UNIVERSIDADE FERNANDO PESSOA

INFLUENCE OF PROSTHETIC EMERGENCE PROFILE ON PERI-IMPLANTITIS – A SYSTEMATIC REVIEW

[Influência do perfil de emergência protético na peri- implantite – revisão sistemática]

Dissertação de Mestrado

Mestrado Integrado em Medicina Dentária

Vitória Martins Tavares

Orientador:

Professor Filipe Castro

Outubro / 2024

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"Dar o exemplo não é a melhor maneira de influenciar os outros, é a única!"
(Albert Schweitze)

RESUMO

INTRODUÇÃO: Os tecidos moles e duros peri-implantares são cruciais para o sucesso a longo prazo das restaurações suportadas por implantes unitários. O perfil de emergência, como interface entre a área peri-implantar e o exterior, deve ser bem compreendido, pois pode estar diretamente relacionado à saúde desses tecidos e, consequentemente, ao sucesso do tratamento.

OBJETIVO: O objetivo desta revisão sistemática foi investigar a influência do perfil de emergência na saúde dos tecidos peri-implantares.

MATERIAIS E MÉTODOS: Esta revisão sistemática foi registada no *PROSPERO* (número de registo: *CRD42024578791*) e conduzida de acordo com as diretrizes *PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)* para revisões sistemáticas. A questão central foi elaborada com base na estratégia PCC (P = população, C = conceito, C = contexto). A pesquisa foi realizada em 4 bases de dados diferentes: PubMed, ScienceDirect, Cochrane Library e B-on. As palavras-chave selecionadas foram: abutment, implante dentário unitário, design de abutment, peri-implantite. Foram identificados 829 registos. Os duplicados foram removidos e aplicaram-se os critérios de inclusão (Publicado nos últimos 10 anos; Língua inglesa; Texto completo disponível; Desenho do estudo considerado elegível: ensaios clínicos randomizados, estudos de coorte, estudos transversais e estudos de caso-controle; Estudos em humanos adultos (>18 anos; Pacientes sistematicamente saudáveis, fumadores <10 cigarros/dia); Apenas restaurações de implantes unitários) e critérios de exclusão (Prótese total suportada por implantes; Dentaduras parciais suportadas por implantes, overdenture; Restauração de implantes com dentaduras (parciais); Estudos seletivos como revisões narrativas, relatórios de caso, artigos de opinião, estudos in vivo/in vitro). Os artigos finais foram submetidos ao Rob 2.0 da Cochrane para ensaios clínicos randomizados.

RESULTADOS: No total 10 artigos foram selecionados, categorizados como de baixo risco e com algumas preocupações. Aqueles com preocupações gerais relacionadas ao processo de randomização e ao *blinding* de operadores/pacientes foram considerados eficazes na investigação e pareceram não ter um impacto significativo direto no resultado esperado.

CONCLUSÃO: Esta revisão explora como os perfis de emergência protéticos impactam a saúde peri-implantar, enfatizando o papel do material, tipo de conexão e design. Abutments de zircônia e conexões cônicas parecem melhorar a saúde oral e a estética, destacando a necessidade de abordagens individualizadas.

PALAVRAS – CHAVE: 'ABUTMENT', 'IMPLANTE DENTÁRIO UNITÁRIO', 'DESIGN DE ABUTMENT', 'PERI- IMPLANTITE'

ABSTRACT

BACKGROUND: Peri- implant soft and hard tissues are the key for long- term success of single implant- supported restorations. The emergence profile as the interface between the peri- implant area and the exterior should be well understood once it may be directly linked to the health of this tissues and, consequently, the success of the treatment.

OBJECTIVE: The aim of this systematic review was to investigate the influence of the emergence profile on peri-implant tissue health.

MATERIALS AND METHODS: This systematic review was registered with *PROSPERO* (registration number: *CRD42024578791*) and conducted in accordance with the *PRISMA* (*Preferred Reporting Items for Systematic Reviews and Meta- Analyses*) guidelines for systematic reviews. The focus question was designed based on the PCC strategy (P = population, C= concept, C= context). Research was conducted in 4 different databases: PubMed, ScienceDirect, Cochrane Library and B-on. The key words selected were: abutment, single dental implant, abutment design, peri-implantitis. 829 records were identified. Duplicates were removed and applicated the inclusion (Published in the last 10 years; English language; Full text available; Study design considered eligible: randomized controlled clinical trials, cohort studies, cross-sectional studies, and case-control studies; Human studies in adult patients (>18 years; Systematically healthy patients, smoking <10 cigarettes/ day); Only single tooth implant restorations) and exclusion criteria (Total implant-supported prosthesis; Implant-supported partial dentures, overdenture; Implant restoration with (partial) dentures; Selective studies such as narrative reviews, case reports, opinion papers, in vivo/ in vitro studies). The final articles were submitted to Rob 2.0 by Cochrane for randomized clinical trials.

RESULTS: A total of 10 articles, categorized as low risk and some concerns, were kept. Those with an overall of some concerns relatable to the randomization process and blinding of the operators/patients kept, appeared to put into effect in the investigation and it seemed not to have a directly significant impact on the outcome expected.

CONCLUSION: This review explores how prosthetic emergence profiles impact peri-implant health, emphasizing the role of material, connection type, and design. Zirconia abutments and conical connections appear to enhance oral health and esthetics, highlighting the need for individualized approaches.

KEYWORDS: 'ABUTMENT', 'SINGLE DENTAL IMPLANT', 'ABUTMENT DESIGN', 'PERI-IMPLANTITIS'

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LIST OF ABBREVIATIO

BoP	Bleeding on Probing
PD	Probing Depth
EP	Emergence Profile
EA	Emergence Angle
RCT	Randomized clinical trial
MBL	Marginal Bone Loss
IAI	Implant Abutment Interface
CAD/ CAM	Computer aided design/ computer aided manufacturing
Rob	Risk of Bias

I. INTRODUCTION

Dental implant replacement is a well-documented treatment alternative for replacing a single missing tooth. It is well-documented in the literature and it has a 5-years survival rate of 97,6% to 98,3% (Papavasiliou et al., (2023)).

PERI- IMPLANTITIS – DIAGNOSE:

The major biologic complication for implant supporting single crowns is peri-implantitis, defined has pathological condition in tissues around dental implants. Clinically characterized by inflammation in the peri-implant connective tissue and a progressive loss of the supporting bone. Diagnosed by bleeding and/or suppuration on probing (BoP) combined with increased probing depth (PD) and radiographic bone loss either compared with previous examinations or radiographic bone level greater than or equal to 3mm combined with BoP and probing depth greater than or equal to 6 mm. Peri-implantitis can be triggered by peri-implant infection or occlusal trauma. This condition can be associated to mobility of the implant. Most commonly seen in advanced stages, associated to a higher peri- implant bone loss (Schwarz et al., (2022)).

Table Nº 1: Diagnose implant criteria

Peri-implant Health	Peri- implant Mucositis	Peri- implantitis
No signs of clinical inflammation.	Localized erythema, swelling, suppuration, bleeding on probing (BoP).	Localized erythema, swelling and/or suppuration, bleeding on probing (BoP).
Probing depth (PD) not increased or ≤ 5mm (reduced periodontium patients).	Probing depth (PD) may be increased.	Increased probing depth (PD ≥6 mm or in comparing with previous measurements).
No significant changes of marginal bone level after osseointegration period (≤ 2mm).	No significant changes of marginal bone level.	Radiographic bone loss (compared with previous examinations or bone level ≥ 3mm combined with BoP or probing depth ≥ 6mm).
Favorable prognosis.	Moderate prognosis. Reversible inflammation.	Unfavorable prognosis. Nonreversible inflammation.

Peri-implant infection is a plaque associated condition which mainly involves microorganisms such as *Porphyromonas gingivalis, Prevotella intermedia, Actinobacillus actinomycetemcomitans* and *Fusobacterium nucleatum (*Koyanagi et al, 2010*)*.

PERI- IMPLANTITIS – RISK FACTORS:

Peri-implantitis can be influenced by patient related factors, chirurgical related factors and prosthetic related factors.

Table Nº 2: Risk factors category (Papavasiliou et al., (2023))

Patient related factors	History of peri-implantitis, poor oral hygiene, lack of maintenance, systemic diseases such as diabetes, smoking habits
Chirurgical related factors	Implant position (depth, 3D position), mechanical stress, technique (submerged, non- submerged), surgical trauma
Prosthetic related factors	Emergence angle, restoration contour/ design, type of retention, type of implant-abutment connection, abutment type, abutment material, restorative material selection

Regarding to patient related risk factors for peri-implantitis the highlight goes to lack of maintenance, failure to attend monitoring appointments, poor oral hygiene, systemic diseases such as diabetes, smoking habits, previous history of peri-implantitis or periodontitis (Renvert et al., 2018).

In the other hand, the moment of the surgical operation can influence as well the prognosis of the treatment. The 3D implant position and the relation to the bone crest (apico-coronally, bucco-lingually, mesio-distally, bucco-lingual inclination), the mechanical stress and surgical trauma, the choice of the implant and abutment characteristics, submerged vs. non- submerged technique, the selected loading protocol (Papavasiliou et al., (2023)).

Table Nº 3 : Implant Position considerations (Hamilton et al., (2023))

Apico - coronal	Depth of the implant – is the most critical position of the implant. Modified by the alveolar crest position and the design of the implant. Ideally bone level implant depth around 3-4 mm from the proposal mucosal margin as the reference position. Shallow placement limits the emergence prosthetic restoration contour and deeper implant placement have showed higher prevalence of peri-implantitis.
Bucco – lingual	Should be located 1.5 – 2 mm palatially to the emergence of the buccal future crown.
Mesio - distal	Relation to the adjacent teeth or implants – it is recommended to be 1.5 mm away from the adjacent teeth and minimum 3 mm from the

	adjacent implants. By that it prevents bone loss and improve inter-implant mucosa fill. Platform switching can reduce the distance to 2 mm if necessary.
Bucco – lingual inclination	Direct impact on prosthetic option restoration and peri-implant tissue stability. The angulation of the implant will affect the screw channel position and possibility for a screw retained restoration. In cases were that is not possible, cemented retained restoration is the option. Excessive buccally placed implants are more prone to buccal tissue defects.

Table Nº 4: Implant Design considerations (Hamilton et al., (2023))

Implant-abutment connection design	Geometry of the implant- abutment connection is strongly related to the mechanical stability of the protheses and the transfer of occlusal forces (which translates to bone loss). External hex, platform matching, flat-to-flat implants – bone remodeling after osseointegration, meaning, bone loss which leads to exposure of the rough surface of the implant and peri-implant groove open to bacterial colonization. Tissue level and platform switch implant move the micro-gap away from bone crest by narrowing the diameter of the abutment in relation to the diameter of the implant. This leads to reduce early bone loss. Internal conical connections give the restoration the higher capacity to resist to lateral loading.
Implant fracture	Internal connection design increases the stability of the implant-abutment connection. Besides, transfers occlusal loading forces to crestal module of implant. This may be a risk factor for implant fracture if we are in the presence of smaller diameter implant with thin walls and pure titanium made.

Besides the mentioned factors, literature have suggested prosthetic related factors as predisposing to peri-implantitis. There are subjects who have been studied:

- Emergence Angle (≥30 degrees or ≤30 degrees): Soulami et al., (2022) observed that seemed to exist an association with higher prevalence of peri- implantitis or marginal bone loss and a larger EA (> 30º) compared to a smaller EA (< 30º).
- Restoration contour (concave, convex, flattened): Soulami also suggested that a convex EP was associated to a higher prevalence of peri- implantitis. Mostly related to the way that induces or avoids plaque accumulation and ability to cleansing by the patient.
- Type of retention: (cemented versus screw-retained restoration): Screw-retained restorations provides a cement-free transition from the head of the implant to the free gingival margin. A screw-retained approach also permits an easy access and manipulation to the implant itself and emergence profile. Cement exceed is associated to inflammation due to foreign body reaction, inducing peri- implantitis and

hampering the cleansing, favoring plaque accumulation which also induces peri-implantitis (Sethi & Kaur, 2021).

- Type of implant-abutment connection (external hexed, internal hexed, …): In regard to connection type, external connections revealed a higher prevalence of peri-implantitis compared to internal connections (Papavasiliou et al., (2023)). Caricasulo et al., (2018) observed internal interfaces to be more effective maintaining the bone levels.
- Abutment design and material (titanium, zirconia): Both biocompatible, zirconia and titanium. Selection criteria is in majority related to esthetic demand of the restoration. Titanium gives to a thin mucosa a greyish appearance that zirconia seems to avoid, once its white colored. Abutments can be customized or stocked – customized abutments are more expensive but designed to individual specifics, to have an intimate adjustment – reducing mismatches where bacteria can accommodate, improving emergence profile and better esthetic (García-García & Otero, 2019).

So, attention turns to the prosthetic profile and the crucial role of the peri-implant soft tissue in functional and esthetically long- term prognosis, therefore in the success of treatment. It modulates the shape and position of the soft tissue. Since implants do not have periodontal ligament, the role of the soft tissue is exponentialized – acting as a barrier in the transition zone – the emergence profile.

PERI- IMPLANTITIS – SOFT TISSUE ROLE

Peri- implant soft tissue is different from the periodontium around the natural tooth.

Periodontium has transverse fibers inserted into the cementum of the tooth root with Sharpey's fibers forming the connective tissue attachment. This connection provides a strong and stable basis for the soft tissue around the tooth (Schoenbaum T. R., (2015)).

Implant, on the other hand, has no periodontium. The implant has no specified tissue to function as periodontium - supporting the tooth, load absorption, attaching to the bone and protection against oral microflora. Soft tissue become even more relevant since it is the barrier between bone and implant surface and also implant and oral microflora (Nagy & Tóth, 2021).

Mucosal can be affected by the quantity and quality of soft tissue, surgical procedure and prosthetic design. A band of keratinized tissue around the implant may act as a physical barrier against the bacterial infections, by reducing the deposition of biofilm around the implant, improving capacity of oral hygiene and reducing the incidence of recession that would exposure the implant surface (Koutouzis & Wang, 2019).

Healthy peri-implant tissue is a requirement for long-term success of dental implant restoration (Hamilton et al., (2023)). Aware of this importance, it is relevant to understand the role of prosthetic design in peri-implant health.

Note that healthy peri-implant soft tissue is constituted by a band of well- keratinized oral epithelium, sulcular epithelium, junctional epithelium and underlying connective tissue. Sulcular epithelium and junctional epithelium are non- keratinized tissues who are responsible by the defense against external microorganisms. Peri- implant attachment is performed by hemidesmosomes and basal lamina, but in is much more fragile than the attachment of the natural tooth.

The transverse fibers inserted the cementum of a natural tooth, appear to reorient around the implant, into a circumferential fiber developing a protective "O-ring" in the minimal diameter region. This pseudo- structure takes 4 to 6 weeks to develop (Schoenbaum T. R., (2015)).

Know the constitution of peri-implant soft tissues permit the clinician to predict and to manage factors in the restoration – the provisional and the definitive - to achieve the success of the rehabilitation and the health of the tissues, consequently. It manipulates the position of the free gingival margin and adjacent papilla (Koutouzis & Wang, 2019).

Nonetheless, esthetic success is not only related to the emergence profile (EP). It is important to mention that sufficient tissue volume is a pre-requisite. Satisfactory hard and soft tissue adjacent is required to achieve an esthetic and functional result and, forehead a favorable prognosis.

An inadequate width of keratinized mucosa was correlated with higher values of mucosa recession and the loss of attachment (Lops et al., (2022)). Literature recommends a minimum of 2 mm of keratinized tissue around the implant for a favorable prognosis.

Furthermore, peri-implant tissue architecture may be affected and shaped by the prosthetic emergence profile design. This is the relation, between peri-implant tissue health and prosthetic emergence profile design, this review aimed to investigate (Buser & Weber, 2019).

PERI- IMPLANTITIS – EMERGENCE PROFILE:

In an attempt to summarize the conclusions of the recent randomized clinical trials, this systematic review tries to comprehend the influence of the emergence profile on peri-implant soft tissue health and moreover peri- implantitis.

Emergence profile is by definition the contour of the tooth or the restoration (crown, restorative material such as composite or ceramic, dental implant, dental implant abutment) and its relation with the soft tissue around that emerged superficies. It can also be interpreted as the area of the abutment extended from the implant to the free gingival margin (Schoenbaum T. R., (2015)).

It influences the peri- implant soft tissue shape and the interproximal papilla contour, gingival margin scalloping and the thick of buccal soft tissue.

The prosthetic emergence profile design of the implant- abutment can modulate and optimize soft tissue volume and shape to the desired esthetic goal – by controlling the apico-coronal position of the peri-implant soft tissue (Koutouzi & Tsirlis, 2018).

Please bear that there are also factors outside of control of the treatment who have direct influence on the papilla and soft tissue behavior, including patient genetic, tissue biotype (thickness vs. thinness), oral microbiology and oral hygiene (Jepsen et al., 2018).

A correct prosthetic emergence profile design gives the patient the ability to correctly hygiene, cleansing biofilm and avoiding plaque accumulation, and by that reduces the probabilities of inflammation of the soft tissue around the implant and implant abutment (Linkevicius et al., 2014; Koutouzi & Tsirlis, 2018).

Among the factors controlled by the treatment are included implant diameter, volume of the peri-implant bone, position of the implant in relation to the adjacent bone/root, implant connection design, inter-implant distance, shape of the emergence profile (Buser et al., 2017; Chappuis et al., 2018).

Emergence angle (EA) was one of the factors related to the emergence profile (EP) pointed to have influence on the peri implant tissue health. Emergence angle is the angle between the tangent of the transitional contour and the long axis of the tooth. It recommended not to overcome 30 degrees in an attentive to preserve the soft tissue health in the transition zone (Lops et al., (2022)).

Soulami et al., (2022) concluded, in a systematic review, that emergence angles EA $\geq 30^{o}$ and higher prevalence of periimplantitis were associated and convex emergence profile was also associated with the higher prevalence of peri-implantitis.

Higher prevalence of peri-implantitis was founded when emergence angle EA $\geq 30^{o}$ (bone- level external connection) compared with EA $\leq 30^{o}$ and in convex profile types compared to others. Yet, both of these factors (EP and EA) interacted significantly with each other. Meaning that EP convex profiles associated with emergences angles EA $\geq 30^{o}$ were associated to higher prevalence of peri-implantitis. Thus, Soulami and her colleagues reviewed this relation, it is important to emphasize the lack of studies related to this subject. Further researches should take it in consideration.

It is simple to understand that emergence profiles with an over contoured restorations lead to difficulty to proper oral hygiene, which facilities accumulation of biofilm and promotes soft tissue inflammation. Over contoured abutment design will pressure the papilla to a more apical position. This pression will decrease the blood supply to the soft tissue – which will make it more fragile. This event can be strategically used to reposition the peri- implant soft tissue to a desired place. Whereas, under contoured abutment design with immediate loading will permit space for potential growth in soft tissue volume or a draping of it coronally, used in provisional restoration (Schoenbaum T. R., (2015)).

Dental care professionals and technicians can benefit from understanding the possible relation between emergence profile and soft tissue behavior, moreover peri- implantitis. This entails importance to the subject this study intended to investigate.

Implant Abutment and Emergence Profile (EP)

Implant abutment connection and implant abutment interface are components with a high impact on the long- term success of the treatment (Schwarz et al., 2018; Hämmerle et al., 2012).

Implant abutment connection

There are four major types of implant abutment connection: external hex connection (EH), internal hex connection (IH), internal conical connection and morse taper connection (Jansen et al., 2018; Merz et al., 2000, Misch, 2014).

Table Nº 5: Implant abutment connection types

External Hex Connection	Simple and easy to use, can be combined with multiple abutment options. Less stable, and therefore, susceptible to mechanical complications such as screw loosening and micromovement.
Internal Hex Connection	Offers good stability and resistance to rotational forces, reducing the risk of screw loosening. This complexed design can be hard to achieve to the manufacture.
Internal Conical Connection	A friction fit connection empowered with excellent stability and consequently minimizing the micromovements and microbiological leak. To accomplish this precision connection makes it more technique- sensitive.
Morse Taper Connection	Excellent mechanical stability. High resistance to micromovement and bacterial infiltration. Only disadvantage of this very tight fit connection is the difficulty to disrupt it, if needed.

In order to correctly choose the most adequate connection for each case, the clinician should consider mechanical stability, esthetic and functional demand, long- term success and ease of use (Lops, D., et al. (2022)).

Demystifying, internal connections and morse taper connection often provides better mechanical stability and less micromovement. The connection type can influence the esthetic outcome and functional performance. External hex connection may be easier to use but may have higher incidence of complications. The longer termed success

connections will be the ones that reduces the micromovement and the microbiological leak ((Perriard et al., 2002; Merz et al., 2000; Schwarz et al., 2018)).

However, the clinical implications allocated to this selection is to also considerate anatomical location, loading protocol, esthetic demand and to educate the patient about the importance of the oral hygiene and the follow- up visits to early detect any anomalies (Buser et al., 2017; Pjetursson et al., 2004; Roccuzzo et al., 2018).

Implant abutment interface (IAI)

The surface where the prosthetic abutment and dental implant are connected – IAI.

If the success of the treatment was presented as a triad, most likely it would have three keys: 1) hard tissues health (osseointegration); 2) soft tissues health; 3) implant abutment interface integrity. During the course of this review the reader should kept it in mind.

This interface is probably the mechanical key for the longevity of the implant- supported restoration. Its functions are to biological seal and to keep the mechanical integrity.

Implant abutment interface must seal the implant abutment system in order to prevent microbiological invasion. An intimate fit with a minimal micro gap is crucial to assure this sealing. The micro gap is a small space at the implant abutment interface that often occurs even in well fitted connection types. This gap will quickly be occupied by bacteria from the oral microbiome. Leading to inflammation and consequently peri- implantitis. Choose the connections that reduces this micro gap, correct surgical technique and accurate fabrication of the system pieces are some steps to minimize micro gaps (Schwarz et al., 2018; Merz et al., 2000; Jansen et al., 2018).

Implant abutment interface must support occlusal forces and prevent fracture of the abutment or implant and also prevent screw loosening. Therefore, the importance of the material selection and to certificate that the manufacturing was exact. This interface is responsible for the stress distribution. Reducing micromovements, by selecting tight fitting connections, is critical to inhibit bone loss and implant failure (Pjetursson et al., 2004; Merz et al., 2000; Buser et al., 2017).

Implant abutment interface interacts directly with soft tissue shape and position (Schoenbaum T. R. et al., (2015)).

Schoenbaum T. R. et al., (2015) described how larger emergence profile will compress soft tissue by the abutment pressure, consequently decreased blood flow and that moves soft tissue apically. On the other side, narrowed emergence profile allows draping of the soft tissue, resulting in a coronally position of the soft tissue and remain a maximum distance from the peri-implant bone maintaining the critical interproximal bone peaks.

However, there is no way to predict how much positional change there will be. Literature points on abutment size, tissue thickness, oral hygiene and bone position to influence it. Clinicians should take it in consideration. This acknowledgement gives them an improved

chance to achieve esthetic goals. Patient expectation and patient selection are not going to be discussed in this research but are as well strongly important and should be taking as well in consideration by the clinicians. As well as patients' comfort and perception of the implant treatment (Koutouzi & Tsirlis, 2018; Kahn et al., 2020; Derks et al., 2016).

Platform Switch Concept

This concept was designed to improve functional and esthetic of the implant- supported restorations and preserving peri- implant bone level (Roccuzzo et al. (2023)).

By the use of an abutment with a smaller diameter than the diameter of the implant it supports it. It means that the abutment and the implant are mismatching, it creates a stepping stone or a reversed step in the implant abutment interface. This was pointed to provide the implant- supported restoration with some advantages.

The major one would be to preserve the peri- implant bone level which is only by itself good but also good prognosis to a long- term maintenance of peri- implant health and longevity. To reduce inflammation due to the distancing of the implant abutment interface away from the marginal bone, once it reduces the bacterial infiltration it reduces the inflammatory response. It promotes a better adjustment of the soft tissues who have more space to proper healing, improving by that the esthetic of the emergence profile (Koutouzi & Tsirlis, 2018; Tzafestas et al., 2019; Pjetursson et al., 2004).

IMPLANT VS. PERI- IMPLANT HARD AND SOFT TISSUES: THE KEY FOR SUCCESS

Hard and soft tissues stability surrounding the dental implant appears to be the key for a success treatment. Not only concerning esthetics, but function and long-term maintenance as well. Literature predicts that during the first year after the implant surgery placement – osseointegration period – a bone loss of 0.2mm to 1.2mm occurred (Buser et al., 2017; Adell et al., 2014; Derks et al., 2016).

Osseointegration defines a structural and functional connection among the dental implant loaded and the surrounding bone. This event is an essential criterion for loading stages, for implant stability and long-term maintenance. Implant- tissue interface is an enormously dynamic zone. The success of this process depends on: the biocompatibility of the implant material, macro and microscopic nature of the implant surface and design, condition of the implant site in a health and morphologic context (bone quality), surgical technique, undisturbed healing phase, loading condition. Literature estimates it to be around 6 months in maxilla and 4 months in the mandible (Buser et al., 2017; Wang & Wang, 2016).

Finally, bone level is mostly one of the indicators that investigators take in concern to evaluate implant related factors. Marginal bone loss is the loss of the bone surrounding the implant abutment interface, normally the reference to evaluate the changes of the peri-

implant bone level – an excessive or progressive MBL can be predictive of complications such as peri- implantitis. Bone loss will affect the stability and consequently function of the implant. It is measured radiographically by the comparison with previous radiographies. An early detection and management of the bone loss is crucial to prevent further progression (Schwarz et al., 2018; Derks et al., 2016).

The treatment of peri- implantitis is control of plaque accumulation, treatment of the infection, control of the inflammation. The treatment will depend on the severity of the condition, patient factors (smoking habits, systemic condition, patient compliance, oral hygiene) and implant position, in terms of accessibility. There are non- surgical treatment (mechanical debridement, antiseptic treatment, antibiotic therapy, laser therapy), surgical treatments (open flap debridement, resective surgery, regenerative surgery, implantoplasty) and adjunctive therapies (photodynamic therapy, probiotics, supportive periodontal therapy). Be advised that this will not be subject of investigation in this review (Schwarz et al., 2018; Derks et al., 2016; Froum et al., 2017).

Clinical Relevance

To project a correct emerge profile is crucial for long- term success of the implant-supported restoration. An inadequate emergence profile could lead to complications such as gingival inflammation, peri- implant bone loss, esthetic or functional failure.

It should support soft tissues surrounding the implant, improve hard and soft tissues health and provide the restoration with a natural and harmonious appearance.

Applicability

Surgical and prosthetic planning - Planning the correct position of the implant and chose the abutment design can be done with the guidance of surgical guide and TC to an accurate positioning.

Abutment design - Abutment should be designed to smoothly transit between the implant and the crown, in a way that promotes soft tissue adjustment and natural esthetic appearance.

Soft tissues Health - Promoting a correct emergence profile empowers the patient to effectively hygiene, which help to avoid inflammation and bone loss.

II. MATERIALS AND METHODS

This systematic review has been registered on the *PROSPERO* platform (registration number: *CRD42024578791*), an international database of systematic reviews. The

registration purposes to assurance the transparency of the process and the prevention of bias in the publication of results.

The following work involved the collaboration of three independent investigators. The main one Vitória Tavares (V. T.), secondary one Filipe Castro (F.C.) and a third one Paulo Ribeiro (P. R.).

The study followed the *PRISMA* (*Preferred Reporting Items for Systematic Reviews and Meta- Analyses*) Statement Guidelines for systematic reviews (Attachment Nº1). Focus question was elaborated according to PPC strategy (Population, Concept, Context), in order to investigate multiple factors associated with the prosthetic emergence profile in single implant- supported restorations and the increased possibility of developing peri- implantitis.

FOCUSED QUESTION

The focused question was defined, in order to achieve the objective of this review, considering the Population, Concept and Context strategy (PCC strategy), as it follows: "patients with single dental implants" (P) where was investigated the prosthetic emergence profile and the increased possibility of developing peri- implantitis (C), in order to relate it to the multiple factors associated with the prosthetic emergence profile (C).

Table Nº 6: PCC strategy

Population	Patients with single dental implants.
Concept	Investigate the prosthetic emergence profile and the increased possibility of developing peri- implantitis
Context	Relate the multiple factors associated with the prosthetic emergence profile.

Information Sources and search strategy

The research was conducted in 4 different databases - PubMed, ScienceDirect, Cochrane Library and B-On. The timeline was set from 2013 to 2023, in order to include all articles published in the last 10 years. Only articles written in English were included.

The key-words selected were: "abutment", "single dental implant", "abutment design", "peri-implantitis". BOOLEAN markers "AND" and "OR" with specific adjustment for each database were used to combine all key-words.

Such research resulted in 829 records identified. Duplicates were removed manually and automatically with Mendeley Reference Manager (n= 369). Then, based on the inclusion and exclusion criteria, titles of interest were selected (n= 153) followed by the selection of the abstract (n= 73) and finally the full text (n= 18).

INCLUSION AND EXCLUSION CRITERIA

Inclusion criteria:

- Published in the last 10 years (2013 to 2023);
- English language;
- Study design considered eligible (randomized controlled clinical trials, cohort studies, cross-sectional studies, case-control studies);
- Human studies in adult patients (> 18 years);
- Systematically healthy patients, smoking < 10 cigarettes/day;
- Only single tooth implant restorations with natural adjacent tooth;
- Follow-up period ≥ 12 months.

Exclusion criteria:

- Total implant-supported prothesis;
- Implant-supported partial dentures, overdenture;
- Implant restoration with partial dentures;
- Selective studies such as narrative reviews, case reports, opinion papers, in vivo/ in vitro studies, histological or immunological analysis.

Selection of studies

Abstracts were screened out (n=153) – those who fulfilled inclusion criteria and were relevant to the study aim. Full texts (n= 73) were fully read and resulted in articles selected for further assessment of risk of bias (n= 18). This procedure is well documented in *PRISMA* flow diagram (Attachment Nº 1).

RISK OF BIAS AND QUALITY ASSESSMENT

The risk of bias and quality assessment of the included investigations was conducted according with Rob - Risk of Bias 2.0 tool by Cochrane, recommended for randomized trials.

For each article, five domains were assessed:

Domain 1 (D1) – risk of bias arising from the randomization process.

Examine if the random allocation sequence was properly generated and concealed.

Domain 2 (D2) – risk of bias due to deviations from the intended interventions.

Examine if the study participants received the intervention initially planned and if deviations were appropriate.

Domain 3 (D3) – risk of bias due to missing outcome data.

Examine the impact of missing data on the study outcome.

Domain 4 (D4) – risk of bias in measurement of the outcome.

Examine if the outcome was measured accurately and consistently.

Domain 5 (D5) – risk of bias in selection of the reported result.

Examine if the reported outcome was selected based on the results rather than the protocol initially planned.

Finally, considering all domains, an overall risk of bias judgment was achieved. This overall risk of bias judgement can be categorized as low risk of bias, some concerns or high risk of bias. Subsequently applying this tool, 10 articles were considered legible.

Regarding those who were excluded the reasons were related to unpublished protocol, absence of blinding with possible impact on the outcome, missing outcome data, significant loss of follow-up sample, considering articles with high risk of bias and some concerns.

Please note that Farronato et al., (2020), Ahmed et al., (2016) and Schepke et al., (2016) were selected above an overall of some concerns, once the concerns about these studies were related to the randomization process and blinding of the operators/patients. But, it seems it was put into effect in the investigation and it seems not to have a directly significant impact on the outcome expected.

Table Nº 7: Rob 2.0 syntheses

Reference	Domain 1: Risk of bias arising from the randomization process.	Domain 2: Risk of bias due to deviations from intended interventions (effect of assignment and adherence to the intervention).	Domain 3: Missing outcome data.	Domain 4: Risk of bias in the measurement of outcomes.	Domain 5: Risk of bias in the selection of the reported result.	Overall risk of bias.
Ayyadanveettil et al. (2022)	Low: even though there are no details about the exact randomization method, the study used a simple randomization process, which appears to be performed appropriately by one examiner.	Low: treatment and interventions were caried out according to the specified protocol and patient adherence to treatment seems to be adequate, with no issues being reported.	Moderate: 3 participants did not attend follow-up appointments, and there is no clear indication on how this missing data were handled or if additional methods were implemented to address missing data.	Low: there was a single evaluator involved in clinical and radiographic evaluations, and there were blinded as to the type of abutment used. Nevertheless, there is lacking information regarding evaluator calibration.	Low: outcomes related to all parameters were reported and there is no evidence of result manipulation or selective reporting. Results are comprehensively presented according to the objectives of the study.	Low.
Bharate et al. (2020)	Low: randomization was performed using a split-mouth design, minimizing selection bias, though details on the randomization method were lacking.	Low: the interventions were conducted as planned, with no significant deviations reported.	Low: no missing data or losses to follow-up were reported, and all outcomes were accounted for.	Moderate: standardized radiographic techniques and blinding were used, but details about examiner training and error control were limited.	Low: all relevant outcomes were reported with no indication of selective reporting.	Low.
Farronato et al. (2020)	Low: randomization was done using a coin toss, with appropriate allocation to groups.	Moderate: the randomization method may have caused an imbalance in group sizes, potentially affecting results.	Low: no significant missing data reported, and measurements were conducted as planned.	Moderate: indirect measurements using plaster models and digital scanning may introduce errors.	Low: all relevant outcomes were reported with no indication of selective reporting.	Moderate.
Kim et al. (2019)	Low: the authors used a randomization program to create the allocation sequence, using opaque envelopes, and the process was handled by an independent subject.	Moderate: there was a clear and standardized treatment protocol and patients were blinded. However, 2 patients did not attend to follow-up visits.	Low: missing data from patient dropout was introduced in a final analysis, and all outcomes of interest were reported.	Low: a trained examiner performed standardized radiographic techniques and measurements, using consistent procedures and equipment.	Low: there is no indication that the selection of results was manipulated or reported selectively.	Low.
Lago et al. (2018)	Low: the randomization process was described according to CONSORT guidelines and inclusion criteria.	Low: the interventions were carried out with minimal deviations and was followed closely, giving thorough descriptions.	Low: even though there were patient dropout, there were accounted for in the analysis with detailed information.	Low: reliable and precise radiographic techniques were used by multiple evaluators. There was also a robust consensus for measurements.	Low: all planned outcomes were reported, with details for each measurement. Selective reporting is not suspected.	Low.
Ahmed et al. (2016)	High: there is a lack of detailed information about how the randomization was performed, even though the random assignment of implants was mentioned in the treatment protocol.	Moderate: the blinding of the participants and/or the evaluators is not mentioned, even though it is stated that all participants followed the same protocols and adherence to the intervention was apparently well maintained.	Low: All participants attended follow-up during the study and there is no indication of missing data.	Moderate: even though clinical results were measured using standardized techniques, it is not explicitly indicated whether or not evaluators were blinded.	Low: statistical analysis and relevant outcomes are correctly reported, with no evidence of selective reporting.	Moderate.

Schepke et al. (2016)	Low: the allocation concealment process is not thoroughly detailed.	Moderate: 7 patients were excluded from the radiographic evaluation in relation with the quality of the images obtained. Deviation from the intervention does not seem to contribute to the risk of bias.	Moderate: data los may have occurred due to the exclusion of 7 patients from the radiographic evaluation.	Moderate: measurements of clinical and radiographic parameters were carried out by researchers in an independent manner and with a high interobserver reliability. Nevertheless, there was a lack of blinding of the operator regarding the abutment assignment.	Low. all outcomes were reported where relevant and there is no evidence of data being omitted.	Moderate.
Ferrari et al. (2015)	Low: according to the study, a computer-generated random list was utilized to allocate participants, and this process was concealed using numbered envelopes.	Low: there were no deviations from the planned interventions, treatment adherence was uneventful and all the procedure were carried out by experienced operators.	Low: all outcomes relevant to the study were reported for all participants.	Low: the intervention was carried out by a single, blinded and calibrated examiner, and standardized methods were used to measure outcomes.	Low: the report of the outcomes obtained seems transparent and in accordance with established methods. Moreover, there are no signs of selective reporting.	Low.
Nemli et al. (2014)	Low: the design of the study being Split-mouth is considered to be robust, even though the specific method of randomization was not described in the text in detail.	Low: the planned interventions were carried out with Good adherence and there is no mention of deviations from the protocol. The study design is crucial in controlling patient-specific factors. However, there is no clear mention of whether patients or clinicians were blinded to the allocation.	Moderate: 2 patients were excluded from the study, which represents 10% of the total of the initial 20 patients. Besides, there is no mention of how the missing data were handled or if any additional measure was implemented to mitigate bias.	Moderate: even though clinical parameters were measured by an experienced examiner and the study appears to have used standardized procedures for measurements, it is not mentioned whether or not the examiner was blinded.	Low: there is no evidence of selective reporting, and all outcomes seem to have been pre-specified and reported transparently.	Low.
Patil et al. (2014)	Low: the design of the study was Split-mouth and the randomization process seems to be correctly implemented.	Low: no significant deviations were indicated and the article reports Good adherence to the planned interventions.	Low: even though detailed information about the handling of missing data is not given, results are clearly reported for all groups.	Low: outcomes were measured by means of standardized methods with high observer reliability. Besides, performers were blinded.	Low: primary outcomes were predefined and correctly reported, with no evidence of selective reporting.	Low.

III. RESULTS

The next stage of this systematic review was an integrative analysis of the 10 legible studies. The results are presented below.

STUDY SELECTION

Subsequently the bibliographic research phase on the influence of prosthetic emergence profile on peri-implantitis, resulted in a total of 10 articles in the light of current scientific evidence. Thus, for a better understanding of the included literature, strictly related to the subject, the objectives of each study, the materials and results are described below, which will then be analyzed and discussed.

Table Nº 8: Studies included characteristics

Reference	Study Design	Objective	Sample (patients, genres)	Mean ages	Time	P value
1. Ayyadanveettil et al. (2022)	RCT	To investigate if PEEK (polyetheretherketone) implant abutments provide similar esthetic and biologic parameters and survival rates as zirconia implants abutments.	37 patients	20 to 50 years	T0 (baseline – 2 weeks post-operation) T1 (12 months) T2 (36 months) T3 (60 months)	P ≤ 0.05 significant
2. Bharate et al. (2020)	RCT (split- mouth, single blinded)	To investigate crestal bone level around two different abutment materials – titanium and zirconia for implant retained crowns in posterior mandibular region.	11 patients	20 to 45 years	T0 (baseline – immediately after abutment placement) T1 (3 months after) T2 (12 months after)	P ≤ 0.05 significant
3. Farronato et al. (2020)	RCT	To investigate the influence of the implant-abutment connection on the ratio between height and thickness of tissues at the buccal zenith.	104 patients 40 males, 64 females	Range 43 to 88 years	T0: (Implant placement or Baseline) T1: (Screw-retained provisional: not specified) T2: (Silicone impressions: 12 months)	P ≤ 0.05 significant
4. Kim et al. (2019)	RCT (patient-blind)	To investigate the effect of different implant-abutment connection structures with identical implant design on peri-implant bone level.	22 patients 13 males, 9 females	9 patients under 45 years 13 patients above 45 years	T0 (baseline) T1 (4 months after implant placement) T2 (1 year post loading)	P ≤ 0.05 significant
5. Lago et al. (2018)	RCT	To investigate the differences in radiographic level of peri-implant bone crest between tissue-level implants restored with platform matching (control group) and bone level implants restored with platform switching (test group) in the posterior region.	96 patients	25 to 70 years	T0 (baseline – moment of prothesis delivery) T1 (12 months after definitive restoration) T2 (60 months after definitive restoration)	P ≤ 0.001 significant
6. Ahmed et al. (2016)	RCT	To investigate the role of the type of abutment/implant connection on the marginal bone loss around dental implant.	11 patients 6 males, 5 females	26 to 45 years	T0 (implant placement) T12 (12 months after provisional and tissue maturation, final impressions	P ≤ 0.05 significant
7. Schepke et al. (2016)	RCT	To investigate potential benefits of individualization of zirconia implant abutments with respect to preservation of marginal bone level and several clinical and patient- based outcome measures	42 patients	18 to 79 years	T0 (implant placement) T1 (two weeks after) T12 (12 months after delivery the restoration)	P ≤ 0.05 significant
8. Ferrari et al. (2015)	RCT	To investigate the effect of three different prosthetic abutments (titanium, gold- hue titanium, zirconia).	47 patients 21 males, 26 females	22 to 72 years	T0 (fixture installation) T1 (4-5months after T0) T2 (2 weeks after T1) T3 (1 week after T2) T4 (8 weeks after T3) T5 (placement of definitive restoration)	P ≤ 0.05 significant

					T6 (24 months after T5)	
9. Nemli et al. (2014)	RCT (split- mouth)	To evaluate clinical and radiographic results of submerged and non-submerged implants for posterior single-tooth replacements and to assess patient-based outcomes.	18 patients 8 males, 10 females	23 to 51 years	T0 (baseline) T1(6 months) T2 (12 months) T3 (24 months)	P < 0.01 significant (MBL, BoP) P < 0.05 significant (Plaque Index, PD, Gingival Index)
10. Patil et al. (2014)	RCT (split- mouth)	To investigate the response of the soft tissue around two different abutment designs (curved vs. straight) in healed sites in the esthetic zone	26 patients	17 to 56 years	T0 (baseline – 8 weeks after abutment insertion) T12 (1-year post-definitive crown placement)	P ≤ 0.25 significant (MBL) P ≤ 0.41 significant (PES) P ≤ 0.85 significant (PD)

Table Nº 9: Studies included characteristics – prosthetic parameters

Reference	Abutment type, material	Connection type	Restoration material	Implant informations (number, depth, etc.)
1. Ayyadanveettil et al. (2022)	Titanium supporterd PEEK abutments (SKY elegance abutment, bredent medical GmbH & Co KG) Zirconia abutments (SKY Zirconia abutment, bredent medical GmbH & Co KG)	Torx connection Cemented	Pressed lithium disilicate ceramic crowns	37 implants BlueSky, bredent medical GmbH & Co KG
2. Bharate et al. (2020)	Zirconia abutment Titanium abutment	Metalic internal implant-abutment connection Cemented	Metal ceramic crowns	22 implants Titanium screw implant
3. Farronato et al. (2020)	Titanium standard abutments	Switching Platform design	Metal- ceramic restoration	188 implants Implants placed at the bone level Group 1 – implants with a 5º conical internal hexed connection (Anyridge, MegaGen, South Korea) Group 2 – implants with a 45º internal hexed connection (Core, Kristal, Italy)
4. Kim et al. (2019)	Customized gold abutment Titanium abutment	Control group - 11 external connection structure Test group – 11 internal connection structure Screwed and cemented-retained	Metal ceramic gold crowns	22 implants (11 implants per group) Implants placed at buccal bone crest level at maxillary or mandibular second molar region External hex connection type, Sola, Shinhung, Seoul, Korea Internal friction connection type, Luna, Shinhung, Seoul, Korea
5. Lago et al. (2018)	Titanium abutments Control group – matched abutments Test group – abutments with a smaller diameter than the implant body	Internal connection Cemented	Metal- ceramic crowns	197 implants (98 in control group, 99 in test group) Control group – tissue level implants, Standard Plus Type (Institut Straumann) Test group – bone level implants, Bone Level Type (Institut Straumann)
6. Ahmed et al. (2016)	Titanium abutments	Cemented	Splinted single-unit crowns	20 implants in maxillary premolar area Root shaped dental implant, inserted at the bone level crest Screw Plant Implant, Implant Direct Company, USA Control group – internal bevel that hide the external bevel in the collar of the fixture Study group – no internal bevel, platform-switching design
7. Schepke et al. (2016)	Zirconia abutments 20 stock abutments ZirDesign, Dentsply Sirona Implants, Molndal, Sweden 22 CAD/CAM customized zirconia abutments Atlantis, Dentsply Sirona Implants	Screw- retained	Resin Nano Ceramic crown (RNC crown, Lava Ultimate, 3M ESPE, Seefeld, Germany)	42 implants Placed in premolar mandibular or maxillary region AstraTech OsseoSpeed TX 3.5S Dentsply Sirona Implants, Molndal, Sweden

8. Ferrari et al. (2015)	Customized abutment - 15 Titanium (group 1) - 18 Gold- hue titanium (group 2) - 14 Zirconia (group 3)	Screwed	Implant supported single crown or bridge Zirconia coping or metal coping and felspathic porcelain stratification according with to the allocation	97 implants Osseo Speed Dentsply Implant System
9. Nemli et al. (2014)	Titanium standard abutments	Morse taper implant-abutment connection Cemented	Metal- ceramic crowns	36 implants IDcam implants, IDI, Paris, France Threaded, tapered shape, with a concave-shaped apex design CSO, concave security osseo-wedging Submerged implants Non submerged implants
10. Patil et al. (2014)	Titanium abutments Conventional divergent (straight) – control (Esthetic, Nobel Biocare) Curved and grooved – experimental (Curvy, Nobel Biocare)	Not mentioned.	Porcelain-fused-to-metal crowns	52 tapered implants Replace Select, Nobel Biocare Facial side of the implant shoulder was placed at the crest of the bone

Table Nº 10: Studies included characteristics – clinical parameters

Reference	Probing Depth (PD) / Keratinized Tissue (KT)	Bone Loss (MBL)	BOP	Others
1. Ayyadanveettil et al. (2022)	**PPD (Probing Pocket Dept)** ZIR 2.32 ± 0.50 PEEK 2.13 ± 0.60	**mMBL (mean mesial bone level)** T0 – ZIR 1.5 ± 0.6, PEEK 1.4 ± 0.6 T1- ZIR 1.4 ± 0.6, PEEK 1.5 ± 0.6 T2 – ZIR 1.7 ± 0.4, PEEK 1.7 ± 0.5 T3 – ZIR 1.8 ± 0.5, PEEK 1.9 ± 0.6 **mDBL (mean distal bone level)** T0 – ZIR 1.5 ± 0.4, PEEK 1.4 ± 0.5 T1 – ZIR 1.5 ± 0.5, PEEK 1.5 ± 0.6 T2 – ZIR 1.6 ± 0.6, PEEK 1.6 ± 0.4 T3 – ZIR 1.7 ± 0.6, PEEK 1.8 ± 0.3	**BoP** ZIR 0.12 ± 0.11 PEEK 0.08 ± 0.12	**PCR** (plaque control record) ZIR 0.19 ± 0.19 PEEK 0.15 ± 0.17
2. Bharate et al. (2020)	Not mentioned.	**Crestal bone level change (mm)** T0 – titanium 0.32 ± 0.889, zirconia 0.202 ± 0.121 T1 – titanium 0.346 ± 0.189, zirconia 0.285 ± 0.115 T2 – titanium 0.621 ± 0.207, zirconia 0.487 ± 0.159	Not mentioned.	Not mentioned.
3. Farronato et al. (2020)	**MH (mucosa height)** 3.32 ± 0.02mm group 1 2.70 ±0.16mm group 2 **MT (mucosa thickness)** 4.37 ± 0.16mm group 1 3.93 ± 0.18mm group 2 MT/MH 1.50 ± 0.88 group 1 1.81 ± 1.20 group 2	Not mentioned.	Not mentioned.	Not mentioned.
4. Kim et al. (2019)	**PA – peri-implant area (secondary outcome)** T0 – Baseline External 0.34 (-0.12 -0.80) Internal 0.31 (-013 -0.75) T2 - 1 year loading External 0.44 (-0.22 -1.10) Internal 0.40 (-0.02 -0.82) T0 – T2 External 0.10 (-0.21 - 0.41) Internal 0.09 (-0.25 -0.43)	**DIB -distance from implant shoulder to first bone-to-implant contact (primary outcome)** T0 – Baseline External -0.06 (-0.62 – 0.50) Internal 0.21 (-0.45 -0.87) T2 - 1 year loading External 0.53 (-0.23 – 1.29) Internal 0.26 (-0.21 -0.74) T0 – T2 External 0.59 (-0.05 -1.23) Internal 0.04 (-0.45 -0.47)	Not mentioned.	Not mentioned.
5. Lago et al. (2018)	Not mentioned.	**MBL** T1- T5 Control 0.34 ± 0.54 Test -0.17 ± 0.67 Mean difference 0.53 ± 0.10 T0 – T5 Control 0.61± 0.73 Test -0.20 ± 0.75	Not mentioned.	Not mentioned.

		Mean difference 0.85 ±0.13		
6. Ahmed et al. (2016)	Not mentioned.	**Mean bone loss during 12 months** **Mesial** (T0- T2, P= 0.0034) -Control -1.29mm SD 0.33 -Study -0.98mm SD 0.26 **Distal** (T0- T2, P= 0.0028) -Control -1.52mm SD 0.28 -Study -0.92mm SD 0.15	Not mentioned.	Not mentioned.
7. Schepke et al. (2016)	**Probing Pocket Depth (PPD)** T1 Stock 2.11 (0.60) mm Customized 2.12 (0.79) mm T12 Stock 2.32 (0.85) mm Customized 2.44 (0.78) mm **Gingival margin apposition at the adjacent teeth** T12 – Stock 0.24 (0.77) mm, Customized 0.40 (0.99) mm	**MBL** (mean) T12 Stock 0.06 (0.23) mm Customized 0.11 (0.20) mm	**BoP (0-3, median)** T1 Stock 0 (0.41) Customized 0 (0.41) T12 Stock 0 (0.56) Customized 0 (0.58)	**Plaque Index** (0-3, median) T1 – Stock 0 (0.51), Customized 0 (0.49) T12 – Stock 1 (0.57), Customized 1 (0.40) **Calculus score** (0-1, median) T1 -Stock 0 (0.00), Customized 0 (0.00) T12 - Stock 0 (0.00), Customized 0 (0.00) **Gingival Index** (0-3, median) T1 – Stock 0 (0.20), Customized 0 (0.00) T12 – Stock 0 (0.41), Customized 0 (0.54)
8. Ferrari et al. (2015)	Baseline **KT** 2.376mm (SD 1.087) **PD** 1.809 (SD 0.821) Recall (4-6months) **KT** 2.361mm (SD 1.110) **PD** 1.845mm (SD 0.827) Soft tissue thickness above bone crest 2.232mm (SD 1.028)	**T6** Group 1 - 0.42mm (titanium abutments) Group 2 - 0.48mm (titanium nitrate abutments) Group 3 - 0.57mm (zirconia abutments)	Not mentioned.	Not mentioned.
9. Nemli et al. (2014)	**PD (Probing Depth)** **T1** Non-submerged 1.75 Submerged 2.25 **T2** Non-submerged 2.00 Submerged 2.50 **T3** Non-submerged 1.50 Submerged 2.00	**MBL** **T1** Non-submerged 0.35mm Submerged 0.50mm **T2** Non-submerged 0.55mm Submerged 0.70mm **T3** Non-submerged 0.77mm Submerged 0.85mm	**BoP (%)** **T1** Non-submerged 30% Submerged 49% **T2** Non-submerged 30% Submerged 42% **T3** Non-submerged 27% Submerged 25%	**Plaque Index** **T1** Non-submerged 0.42 Submerged 0.55 **T2** Non-submerged 0.375 Submerged 0.30 **T3** Non-submerged 0.11 Submerged 0.25 **Gingival Index** **T1** Non-submerged 0.30

				Submerged 0.41 **T2** Non-submerged 0.20 Submerged 0.50 **T3** Non-submerged 0.02 Submerged 0.70
10. Patil et al. (2014)	**Attached mucosa** T12 Curved 2.85mm ± 0.37 Straight 2.85mm ±0.46 T12 – T0 Curved -0.08mm ±0.39 Straight 0.00mm ±0.28 **Probing Depth** T12 Curved 3.41mm ±0.30 Straight 3.37mm ±0.36 T12 – T0 Curved 0.32mm ±0.37 Straight 0.29mm ±0.40	**MBL** T12 Curved 1.26mm ±0.60 Straight 1.48mm ±0.66 T0 – T12 Curved 0.00mm ±0.37 Straight 0.12mm ±0.27 **Bone Level** T0 Curved 1.25mm Straight 1.4mm T12 Curved 1.25mm Straight 1.5mm	Not mentioned.	**PES – Pink Esthetic Score** T12 Curved 10mm ± 2.3 Straight 9.7mm ±2.3 T0 – T12 Curved 1.2mm ±2.0 Straight 0.6mm ±2.0

STUDY CHARACTERISTICS

2.1 AYYADANVEETTIL ET AL., (2022)

Ayyadanveetil et al., (2022) studied esthetic and clinical performance of titanium-supported zirconia and polyetheretherketone (PEEK) abutments. Probing pocket depth (PPD), plaque control record (PCR), bleeding on probing (BoP) and radiographic bone level and mucosal color were measured. Bone level was radiographically measured – from the implant shoulder to the most coronal point of the implant bone contact, both mesial and distal sites.

The results of this study revealed that no statistically significant differences were spotted between the two groups, ZIR and PEEK and control teeth in PPD, PCR and BOP regardless of the time. Mean PPD was higher for implants compared to contralateral teeth. Radiological evaluation at 5 years showed no statistically difference in mesial and distal bone level between ZIR and PEEK groups. No visible color change of the mucosa was noticed between baseline and follow-up, for both groups.

Peri-implant mucosa and gingiva of the control teeth were statistically different at 1, 3, 5 years. Between ZIR and PEEK groups there were no shade difference of the restoration, regardless of the time. Both were restored with ceramic crowns and performed excellent shade matching with adjacent teeth.

The limitation of this study was the inclusion of only anterior and premolar teeth, with low occlusal forces and the follow- up of 5 years, considering further studies with longer -terms may reveal different results, as well as with larger sample size.

The authors concluded that zirconia and PEEK implant abutments for a single tooth anterior restoration are clinically and esthetically successful; shade of zirconia and PEEK material contributed to the translucent nature of lithium disilicate crowns and did not discolor peri -implant mucosa; both materials appeared to have a good biocompatibility; PEEK abutments can perform similar or even better as zirconia abutments – however, long- term studies are necessary to assure the longevity of these materials.

2.2 BHARATE ET AL., (2020)

Bharate et al., (2020) studied the crestal bone height in two abutment materials – zirconia and titanium. Radiographic measures were assessed – distance between shoulder of the implant and first bone- to- implant contact (BIC) was calculated with pixel/mm ratio.

The results of this study revealed that there was no statistically significant difference at any time between titanium and zirconia abutments, concerning to crestal bone height. The change in marginal bone height, for both abutments tested, the mean difference from baseline to 12 months, was statistically lower for zirconia abutment (0.487 ± 0.159) compared to titanium abutment (0.621 ± 0.207). The rest of the mean differences were not significant, regardless of the time.

The limitations of this study were the limited sample size and follow- up period. Zirconia physical properties decrease among time. The design of the abutment and implant abutment connection can also influence the clinical behavior.

The authors concluded that titanium implant abutment junction shows time dependent change in crestal bone height regardless of the abutment material. Zirconia abutment on titanium implants showed less reduce crestal bone height compared to titanium abutment in one year.

2.3 FARRONATO ET AL., (2020)

Farronato et al., (2020) studied MH (mucosal height) and MT (mucosal thickness) in two different implant abutment connection – 5º conical internal hexed connection (group 1) and 45º internal hexed connection (group 2). A desktop scanner measured at the buccal zenith: MH from the vestibular shoulder of the implant analogue to the upper gingival margin of the supra- implant tissue and MT from the vestibular shoulder of the analogue to the external mucosa point perpendicular to the implant major axis.

The results of this study revealed: MH (G1= 3.32 ± 0.02mm, G2= 2.70 ±0.16mm), MT (G1= 4.37 ± 0.16mm, G2= 3.93 ± 0.18mm) and ratio MT/MH (G1= 1.50 ± 0.88, G2= 1.81 ± 1.20). The values were significantly affected by the sector where the implant was placed and the group.

The limits of this study were the comparison of only two implant systems, indirect digital methods that may entail measurement defects, randomization process to define group participants (coin cross, which resulted in 125 implants in group 1 and only 63 in group 2) and the choice of the abutment height in relation to the soft tissue thickness (short abutments ≤ 2mm can led to MBL independently of the soft tissue thickness).

The authors concluded that the 5º implant connection showed a significantly higher tissue thickness and height which can be preferable to the 45º implant connection, especially in esthetic areas. Plus, tissue trophism seemed to be sensitive to the sector and the implant abutment connection.

2.4 KIM ET AL., (2019)

Kim et al., (2019) studied the bone level in implant abutment external (control group) and internal (test group) connections. Also, peri- implant area (PA). Radiographic assess – distance from implant shoulder to first bone- to- implant contact (DIB), mesial and distal.

The results of this study revealed at baseline (prothesis delivery) no statistically differences between the two tested groups. The DIB changes from baseline to 1 year were not statistically significant between the external and internal connection structures. The PA between baseline to 1 year were also not statistically significant between the two groups.

The limitations were the small sample size and short period of follow- up.

The study concluded that, according to the results, the internal friction connection is more effective maintaining the marginal bone level, considering the effect size in the vertical bone level change, despite of no significant differences in the bone level between the implant- abutment connection structures.

2.5 LAGO ET AL., (2018)

Lago et al., (2018) studied the radiographic crestal bone level around platform matching (control group) and platform switching implants. Bone level was radiographic assessed – first point of bone- to- implant contact (BIC) and the implant shoulder, mesial and distal.

The results of this study showed that the level of peri-implant bone crest in tissue level implants restored with platform matching was statistically significant in the three interval times. MBL changes for bone level implants restored with platform switching were not statistically significant in the interval times. Still, the mean difference between the control and test groups was statistically significant.

2.6 AHMED ET AL., (2016)

Ahmed et al., (2016) studied the crestal bone loss around standard implants and platform switch implants. Bone level was measured by radiographic analysis – the distance from the mesial and distal margin of the implant apex to the most coronal point where the bone appeared to contact with the implant. All implants were placed at bone- level crest.

The results of this study revealed that none of the implants showed signs of peri-implant infection or soft tissues inflammation. Radiographies presented successful osseointegration, with no peri-implant radiolucency. Measurements showed marginal bone loss for all implants.

At the prosthetic stage all the implants were clinically osseointegrated, with no signs of peri-implant infection or soft tissue inflammation.

The study revealed the total mean of bone loss during the follow-up period was 1.2mm (± 0.2 SD) on the control group (standard implant), 0.7mm (± 0.1 SD) on the test group A and 0.5mm (± 0.1 SD) on the test group B (platform switch implants, mesial and distal). There was a statistically significant difference between the control and both test groups.

The limitation of this study was standardized radiographic evaluation, which only provided 2D information, about mesial and distal bone levels. Buccal and palatal bone levels were not evaluated.

The authors concluded that implants with a platform switching concept exhibited significantly less marginal bone loss than implants with matching implant- abutment diameters, regarding soft and hard tissues.

2.7 SCHEPKE ET AL., (2016)

Shepke et al., (2016) studied marginal bone level in standard prefabricated zirconia abutments and CAD/ CAM customized zirconia abutments. Also, patient- based outcomes. Marginal bone level was measured radiographically – distance from a reference point to the marginal bone.

The results of this study revealed that the difference between the stock and CAD/CAM customized abutments, in bone apposition, was not statistically relevant. Overall, the soft tissues appearance improved during the 12 months period – must due to mesial and distal papilla fill, soft tissue texture and contour. Regarding to PES, there were no statistically significant difference between the two abutments tested at any time studied. As well as plaque accumulation, PPD, dental calculus, gingiva- index and bleeding tendency. No differences were detected concerning to patients' expectations and comfort.

The limitation of this study is the small size sample and reduced follow- up period.

The authors concluded that CAD/ CAM customized zirconia abutments to restore a single tooth is not associated to a relevant improvement of the outcome treatment when concerning to clinical performance, peri- implant bone alteration and patients' expectation comparing with stock zirconia abutment.

2.8 FERRARI ET AL., (2015)

Ferrari et al., (2015) studied the peri- implant bone loss around different prosthetic abutments – titanium, gold- hue titanium and zirconia. Radiographic measures were assessed – bone level mesial (the distance from the implant shoulder to the bone at the mesial site) and bone level distal (the distance from the implant shoulder to the bone at the distal site). Also studied clinical parameters – probing depth at 6 points/ tooth, recession depth at the central buccal site measured from the incisal margin to the gingival margin and keratinized tissue measured from the most apical point of the gingival margin to the mucogingival junction at the middle buccal point.

The results of this study revealed that the mean amount of bone loss at the last follow-up was - 0.42 mm for G1 (titanium abutments), -0.48 mm for G2 (titanium nitrate abutments) and -0.57 mm for G3 (zirconia abutments). In G1, peri-implant biotype was rated as thick at 15 and thin at 12 implants; in G2, 22 implants showed thick and 20 thin peri-implant biotypes; in G3, peri-implant biotype was rated as thick at 15 and thin at 13 implants. For 59 (60.82%) implants the peri- implant biotype corresponded with the periodontal biotype. Recession of the gingival margin was detected only at 13/97 (13.4%) implants

at the final follow-up. Statistical analysis reflected no statistically significant relation between abutment type and peri- implant biotype. Neither age, gender, abutment type, periodontal biotype was identified as predictor of recession.

The authors concluded that abutment type did not influence peri-implant variables after 2 years and there was no significant relation with periodontal biotype at patient- level and peri- implant biotype. Also, peri- implant soft tissue variables at baseline did not predict mucosal recession at 2 years. Plus, the use of zirconia abutment did not improve the peri-implant soft tissue when compared with titanium and titanium nitride abutments. The indication of zirconia abutment can be useful in anterior high esthetic area, where fixture shows buccally a soft tissue thin biotype.

2.9 NEMLI ET AL., (2014)

Nemli et al., (2014) studied the marginal bone level in submerged and non- submerged implants. Measures were assessed radiographically – distal and mesial distances from the implant shoulder and marginal bony crest were measured and averaged for each implant. Evaluated also clinical parameters: Plaque Index (PI), Gingival Index (GI), Probing Depth (PD) and Bleeding on Probing (BoP).

The results of this study illustrated that marginal bone level was lower for non- submerged implants, independently of the time, compared with submerged implants. Plaque index was not significantly different between the two implants tested, regardless of the time. Concerning gingival index, only at 24 months were found differences that indicated that submerged implants was significantly higher than the non- submerged implants. Probing depths were significantly lower for non- submerged implants, regardless of the time, compared with submerged implants. BoP measurements were not statistically different between two surgical techniques at any time. Patients related higher satisfaction with non-submerged implants than with submerged implants – comfort, comfort in prosthetic phase, satisfaction with the prothesis, esthetic of the crown, cleaning ability, general satisfaction.

The limitation of this study was the small sample size, although split- mouth design requires a smaller sample size, and the limited follow- up period.

The authors concluded that non- submerged implants behave clinically similar as to submerged implants, but revealed higher patients' satisfaction due to the minimal surgical interventions and earlier prosthetic phase. Non- submerged techniques can be successfully used in single implant supported restorations.

2.10 PATIL ET AL., (2014)

Patil et al., (2014) studied the MBL, clinical parameters and soft tissue behavior (PES – pink esthetic score) in two different abutment designs – conventional (control) and curved (experimental).

The results of this study presented mean MBL between T0 to T12 was 0.00 ± 0. 37 mm in experimental group and 0.12 ± 0.27 mm in the control group – the difference was not statistically significant. At T0 the experimental group (0.54 ± 0.87 mm) showed less MBL than the control group (0.81 ± 0.70 mm). At T12 (1 year follow up) experimental group had a MBL of 1.26 ± 0.60 mm and the control group 1.48 ± 0.66 mm.

No statistically significant differences were verified in PES values from T0 and T12 (experimental 1.2 ± 2.0, control 0.6 ±2.0) and Probing Depth (experimental -0.8 ± 0.39mm, control 0.00± 0.28mm).

The authors concluded, based on the results, that conventional (straight) and experimental (curved and grooved) abutment designs provided a stable soft tissue after 1-year of follow-up period - no statistically significant differences between the two were detected and confounding factors showed no predictive behavior.

IV.DISCUSSION

COMPARISON OF THE RESULTS BASED ON METHODOLOGIES

During the course of this systematic review, various clinical studies were critically evaluated to investigate the influence of prosthetic emergence profiles on the incidence of peri-implantitis. Differences in marginal bone loss, probing depth and bleeding on probing are variables that can be used to establish differences between specific methodologies employed in the different studies, among which we count prosthetic components used and the surgical protocols followed.

1. PERIODONTAL PARAMETERS

1.1 MARGINAL BONE LOSS

Ahmed et al., (2016) carried out a study in which a marginal bone loss of 0.7 mm was observed in the group utilizing platform switching, a result significantly lower than the 1.2 mm loss reported in the control group with conventional implants ($P < 0.05$). The existence of a micro gap away from the bone, reducing the inflammatory response and subsequent bone loss, can account for this difference. On the other hand, another study

by **Lago et al., (2018)** showed a smaller difference in this variable between the groups of intervention, which received bone-level implants (-0.20 mm) and tissue level implants (0.61 mm), after a period of 5 years ($P < 0.01$). The platform switching concept present in the implant design, which helps preserve the crestal bone, may be a critical factor in the reduce bone loss in bone level implants. **Kim et al., (2019)** compared external hexagonal connections and internal friction connections and found no statistically significant differences in MBL between the two groups ($P < 0.05$). Additionally, **Ferrari et al., (2015)** evaluated different abutment materials (titanium, titanium nitride, and zirconia) and their study found marginal bone loss values ranging from 0.42 mm to 0.57 mm depending on the material used. In this case, zirconia abutments showing slightly more bone loss compared to titanium abutments. Though, the differences were not statistically significant ($P < 0.05$). Finally, **Nemli et al., (2014)** reported that during 24 months, non- submerged implants (0.57 ± 0.21mm) revealed significant lower bone loss than submerged implants (0.68 ± 0.22mm) [$P < 0.1$]. Pérez-Sayans et al., (2022) reported MBL of -0.4 ± 0.6 mm at 6 months for implants with cylindrical and concave abutments. The short follow-up period of 6 months led to its exclusion, as it does not meet the criterion of a follow-up $\geq$ 12-month. Findings by Enkling et al., (2013) state that variations in implant design may not markedly impact long-term bone stability. In their study, at 3 months, 25 months, and 38 months, the bone loss for both implant types was relatively similar, with platform switching exhibiting slightly less bone loss but not significantly so. Specifically, the difference in vertical bone-level alterations between standard and platform-switching implants ranged from 0.05 mm to 0.07 mm, and the general horizontal bone-level alteration was also comparable. However, this study was not included because it was not published in the last 10 years. Previous research by Bernabeu-Mira et al., (2023) also reported that narrower abutment profiles result in reduced bone loss compared to wider profiles. Specifically, the cylindrical group experienced marginal bone loss of 0.03 mm at 12 months, while the wide group had a loss of 0.48 mm. Nevertheless, the study involved implants for a 2–3 crown bridge, not single tooth implants with natural adjacent teeth and thus it was not included.

After revising these studies, it became evident that implant designs, especially those incorporating platform switching, have a significant impact on marginal bone loss results. The variance in marginal bone loss observed across studies could also be influenced by other factors such as the biotype of the periodontal tissue and the loading protocol used.

In the article by **Kim et al., (2019)** there were no significant differences in marginal bone loss between groups with different connection types, in this case external hexagon and internal friction, suggesting that while the type of connection might play a role, it is not the sole determinant of bone loss ($P < 0.05$).

1.2 PROBING DEPTH

The probing depth is another indicator used to predict periodontal health. This variable showed significant differences across the studies due to changes in prosthetic designs and materials. **Nemli et al., (2014)** published an article where implants with non-submerged techniques showed significantly lower probing depths compared with that of submerged implants ($P < 0.01$). This finding suggests that the surgical approach and implant placement level relative to hard and soft tissues play a significant role in determining probing depth. In contrast, a study by **Patil et al., (2015)** reported no significant differences in probing depth between conventional straight abutments and an experimental design of concave abutments after an evaluation period of one year ($P < 0.05$). This indicates that, while the emergence profile may influence other aspects of peri-implant health, its effect on probing depth might be minimal or become apparent only under specific conditions, such as the presence of inflammation due to poor oral hygiene. In their comparison of CAD/CAM customized abutments and standard abutments, **Schepke et al., (2016)** reported slightly improved probing depth outcomes with customized abutments, even though those were not statistically significant ($P < 0.01$). Pérez-Sayans et al., (2022) reported probing depths of 3.9 ± 2.2 mm at baseline and 3.4 ± 1.2 mm at 8 weeks. The short follow-up period excluded this study from the review.

It is important to state that these differences in probing depth measures across different studies might be related with factors related to specifies in patient populations, such as differences in oral hygiene practices, the presence of systemic conditions, and the biotype of the peri-implant tissue. Besides, the duration of the follow-up period could also contribute to these differences, as changes in probing depth might only become significant over a longer period.

1.3 BLEEDING ON PROBING

Bleeding on probing is another variable that showed different results across the studies included in this review. In the study by **Schepke et al., (2016)** the importance of prosthetic fit and precision in minimizing inflammation around the implant was highlighted. Differences between the groups were not statistically different ($P < 0.05$), nonetheless bleeding tendency was for both detected to be identical low during the times tested. As well, **Nemli et al., (2014)** detected also no statistically significant differences (%) between submerged and non- submerged implants regarding to bleeding tendency in all times tested. Finally, and supporting the results, biologic parameters, including bleeding tendency in **Ayyadanveetil et al., (2022)** revealed that between groups tested – zirconia and PEEK abutments – and between groups and control teeth there were no statistically significant differences ($P < 0.99$). Pérez-Sayans et al., (2022) reported a reduction in BOP from 16.9 ± 11.5% at baseline to 8.4 ± 8.8% at 8 weeks, but its exclusion was due to the study's short follow-up.

The results suggest that while the choice of abutment material is important, it should be considered alongside other factors like an appropriate maintenance schedule and the precision of the prosthetic fit. It is important to remind that cofactors as oral hygiene, the position of the micro gap may play a more decisive role in determining biological response.

2. PROSTHETIC COMPONENTS AND PERI- IMPLANT HEALTH

2.1 ZIRCONIA AND TITANIUM ABUTMENTS

When evaluating the relationship between different prosthetic components and peri-implant health, the studies included in our review highlight that certain designs and materials are associated with better clinical outcomes. An important example of this relationship was found in the study by **Bharate et al., (2019)**, who demonstrated that zirconia abutments were associated with less marginal bone loss and bleeding on probing, apparently due to the material’s biocompatibility and reduced plaque accumulation.

The results of **Kim et al., (2019)** and **Ferrati et al., (2015)** suggest that titanium abutments are also well performed in maintaining peri-implant health, with no significant differences reported in probing depth or bleeding on probing when compared to zirconia

abutments. This indicates that even though zirconia may offer some advantages, titanium remains a reliable option, particularly in terms of strength and long-term durability.

2.2 INTERNAL AND EXTERNAL CONNECTION TYPE

In the article by **Kim et al., (2019)** a comparison was stablished between external hexagon connections and internal friction connections, reporting less marginal bone loss with the use of internal connections. Nevertheless, this difference was not statistically significant. Internal connections, particularly those with a conical interface, are thought to provide a more stable and bacteria-resistant seal, which could explain the observed differences in bone preservation.

Similarly, **Farronato et al., (2020)** reported that implants with a 5° internal hexed connection showed better soft tissue outcomes compared to those with a 45° internal hexagonal connection. The enhanced soft tissue response could be attributed to the tighter seal provided by the internal connection, which minimizes micromovement and reduces the risk of bacterial infiltration.

2.3 EMERGENCE PROFILE AND PERI- IMPLANT HEALTH

The emergence profile is a term used to refer to the shape and contour of the prosthetic component as it exits the gingival tissue. This design component significantly affects both the aesthetic and functional outcomes of dental implants. Also, a well-designed emergence profile can minimize plaque accumulation and facilitate proper oral hygiene by the patient, which in term helps to maintain healthy soft tissues and prevent peri-implantitis.

Patil et al., (2014) compared the influence of concave and straight emergence profiles on peri-implant health and found no significant differences in marginal bone loss or soft tissue stability between the two designs. However, the authors state that concave profiles are often preferred for their ability to support soft tissue contours and improve aesthetics, particularly in cases where gingival recession may be a concern.

Schepke et al., (2016) reported in their study that CAD/CAM produced abutments, which can be digitally designed to create an emergence profile specifically tailored to the patient's tissues, led to slightly better outcomes in terms of bone level maintenance and

soft tissue aesthetics compared to standard abutments. These findings suggest that personalized prosthetic designs that take into account individual patient anatomy might offer superior results peri-implant health variables.

3. IMPLICATIONS FOR FUTURE INVESTIGATIONS

Despite the valuable insights provided by the studies reviewed, further investigation is required in several areas. These gaps include long-term studies with larger sample sizes, which are needed to confirm the advantages of zirconia abutments over titanium and to evaluate the durability of different connection types. Additionally, more research is needed to explore the impact of personalized emergence profiles on peri-implant health over extended follow-up periods. To sum up, while the current evidence suggests that certain prosthetic components can improve peri-implant health outcomes, future studies should aim to refine these findings and provide more definitive guidelines for clinical practice.

There seems to be a critical need for strengthening research methodologies and establishing a standardized protocol prior to conducting clinical studies, which is particularly evident in how certain peri-implant health indicators, such as marginal bone loss, probing depth, bleeding on probing, keratinized tissue, and radiographic evaluations. Overall, these parameters are either selectively or inadequately assessed. By strengthening research methodologies and adopting standardized diagnostic criteria, the investigators can ensure that future studies will contribute more consistently to both clinical practice and academic research.

V.CONCLUSION

In this systematic review, it was aimed to investigate the influence of prosthetic emergence profiles on peri-implant health.

During the course of this research, it became clear that the choices made in prosthetic design, whether it is in the material of the abutment, the type of connection implant-abutment, or the shape/contour of the emergence profile, has a direct impact on peri-implant health, straight in periodontal parameters, such as bone level changes, bleeding tendency and probing depth. For that reason, those are decisions that can affect the implant supported rehabilitation prognosis and patient's long-term oral health and, for that, must be taken into consideration.

The literature suggests that zirconia abutments, due to the esthetic appeal and biocompatibility, may offer advantages in reducing inflammation and bone loss, particularly in esthetic areas where both function and appearance are paramount. Nevertheless, the literature revealed no statistically significant differences between zirconia and titanium abutments, regarding to the marginal bone level and bleeding tendency, with the follow-up periods of the studies included.

Studies with a larger samples and follow-up period can however reveal different conclusions or strengthen this conclusion and because of that are needed. Long term inflammation due to oxide titanium and the effect on marginal bone level should be investigated in further randomized clinical trials.

Meanwhile, the choice of an internal connection, especially those with a conical design, seems to provide a more secure and stable environment, helping to protect the bone and soft tissues around the implant. Yet, the differences were also not statistically significant between the external hexed connection and the internal frictional type connection.

Also, as each patient is unique, it was suggested that the best outcomes could be achieved by tailoring the prosthetic design to the individual's specific needs. Yet, statistics showed no significant differences between customized and standard abutments, for the follow- up period evaluated.

The present literature, included in this review, presented limitations that must bear in mind for further researches.

More studies, randomized clinical trials, must be carried out with larger follow-up periods, larger sample sizes, methodology standardized. For that we suggested to

standardize implant, abutment and prothesis characteristics by only changing the component object of investigation. This data should be mentioned. Measures of the periodontal parameters should be taken in each clinical appointment (MBL, BOP, PPD, KT) and references should be the same across all studies as well as occlusion should be considered and measured to. In medical practice this can be hard to achieve, yet it would be the superlative way to investigate the influence of each parameter. The non- controlling factors must be reduced to the patient's oral hygiene and the clinician experience.

Finally, the goal should always be the same: to restore not just a missing tooth, but the whole environment involving that missing tooth. And improve by that oral health and patient's health.
As we move forward, it is essential to continue refining these approaches through ongoing research and clinical innovation. By doing so, we can offer patients not just effective treatments, but also a sense of trust and reassurance in the care they receive.

To the present, literature presents options to treat implants suffering with peri- implantitis. Raising hopes that peri- implantitis cannot be the rehabilitation end line. Yet, knowing that peri- implantitis is the most common biological complication, to prevent it would be the better clinical ethical behavior.

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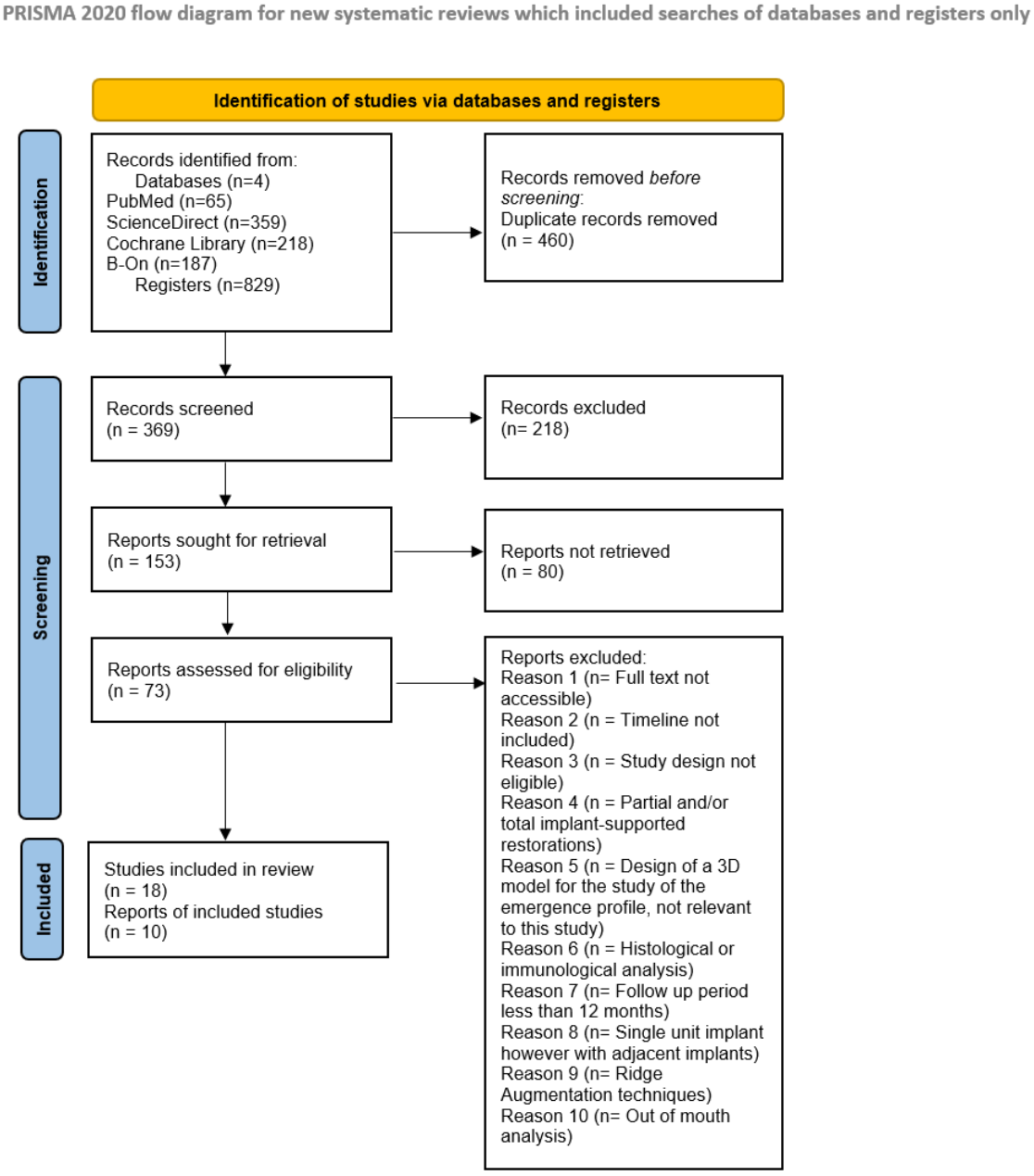
ATTACHMENTS

ATTACHMENT Nº1 – FLOW DIAGRAM PRISMA WITH DIFFERENT STAGES OF SEARCH AND PROCESS OF SELECTION OF THE STUDIES INCLUDED IN THIS STUDY.



ATTACHMENT N°2 – RISK OF BIAS ANALYZE ACCORDING WITH ROB 2.0 TOOL BY COCHRANE.

Low Risk + Some Concerns ! High risk -

Study	D1	D2	D3	D4	D5	Overral
1.	!	!	+	!	+	!
2.	!	!	+	!	+	!
3.	+	+	+	+	+	+
4.	+	+	!	+	!	!
5.	+	+	!	+	!	!
6.	!	-	+	!	+	-
7.	!	!	!	!	+	!
8.	+	!	+	!	+	+
9.	+	!	+	!	!	!
10.	+	+	+	+	+	+
11.	!	+	+	+	+	+
12.	!	+	+	+	+	+
13.	+	!	+	+	+	+
14.	+	!	-	!	+	-
15.	!	!	-	!	+	-
16.	+	!	+	+	+	!
17.	NA	+	!	+	+	!
18.	+	+	!	+	+	!