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FACULDADE DE MEDICINA DENTÁRIA
VISEU

THE INFLUENCE OF ROOT PROMINENCE IN THE ONSET OF GINGIVAL RECESSION AND ITS SIGNIFICANCE AS A RISK FACTOR FOR ROOT COVERAGE TREATMENT: A SYSTEMATIC REVIEW

Dissertação apresentada à Universidade Católica Portuguesa
para obtenção do grau de Mestre em Medicina dentária

Por: Girolamo Raso

Viseu, 2022

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Orientador: Professora Doutora Anna Carolina Volpi Mello-Moura
Coo-orientador: Professor Doutor Gustavo V. O. Fernandes

Viseu, 2022

Per Aspera,
Ad Astra.
Virgilio (*Eneide* IX, 641)

DEDICATORIA

Ai miei genitori,
che senza chiedere in cambio nulla per sé stessi,
mi hanno donato la libertà,
su ogni livello.
Vi amo.

A Selene,
che mi chiama fratello maggiore,
ma non sa quanto sia preziosa per me,
la sua esperienza e determinazione.

Alla mia grande famiglia,
che mi sostiene incondizionatamente,
che rappresenta l'unità fondamentale della mia identità,
e che anche in capo al mondo, per l'eternità,
non smetterei mai di sentirvi CASA.

A Zia Maria,
per tutto ciò che sei e sei sempre stata,
sei insostituibile e
se non ci fossi, andresti inventata.

A Greta,
che con forza e coraggio ha continuato ad accompagnarmi
in questi cinque anni senza mai mollare la presa.

RINGRAZIAMENTI

A tutte le amicizie
che la lontananza ha fortificato
e il tempo ha fatto maturare.

A tutte le amicizie
che Viseu mi ha concesso
e che spero mi accompagnino per il resto del mio percorso.

Aos meus orientadores,

pelo apoio e colaboração,

pela dedicação e por todo o conhecimento partilhado.

A Universidade Católica Portuguesa, por me

acolherem de braços abertos, num ambiente

fantástico, dinâmico e familiar.

RESUMO

Introdução: A patologia muco gengival apresenta-se como uma interrupção aberta do complexo muco gengival ou como uma recessão da margem gengival (GR). A etiologia das GRs é multifatorial, e os fatores envolvidos podem ser de varia natureza e ser relacionados ao paciente ou específicos do sítio a ser tratado. As novas tecnologias ao nosso dispor podem ajudar-nos a perceber fatores que até agora era difícil de avaliar. A proeminência radicular é um desses, mas a literatura está ainda carente sobre o tema.

Objetivo: Esta revisão sistemática visa identificar, avaliar e resumir os resultados de todos os estudos individuais relevantes sobre a proeminência radicular e a sua correlação com as recessões gengivais.

Materiais e métodos: Esta revisão sistemática foi conduzida de acordo com PRISMA *guidelines*. A revisão é baseada na pergunta PICO "Em dentes com raiz com prominência vestibular ou com o processo alveolar com prominência, qual a chance desta característica anatômica, conduzir à recessão gengival ou dificultar o procedimento de recobrimento radicular, quando comparado com dentes corretamente posicionados ou sem proeminência?" Assim, foi efetuada uma pesquisa em três bases de dados: Embase, PubMed e Wiley. Em complemento a esta pesquisa inicial, foi feita uma pesquisa manual.

Resultados: Foram incluídos três estudos. Correlações negativas foram encontradas quando se compararam as variáveis: recobrimento radicular linear, área radicular coberta e ganho de espessura linear. Em proeminências superiores a 1 mm, houve uma diminuição acentuada do recobrimento radicular. Adicionalmente, uma série de casos relata ganhos relevantes de tecido queratinizado no tratamento de recessões gengivais após a odontoplastia da raiz.

Conclusão: Devido às limitações do estudo e ao baixo número de publicações encontradas sobre o tema, não foi possível realizar conclusões específicas. Assim, mais estudos, especialmente, estudos clínicos controlados e randomizados (RCT), são necessários a fim de reforçar a significância da GRs como fator de risco sítio específico e para melhorar a forma como estes defeitos são geridos.

Palavras-chave: Recessão gengival, proeminência radicular, proeminência óssea.

ABSTRACT

Introduction: Muco-gingival pathology presents as an open disruption of the periodontium or as recession of the gingival margin (GR). The etiology of GR is multifactorial, and the factors involved can have different natures and can be either patient-related or site-specific. New technologies at our disposal can help us to understand more factors that until now were hard to assess. Root prominence is one of these, but the literature is still lacking on the topic.

Aim: This systematic review aims to identify, evaluate, and summarize the results of all relevant individual studies on radicular prominence and its relationship with gingival recessions.

Materials and Methods: This systematic review has been conducted according to the Preferred Reporting Reviews and Meta-Analysis guidelines (PRISMA).
The review is based on the PICO question "In teeth with vestibular site-specific root or alveolar bone prominence, what are the chances that this will lead to gingival recession or difficulty in root coverage procedures, compared to teeth correctly positioned in the alveolar bone or without anatomical root prominence?" A search was carried out on three databases: Embase, PubMed and Wiley. This initial search was complemented with manual research.

Results: It was included four studies. Negative correlations appeared when comparing the variables root prominence with linear root coverage, root surface area covered and linear thickness gain. For prominences greater than 1 mm there was a precipitous drop in root coverage. In support, a case series reports relevant keratinized tissue gains in the treatment of gingival recessions after odontoplasty.

Conclusions: Within the limitation of this study and the low number of studies found, it was not possible to draw strong conclusions. It is suggested the development of more studies, especially (randomized controlled trial) RCT, in order to establish more significance for this site-specific risk factor, and to improve the know-how to manage this condition.

Keywords: Gingival recession, root prominence, bone prominence.

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Acronyms and Abbreviations

GR: Gingival Recession

SCI: Sub-epithelial cells injury

CAL: Clinical attachment loss

PD: Probing depth

NCCL: Non carious cervical lesions

MGJ: Muco-gingival junction

RT: Recession type

RCT: Randomized controlled trial

CTG: Connective tissue graft

KT: Keratinized tissue

RES: Root coverage esthetic score

GTR: Guided tissue regeneration

VISTA: Vestibular incision subperiosteal tunnel access

INTRODUCTION

1. INTRODUCTION

1.1 THE PERIODONTUM

The periodontium is as a complex of different tissues surrounding the teeth. The involved tissues are root cementum, periodontal ligament, alveolar bone, and gingiva.

The gingiva is part of the masticatory mucosa, its primary function is to protect the inner tissues against bacterial invasion and other type of aggressions. Indeed, the integrity of the periodontal structures are of vital importance for the stomatognathic apparatus health and functionality.[1,2]

Root cementum is a mineralized, avascular, and consequently acellular tissue. Despite this, its resorption is counterbalanced by continuous affixation throughout life. Its function is to stabilize the periodontal ligament fibers to the roots and to contribute to the repair process after damage to the root surface.[2]

The periodontal ligament is a lax, highly vascularized, cellular connective tissue that surrounds the roots of the teeth and connects the root cementum to the alveolar bone.

Alveolar bone is composed of the alveolar processes, which are formed from the basal bone of the maxillae. Synergistically working with the root cementum and periodontal ligament, it provides accommodation for the teeth, as well as supporting and distributing the mechanical pressures generated by the functioning of the stomatognathic apparatus.[1,2]

1.2 THE DENTAL-GINGIVAL JUNCTION

The dental-gingival junction is the interface between tooth and gingiva, it is divided into compartments, and is composed of epithelial and connective tissue.

The gingival epithelium facing the tooth is known as sulcular epithelium (SE). It is composed of squamous and non-keratinized tissue. It has a 0,5mm mean depth in a healthy periodontium.[1]

The SE continues apically with the junctional epithelium (JE), a nondifferentiated and stratified squamous epithelium which is directly connected to the tooth by the epithelial attachment. This is a structural complex, consisting of a basal lamina-like structures and hemidesmosomes (present in the cytoplasmatic membrane of the JE's cellules) which are capable to link to the enamel. Hemidesmosomes are present in the connective tissue (CT) too, so that the interface between JE and tooth is similar to the one occurring between the JE and the CT.

JE isolate the inner periodontium from the outer oral environment and periodontal diseases arise when this seal fails.[1]

1.3 GINGIVAL RECESSIONS

Pathological mucogingival tissues usually presents two forms. The first, potentially more harmful to the tooth, occurs when an open disruption is created between the compartments of the dental-gingival junction. This is related to the formation of periodontal pockets that will presents pathological probing measurements (PD > 3mm). The other condition, potentially less aggressive, is known as gingival recession (GR). It consists in the migration of the gingival margin in apical direction, until being dramatically displaced from the CEJ. This loss of CAL may not be isolated only to the vestibular face of the margin so that interproximal areas may be interested too. The clinical result will be a denuded root surface, exposed to the oral environment, with involvement of one or more sides of the root. [3-4]

The oral ambient is a hostile place for the body cells, which suffer stresses and changes, happening in their internal and external environment.[5]

Cells begin to digest their own structural components and organelles, to reduce the amount of energy needed to execute the cell's vital processes, to able to survive in hostile ambient too.[5]

GRs results from atrophic cellular changes. The term "atrophy" refers to a decrease in cell volume or number, resulting from sublethal cell injury (SCI).[6]

Since SCI is essentially reversible once the causal factor is removed, the process of volume reduction should cease and the number and size of cells might be restored to normal levels; however, it all depends on the severity of the lesion.

GRs are a common condition especially found in adults' teeth both with high or low hygienical standards and with healthy periodontium. GRs are defined localized when affecting only one tooth or generalized when affecting multiple teeth. Usually, they are more detectable in teeth with one root than in teeth with many roots.[7–9]

In patients with high standard oral hygiene, GRs are more expectable to occur on the buccal surface of teeth, especially on the mandibular incisors and usually, they do not present interproximal loss of attachment. In patients with poor oral hygiene, recessions tend to be generalized, due to the nature of the aggression, with involvement of interproximal areas, presenting the typical horizontal pattern of tissue loss.[10]

Kassab et al. stated that almost 50% of adult patients with an age range from 18 to 64 present at least a site with 1mm recession, and that 88% of patients older than 65 presented at least one site with clinical attachment loss (CAL), confirming the trend that periodontal loss of support increase with age.[11]

GRs increase the incidence of root caries and are related to the onset of NCCL (non-carious cervical lesion, patients usually seek a treatment referring tooth hypersensitivity or aesthetic concerns.[11] They tend to aggravate rather than improve, though rarely results in tooth loss.[12,13]

1.4 ETIOLOGY

Since the changes that occur at the cellular level in GR result from processes that are essentially reversible[5], early identification of those factors that are causing these processes becomes essential.

The etiology is multifactorial, involving a big variety of mechanisms (anatomical, physiological, mechanical, traumatic, inflammatory or pathological, and iatrogenic) that often work synergistic in causing the recession.[14]

The etiological factors related to the occurrence of gingival recessions can be divided into two groups, predisposing factors, and precipitating factors. Predisposing factors are those conditions that are favorable to the occurrence of GR while precipitating factors are those contributing to the onset of GR.[10]

PREDISPOSING FACTORS	PRECIPITATING FACTORS
Dimension of the gingiva	Orthodontic treatment
Abnormal frenal attachment	Plaque induced inflammation
Root prominence	Traumatic toothbrushing
Bone prominence	Smoking
Dental malposition	Sub-gingival restoration
Physiological factors	
Bone dehiscence/fenestration	

Figure 1. Predisposing and precipitating factors for recession.

Predisposing factors

Bone dehiscence/fenestration

It has been investigated, how bone morphology can influence the overlying gingiva, and positive correlations between bone defects and GR were found[15], hence when analyzing an apical migration of the gingival margin we can expect, deeper, a bone defect of dehiscence or fenestration, however, these kinds of bone defects may not alone cause or accelerate the gingival margin degradation process.[10]

Dimensions of gingiva

Gingival thickness is suggested as key factor in the periodontal health. In contrast to what was formerly believed, it is not the height of the keratinized layer that is determinant, but rather the thickness[16].

Abnormal frenal attachment

Despite the contradictory results reported in the literature, an abnormal frenal attachment can directly act on the gingival margin by pushing it in an apical direction.[17,18]

Root prominence/bone prominence

Despite root prominence is considered detrimental for the mucogingival complex, and it is suggested as an etiologic agent and risk factor for gingival recessions or root coverage procedures respectively the amount of cohort studies and randomized controlled trials (RCT) about the topic, is very scarce.[18–20] When prominent root are adjacent, because of the increased volume of space in the vestibular-lingual plane, concavities between the tooth and the adjacent bone may be visible[21] causing the retraction of the overlying gingiva.

It is common, especially in those patients with high hygienical standards who practice a faulty toothbrushing, to find GRs in those areas affected by bone prominences, which forms a wedge-shaped defect with the normal plane of the alveolar bone.[1] Even if the retraction only occurs on the prominent site of the bone, it is more common for it to progress than to stabilize.[22]

Clinicians should be able to identify areas of bone or root prominences, not only because it can improve the prognosis, but also in a preventive sense. Doing counseling with the patient and being aware of the risk of recession occurrence may limit the onset.

Dental malposition

A mispositioned tooth, depending on the site of eruption, can show little or no keratinized tissue, which is a predisposing factor for a more sensible gingival tissue.[23] Over extruded teeth may suffer a displacement, depending on the occlusal force, causing an occlusion trauma which can result in gingival recession.

It has also been pointed out by several studies, how the repositioning of a misplaced tooth, within the alveolar socket, contributes to the neoformation of keratinized tissue and the gain of tissue volume in general.[6]

Physiological factors

Caucasian race, masculine sex, aging, craniofacial abnormalities, and thin biotype are physiological factors that research has shown as predisposing for GRs.[7,24,25]

Precipitating factors

Traumatic toothbrushing

Traumatic brushing technique (noncomplex brushing technique) is among the most relevant precipitating factors, especially among young patients.[1] Patients with high hygienical standards are those with the biggest prevalence of traumatic toothbrushing-related GRs.[10] In addition, it's cited in the literature the relationship between the occurrence of GRs in the canine and premolar region of the mandibular hemiarch corresponding to the dominant hand side.[26] NCCL may be a complementary finding, especially abrasion lesions.

Plaque induced periodontal inflammation

Along with traumatic toothbrushing, plaque-induced inflammation represents one of the major precipitating factors in the onset of GRs. The connective tissue underlying the gingiva is the most affected tissue during this kind of biological attack, resulting in CAL and proliferation of junctional epithelium in the place of the connective tissue. This ectopic proliferation leads to epithelium surface collapse, with a consequent recession of the gingival margin.[10,16]

Usually, when a GRs is associated with plaque-induced inflammation the interproximal area is also involved, interproximal CAL may be found, and all teeth surfaces may be involved. When a periodontal inflammation disease is already established, its surgical or nonsurgical resolution may result in GRs during the healing period.[10]

Recessions associated with plaque usually appear in patients with thin biotypes. This is because it is measured that bacterial expansion and the diffusion of inflammatory exudate do not exceed 1-2mm in an apical and lateral direction. Consequently, in thick biotype gingiva, bacterial proliferation will not reach deep areas like it would in a thin biotype, where the entire connective area may be interested.[1] It has been shown that in the presence of plaque-induced inflammation, a thin periodontal biotype is more prone to degenerative changes.[27]

Subgingival restorations

Dental restorations or crowns, with subgingival margins, contribute to GRs either directly or indirectly. They may act directly, in the case of excessively prominent margins or due to direct contact between the restorative material and the periodontium, or indirectly by causing plaque accumulation localized at the margin of the restoration and subsequent inflammation.[10]

Orthodontic therapy

Sometimes orthodontics movements result in out-of-the-bone movements, consequently, a fenestration or dehiscence may occur, which provides a bigger potential for GRs occurrence.[1] The most affected site is the buccal aspect of the lower incisor, especially when movements are made in an anterior direction. Molars can be affected too if out-of-the-bone lateral movements are made.

It is necessary to cite that orthodontic treatment is considered also possible treatment solution for gingival recessions.[6]

Smoking

Smoking is cited as one of the most common causes of GRs. Smoke affects the prevalence severity and extent of GRs. Smoking influences clinical outcomes of surgical or non-surgical treatment of GRs[28].

1.5 EXISTANT CLASSIFICATIONS

Since 1968, various authors proposed their classification:

- Sullivan and Atkins (1968);
- Mlinek (1973);
- Liu and Solt (1980);
- Benque (1983);
- Miller (1985);
- Smith (1990);
- Pini-Prato et al. (2010);
- Cairo et al. (2011).

The first classification proposed, by Sullivan and Atkins[29], divides recessions into four groups depending on the depth and the width of the defects: deep wide, shallow wide, deep narrow, and shallow narrow. Even if it's a simple classification its limitation is the subjective interpretation that was left open.

In 1973, Milnek et al.[15] introduced a numerical value to differentiate between shallow narrow and deep wide defects, respectively defects <3 mm and > 3mm. Although this could limit the free subjective interpretation another issue occurred, there wasn't any landmark for horizontal measurements.

Liu and Solt's (1980)[30] classification divided recession defects into two categories: 1) visible which is the measurement from the CEJ to the gingival margin; 2) hidden which is the depth of the sulcus/pocket, measured from the gingival margin to the bottom of the sulcus/pocket. The sum of these two measurements gives us the total amount of the recession. This classification could not accomplish the task to assess those cases where CEJ was absent and does not provide information about prognosis.

In 1983, Benque et al.[31] classified gingival recession defects based on the shape of the defect and the prognosis: (i) U-shaped: poor prognosis for covering treatment, (ii) V-shaped: favorable prognosis, (iii) I shaped: good prognosis for covering treatment. The limitation of this classification was the poor scientific support.

In 1985, Miller came out with his classification which is still probably the most widely used.[32] The classification is essentially based on the radicular-crown extent of the marginal recession, and the extent of the interproximal hard and soft tissue lost in the area surrounding the recession.[7,33] This classification is relevant because of how much it says about the prognosis of root coverage using a free gingival graft procedure. Miller's classification has four classes in ascending order of severity and difficulty in treatment:

- Class I and II: In the first two classes are included recession defects with no bone or soft tissue lost in interproximal areas and a good prognosis of complete coverage of the recession is expected. The only difference is the apical extension of the recession, which is limited to the attached gingiva in class I and it goes above the MGJ in class II.
- Class III: Recession that goes to or above de MGJ and characterized by loss of hard and soft tissue in the interproximal area that does not extend more apical than the buccal recession does or by a mispositioned tooth. This type of defect does not produce 100% root coverage.

- Class IV: It is similar to the class III recession but in this case, the interproximal loss goes to or beyond the buccal surface recession. The defect is so severe that we cannot make a predictive prognosis for the coverage of the exposed root.

In 1990, Smith[34] proposed an index of recession formed by two digits separated by a dash. The first digit is used to state the horizontal and the second to state the vertical component of the recession. In horizontal extent, score 0 is used with no evidence of root exposure; score 1, when clinically there is no evidence of the exposed root but there is a dentinal hypersensitivity in response to air blast and\or if the CEJ is exposed for up to 10% of the estimated mid-mesial to mid-distal distance; score 2, for horizontal exposure of the CEJ more than 10% not exceeding 25% of the estimated mid-mesial to mid-distal distance; score 3, exposition of the CEJ more than 25% of the mid-mesial to mid-distal distance but not exceeding 50%; score 4, for exposure of the CEJ more than 50% of the mid-mesial to mid-distal distance but not exceeding 75%; whereas, score 5 is the exposure of the CEJ more than 75% of the mid-mesial to mid- distal distance up to 100%.[35]

And for vertical extent, score 0 had no exposed root is clinically observed; score 1, no clinical signs of root exposure but the patient refers to dentinal hypersensitivity and\or the CEJ is exposed not more than 1mm vertically to the gingival margin; score 2-9, root exposed from 2mm to 9mm to the base of the soft-tissue defect.

An asterisk (*) is used in the score, next to the second digit, whenever the vertical component of the soft-tissue defect encroaches into the mucogingival junction (MGJ) or extends beyond it into alveolar mucosa; the absence of an asterisk implies either the absence of MGJ involvement at the indexed site or its noninvolvement in the soft tissue defect.[34,35]

In 2010, Pini Prato et al.[36] proposed a new classification with the purpose to introduce some clinical parameters to analyze the exposed root conditions. The researchers aimed to integrate into the already existent classifications some information about the presence or absence of the CEJ and about the condition of hard tissues, like the presence of discrepancy in hard tissues (step) in the root surface, which could result from the NCCL. This is because even Miller's class I or II recession type could be difficult to quantify the complete root coverage in the absence of such an important landmark as the CEJ. Also, dental elements associated with a non-visible CEJ are usually not included in the studies because of this limitation. So, we have:

- Visible CEJ = A
- Non-visible CEJ = B
- Presence of step = +
- Absence of step = -

Cairo et al. (2011)[37] created a classification based on the assessment of CAL in interproximal and buccal surfaces. The recession types (RT) were divided:

- RT1: GR not associated with interproximal attachment loss. CEJ is not detectable interproximal;
- RT2: GR with interproximal loss of CAL. The interproximal loss of CAL (measured from interproximal CEJ to the bottom of the sulcus) is less or equal to the buccal CAL loss (measured the same way then the interproximal, but this time is on the buccal surface);
- RT3: GR with interproximal loss of CAL. The amount of interproximal CAL is higher than the base of the recession.

1.6 TREATMENT

The treatment of GR has many indications such as esthetic demands, root sensitivity, preventing and reversing of the advancing trend of the recession, and as a complementary treatment for class V carious lesions.[32]

Studies have demonstrated that Identifying the CEJ has a big relevance in the diagnostic and treatment of gingival recessions, this is because it's a landmark in various classification systems, and we can use it to quantify the level of gingival margin retraction and it is also helpful to predict the treatment outcome as well as guide us to make a differential diagnostic with incomplete exposure of the anatomical crown due to eruption process issues.[14,38]

Root coverage has become always more studied, various type of surgical approaches are described in literature, but even if RCT studies have been conducted and expressed positivity about all proposed surgical approaches, none expressed superiority among the others.[39]

Since there are various path to follow for the obtention of complete root coverage, clinicians should apply the best technique for every patients, individualizing every situation, with focus on the resolution of the esthetic concern and other eventually related symptoms.[19]

Given this, Chambrone et al. (2022)[40] affirmed that coronally advanced flap in conjunction with the use of subepithelial connective tissue graft, is the golden standard for root coverage procedures.

MATERIALS AND METHODS

2. MATERIAL E MÉTODOS

This systematic review has been conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis guidelines (PRISMA). The protocol for this study will be registered on PROSPERO. The focused question for the present review was as follows: “Is there a relation between the presence of anatomical abnormalities of the bone or tooth (malposition, prominences, and dehiscence or bone fenestrations) and the appearance of GRs?”

2.1 PICO QUESTION

The acronym PICO is used to indicate four essential factors for conducting an investigation.

In teeth with vestibular site-specific root or alveolar bone prominence (P), what are the chances (O) that this will lead to gingival recession or difficulty in root coverage procedures (I), compared to teeth correctly positioned in the alveolar bone or without anatomical root prominence (C)

P: teeth with site-specific root/bone prominence

O: the likelihood

I: occurrence of gingival recession or difficulty in root coverage procedure

C: patient who does not present root or alveolar prominence

2.2 INFORMATION SOURCES AND SEARCH STRATEGY

A bibliographic search was conducted using MEDLINE/PubMed, Web of Science, and EMBASE, to collect articles published between January 2012 and January 2022 (10 years), with English language restriction. The used terms were ((gingival recession OR retraction OR recession) AND (protuberances OR prominence OR eminence OR malposition OR exostosis OR rotation)) AND (coverage). The research has been performed by combining the previous terms and applying inclusion/exclusion filters. An additional manual research was performed.

2.3 INCLUSION CRITERIA

This study was conducted based on any type of clinical study, such as randomized clinical trials, controlled clinical studies, case series, and case reports. The mandatory

simultaneous criteria used were clinical study; studies published in English; publication date from January 2012 to January 2022; human studies; and articles that have the search terms in the title or abstract.

2.4 EXCLUSION CRITERIA

Clinical studies that did not fully meet the inclusion criteria, studies based on questionnaires, editorial letters, SRs, and meta-analysis, laboratory and animal studies, and interviews.

2.5 STUDY SELECTION

After the bibliographic search, two independent researchers (G.R. and G.V.O.F.) filtered relevant articles that fitted the study by analyzing the title and abstract for study selection. Any disagreement between the reviewers was discussed with a third author (N.B.M.S.). Cohen's kappa test was performed to assess the reviewers' agreement. The same strategy of disagreement resolution has been applied for the manual research.

2.6 DATA EXTRACTION AND QUALITY ASSESSMENT

Reviewers extracted the data independently from the selected articles for further analysis using data extraction tables which included the following parameters: author(s), year of publication, study design, main goal, the number of participants, inclusion and exclusion criteria, analyzed clinical parameters. All values and details were reported.

Assessment of risk of bias and study quality of the included studies has been performed independently by two reviewers (G.R. and G.V.O.F.). The ''strengthening the Reporting of Observational Studies in Epidemiology'' (STROBE) statement was applied. The ratings obtained will be verified by a third reviewer (N.B.M.S.) and any discrepancy will be resolved by discussion of the group.

RESULTS

3. RESULTS

3.1 BIBLIOGRAPHIC RESEARCH

After bibliographic research on three database (Embase; MedLine/PubMed; Wiley) a total of 163 articles were found. Title and abstract were evaluated, and 27 articles successfully passed this stage and have been selected for full text reading. After full text reading 25 article were excluded due to incongruency with this review. Therefore, the bibliographic search on the databases produced a total of 2 articles of interest. Additionally, manual research produced 1 more article.

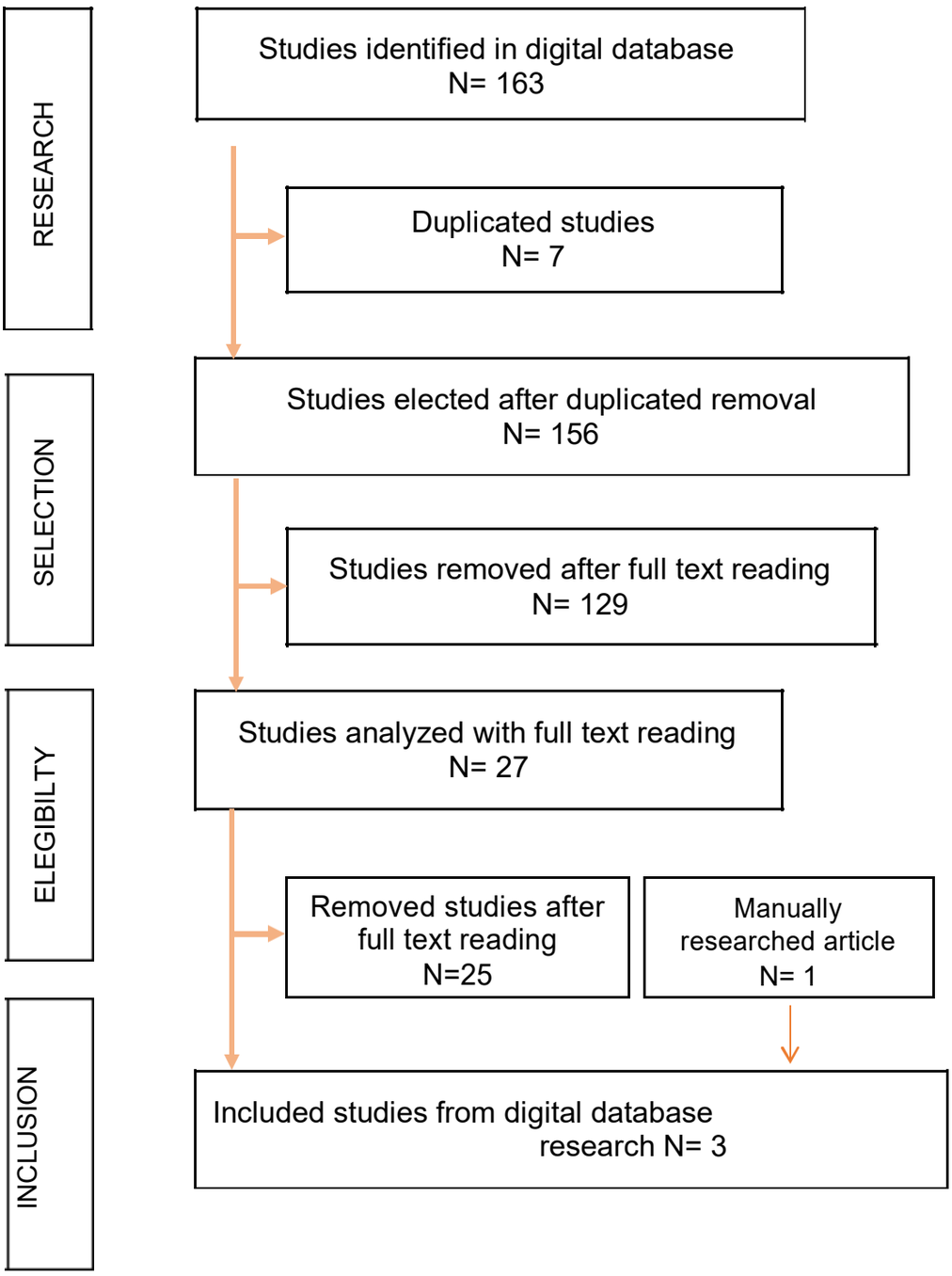

Figure 2. Flow diagram for the selection process for the included articles.

3.2 INTER EXAMINATOR AGREEMENT

Cohen's Kappa coefficient was applied in the study of inter-examinator agreement. Standard deviation revealed a value of K= 0.92. Values higher then 0.80 are considered excellent, meaning that all disagreement were resolved with consensus.

3.3 QUALITY ASSESMENT

The STROBE checklist was used to establish quality of the included studies. All studies had a high-quality assessment, found values greater than 85%.

Table 1. Quality assessment.

items / articles	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Tot %	Tot
A1	1	1	1	1	1	1	1	1	0	0	1	0	1	1	1	1	0	1	1	1	1	1	86%	19
A2	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	1	1	1	1	1	1	91%	20
A3	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	95%	21

3.4 STUDIES CHARACTERISTICS

All included studies were detailed in the tables 2-4.

Table 2. Studies characteristics.

Article	Authors	Title	Year	Country	Study design
A1	Javier Núñez et al. (41)	A two-step surgical approach with flattening of the root surface to treat localized gingival recessions affecting mandibular incisors: a case series report.	2018	Spain	Case Series Report
A2	Alfonso Gil et al.(42)	Treatment of multiple recession defects with vestibular incision subperiosteal tunnel access (VISTA): a retrospective pilot study utilizing digital analysis.	2018	California, USA	Retrospective Study
A3	Alfonso Gil et al.(43)	Three-dimensional volumetric analysis of multiple gingival recession defects treated by the vestibular incision subperiosteal tunnel access (VISTA) procedure.	2019	California, USA	Retrospective Study

Table 3. Articles details.

Article	Analyzed clinical parameters	Objective	Results
A1	-Gingival recession (GR) -Clinical attachment level (CAL) -Keratinized tissue width (KTW) -Bone dehiscence (BD) -Evaluation of the esthetic outcome (1 year) by means of the RES -Dentin hypersensitivity	The aim of this case series study was to analyze the clinical outcome of the two-step procedure in patients with localized gingival recessions and prominent roots secondary to orthodontic therapy.	-Root coverage: 100% in all RT1-2 defects - 80.5% root coverage in RT3 defects -Clinical attachment level gain ($p<0.001$) -Keratinized tissue width gain ($p<0.001$) -Recession defect reduction ($p<0.001$)
A2	Recession class -Tooth type -Graft type -Root prominence -Initial recession depth/ width -Initial gingival margin thickness -Arch location.	To examine the correlation between initial site-specific characteristics of patients with multiple gingival recession defects and the outcome of root coverage therapy.	-Mean root prominence and linear root coverage ($r= -0.80$; $p<0,001$) -Mean root prominence and root surface area covered ($r= -0.83$; $p<0,001$). -A precipitous drop in root coverage was observed in sites with root prominence greater than 1 mm.
A3	-Initial recession depth -Initial gingival thickness -Types of recession -Tooth type (incisor, canine, premolar, or molar) -Graft type -Root prominence -Anatomical location in the arch -	This study sought to evaluate gingival volume changes following root coverage with the vestibular incision subperiosteal tunnel access (VISTA) procedure.	-Initial root prominence and linear thickness gain ($R = –0.18$) ($P = .02$), when the gains achieved at 2-, 3-, 4-, and 5-mm levels were combined. -Initial root prominence and volume gain did not show a significant correlation ($P = .71$)

Table 4. Selective criteria.

Article	Sample	Inclusion Criteria	Exclusion Criteria
A1	-10 patients (3M-7F) -Mean age: 28±10	-GR mandibular incisor -Age > 18 -Systemically healthy -Lack of KT -Shallow vestibule	-Smokers <10 cigarettes -Systemically unhealthy -GR associated with NCCL
A2	21 Patient (154 teeth) 8M-13F. Mean age: 52.4 ± 9.5	-Age: 18-75 years. -RT1-2 (>1 mm in depth) on at least 2 adjacent teeth. -Presence of identifiable cementoenamel junction (CEJ) or restorative margin that was reliable to use as a reference. -Availability of diagnostic quality study casts at preoperative (within 3 months prior to therapy) and post-therapy (≥12 months postoperatively).	-Smokers >10 cigarettes a day. -Miller Class IV gingival recession. -Patients taking medication that could affect the gingival health or anatomy. -Previous mucogingival surgeries performed in the area of analysis.
A3	-21 Patient (154 teeth) 8M-13 -Mean age: 52.4 ± 9.5	-Patients between 18 to 75 years of age. -Multiple recession type I (RT I) or II (RT II) defects on at least two adjacent teeth -Presence of identifiable cementoenamel junction (CEJ) or restorative margin that was reliable to use as a reference. -Availability of diagnostic quality study casts at preoperative (within 3 months prior to therapy) and post-therapy (≥12 months postoperatively.	-Heavy smoking (more than 10 cigarettes a day). -Recession type III (RT III) defects. -History of mucogingival surgeries in the area.

3.5 STUDIES RESULTS

- **Study A1**. This study described a treatment strategy for anterior localized gingival recessions composed of two steps. First, odontoplasty is performed to modify the root surface, creating a new emergence profile, and after eight weeks, tunnel root coverage procedure + CTG is performed. The goal was to provide extra space for the graft (which should directly cause thickening of the gingival margin) and be able to correct the root prominence.

The small number of patients comprising the study, lack of a control group, non-quantification of odontoplasty, and lack of control of investigator-operator bias are limitations to this study. Nonetheless, the results related to this case series are favorable, in terms of % root coverage, CAL gain, and especially in terms of KT gain.

- **Study A2**. It consisted in a retrospective study, investigating the relationship between site specific characteristics of patient treated with VISTA technique, and the outcome of the root coverage procedure. Mean root prominence = 0.8 ± 0.6, was negative correlated (r= -0.80) with linear root coverage. The exposed root area covered after the surgical procedure is also negatively correlated with mean root prominence (r= -0.83).

The lack of a control group and the inability to quantify true mucosal thickness are limitations of this study but valuable benefits can be derived from this study, including having proposed an innovative measurement technique that gives the opportunity to make superimpositions of preoperative and postoperative images, for more reliable comparation results, and because of the nature of the measurement technique, new parameters, usually hard to evaluate, could be established.

- **Study A3**. It reported digital volumetric measurements of preoperative and postoperative periodontal data of multiple recession-type defects treated with the VISTA technique, seeking to evaluate which were the gingival volume changes following root coverage with the vestibular incision subperiosteal tunnel access (VISTA) procedure.

Linear and volumetric changes in gingival thickness at 1-2-3-4-5 mm from the postoperative gingival margin were analyzed. For gingival linear gain, initial root prominence was again shown to be detrimental, with a negative correlation r= -0.18 (p=0.02). In this case, however, initial root prominence and volumetric thickness gain had no significant correlation.

The lack of a control group, and the fact that we only know the thickness changes but not the actual thickness of the gingival tissue, represent limitations for this study.

DISCUSSION

4. DISCUSSION

Gingival recession is one of the most current topic debated in the literature, and there are many etiological factors associated with it. One of them, which has low level of research published, is the prominence of the root. Teeth characterized by an exceedingly buccal location are associated with poor periodontal characteristics (thin biotype) (19) and are generally more prone to mucogingival defects. The research strategy used in this systematic review, resulted in the identification of works where the effects on the periodontium of excessively prominent root, are studied *in vivo*, and which tools and techniques are more powerful and reliable to be able to establish the nature of this parameters. Beyond that, this research highlighted the low number of cohort and case/control studies on the topic, emphasizing the need for further research to better understand and assess root prominence.

Root prominence is a risk factor in the treatment of GRs. Its influence on the outcome of GRs treatment has been shown to be detrimental, showing negative correlation with both: mean root coverage and linear thickness gain. The unfavorable action of the root prominence was better observed in those cases where the root was > 1mm prominent (42,43).

In support to what reported, a case series, suggested how reducing prominent sites in dental roots, by means of odontoplasty, is beneficial for the outcome of root coverage procedures. The treatment protocol provided extra space for both the placement of the graft and the subsequent formation of a thicker gingival profile, compared to other studies where odontoplasty technique was not performed (41).

It has been pointed out that the polishing of root surfaces does not substantially modify them, and in cases of root curvature even a vigorous root planning did not affect the prominence, but only demonstrate to slightly reduce the mesiodistal dimension, resulting in a slightly flattened root surface (6%) (20). While normal root planning has not demonstrated differences in healing pattern in controlled experimental and clinical studies (44), it is safe to say that in those cases where root prominence occurs, extensive root planning, even with the use of rotatory instrument to reduce the avascular bed for the flap, is suggested (45,46). Moreover, in GTR technique, the same philosophy is encountered, and the creation of little convexity, on the root, is suggested in order to create more space for tissue regeneration (47).

This systematic review, although limited by the number of included studies and their nature, encompass relevant information about: (i) the benefits that could be gained by complementing mucogingival surgery with odontoplasty techniques vise to reduce prominence before the surgery; (ii) how to quantify root prominence and gingival changes, with an efficient, reliable, and reproducible method; (iii) the contribute that different prominence degrees give to the outcome of root coverage treatment. Despite the obtained results confirm that root prominence may be detrimental for both, periodontal health and root coverage procedure, more studies, with a major evidence should be carried out, to assess: the reproducibility of the measurement methodology applied in studies A2 and A3, the outcome of root coverage procedure preceded by odontoplasty and the real quantified influence that root or bone prominence have on the occurrence of gingival recession and the outcome of root coverage procedure.

Evidence about tooth malposition and its significance for periodontal health have been investigate early in the past. It is described in literature that the eruption pattern of the tooth appears to be correlated with the periodontal status of the tooth. For teeth erupted in a labial direction, the thickness of the attached gingiva is narrow, with an absence of keratin at the gingival margin. These conditions are considered detrimental to periodontal health (48–50).

Periodontal health at level of gingival thickness could also be compromised, in cases of impacted teeth in an excessively labial position before the treatment (51,52).

In a study analyzing the periodontal status after orthodontic treatment in maxillary canines with labial eruption pattern, it was seen that out of ninety-four canines observed, sixty-nine had an ectopic eruption pattern. Of the sixty-four ectopic canines, 15 had gingival recession. The authors defend that the value is high, considering the age of the studied population, concluding that labial eruption pattern may affect periodontal status (53).

CONCLUSIONS

5. CONCLUSIONS

It was developed a review focused on the influence that a site-specific characteristic, specifically root or bone prominence, may have on the occurrence of GRs or on the outcome of the treatment of GRs. It is also emphasized that the literature already considers these characteristics as negative for the outcome of root coverage procedure and as risk factor for the onset of GRs. Indeed, it is already mentioned in studies as a variable to be considered when approaching this type of mucogingival defects. Therefore, within the limitation of this study and the low number of studies found, it was not possible to draw strong conclusions.

Moreover, due to the use of digital technologies, new paths for the assessment of such parameters are arising, and so does the interest on the issue, with new evidence, being pointed, on the topic. Therefore, it is deemed necessary to emphasize once again the importance of conducting, above all, randomized studies, with regard to root prominence, gingival recessions, and tissue thickness, in order to increase the scientific significance of this factor and to increase knowledge and know-how on how to handle clinical cases in which this characteristic occurs.

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6. REFERENCES

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