combined restorations, placed on a tooth and on an implant, reported by Rammelsberg *et al.*, in 2016 (23). The length of edentulous area was not a statistically significant factor in favor of one type of implant over the other according to these studies (18,23).

4.3.1 Bone augmentation and loading time

In case of bone augmentation done by guided bone regeneration done prior to the implant placement with autogenous bone grafts and Bio-Oss, some studies reported a slightly more elevated initial bone loss compared to natural bone, independently of the implant type used (18,22). No implant system showed a statistically significant superiority in these cases. Shen *et al.*, reported an unexpected higher marginal bone loss during the healing time around tissue-level implants, without being significant, and stabilizing over time (18).

The loading time did not alter the outcome of the implants, with most of the studies using conventional loading (18–24). The primary stability appeared as the main factor determining survival (24). Hadzik *et al.*, (2017), reported a statistically significant higher primary stability around short bone-level implants when placed in the lateral aspect of the mandible (24).

5. DISCUSSION

This systematized review highlights that the distinction between bone-level and tissue-level implants is not based on an opposition of their global performances, which appear to be similar, but is rather based on different biological, mechanical, prosthetic, and aesthetic philosophies. The results also highlight some more subtle differences. These two systems both have their own indications, depending on several factors.

The results confirm that both implant types have similar and comparable long-term stability, but they also show differences in terms of marginal bone loss at various times, soft tissue behavior, and predictability (18–25).

5.1 Bone resorption: a multifactorial phenomenon

Peri implant bone resorption is one of the main biological challenges in modern implantology (14). It used to be interpreted as a biological or mechanical failure, but nowadays, it is recognized as a complex and multifactorial phenomenon (1,26,27). It results from the interaction between biological, surgical, and prosthetic factors (1,25,26).

5.1.1 Physiological resorption due to the establishment of a biological attachment

Following the implant placement and the prosthesis load, an early marginal bone loss is frequently observed (26). It corresponds to a physiological remodeling phase, necessary to the establishment of the peri-implant biological attachment (1,14,20,22). This epithelio-conjunctive attachment requires space, leading to an adaptation of the underlying tissues (9,13,28). It can be seen as a programmed biological response from the bone, which goal is to create enough space for the establishment of a sealing barrier, instead of a pathological process (1,8,10).

According to literature, the reorganization around bone-level implants directly happens at the bone crest, which could explain why the early marginal bone loss is usually more important around them, particularly when they are not used with a platform switching technique (1,8,18,20,22). This observation is coherent with a mechanical adaptation of the bone crest to the new forces applied on it, and with the need to create a more important biological space when the implant-abutment junction is at this height (1,29). Is it also compatible with a local post-surgical inflammatory reaction located closer to the bone crest, and therefore leading to a more intense resorption (14,29). Tissue-level implants reduce the need for this adaptation, as there is already more space available due to their position, which leads to a better preservation of the marginal bone in the first healing phases (1,16,30). However, the studies included in the

analysis showed lower mean marginal bone loss around bone-level implants in the first phases, as it can be seen in Figure 2 (18,21,22,24). It suggests that other factors may affect the bone level changes.

5.1.2 Bone resorption due to low grade chronic inflammation

The marginal bone loss can also be influenced by a low-grade chronic inflammation, often linked to the presence of a micro gap between the implant and the restoration (28,31). This gap is inevitable and is a potential zone for bacterial colonization, and it can induce micro movements under functional loads (1,19,29). When this junction is located close to the bone, inflammatory mediators can act directly on the bone crest, stimulating osteoclastic activity and therefore promoting a progressive bone resorption (1,29).

Tissue-level implants avoid the direct inflammation of the bone crest due to the further position of the junction from the bone crest, which could explain the more predictable bone stability observed in various studies at medium and long-term (20–22,25,29). In bone-level implants, when using the platform switching technique, the gap can be moved towards the center of the implant and therefore away from the bone, by using an abutment with a diameter smaller than the one of the implant, which helps to keep the inflammation further away from the bone, and therefore to prevent marginal bone loss (30). Most of the bone-level implants included in this study were used with smaller diameter abutments, which could explain their long-term higher average performance as it is shown in Figure 2.

Bone to implant distance values for bone-level implants showed a higher range between placement and the final measurement, but with lower average value compared to tissue-level implants, suggesting an increased sensitivity to clinical factors such as occlusal loads or prosthesis conception, but without being statistically significant (1,17,20,23,31). Around multiple restoration abutments, the marginal bone loss was not always considered stabilized after 2 years, as it can be observed in Figure 2, with a bone apposition between the first and the third year after placement, and with a bone loss increasing between 3 and 5 years after placement (22,23). However, these differences are not clinically relevant as the implants show similar performances, with changes smaller than 1 mm over 5 years. They could be linked to the localization of the micro gap, as well as the repartition of the mechanical forces applied on the implants, and the maturation of the bone apposed in the early-stage remodeling (1,19,22,23,29).

The long-term perspective constitutes an essential element to assess the real performance of the implants. Short- and medium-term evolutions allow to assess the early remodeling and the

trend of the marginal bone loss, but not the durable bone stability, influenced by repeated mechanical forces and delayed biological reactions (18–22,25). However, these observations probably need to be confirmed with larger sample studies and longer follow-up periods, with more regular measurements, in order to obtain more reliable and significant results. In the studies included in the review, a potential source of bias could be that these implants were placed by experienced operators, which could also explain the similarity of results between both types of implants.

5.2 Biological complications

Peri-implantitis is the most common biological complication after implant placement and is more often linked to bone-level implants, particularly when their placement is excessively infra crestal (14,29). Tissue-level implants have globally a lower rate of biological complications, but the difference found is not statistically significant (18,21,23). It is due to a chronic inflammation of the soft tissues surrounding the implants, associated with a marginal bone loss exceeding the physiological remodeling (14,33). Peri-implantitis results from a complex interaction between bacteria, immunological susceptibility and local mechanical factors (29,34,35). Biofilm accumulation on the implant surface and at the implant-abutment junction induces an inflammatory response, led by an increased expression of pro-inflammatory cytokines (IL-1B, TNF-A, IL-6), which activate osteoclastic activity via the RANK/RANKL/OPG system (33–35). This phenomenon leads to a faster bone resorption, more circumferential than the bone resorption due to mechanical reasons (29,33). Some studies suggest that bone-level implants had a faster evolution towards marginal bone loss when a persistent inflammation is present, however, clinical studies don't demonstrate significant differences for peri-implantitis prevalence between these types of implants, when the surgical protocols, prosthesis load and design, and maintenance are correct (20,22). Systemic and local conditions such as diabetes, periodontitis, lack of plaque control, smokers, occlusal overload, appear to be determinant in the initiation and progression of peri-implantitis (26,29). A mechanical overload can affect the inflammatory reaction by increasing the permeability of the micro gap, and by inducing micro lesions at the bone level, highlighting the link between biomechanical forces and inflammatory processes (33–35). Peri-implantitis cannot exclusively be attributed to the implant design, it must be considered as the result of a multifactorial disbalance within the bone-implant-prosthesis complex, where the implant design act as a modulator and not as an isolated cause (14,34). It also must be linked with systemic and local conditions affecting the patients, such as

periodontitis which could explain the higher rate of peri-implantitis around tissue-level implants in the study performed in 2023 by Morón-Conejo *et al.*, (27,29).

5.3 Role of the implant collar

The biological attachment around the implant is made of a junctional epithelium, and of a conjunctive tissue parallel to the implant surface, offering a biological barrier, but weaker than the one made by the periodontal ligament (10,11,14). This attachment forms at the level of the implant collar (3,29). The main difference in these types of implants resides in the vertical position of this collar compared to the bone crest, and therefore of the implant-abutment junction (1,3,10,13,20). In bone-level implants, by having this junction at the crestal level or even under it in infracrestal implants, the bone crest is more exposed to implant micro gaps, functional micromovements and is more sensitive to potential bacterial contamination (1,8,22,25,31,36). It can therefore induce low-grade chronic inflammation, which increases marginal bone loss (1,8,13,37).

The collar height has an essential role in the stability of peri-implant soft tissues, particularly around tissue-level implants (3,29). Different transmucosal collar heights are available, allowing a correct adaptation to the gingival biotype as well as the crestal topography. An adequately selected collar allows to place the implant-prosthesis junction further away from the bone, which can contribute to a better bone stability in short- and medium-term analysis, by limiting the micro gap influence on the marginal bone (1,8,13,37). Linked to bone apposition and maturation, as well as functional adaptation of the tissues, it could explain the decrease in bone to implant distance seen in Figure 2, between 1 year and 3 years after placement. The distance increase from 3 to 5 years could be linked to the forces exerted on the implants.

5.4 Transmission of forces

The transmission of forces to the surrounding bone is different in implants compared to natural teeth, due to the lack of periodontal ligament (10,11,14,38). The periodontal ligament provides an absorption, a distribution and a progressive adaptation of mechanical forces; the implant transfers them directly and in a more rigid way to the bone (2,30).

These forces can be classified in various categories, such as axial, lateral, oblique forces and flexion moments (27,39). The non axial forces are the ones creating the highest load on the bone crest, particularly around the implant collar (40). The effect of these forces on the bone can be analyzed through animal studies, as they appear to have the same behaviors in human bone (39). The collar position will directly affect the way these forces are transmitted (38). In bone-

level implants, the maximal concentration of forces is located at the level of the bone crest, particularly with lateral forces, which can cause repeated micro lesions to the bone, as well as a local inflammatory response and lead to more marginal bone loss (27). Tissue-level implants have this concentration zone located in the supra crestal area, reducing the marginal bone exposure to high mechanical solicitations (40,41). The transmucosal collar acts as a mechanical transition, allowing a more progressive dissipation of the forces before reaching the underlying bone (1,8,13,37). This could explain the bone stability observed around tissue-level implants in posterior sectors, where the functional loads are higher; however, the articles included in this review showed similar results for both types of implants (18,21,22,24,25). The platform switching technique used with bone-level implants contributes to a more efficient repartition of the forces.

Peri-implant bone biologically adapts to the new forces (38,41). Moderate physiological loads enhance bone stability, whereas excessive or not well distributed forces can cause an overload, leading to micro fractures and activating more bone remodeling (27,38). When these phenomena overcome bone adaptive capacity, it produces marginal bone loss in order to find a new biological balance (32,40,41).

A systematic review done by Valente *et al.*, in 2019 describes different shapes of abutments, designed to dissipate the functional loads more efficiently (2). However, as it has been reported by Morón-Conejo *et al*, in 2023, there is no statistical difference between both types of implants by using a convergent transmucosal neck on tissue-level implants or a straight neck on bone-level implants (20). Convergent necks have a similar concept as platform switching: the goal is to give more horizontal space to the soft tissues (20).

In functional loads, tissue-level implants show a better tolerance to repeated forces, particularly in multiple restorations and in posterior sectors (41). Bone-level implants are more sensitive to occlusal disbalances and prosthetic conception errors (38,40).

An optimal implant design should ensure an appropriate balance between compressive and tensile stress while minimizing shear forces (26,41). Compressive forces generally have a beneficial effect on the bone, as they enhance mechanical strength and bone density (26,38,39). Excessive compressive forces, such as the ones caused by implants inserted with an excessive torque, may lead to mechanical overload and therefore be harmful for the bone, as it could create inflammation (26,38–40). It can impair the local vascularization, the innervation and negatively influence bone cell activity, altering the bone structure and leading to bone resorption (39,40). Shear forces are the least well tolerated by the bone and may compromise peri-implant bone stability (26,41).

The type of abutment used affects the dissipation of forces (1,27,42). They can be straight or angulated, standard or personalized, and have conical or hexagonal connections, which can be internal or external (1,27,42). Angulated abutments increase the flexion moments, and therefore the quantity of forces transmitted, compared to straight ones (1,27,42). Internal conical connection implant systems offer better mechanical stability, fewer micromovements and a better repartition of the forces (1,9,30). However, if this connection is located at the crestal level, the loads keep being concentrated at the implant collar area (1,4,42). Implants with internal connection are commonly used with conical abutments, as it may offer a higher sealing and less movements at the micro gap junction compared to other designs (1,27,42). However, the peri-implant bone stability is also dependent on biological and biomechanical associated factors.

5.5 Other factors affecting the bone-implant-prosthesis complex

The comparative analysis of bone-level and tissue-level implants can not only be reduced to a difference in vertical position of the implant-abutment junction. It implies a global understanding of the biomechanical and biological system constituted by the implant material, the macro design, the surface topography, the bone density, the soft tissue profile, the surgical protocol, the occlusion scheme the loading time, the type of restoration and the length of the edentulous area (2,5–7,10–12,14,20,26,30,34,37).

5.5.1 Implant materials composition and properties

The majority of the implants used in the studies included in the results are made of pure commercial titanium grade IV, or an alloy made of titanium, aluminum and vanadium (18–25). Titanium is widely used because it has an excellent biocompatibility, with proven osseointegration properties, as well as a high resistance to corrosion (3,27). It also has a higher elasticity modulus compared to the one of the cortical bone (32). However, the titanium elasticity modulus, often around 110 GPa, is still highly superior to the one of the bone, around 10-30 GPa depending on the area, which involves a rigidity difference (26,27). It can lead to a concentration of the forces at the crestal level, particularly in bone level implants where these forces can be more direct and lead to a higher bone resorption (26). In tissue-level implants, these forces can be dissipated more towards the soft tissues, as the transmucosal neck absorbs the initial loads (27).

5.5.2 Implant surfaces, macro design and osseointegration

Modern implant surfaces can be of different types: sand blasted, large-grit, acid-etch (SLA), oxidated, machined or modified by chemical treatments, as mentioned in the study realized by Hadzik *et al.*, in 2017 (24,32,34). These surfaces increase the microscopic rugosity, which enhances cellular adhesion and osteoblastic proliferation, and therefore the osseointegration speed (14,34). However, the cervical rugosity can also help the bacterial colonization and the marginal inflammation (26,34). Tissue-level implants present a smooth collar, which could contribute to better soft tissues stability and a reduction of the marginal bacterial accumulation (3,10,20).

The implant diameter influences the implant-bone surface and therefore the distribution of the loads. Larger diameters increase mechanical stability and reduce the force concentration at the crestal level, particularly in posterior sectors receiving higher functional loads. Implant lengths also contribute to global stability and to load repartition and should be adapted in order to respect the anatomical structure around the implant location (26,32). Shorter implants, under 10mm, have been used by Hadzik *et al.*, in 2017, to be placed in the lateral part of the mandible, to compensate an advanced bone resorption and low alveolar ridges, with a statistically significant difference in favor of bone-level implants in this study (24).

Implants geometry, such as parallel and conical or tapered implants, influences primary stability and the repartition of forces, as well as the threads depth and pitch, as explained in 2022 in a systematic review performed by Kreve *et al.*, (2,26). Tapered implants apply a lateral compression on the bone during their insertion, which increases their primary stability in low density bone and helps to reduce the micromovements when they are immediately loaded (2,26). Parallel implants are generally preferred in dense bone as they limit an excessive compression on the cortical bone and therefore protect it (2,26).

Implants also differ by the threads they have on their body. Various designs exist according to the brands and the implant type, with different width, helix angle or pitch. The objective is to increase the bone to implant surface, to provide a better primary stability, and to transmit forces in a more efficient way to protect the bone (2,9,26). They can also have cervical micro threads, such as the ones used in the study performed by Morón-Conejo *et al.*, in 2023, which, when combined with an adapted pitch, allow to transform shearing forces into compressive ones, which are better tolerated, limiting marginal bone loss (20,26).

5.5.3 Insertion torque

Torque is an essential biomechanical parameter for implant placement, as it directly reflects the mechanical interaction between the bone and the implant (1,43). It is a primary stability indicator, and depends on the bone density, macro design, diameter and lengths of the implant. Implants should be inserted with medium-high torque values, around 30 to 45 N.cm, particularly in the case of immediate loading, as they are associated with better initial stability by compressing the trabecular bone surrounding the implant, and increasing its anchorage (32,43). However, high values of torque, which can be superior to 50 N.cm, can cause bone micro lesions and lead to failure of the implant and marginal bone loss (43).

5.5.4 Loading time effects

An immediate loading time implies early loads on the bone-implant interface, and a higher risk of excessive micromovements ($> 100 \mu\text{m}$) (12,26,32). Bone-level implants, with their internal connection located at the crest level, could be more sensitive to early micromovements if the primary stability is not sufficient (27), as it has been reported by Pera *et al.*, in 2023, a statistically significant difference was found, showing a higher marginal bone loss around bone-level implants. Tissue-level implants, due to their cervical monolithic transmucosal design, may offer a more homogenous initial mechanical stability (10,20). However, literature shows that the primary stability and the insertion torque are determining factors, regardless of the type of implant (27,32).

With conventional loading, the initial bone remodeling is more stable, and bone maturation around the implant is more advanced before receiving functional loads (26,41). In this case, the difference between tissue-level and bone-level implants tends to decrease. It suggests that the implant design might not be the only critical factor, rather the interaction between design and loading protocol (26,41).

5.5.5 One-stage vs two-stage surgery

Surgical procedures also affect marginal bone stability. Implants placed with a one stage surgery allow immediate exposure of the transmucosal collar or platform, which can reduce the peri-implant trauma and limit the initial resorption if the torque is well controlled (15,44,45). Two-stage surgery allows complete bone coverage and may promote healing, particularly in low density bone, and can limit the mechanical pressure on the cortical bone during cicatrization (45). It also helps to obtain better keratinized tissue around the implant, but the overall

treatment time is longer, therefore it can be more stressful for the patient (44,46). However, it can be less invasive, particularly for patients having systemic conditions and allows a shorter time to load the implant after the surgeries (45). It also allows to obtain good aesthetic results in anterior sectors (46). These two protocols can achieve similar results in terms of bone stability when they are adequately planned, but soft tissue management can be more complex in one-stage surgery when using bone-level implants (44). Two-stage surgery should be preferred when the primary stability is not optimal (46).

5.5.6 Edentulous length and type of restoration

The medio-distal edentulous length is an essential factor of implants planning, as it will affect the number of implants, their size and their design (1,47). On one hand, when the prosthetic space is relatively wide, around 15 mm, the placement of only one standard implant can leave interproximal embrasures, which can increase the food impaction and make the hygiene more complicated (1,47). On the other hand, when the space is more limited, around 7 to 9 mm, the implant needs to respect 1,5 mm with the adjacent tooth, to preserve bone vascularization and limit the crestal resorption (1). In extended edentulous areas, superior to 18 to 20 mm, two implants should be considered to distribute the occlusal loads in a more efficient way (1). In narrow arches, small diameter implants can be used, around 3 to 3,5 mm, to respect the biological widths of adjacent teeth, and also to improve the emergence profile (1,47).

Unitary restorations are generating more concentrated forces, with higher flexion moments and transmit the forces more directly towards the bone underlying (32,48). In this situation, bone-level implants offer a precise management of the emergence profile, and therefore an optimal aesthetic adaptation (26). But they require precise tridimensional planning and strict occlusal control (32,48).

In multiple and extended restorations, the forces are more spread over the arch, the implants are working synergistically, and the individual loads decrease (38,41). Cantilever restorations are also not considered optimal, as the load accumulation of several teeth is supported by one pillar, which can become an overload (32). If they must be used, the pontic should be located on the mesial side of the pillar tooth, in order to reduce the lever effect. Tissue-level implants might present a mechanical advantage in long posterior restoration, particularly in patients with a strong masticatory activity, bruxism, or a decreased bone density (26,27).

5.5.7 Gingival biotype

The biotype has a determinant role in aesthetic stability, bone preservation and resistance to micro inflammations (5–7,12,14,34,36). Thin biotypes are more susceptible to recessions, they can also have a lower vascularization, as well as being more sensitive to mechanical variations (33,34). Bone-level implants placed in an infra crestal position in a thin biotype can suffer from a higher marginal bone loss (14,7). They need a precise management of their vertical position in this situation (14,33,34).

Thick gingival biotypes are more stable, show a better resistance to inflammation and present less recessions. In this case, both types of implants have similar outcomes (5–7,12,14,34,36).

5.5.8 Prosthesis height and crown/implant ratio

This ratio corresponds to the height of the prosthetic crown compared to the length of implant inserted in bone (27,49,50). Unlike natural teeth, in which the periodontal ligament allows a dissipation of forces, the implants are ankylosed in the bone (23,50).

A longer crown generates more lever effect, with a higher flexion moment. It can lead to a higher concentration of forces to the cervical area of the implant, even if the occlusal loads remain the same (27,48). The overload at the crestal level can induce bone remodeling, activation of the osteoclasts, micro fractures and progressive marginal resorption (50). This phenomenon is different from inflammatory peri-implantitis, it is an adaptative mechanical resorption called “bone fatigue response” (27,37,40).

A higher prosthetic height is often observed in posterior mandibular sectors with a vertical bone resorption, in posterior maxillary area with sinus lifts, or in anterior sectors after some bone loss (48,49). Some studies suggest that this ratio is not necessarily linked to an increased bone loss if the occlusion is well controlled, the loads are axial, and if the patient does not have any contact prematurity or suffer from parafunctions, such as repeated lateral forces like bruxism or unilateral mastication pattern (27,37,40).

This stability depends on a precise biomechanical pattern, and this ratio is not an isolated factor determining bone loss, but an amplifier of the loads (48–50). A short implant associated with a long crown will have a high ratio, as it reduces the bone anchorage surface, and concentrates the forces in the cervical area (48–50).

6. CONCLUSION

The different studies converge towards clear different clinical indications for bone-level and tissue-level implants. Existing data do not show an absolute superiority of one type of implant over the other, their uses are different and depend on the clinical situation of the patient.

Bone-level implants should be preferred in anterior sector restorations or in visible posterior sector areas, or in cases implying a higher aesthetic demand (1). This type of implant has also demonstrated good results in thin gingival biotypes, as well as in situations requiring precise management of the tridimensional position of the implant (14). Several studies highlight that bone-level implants give higher prosthetic flexibility, allowing better and progressive management of the soft tissue, helping to control the emergence profile of the prosthesis, and therefore improving the final aesthetic result (26,32). They should also be used in anterior sectors of full-arch restorations. Their bone loss can be less predictable in a long-term aspect, but it can be compensated by using the platform switching technique or implants with threads dispersing the occlusal loads more efficiently (23,30).

Tissue-level implants showed reliable results in posterior sector or in cases where aesthetic is not as important, as their placement protocol is very standardized (47). This type of implants also had a good outcome in areas supporting great occlusal load and forces and in patients with thick biotypes, as they are biologically more predictable (26,32). They also help to reduce the surgical risks during their placement, as the soft tissue surface limits their entry in the bone, particularly in posterior sectors. They offer an additional degree of protection to the structures underneath such as the inferior alveolar nerve or sinuses.

The survival rate of both types of implants was frequently over 95%, on medium- and long-term follow-up (19–25). No statistically significant difference has been reported in the survival of one type of implant over the other. However, some studies showed a slightly superior variability for bone-level implants, particularly in complex clinical situations or when the surgical and prosthetic parameters were less strictly controlled (19). Adequate treatment planning is essential, the choice needs to be individualized, considering all these parameters: 3-dimensional position of the implants, intermediate abutment used, type of restoration, possibility of placing several implants, occlusal adjustment, implant characteristics, insertion torque, loading time and surgical protocol. They need to be carefully selected to obtain the best biomechanical and biological balance, and therefore the most predictable and reliable outcome.

7. SUSTAINABILITY

This study is aligned with the United Nations 2030 Agenda for Sustainable Development, particularly Sustainable Development Goal (SDG) 3 (Good Health and Well-being), SDG 9 (Industry, Innovation and Infrastructure) and SDG 12 (Responsible Consumption and Production). The choice between bone-level and tissue-level implants depends on the patient's anatomy, location and size of the edentulous area, desired aesthetic, gingival profile and biotype, forces applied and bone density (SDG 3). Bone-level implants offer higher prosthetic flexibility and a precise placement, but they require a two-stage surgery, which is usually more expensive. Tissue-level implants decrease the number of interventions by being placed with a one-stage surgery, and therefore soft tissue manipulations, as well as a lower consumption of materials and energy, favorizing a durable approach by reducing carbon footprint while improving patient comfort. From a social point of view, treatment planning strategies need to include an adapted offer to the patient, with the use of numerical technologies, to decrease waste, as well as making the implant planning process less stressful (SDG 9 and 12). Actual data show similar survival for both types of implants, highlighting that durability needs to be considered in the clinical decision and does not compromise outcomes.

8. REFERENCES

1. Lago L, Da Silva L, Fernández-Formoso N, Rilo B. Systematic assessment of soft tissue level and bone level dental implants. *J Oral Maxillofac Surg Med Pathol*. 2023;35(5):375-82. doi:10.1016/j.ajoms.2023.02.007
2. Valente N, Wu M, Toti P, Derchi G, Barone A. Impact of Concave/Convergent vs Parallel/Divergent Implant Transmucosal Profiles on Hard and Soft Peri-implant Tissues: A Systematic Review with Meta-Analyses. *Int J Prosthodont*. 2020;33(5):553-64. doi:10.11607/ijp.6726
3. Paul S, Nesic D. Influence of the Transmucosal Surface of Dental Implants on the Soft Tissue Attachment Level and Marginal Bone Loss in Preclinical Studies: A Systematic Review. *Int J Oral Maxillofac Implants*. 2024. doi:10.11607/jomi.10398
4. Van Eekeren P, Tahmaseb A, Wismeijer D. Crestal Bone Changes Around Implants with Implant-Abutment Connections at Epicrestal Level or Above: Systematic Review and Meta-Analysis. *Int J Oral Maxillofac Implants*. 2016;31(1):119-24. doi:10.11607/jomi.4235
5. Akcalı A, Trullenque-Eriksson A, Sun C, Petrie A, Nibali L, Donos N. What is the effect of soft tissue thickness on crestal bone loss around dental implants? A systematic review. *Clin Oral Implants Res*. 2017;28(9):1046-53. doi:10.1111/clr.12916
6. Da Silva DM, Castro F, Martins B, Fraile JF, Fernandes JCH, Fernandes GVO. The influence of the gingival phenotype on implant survival rate and clinical parameters: a systematic review. *Evid Based Dent*. 2025;26(2):119-119. doi:10.1038/s41432-025-01114-x
7. Tavelli L, Barootchi S, Avila-Ortiz G, Urban IA, Giannobile WV, Wang H. Peri-implant soft tissue phenotype modification and its impact on peri-implant health: A systematic review and network meta-analysis. *J Periodontol*. 2021;92(1):21-44. doi:10.1002/JPER.19-0716
8. Cosola S, Marconcini S, Boccuzzi M, Menchini Fabris GB, Covani U, Peñarrocha-Diago M, et al. Radiological Outcomes of Bone-Level and Tissue-Level Dental Implants: Systematic Review. *Int J Environ Res Public Health*. 2020;17(18):6920. doi:10.3390/ijerph17186920
9. Schoenbaum T, Karateew E, Schmidt A, Jadsadakraisorn C, Neugebauer J, Stanford C. Implant-Abutment Connections and Their Effect on Implant Survival Rates and Changes in

- Marginal Bone Levels (Δ MBL): A Systematic Review and Meta-Analysis of 45,347 Oral Implants. *Int J Oral Maxillofac Implants*. 2023;38(suppl):37-45. doi:10.11607/jomi.10411
10. Chen Z, Zhang Y, Li J, Wang H, Yu H. Influence of Laser-Microtextured Surface Collar on Marginal Bone Loss and Peri-Implant Soft Tissue Response: A Systematic Review and Meta-Analysis. *J Periodontol*. 2017;88(7):651-62. doi:10.1902/jop.2017.160805
 11. Laleman I, Lambert F, Gahlert M, Bacevic M, Woelfler H, Roehling S. The effect of different abutment materials on peri-implant tissues—A systematic review and meta-analysis. *Clin Oral Implants Res*. 2023;34(S26):125-42. doi:10.1111/clr.14159
 12. Aldhohrah T, Qin G, Liang D, Song W, Ge L, Mashrah MA, et al. Does simultaneous soft tissue augmentation around immediate or delayed dental implant placement using sub-epithelial connective tissue graft provide better outcomes compared to other treatment options? A systematic review and meta-analysis. Al-Moraissi E, editor. *PLOS ONE*. 2022;17(2):e0261513. doi:10.1371/journal.pone.0261513
 13. Díaz-Sánchez M, Soto-Peñaloza D, Peñarrocha-Oltra D, Peñarrocha-Diago M. Influence of supracrestal tissue attachment thickness on radiographic bone level around dental implants: A systematic review and meta-analysis. *J Periodontal Res*. 2019;54(6):573-88. doi:10.1111/jre.12663
 14. Bressan E, Guazzo R, Tomasi C, Peña TG, Galindo-Moreno P, Caponio VCA, et al. Influence of soft tissue thickness on marginal bone level around dental implants: A systematic review with meta-analysis and trial-sequential analysis. *Clin Oral Implants Res*. 2023;34(5):405-15. doi:10.1111/clr.14032
 15. Perrotti V, Zhang D, Liang A, Wang J, Quaranta A. The Effect of One-Abutment at One-Time on Marginal Bone Loss Around Implants Placed in Healed Bone: A Systematic Review of Human Studies. *Implant Dent*. 2019;Publish Ahead of Print. doi:10.1097/ID.0000000000000931
 16. Valles C, Rodríguez-Ciurana X, Clementini M, Baglivo M, Paniagua B, Nart J. Influence of subcrestal implant placement compared with equicrestal position on the peri-implant hard and soft tissues around platform-switched implants: a systematic review and meta-analysis. *Clin Oral Investig*. 2018;22(2):555-70. doi:10.1007/s00784-017-2301-1

17. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *Syst Rev.* diciembre de 2021;10(1):89. doi:10.1186/s13643-021-01626-4
18. Shen X, Yang S, Xu Y, Qi W, He F. Marginal bone loss of tissue- or bone-level implants after simultaneous guided bone regeneration in the posterior mandibular region: A retrospective cohort study. *Clin Implant Dent Relat Res.* 2023;25(1):68-76. doi:10.1111/cid.13144
19. Lago L, Da Silva L, Martinez-Silva I, Rilo B. Radiographic Assessment of Crestal Bone Loss in Tissue-Level Implants Restored by Platform Matching Compared with Bone-Level Implants Restored by Platform Switching: A Randomized, Controlled, Split-Mouth Trial with 3-year Follow-up. *Int J Oral Maxillofac Implants.* 2019;34(1):179-86. doi:10.11607/jomi.6954
20. Morón-Conejo B, Sanz-Sánchez I, Salido MP, Martínez-Rus F, Pradíes G. The effect of a convergent transmucosal neck on soft tissues and radiographic outcomes: a 1-year follow-up randomized controlled trial. *Clin Oral Investig.* 2023;27(6):2923-33. doi:10.1007/s00784-023-04892-9
21. Lago L, Da Silva L, Martinez-Silva I, Rilo B. Crestal Bone Level Around Tissue-Level Implants Restored with Platform Matching and Bone-Level Implants Restored with Platform Switching: A 5-Year Randomized Controlled Trial. *Int J Oral Maxillofac Implants.* 2018;33(2):448-56. doi:10.11607/jomi.6149
22. Aydogmus G, Diker N, Altiparmak N. Comparison of the success rate of bone level and tissue level implants placed in autogenous onlay bone block grafted ridges: a retrospective study. *BMC Oral Health.* 31 de octubre de 2025;25(1):1707. doi:10.1186/s12903-025-07132-6
23. Rammelsberg P, Lorenzo-Bermejo J, Kappel S. Effect of prosthetic restoration on implant survival and success. *Clin Oral Implants Res.* 2017;28(10):1296-302. doi:10.1111/clr.12974
24. Hadzik J, Botzenhart U, Krawiec M, Gedrange T, Heinemann F, Vegh A, et al. Comparative evaluation of the effectiveness of the implantation in the lateral part of the mandible between short tissue level (TE) and bone level (BL) implant systems. *Ann Anat - Anat Anz.* 2017;213:78-82. doi:10.1016/j.aanat.2017.05.008
25. Pera F, Carossa M, Bagnasco F, Crupi A, Ambrogio G, Isola G, et al. Comparison between Bone-Level and Tissue-Level Implants in Immediate-Loading Full-Arch Rehabilitations: A

- Retrospective Multi-Center 1-Year Follow-Up Study. *Prosthesis*. 30 de noviembre de 2023;5(4):1301-11. doi:10.3390/prosthesis5040089
26. Kreve S, Ferreira I, Da Costa Valente ML, Dos Reis AC. Relationship between dental implant macro-design and osseointegration: a systematic review. *Oral Maxillofac Surg*. 2022;28(1):1-14. doi:10.1007/s10006-022-01116-4
 27. Hingsammer L, Pommer B, Hunger S, Stehrer R, Watzek G, Insua A. Influence of Implant Length and Associated Parameters Upon Biomechanical Forces in Finite Element Analyses: A Systematic Review. *Implant Dent*. 2019;28(3):296-305. doi:10.1097/ID.0000000000000879
 28. Liegeois L, Borie M, Lecloux G, Van Hede D, Lambert F. Influence of Implant Component Materials on Peri-Implant Soft Tissue Healing: A Comparative Histological and Immunohistochemical Study in Humans. *Clin Oral Implants Res*. marzo de 2025;36(3):397-409. doi:10.1111/clr.14391
 29. Zheng Z, Ao X, Xie P, Jiang F, Chen W. The biological width around implant. *J Prosthodont Res*. 2021;65(1):11-8. doi:10.2186/jpr.JPOR_2019_356
 30. Uraz A, Isler SC, Cula S, Tunc S, Yalim M, Cetiner D. Platform-switched implants vs platform-matched implants placed in different implant-abutment interface positions: A prospective randomized clinical and microbiological study. *Clin Implant Dent Relat Res*. 2020;22(1):59-68. doi:10.1111/cid.12873
 31. Tajti P, Solyom E, Váncsa S, Mátrai P, Hegyi P, Varga G, et al. Less marginal bone loss around bone-level implants restored with long abutments: A systematic review and meta-analysis. *Periodontol 2000*. 2024;94(1):627-38. doi:10.1111/prd.12534
 32. Manfredini M, Poli PP, Giboli L, Beretta M, Maiorana C, Pellegrini M. Clinical Factors on Dental Implant Fractures: A Systematic Review. *Dent J*. 2024;12(7):200. doi:10.3390/dj12070200
 33. Liegeois L, Borie M, Lecloux G, Van Hede D, Lambert F. Influence of Implant Component Materials on Peri-Implant Soft Tissue Healing: A Comparative Histological and Immunohistochemical Study in Humans. *Clin Oral Implants Res*. 2025;36(3):397-409. doi:10.1111/clr.14391

34. Canullo L, Penarrocha Oltra D, Pesce P, Zarauz C, Lattanzio R, Penarrocha Diago M, et al. Soft tissue integration of different abutment surfaces: An experimental study with histological analysis. *Clin Oral Implants Res.* 2021;32(8):928-40. doi:10.1111/clr.13782
35. Huamán-Mendoza AA, Do Amaral GCLS, Vilela N, Chuquimez-Ventura CV, Rovai ES, Romito GA, et al. Potential Biomarkers Indicating Resistance or Resilience in Experimental Peri-Implant Mucositis: A Systematic Review and Meta-Analysis. *Clin Oral Implants Res.* 2025;36(5):525-54. doi:10.1111/clr.14427
36. Tavelli L, Barootchi S. Prevalence, incidence, risk, and protective factors for soft tissue dehiscences at implant sites in the absence of disease: An AO/AAP systematic review and meta-regression analysis. *J Periodontol.* 2025;96(6):562-86. doi:10.1002/JPER.24-0119
37. Chen Z, Lin CY, Li J, Wang HL, Yu H. Influence of abutment height on peri-implant marginal bone loss: A systematic review and meta-analysis. *J Prosthet Dent.* 2019;122(1):14-21.e2. doi:10.1016/j.prosdent.2018.10.003
38. Inci ED, Turp V, Tuncelli FB. Stress distribution in peri-implant bone, implants, and prostheses: 3D-FEA of marginal bone loss and prosthetic design. *Braz Dent Sci.* 2024;27(2):e4168. doi:10.4322/bds.2024.e4168
39. Li B, Murakami N, Xie C, Mouri Y, Matsuno H, Okawara H, et al. Effects of tensile and compressive stress on bone resorption and formation parameters surrounding dental implants. *J Mech Behav Biomed Mater.* 2025;165:106928. doi:10.1016/j.jmbbm.2025.106928
40. Bertolini MM, Del Bel Cury AA, Pizzoloto L, Acapa IRH, Shibli JA, Bordin D. Does traumatic occlusal forces lead to peri-implant bone loss? A systematic review. *Braz Oral Res.* 2019;33(suppl 1):e069. doi:10.1590/1807-3107bor-2019.vol33.0069
41. Mojaver S, Patel N, Sarmiento H, Fiorellini JP. Under pressure: Unraveling the impact of occlusal overload on peri-implant health—A systematic review. *J Prosthodont.* 2025;34(8):784-95. doi:10.1111/jopr.14088
42. Lin G, Lee E, Barootchi S, Rosen PS, Curtis D, Kan J, et al. The influence of prosthetic designs on peri-implant bone loss: An AO/AAP systematic review and meta-analysis. *J Periodontol.* 2025;96(6):634-51. doi:10.1002/JPER.24-0144

43. Lemos CAA, Verri FR, De Oliveira Neto OB, Cruz RS, Luna Gomes JM, Da Silva Casado BG, et al. Clinical effect of the high insertion torque on dental implants: A systematic review and meta-analysis. *J Prosthet Dent.* 2021;126(4):490-6. doi:10.1016/j.prosdent.2020.06.012
44. Gheisari R, Eatemadi H, Alavian A. Comparison of the Marginal Bone Loss in One-stage versus Two-stage Implant Surgery. *J Dent.* 2017;18(4):272-6. PubMed PMID: 29201970; PubMed Central PMCID: PMC5702431.
45. Chaushu L, Naishlos S, Rosner O, Zenziper E, Glikman A, Lavi D, et al. Changing Preference of One- Vs. Two-Stage Implant Placement in Partially Edentulous Individuals: An 18-Year Retrospective Study. *Appl Sci.* 2020;10(20):7060. doi:10.3390/app10207060
46. Alfaer AS, Alharbi NY, Alsulami AA, Alharthi SM, Modahi FH, Modahi NH, et al. A comparative review one-stage and two-stage dental implants. *Int J Community Med Public Health.* 2023;10(9):3387-91. doi:10.18203/2394-6040.ijcmph20232465
47. Buser D, Sennerby L, De Bruyn H. Modern implant dentistry based on osseointegration: 50 years of progress, current trends and open questions. *Periodontol 2000.* 2017;73(1):7-21. doi:10.1111/prd.12185
48. Pellizzer EP, Marcela De Luna Gomes J, Araújo Lemos CA, Minatel L, Justino De Oliveira Limírio JP, Dantas De Moraes SL. The influence of crown-to-implant ratio in single crowns on clinical outcomes: A systematic review and meta-analysis. *J Prosthet Dent.* 2021;126(4):497-502. doi:10.1016/j.prosdent.2020.06.010
49. Meijer HJA, Boven C, Delli K, Raghoobar GM. Is there an effect of crown-to-implant ratio on implant treatment outcomes? A systematic review. *Clin Oral Implants Res.* 2018;29(S18):243-52. doi:10.1111/clr.13338
50. Padhye NM, Lakha T, Naenni N, Kheur M. Effect of crown-to-implant ratio on the marginal bone level changes and implant survival – A systematic review and meta-analysis. *J Oral Biol Craniofacial Res.* 2020;10(4):705-13. doi:10.1016/j.jobcr.2020.10.002