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FACULDADE DE MEDICINA DENTÁRIA
VISEU

ONE-ABUTMENT ONE-TIME INSERTION AND RELATED OUTCOMES: A SYSTEMATIC REVIEW OF THE LITERATURE WITH META-ANALYSIS

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

Por:
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Orientador: Professor Doutor Tiago Gonçalves Ferreira Borges
Coorientador: Professor Doutor Bruno Leitão de Almeida

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QUOTE

“Be as you wish to seem”
Sócrates

Ao meu orientador, Professor Tiago Borges, pela paciência, empenho e exigência sob a forma de incentivo ao longo deste trabalho.

À minha mãe, a minha melhor amiga. A pessoa que me mostrou o verdadeiro significado do amor, da perseverança e que me ensinou que os sonhos nunca são grandes demais para se tornarem realidade.

Ao meu pai, a minha apreciação por tudo o que fez e faz por mim que não passa despercebido. Por me fazer sempre sentir segura, me ter feito chegar aqui e acreditado em mim à sua maneira.

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Abstract

Background: The one-abutment one-time (OAOT) insertion protocol is an emerging approach in implant dentistry, that aims to simplify the rehabilitation procedure compared to conventional protocol. This systematic review with meta-analysis synthesizes the current literature on OAOT insertion, evaluating its effects on clinical outcomes such as survival rates, success rates, and peri-implant indices such as Marginal Bone Loss (MBL) to conventional protocol.

Materials and Methods: This study was registered on the PROSPERO platform and carried out in compliance with the PRISMA statement for systematic reviews. A thorough electronic search was conducted in two primary databases Medline/PubMed and CochraneDatabase focusing specifically on RCTs spanning from 2010 to 2024 to identify pertinent literature. Each identified article underwent meticulous analysis, and inclusion or exclusion was determined based on pre-established standards.

Results: Eleven RCTs with minimum follow-up period of 4 months were selected (550 patients and 830 implants). Notable variances were observed in MBL at 6 and 12 months, favoring the test group.

Conclusions: The OAOT protocol demonstrates a discernible impact on clinical outcomes within the short to medium term, particularly regarding variables like MBL that are indicative of the sustained success of implants.

Key words

Dental implant, one abutment one-time, one-time abutment insertion, marginal bone changes

Resumo

Introdução: O protocolo de inserção de pilar “one-time” (OAOT) é uma emergente abordagem na implantologia dentária que visa simplificar o processo de reabilitação comparativamente ao protocolo convencional. Esta revisão sistemática com meta-análise sintetiza a literatura existente no protocolo de inserção OAOT, avaliando o seu efeito em resultados clínicos como taxas de sobrevivência, taxas de sucesso e índices peri-implantares como a perda óssea marginal, ao protocolo convencional.

Materiais e Métodos: Esta revisão foi registada na plataforma PROSPERO e seguiu as diretrizes estabelecidas na declaração PRISMA para revisões sistemáticas. Foi feita uma pesquisa eletrónica meticulosa em duas bases de dados, Medline/PubMed e Cochrane, focando-se especificamente em RCTs desde 2010 a 2024 para identificar literatura pertinente. Cada um dos artigos identificados foi submetido a uma meticulosa análise, e a inclusão ou exclusão foi determinada baseada nos padrões pré-estabelecidos.

Resultados: Foram selecionados 11 estudos clínicos randomizados com um período mínimo de seguimento de 4 meses (550 pacientes e 830 implantes). As diferenças notórias foram observadas relativamente à perda óssea marginal aos 6 e 12 meses, favorecendo o grupo de teste.

Conclusão: O protocolo OAOT demonstra um impacto significativo em resultados clínicos em curto a médio prazo, particularmente em variáveis como a perda óssea marginal que demonstra a eficácia sustentada dos implantes dentários ao longo do tempo.

Palavras-chave

Implante dentário, one abutment one time, one-time abutment insertion, mudanças ósseas marginais

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Tables and Figure Index

List of abbreviations and acronyms

MBL: Marginal Bone Loss
PS: Platform-Switching
PM: Platform-Matching
OAOT: One-Abutment One-Time
PRISMA: Preferred Reporting Items for Systematic Review and Meta-Analyses
MBC: Marginal Bone Changes
PICO: Population, Intervention, Comparison, Outcome
RCT: Randomised Controlled Trial
PD: Probing Depth
BoP: Bleeding on Probing
PI: Plaque Index
mPLI: Modified Plaque Index
mBI: Modified Bleeding Index
KM: Keratinized Mucosa
ISQ: Implant Primary Stability
PSR: Periodontal Screening and Recording
CI: Confidence Interval
PA: Provisional Abutment
DA: Definitive Abutment

1. INTRODUCTION

I. Introduction

I.1. Dental Implantology Principles

Dental implantology represents a dynamic and innovative field within dentistry, providing cutting-edge options for those facing tooth loss. Its core is the precise positioning of artificial tooth-roots, termed dental implants, which transcends mere restoration. It aims not only to restore functionality and aesthetics but also to ensure lasting stability and seamless integration within the oral structure. Key to success implant treatments is the achievement of osseointegration and maintenance of implant hard and soft tissues (1).

Bone remodeling represents a process set in motion by the forces that impact bone (2). This adaptive response holds pivotal importance in upholding bone strength, integrity, and flexibility in response as they react and adapt to alterations in mechanical stress and environmental stimuli.

Osteointegration is a crucial measure of implant stability, marking the successful integration of the implant (3). This process encompasses the modeling and restructuring of bone tissue, alongside the gradual formation of a mucosal barrier encasing the implant. Initially, a coagulum forms, which then transitions into granulation tissue. This process fosters the emergence of a protective epithelial shield and the enhancement of connective tissue maturity (4).

The biological width denotes the minimum soft tissue dimensions surrounding an implant required to safeguard osseointegration (5). This involves securing the attachment of soft tissue to the implant through the formation of an epithelial junction and supra-bony fibrous tissue, thus facilitating stability (6). In the beginning, there is an initial MBL around the implant during this establishment phase, enabling proper soft tissue adaptation to the implant surface and fostering a stable and healthy peri-implant environment.

Throughout the healing phases of two-piece implants and subsequent procedures like abutment connection and final prosthesis delivery in single-tooth replacements, bone supporting the implants experiences resorption (7–9). Immediate restoration of implants post-extraction has demonstrated favourable aesthetic outcomes (10,11), even with the expected buccal bone resorption post-tooth extraction (12,13). To mitigate the challenge of preserving hard and soft tissues around the implant site, the utilization of graft materials emerges as a promising solution (14).

Efforts to ensure the steadiness of both soft and hard tissues surrounding the implant have prompted the development of varied configurations of implants and ongoing refinement of surgical and restorative protocols, all directed towards securing the long-term success of implants (15).

I.2. Predictable Bone Changes

The success of implant treatments relies on predictability, emphasizing the need to identify potential complications and their causes to prevent them (16). Assessing both the implant's characteristics and patient's condition is pivotal, as each factor significantly influences the prognosis (17).

An expected outcome such as early MBL can be anticipated based on multiple variables such as the creation of the biological width, the implant configuration, the depth of implant placement, the kind and steadfastness of implant/abutment connection (18–20), the abutment height (21), the soft tissue thickness (22,23), possible surgical trauma, the use of intermediate abutments (18), the frequent detachment and reattachment of abutments (14,20,24,25), regular probing throughout the healing phase (14), the micromovements of prosthetic parts (26–30), the bone's response to the applied pressure (31), a microgap between implant and abutment (32) and a smooth implant collar (33).

Literature reveals an average MBL of 0.68 mm at the 12-month examination, challenging conventional understanding that a successful outcome in implant treatment falls within the range of 1.5 to 2mm during the first year (34). Moreover,

Moreno et al. identified that a bone loss of more than 0.45mm at 6 months after loading, serves as a clear sign of continuous bone loss, regardless of its initial trigger. This highlights the importance for clinicians to employ all available measures to minimize initial MBL (21).

The peri-implant mucosa acts as a safeguarding shield between the implant and the oral milieu. Its thickness is pivotal in determining bone loss risks as thinner mucosa may fail to shield against mechanical and microbial pressures, thus fostering inflammation and potential bone loss around the implant. Notably, peri-implant mucosa thickness below 2 mm commonly heightens the vulnerability to bone loss (35,36).

Regardless of the type of implant system utilized, there is a consistent presence of a micro-grap, typically around 10 *μm*, amongst the abutment and the implant interface (37). This micro-gap plays a crucial role in the creation of the biological width. Histometric assessments have revealed that the soft tissues' size surrounding implants are notably impacted due to the existence or lack of a micro-gap amongst the implant and the abutment interface, as well as its positioning relative to the bone crest (38). Notably, there is a marked reduction in bone resorption when the implant-abutment connection is located supra-crestally, in contrast to when it is located below the crest (37).

Regarding material properties and macroscopic design of supracrestal implant components, thus far, no particular design has demonstrated enhanced maintenance of interproximal bone levels (15). Both titanium and zirconia abutments, as well as ceramic abutments, have shown comparable effects on interproximal bone levels (20). To enhance fibrous adhesion and potentially improve the stability of soft tissue surrounding the implant, the introduction of micro-grooves or micro-channels has been suggested as a promising approach. However, the long-term effects on tissue stability remains uncertain (24).

The longevity of implants is crucial for assessing their stability, irrespective of complications. To maintain accuracy, stringent criteria are established. Any debilitating systemic conditions or habits that could obstruct favorable outcomes

are promptly screened out. These encompass diabetes, smoking, a history of periodontal disease, non-compliance with treatment protocols, inadequate oral hygiene, insufficient bone volume, or parafunctional habits (39).

Bone resorption has the potential to trigger peri-implantitis (40), succeeded by soft tissue recession. This sequence of events can sacrifice the aesthetic outcome of anterior restorations and diminish the structural integrity of the bone supporting posterior restorations (37). Mombelli et al. observed that around 10% of the implants and 20% of the patients exhibited peri-implantitis (41). It is essential to conduct risk assessment to identify factors influencing bone loss around implants, particularly since patients with a background of periodontitis who have undergone implant treatment are more prone to exhibit bone loss around implants (21).

Smoking is acknowledged as a risk factor that impacts the outcomes of implant treatment. This behavior is a factor leading to an additional 1.18mm decrease in bone density in implants placed among smokers versus non-smokers (21). This effect is apparent during the initial phases of wound healing, possibly due to reduced tissue vascularization or disturbances in their usual homeostasis (42). The stability of peri-implant bone over time can be impacted by smoke habits and previous periodontal issues. However, the extent of bone degradation as a predictor of forthcoming implant complications is still undetermined (21).

Overall, implant success hinges on the absence of complications throughout the observation period, which can encompass from biological, technical and esthetic factors (39).

I.3. Platform Switching Concept (PS)

PS concept emerges as a method offering benefits such as the preservation of bone levels around implants (43,44), optimization of soft tissue response (20) and improved esthetics. It entails employing abutments with reduced diameter in relation to the implant's platform diameter, resulting in a horizontal disparity

between these elements at the interface of the implant and abutment. (15), thereby relocating the connection away from this interface (45). This advantageous outcome arises from the horizontal displacement at the implant's base, effectively creating a space between the bone ridge and the connective tissue at the junction, accomplished through a narrower abutment (5).

This mechanism minimizes the inflammatory infiltrate observed in the micro-gap, as verified by histologic analysis (46). Internally positioning the implant/abutment connection enlarges the soft tissue attachment area, resulting in the formation of an expanded biological width and decreasing the infiltration of inflammatory cells (38,47). The horizontal formation of the biological width contrasts with its natural vertical configuration. Expanding the horizontal implant surface to create sufficient biological width leads to the displacement of inflammatory cellular infiltration within the connective tissue further away from the bone crest (48,49)(50).

Ensuring the precise vertical insertion of implants at the bone crest is crucial, particularly for implants featuring an internal connection (51,52). Implants placed below the crest of the bone with PS design have demonstrated a notable decrease in peri-implant bone loss. Notably, statistically significant differences were found between 1 mm and 2 mm abutments positioned 3 mm subcrestally for implants placed at crestal level (53).
Recent systematic reviews have robustly demonstrated the efficacy of this method in preserving crestal bone levels. Scientific evidence indicates a notable decrease in marginal bone loss surrounding PS implants (0.49 mm) in comparison to PM implants (1.01 mm) (43,54).

I.4. Conventional Implant Protocol

The conventional protocol for implant-supported rehabilitation poses a risk of mechanical compromise to the soft tissue barrier. Prior to the placement of the final prosthetic restoration, the temporary abutment undergoes frequent disconnecting and connecting for procedures such as taking impression, trying in

the substructure, and adjusting the gingival profile (55). The frequent disassembling and reassembling of prosthetic elements disrupts the epithelial seal, resulting in bleeding and ulceration at the site, and facilitating bacterial and contaminant infiltration through the implant-mucosal barrier (55).

This mechanical disturbance is related to early MBL, as it initiates inflammation (56) and exposes the connective tissue, leading to the epithelial migration and subsequent reinstatement of biological width at a lower position (37). Moreover, the direct attachment of the provisional abutment to the implant body requires the exposure of the latter to the oral cavity (55).

I.5. One-Abutment One-Time Protocol (OAOT)

The OAOT protocol involves placing the definitive restorative abutment during implant surgery and keeping it in situ throughout the healing process. This approach aims to minimize peri-implant bone remodelling, thereby improving the enduring strength and health of the implant site (57). By avoiding the necessity for abutment removal, the adjacent bone experiences less disruption, resulting in better preservation of bone density and structure and maintaining a stable biological width.

This technique highlights several benefits. Firstly, it streamlines the treatment process by removing the requirement for a second surgical procedure to insert the final abutment. This not only saves time but also decreases the overall treatment cost. Additionally, simplifying the procedure may reduce the likelihood of complications associated with multiple surgeries (15).

Keeping the final abutment in position throughout the healing phase encourages advantageous soft tissue healing and esthetic results (15). The abutment's presence aids in contouring and supporting the adjacent gum tissue, resulting in a more authentic and esthetically pleasing appearance upon completion of the final restoration. Also, avoiding connecting and disconnecting the healing abutment improves the biological width establishment, that tends to limit the initial

bone remodelling around the fresh placed implant. This factor is in some literature associated with an improved long term MBL.

I.6. Objective

The main objective of this study is to investigate whether the inclusion of the OAOT protocol in dental implant treatment has a notable influence on clinical and radiographic outcomes of the implant placement.

The secondary aim is to compare these outcomes with those obtained through conventional protocols, providing valuable insights into the potential benefits or differences associated with the OAOT approach in dental implant procedures.

2. MATERIALS AND METHODS

II. Materials and Methods

II.1. Study and Recording Protocol

Type of study: Systematic Review and Meta-Analysis
The followed protocol in this systematic review with meta-analysis was developed in accordance with the PRISMA (Preferred Reporting Items for Systematic Review and Meta- Analyses) statement (58).
This investigation was registered in PROSPERO database under the number: CRD42024493033

II.2. PICO Question

The PICO framework served as a model for crafting the clinical query.
The clinical question for this systematic review is: Does the implementation of the OAOT protocol in dental implant treatment significantly impact clinical outcomes, as measured by survival rates, success rates, and peri-implant indices such as MBL, when compared to conventional protocols?

POPULATION: Individuals undergoing dental implant treatment.
INTERVENTION: OAOT protocol in dental implant treatments.
COMPARISON: Conventional protocol in dental implant treatments.
OUTCOME: Clinical and radiographic outcomes including: peri-implant MBL, survival rate, success rate, bleeding on probing.

II.3. Eligibility Criteria

The criteria for inclusion and exclusion set for this review were:

INCLUSION

- Clinical studies in humans;
- Randomized clinical trials (RCTs) published in English;

- RCTs in which the OAOT protocol is used in dental implant treatments;
- Implant systems featuring internal connection characteristics and PS;
- Follow-up duration of at least four months after abutment connection to implant body;
- Participants older or as 18 years old of age with no history of systemic disease capable of changing the bone healing;

EXCLUSION

- Animal studies;
- Prospective and retrospective non-randomized clinical studies;
- In vitro studies;
- Case reports;
- Case series;
- *Cohort* studies;
- Conference proceedings;

II.4. Source of Information and Search Strategy

Two independent reviewers (MN and TB) underwent a comprehensive electronic search conducted across databases such as Medline/PubMed and the Cochrane Database. The primary objective was to identify RCTs specifically related to the OAOT protocol. This systematic search aimed to gather relevant scientific literature and clinical studies that explore the implications, outcomes, and effectiveness of the OAOT approach in dental implant procedures.

The search strategy employed a PICO framework, covering articles published from 2010 to 2024, exclusively in English, in accordance with the eligibility criteria.

PubMed/Medline: (Dental Implant [Mesh] AND (one abutment one time OR one-time abutment insertion OR marginal bone changes)
“One-Abutment One-Time Effect on Peri-Implant Marginal Bone” (Manual search)
FILTERS: RCT-studies, English language, from 2010 to 2024

Cochrane: ((Dental Implant)) AND ((one abutment one time OR one-time abutment insertion OR marginal bone changes))
"One-Abutment One-Time Effect on Peri-Implant Marginal Bone" (Manual search)
FILTERS: Trials, English language, from 2010 to 2024, source: PubMed

II.5. Quality Assessment

Two reviewers (MN and TB) autonomously assessed the study's quality. The evaluation of bias in RCTs was conducted using a customized adaptation of the Cochrane risk-of-bias tool for randomized trials (RoB2) (59).
The tool's components (RoB2) included assessment of the randomization process, divergence from intended interventions, absence of outcome data, measurement of outcomes, and choice of reported results.

II.6. Meta-Analysis

Gender, age and vertical bone changes in 6 and 12 months were evaluated through a meta-analysis of mean discrepancies.
The analysis of variables employed the random effects model, given its widespread endorsement for generalizing results. This model posits that the effect of interest varies across studies and treats the studies under analysis as a random sample from a hypothetical population of studies. Heterogeneity was assessed through Cochran's Q test and Higgins' I^2 statistic, indicating differences in effect estimates among studies.
Standardized mean differences served as the chosen method for measuring effects.
Review Manager 5.4 software was utilized for all statistical analyses.

3. RESULTS

III. Results

III.1. Study Selection, PRISMA

The initial search across two databases (PubMed/Medline and Cochrane) uncovered 306 articles. Before the screening process, duplicates and triplicates were removed, resulting in the exclusion of 205 articles. Cohen's Kappa Statistic measures how much two evaluators agree when they categorize items into separate groups. It ranges from 0 to 1, with 0 meaning no agreement and 1 meaning complete agreement, reaching a 0.98, indicating a near perfect agreement (60). Primarily, 101 obtained records were assessed by its title, accordingly, 69 were excluded. Secondarily, titles and abstracts of relevant records were screened carefully for eligibility, excluding 69 articles, and assessing 32 for eligibility. Finally, free full texts of clinical studies related to the one-time one-abutment insertion protocol, were assessed carefully; nevertheless, solely controlled clinical studies were taken into account based on clearly outlined inclusion criteria, with any other study type being excluded, resulting in the inclusion of 11 studies in this review and 10 studies in meta-analysis. The selection was conducted by two reviewers (MN and TB).

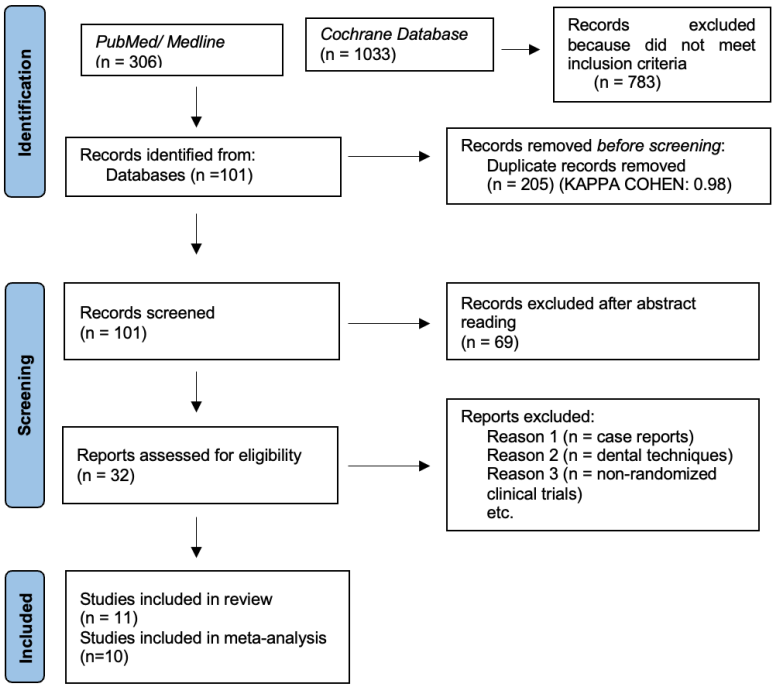


Figure 1: *Flowchart illustrating the selection process as per PRISMA*

III.2. Data Extraction and Outcome Variables

Two reviewers (MN and TB) independently conducted data extraction from the chosen articles meeting the criteria for inclusion. Data retrieval depended on criteria including study scope, participant demographics and implant/abutment insertion protocol. Any discrepancies were resolved through dialogue and cooperation.

The information was gathered within pre-established tables:

- General information: study methodology, publication year, patient count, and patient demographics.
- Data pertaining to implant procedures and time of abutment placement: quantity of implants, positioning of implant placement, type of implant and abutment for both groups, follow-up, and intervals between follow-up.
- Information about surgical protocol includes prophylactic and post-operative medication, local anesthesia, surgical protocol.
- Data related to the study's outcome measures.
- Main outcomes: Survival Rate, MBL or MBC and Probing Depth (PD).
    - Survival Rate: percentage of implants that remain functional and in place within the jawbone over a specified period of time;
    - MBL or MBC: reduction in height or thickness of the bone around an implant over time;
    - PD: distance between the gum tissue and the point where the implant attaches to the surrounding bone;
- Secondary outcomes: Bleeding on Probing (BoP), Plaque Index (PI).

III.3. Study Characteristics

Details of the incorporated studies are outlined within the tables (1 – 4). Eleven randomized clinical trials were analyzed with a total of 543 patients and 830 implants that were divided into 2 groups: the test group (DA was placed) (270 patients and 397 implants) and the control group (PA was placed) (273 patients and 424 implants).

III.3.1. Gender Distribution

Concerning gender, data was extrapolated from 10 articles, totaling 205 men and 255 women. (5,14,15,37,45,55,61–65)

III.3.2. Implant Sites

Regarding the elected area, in 7 RCTs (5,14,15,45,55,61,64) implants were positioned in the posterior region, encompassing premolars**;** in 2 RCTs (63,65)**,** implants were positioned in the anterior region, incorporating premolars.
Concerning the chosen arch, 2 RCTs (14,65) studied implants placed in the maxillary arch; conversely, 2 RCTs (5,61) placed implants in the mandibular arch. 5 RCTs (15,45,55,63,64) used of both maxillary and mandibular arches.
The remaining one RCT (62) unspecified the area, and one RCT (37) both area and arch, so it's impossible to infer this information since it wasn't explicitly stated.

III.3.3. Smoking Habits

The predominant exclusion criterion, as mentioned in these 6 studies (14,15,37,55,64,65), are individuals who smoke over 10 cigarettes daily. Whereas in 4 studies (5,45,61,62)**,** no individual was excluded based on their smoking behavior. One study (63), specified an exclusion criterion for smokers of more than 20 cigarettes per day.

III.3.4. Periodontal Status

Untreated or uncontrolled periodontal disease was a basis for exclusion in 9 of the studies (5,14,15,45,55,61,62,64,65). In two studies (37,63) PSR was conducted, results up to 3 were further treated, and results of a PI up to 2 were excluded.

III.3.5. Alveolar Bone Condition

Two studies (45,55) refer to the minimum width of bone tissue necessary surrounding the implant.

Lack of buccal bone plate and the demand for bone-augmentation procedures meet the exclusion criteria in 5 studies (14,37,62,63,65).

The prerequisite for satisfactory bone quality and quantity, aligned with the manufacturer's guidelines, emerged as a prevailing factor for implant placement, as stated in 5 studies (5,14,15,61,64).

III.3.6. Initial Insertion Torque

The failure to achieve a certain value of initial implant insertion torque is considered an exclusion criterion, as noted in 5 articles (14,37,62,63,65).

Table 1: *Information pertaining to demographics*

AUTHOR	YEAR	STUDY TYPE	PATIENTS NUMBER	MEAN AGE (STANDARD DEVIATION; RANGE)	GENDER (MALE : FEMALE)	TEST GROUP	CONTROL GROUP	FOLLOW-UP
Moreira et al.	2021	RCT	53 Test (DA): 23 Control (HA): 30	32-67 Test: 50.9 Control: 49.5	M: 18 F: 35 Test: M: 39.1% F: 60.1% Control: M: 30% F: 70%	Definitive abutment (DA)	Healing abutment (PA)	12 months
Borges et al.	2020	RCT	29 Group A: 10 Group B: 7 Group C: 12	60.5 ± 11.1 Group A: 62 ± 9.9 Group B: 67 ± 8.7 Group C: 55.6 ± 11.5	M: 8 (27,6%) F: 21 (72,4%) Group A: M: 2 (20%) F: 8 (80%) Group B: M: 2 (28,6%) F: 5 (71,4%) Group C: M: 4 (33,3%) F: 8 (66,7%)	Group A and B	Second stage surgery (Group C)	36 months
Santos et al.	2020	RCT	147 Test (DEF): 71 Control (HA): 76	54.82 ± 11.92 Test: 53.85 ± 12.91 Control: 55.80 ± 10.93	M: 66 (44.9%) F: 81 (55.1%) Test: M: 40 (56.3%) F: 31 (43.7%) Control: M: 35 (46.1%) F: 41 (53.9%)	Definitive abutment (DEF)	Healing abutment (HA)	12 months
Borges et al.	2018	RCT	33 Group A: 11 Group B: 8 Group C: 14	60.5 ± 11.1 Group A: 62 ± 9.9 Group B: 67 ± 8.7 Group C: 55.6 ± 11.5	M: 10 (30.3%) F: 23 (69.7%) Group A: M: 3 (27.3) F: 8 (72.7) Group B: M: 3 (37.5) F: 5 (62.5) Group C: M: 4 (28.6) F: 10 (71.4)	Group A and B	Second stage surgery (Group C)	12 months
Molina et al.	2016	RCT	39 Control (A): 21 Test (B): 18	Control (A): 51.62 (38-68) Test (B): 52.61 (23-71)	M: 22 (56.4%) F: 17 (43.6%) Control (A): M: 11 (50.0%) F: 10 (58.8%) Test (B): M: 11 (50.0%) F: 7 (41.2%)	Group B	Group A	6 months
Luongo et al.	2015	RCT	80 Control (AD): 40 Test (DA): 40	Control (AD): 57.6 (12.9; 33–85) Test (DA): 55.6 (13.6; 30–81)	Control (AD): M: 16 (40%) F: 24 (60%) Test (DF): M: 17 (42%) F: 23 (58%)	Definitive abutment	Abutment disconnection	4 months
Grandi et al.	2014	RCT	25 Control (PA): 13 Test (DA): 12	Control (PA) : 57.08 (43–74) Test (DA): 56.00 (39–70)	Control (PA): M: 4 (30.8%) F: 9 (69.2%) Test (DA): M: 5 (41.7%) F: 7 (58.3%)	Definitive abutment (DA)	Provisional abutment (PA)	12 months
Koutouzis et al.	2013	RCT	16 Test: 8 Control: 8	Test: 59.1 (12.6) Control: 54.2 (13.6)	Test: M: 4 F: 4 Control: M: 3 F: 5	Permanent abutment	Healing abutment	6 months
Degidi et al.	2013	RCT	68 Test: 33 Control: 35	Test: 40.1 Control: 37.7	NM	"One abutment at one time" protocol	Standard prosthetic protocol	12 months
Grandi et al.	2012	RCT	28 Test (DA): 14 Control (PA): 14	Test (DA): 53.2 (43-64) Control (PA): 50.3 (39-60)	Test (DA): M: 5 F: 9 Control (PA): M: 6 F: 8	Definitive abutment (DA)	Provisional abutment (PA)	12 months
Canullo et al.	2010	RCT	32 Test (DA): 15 Control (PA): 10	Test (DA): 51 ± 7.7 Control (PA): 55 ± 13.5	Test (DA): M: 9 F: 6 Control (PA): M: 6 F: 3	Definitive abutment (DA)	Provisional abutment (PA)	36 months

Table 2: *Data regarding implants and abutments*

AUTHOR	YEAR	FOLLOW-UP INTERVALS	NUMBER OF IMPLANTS	TYPE OF IMPLANT	TYPE OF ABUTMENT	IMPLANT PLACEMENT LOCATION
Moreira et al.	2021	T0: implant placement T1: 1-2 weeks T2: 8-12 weeks T3: 6 months T4: 12 months	53 Test: 23 Control: 30	Conical design, 4.0 or 4.5mm diameter platform with an internal hexagon connection change of 0.35 and 0.60 mm, respectively, and 8, 10 and 12 mm in length VEGA Surface ContacTi® (Klockner Implant System, SOADCO S.L., Escaldes-Engordany, Andorra)	Permanent® abutments (Klockner Implant System, SOADCO, Escaldes-Engordany, Andorra)	Posterior area maxilla or mandible
Borges et al.	2020	T0: baseline T1: 4 weeks T2: 16 weeks T3: 12 months T4: 36 months	59 Test: 34 Control: 25	Cylindrical shape implant with an internal tapered conical connection with 3.6 mm diameter and length ranging from 6 mm to 11 mm OsseoSpeed™ EV, ASTRATECH Implant System, Dentsply Implants, Mölndal, Sweden	Uni-abutments™ (ASTRATECH Implant System, Dentsply Implants, Mölndal, Sweden)	Posterior area mandible (minimum of two consecutive implants)
Santos et al.	2020	T0: implant placement T1: 2 months T2: 6 months T3: 12 months	258 Test: 117 Control: 141	Conical implant with an internal connection, 4.0 or 4.5 mm diameter with platform change of 0.35 and 0.60 mm, respectively, and 8, 10, 12, and 14 mm in length Klockner VEGA implants® 4.0 (Klockner Implant System, SOADCO S.L., Andorra)	Permanent® abutments (Klockner Implant System, SOADCO, Andorra)	Premolar and posterior area maxilla and mandible
Borges et al.	2018	T0: baseline T1: 4 weeks T2: 16 weeks T3: 12 months	68 Test: 38 Control: 30	Cylindrical shape implant with 3.6 mm diameter and an internal tapered conical connection and an implant length ranging from 6 to 11 mm OsseoSpeed™ EV, ASTRATECH Implant System, Dentsply Implants, Mölndal, Sweden	Uni-abutments™ (ASTRATECH Implant System, Dentsply Implants, Mölndal, Sweden)	Posterior area mandible
Molina et al.	2016	T0: implant placement T1: 6 months T2: 12 months	60 Test: 29 Control: 31	Camlog Conelog® Screw-Line implant (Camlog Biotechnologies AG, Basel, Switzerland) of diameters 3.8 mm or 4.3 mm, and lengths of 9 mm, 11 mm or 13 mm	Vario SR abutment (Camlog Biotechnologies AG)	Posterior area maxilla or mandible
Luongo et al.	2015	T0: preoperative radiographs (intraoral, panoramic, CT scans) T1: 1 week T2: 4 months	128 Test: 58 Control: 70	ANKYLOS C/X titanium dental implants with internal connection (FRIADENT, DENTSPLY, Mannheim, Germany)	Standard straight or angulated ANKYLOS C non-indexed titanium abutments	Maxilla and mandible in incisor, canine, premolar, molar area

Grandi et al.	2014	T0: preoperative analysis of anatomical features (CT scan) T1: 6 months T2: 12 months	25 Test: 12 Control: 13	Tapered implants (JDEvolution, JDentalCare)	NM	Maxilla or mandible from the left second premolar to the right second premolar area
Koutouzis et al.	2013	T0: after surgery T1: 2 weeks T2: 2 months T3: definitive prosthesis delivery - 3 months T4: 6 months	21 Test: 10 Control: 11	Bone Level, Straumann, diameter of 4.1 or 4.8 mm and lengths varying from 8 to 10 mm	RC Cementable Abutment, Straumann RC Healing Abutment, Straumann	Posterior to the maxillary or mandibular canines
Degidi et al.	2013	T0: after surgery, immediate temporary restoration T1: fitting of final restoration - 6 months T2: 12 months T3: 24 months	68 Test: 33 Control: 35	3.5 or 4.5 mm–diameter square-threaded, gritblasted, and acid-etched implant with a tapered connection (ANKYLOS®, DENTSPLY Friadent, Mannheim, Germany)	Standard A®, DENTSPLY Friadent, Mannheim, Germany	Canine to canine maxillary
Grandi et al.	2012	T0: after surgery T1: 6 months T2: 12 months	56 Test: 28 Control: 28	Tapered self-tapping implants were used (JDEvolution®, JDentalCare, Modena, Italy)	NM	At the crestal level in the healed edentulous ridge
Canullo et al.	2010	T0: implant placement T1: prosthetic delivery - 3 months T2: 18 months T3: 3 years	25 Test: 15 Control: 10	Global Implants (Sweden & Martina, Padua, Italy)	NM	Premolar area of maxilla

Table 3: *Surgical Methodology*

AUTHOR	YEAR	PROPHYLACTIC AND POST-OPERATIVE MEDICATION	LOCAL ANESTHESIA	SURGICAL PROTOCOL
Moreira et al.	2021	One day before surgery: amoxicillin or clarithromycin, anti-inflammatory, and gastric protector Chlorhexidine 0.12% gel (three times a day) Ibuprofen 600mg every 12h	NM	Crestal incision made in the keratinized mucosa, full-thickness flaps were raised to expose the bone. Implant shoulder placed at bone level or subcrestal, and a distance of 1.5 mm from the adjacent natural tooth and 3 mm between implants. Crest remodeling was never performed
Borges et al.	2020	Chlorhexidine 0.12% rising twice per day, during two weeks Amoxicillin 1g (twice per day for seven days) Paracetamol 1000 mg (three times per day)	4% articaine (adrenaline 1:100,000) (Ubistesin™, 3M-ESPE™, St. Paul, MN, USA)	Mid-crestal full-thickness incisions on the edentulous areas, creating a mucoperiosteal flap that exposed the underlying bone. Fixture shoulder was placed at a bone-level position or slight infrabony implant position when insertion was adjacent to a natural tooth. Crest osteoplasty was performed when needed
Santos et al.	2020	Began 30 min before the surgical procedure: Amoxicillin 750 mg/8h for 7 days (or clindamycin 300 mg/8h for 7 days in allergic patients) Ibuprofen 600 mg/8h for 4 days Omeprazole 20 mg/24h for 7 days	Articaine 40 mg/mL + epinephrine 0.01 mg/mL (Artinibsa®, Inibsa Dental, Barcelona, Spain)	Flap raised to full-thickness performing crestal incision preserving 2 mm of keratinized mucosa both in buccal and lingual/palatal areas and after exposing the bone crest. The most coronal part of the implants was placed 1 mm subcrestal in the most apical area of the bone crest; at the mesial-distal level, they were placed at least 1.5 mm to the adjacent tooth and at least 3 mm in case if there is an adjacent implant
Borges et al.	2018	Chlorhexidine 0.12% rising (NM regularity) Paracetamol 1,000mg as needed Amoxicillin 1g twice a day for seven days	4% articaine (adrenaline 1:100,000) (Ubistesin™, 3M-ESPE™, St. Paul, MN, USA)	Mid-crestal incisions were carried on the edentulous areas, and a full-thickness muco-periosteal flap was elevated exposing the underlying bone. Osteotomy procedure for implant placement was made. Implant shoulder was placed at a bone-level position or slight infrabony when insertion was adjacent to a natural tooth, using the buccal aspect of the crest to define the vertical level position of the implant. Crest osteoplasty was performed
Molina et al.	2016	Antibiotic therapy prescribed at the discretion of the clinician Ibuprofen 600 mg/8h upon patient's needs	NM	Implant shoulder (IS) was placed at bone level, and a distance of ≥1.5 mm from the adjacent natural tooth and ≥3 mm between implants. Crest remodelling was performed when needed to ensure appropriate implant placement at bone level around the complete implant shoulder
Luongo et al.	2015	1h prior to surgery: 2g of amoxicillin (or clindamycin 600mg if allergic) 1 min rinsing with 0.2% chlorhexidine Post surgery: Ibuprofen 400mg/ 2-4 times a day, as long as required Amoxicillin 1g twice a day/6 days (for patients treated with a bone substitute or in case of long and complicated surgery)	1% Alfacaina 40 mg/ml with Epinephrine 1:200.000 (DENTSPLY)	Tooth extractions were performed as atraumatically as possible to preserve the buccal alveolar bone and extraction sockets were carefully cleaned. Flapless implant placement was also allowed. Standard implant site preparation procedure as recommended by the implant manufacturer: the round bur or lance drill was used to prepare the cortical entrance, followed by the drills of increasing diameters. Implants were placed 1 mm subcrestally to the palatal wall

Grandi et al.	2014	Chlorhexidine mouthwash 0.2% for 1 min, twice a day, starting 3 days prior to the intervention and thereafter for 1 week 1g of amoxicillin and clavulanic acid every 12h from the day before surgery to the sixth postsurgical day (allergic patients were given clarithromycin 500mg 1h before the intervention and 250 mg twice a day for 1 week)	Articaine with adrenaline 1:100,000	Flapless tooth extraction was performed with particular attention to preserving the integrity of the alveolar bone walls. The implant site was flapless, prepared with sequential drilling under copious irrigation according to the manufacturer's instructions. The implant platform was placed about 0.5 to 1 mm below the vestibular bone crest
Koutouzis et al.	2013	500mg amoxicillin a three times/day for 7 days Rinse with chlorhexidine 0.12% twice/day for 2 weeks	NM	Crestal incisions were used and full-thickness flaps were elevated to expose the bone. The recipient sires were enlarged according to the protocol of the manufacturer. Subsequent osteotomy preparation, the thickness of the buccal and lingual bony plates were measured at a point of 2mm apical to the crest of the ridge with a caliper to the nearest 0.5mm. Dental implants were placed in edentulous segments
Degidi et al.	2013	500 mg of beta-lactam antibiotics twice/day for 5 days, starting 1 hour before surgery	2% articaine/adrenaline 1:100,000	Careful extraction of the compromised tooth, extreme attention was kept in order to preserve the integrity of all the walls of the socket, using a flapless protocol. A single 14- or 17.0-mm-long implant was placed with the rough crestal collar positioned at least 2.0 mm beneath the bone crest
Grandi et al.	2012	0.2% chlorhexidine mouthrinse twice daily, commencing 3 days prior to the intervention and thereafter for a 2-week period 1g of β-lactam antibiotic twice daily for 6 days, starting 1 h before surgery	NM	Implants were placed using a flapless technique to minimise the bone resorption. Two implants were inserted in each patient according to the manufacturer's instructions. Implants were placed at the crestal level in the healed edentulous ridge
Canullo et al.	2010	1h prior to surgery: single dose of 2 g of amoxycillin and clavulanic acid Rinses with 0.12% chlorhexidine gluconate for 2 weeks	NM	Flapless tooth extractions were performed atraumatically. Extraction sites were thoroughly debrided and, when the buccal bone wall was reached undamaged, the implants were placed. The edge of the implant platform was placed at the margin of the buccal bone wall

III.4. Characteristics and Results of Interventions

III.4.1. Protocol Variables

III.4.1.1. Standard Implant Protocol versus *One-Abutment One-Time* Protocol

All eleven selected studies (5,14,15,37,45,55,61–65) compared and made use of repeated abutment replacements and permanent abutments, installed concurrently with the implant procedure and never subjected to removal.

III.4.1.2. Abutment Handling

Seven studies mention the manipulation of the HA or PA as part of the standard implant protocol for disconnection and reconnection.
Four studies (45,55,62,63) disclosed this manipulation at least three times; two studies (37,65) more than three times; and one study (14) didn't disclose the number of abutment manipulation times but stated they were various.
Two studies identified the necessity for abutment removal. One study (15) abutment removal was referenced once, while another study (64) reported the requirement for removal on two occasions.

III.4.2. Radiographic Variables

III.4.2.1. Bone Level Changes

Eight of the selected studies computed values for bone level changes at various time frames, each arriving at different conclusions. These variations can be attributed to differences in study design, methodologies, sample sizes, measurement techniques, patient demographics and follow-up.

Five studies (14,45,55,64,65) found no statistical difference in bone level change between both groups.

Moreira et al. (2021) found that from surgery to 6 months and 6 months to 12 months, the values for vertical bone level changes in the control group were higher (0.23 ± 0.29 mm; 0.21 ± 0.27 mm) than in the test group (0.14 ± 0.18 mm; 0.14 ± 0.21 mm), respectively. The statistical difference found wasn't considered relevant for cumulative bone loss after 12 months in both groups (p=0.330).

Santos et al. (2020) described total bone loss at 12 months for the control group 0.48 ± 0.71 mm and the test group 0.36 ± 0.79 mm. The deviations between surgery and 6 and 12 months had a value of p=0.001.

At 6 months, Koutouzis et al. 2013 described a total vertical bone loss of 0.28 mm for the control group and 0.13 mm for the test group, stating that p values were not significant.

Canullo et al. (2010) conducted the investigation with the most extended monitoring period lasting 3 years, revealing that cumulative bone loss was 0.55 mm in the control group and 0.2 mm in the test group. All follow-up periods revealed no statistically notable variances in MBL between the groups (p=0.05).

Whereas three studies (15,37,63) found significant contrasts emerged between both groups, with the test group displaying reduced bone loss following surgery throughout the 3-year follow-up period.

Molina et al. (2021) found significantly higher bone loss in control group from surgery to 6 months 1.24 ± 0.79 mm, whereas test group presented 0.61 ± 0.40 mm, resulting in a statistical significance value of p=0.028.

Grandi et al. (2014) reported a total vertical bone loss of 0.58 ± 0.11 mm in the control group and 0.11 ± 0.06 mm in the test group at 12 months. This illustrated a statistically notable distinction in bone level alteration between the groups, with a mean difference in bone level changes of 0.48 mm (95% CI 0.40 to 0.55 mm; $p<0.0001$).

Grandi et al. (2012) demonstrated that the control group experienced greater bone loss from surgery to 6 months (0.359 mm) and 12 months (0.435 mm). Contrastingly, the test group showed much lower bone loss over the same periods, with 0.065 mm at 6 months and 0.094 mm at 12 months. Substantial statistical variances were noted between the two groups at both 6 months ($p< 0.001$) and 12 months ($p< 0.001$). The average disparity in bone loss at 6 months was 0.294 mm (CI 95% 0.276;0.312) and at 12 months was 0.341 mm (CI 95% 0.322; 0.36).

One study (65) detected noteworthy horizontal bone degradation subsequent to the placement of the definitive restoration within the hard tissue segment atop the implant platform ($p=0.03$ mm mesial, $p=0.04$ distal) at 2 years follow-up.

III.4.3. Clinical Variables

III.4.3.1. Clinical Assessment

Clinical assessment of dental implants often involves evaluating various parameters to monitor the health and stability of the surrounding tissues. Five studies have adopted different approaches to measure these parameters.

Four studies (5,45,55,61) assessed the following clinical parameters in four sites per implant - mesial, distal, vestibular, and lingual or palatal surfaces. One study (15) assessed the following clinical parameters in six sites per implant – mesio-vestibular, disto-vestibular, mesio-lingual, disto-lingual, mid-vestibular and mid-palatal.

One study (64) assessed PD and BoP in six sites per implant, while visible plaque was assessed in four sites per implant.

All the subsequent variables were evaluated utilizing a periodontal probe.

III.4.3.2. Peri-Implant Mucosal Changes

Evaluation of peri-implant mucosal dimensions is crucial in assessing the health and stability of dental implants. Five studies have explored the impact of various factors on these dimensions.

Four studies (45,55,63,64) did not detect any statistical distinction in peri-implant mucosal dimensions between the two groups.

One study (65) detected variations in peri-implant mucosal dimensions between both groups and noted the following outcome subsequent to the installation of the final restoration: a subtancial 87% increase in average recession of buccal soft tissue within the test group (+ 0.27 mm).

III.4.3.3. Modified Plaque Index (mPLI)

Evaluating the mPLI (66) or the presence of visible plaque is essential for understanding and monitoring oral health, providing valuable insights into the effectiveness of oral hygiene practices and the risk of developing dental diseases. Five studies (14,15,45,55,64) made this evaluation.

In Moreira et al. (2021) and Santos et al. (2020) no statistical disparities were found between the groups during the 6 and 12 month follow-up periods.

Molina et al. (2016) noticed a modest yet noteworthy increase in plaque levels between loading and 6 and 12 months in both groups – test (0.24 ± 0.25) and control (0.35 ± 0.41). However, no significant discrepancies were noted within either group at any time point.

Canullo et al. (2010) described a PI at 3 years of 1.67 ± 0.3 and 1.34 ± 0.21 for the control and the test groups, correspondingly.

III.4.3.4. Probing Depth (PD)

Assessing PD (66) is crucial for evaluating periodontal health and diagnosing periodontal diseases. Four studies (14,15,55,64) made this assessment.

Moreira et al. (2020) found a PD consistently under 3 mm for both groups with no significant variations between them over time.
Molina et al. (2016) reported a small clinical difference in PD values. At 12 months, the control group had a PD of 3.08 ± 0.76 mm, while the test group had a PD of 3.18 ± 0.54 mm. There were no statistically significant variances observed between the groups at any juncture.
Koutouzis et al. (2013) found the average variation between successive measurements as 0.12mm.
Canullo et al. (2010) described PD values for 3 years of 2.80 ± 0.21 mm and 2.75 ± 0.07 mm for control and test group, respectively.

III.4.3.5. Modified Bleeding Index (mBI) or Bleeding on Probing (BoP)

Identifying mBI (66) or BoP is critical for assessing periodontal health and diagnosing periodontal diseases. Six studies (5,14,45,55,61,64) carried out this examination by gently placing the probe into the sulcus with a light touch.
Moreira et al. (2021) and Santos et al. detected no statistically significant variance at 6 and 12 months follow-up between both groups in terms of gingival inflammation.
Canullo et al. (2010) described an mBI of 0.61 ± 0.08 and 0.55 ± 0.13 for the control and test groups, correspondingly.

III.4.3.6. Keratinized Mucosa (KM)

Assessing KM height is vital for maintaining oral health, preventing periodontal and implant-related complications, optimizing prosthodontic outcomes and enhancing patient comfort and satisfaction. Four studies (5,15,61,64) conducted this assessment using a periodontal probe to gauge the distance from the mucosal margin to the mucogingival line on the buccal side of each implant.

Borges et al. (2018) challenge previous findings that suggest KM thickness has a minimal impact on MBL over time. Within test group A, a significant difference

in KM thickness was identified. The study specifically noted significant differences between two subgroups with mucosa thicknesses of <2 mm and ≥2 mm, measuring 0.38 ± 0.15 mm and 0.80 ± 0.35 mm, respectively (p=0.016). At the 3-year mark in Borges et al. (2020), a statistically significant difference in KM thickness within both test group B and control group C for subgroups categorized by mucosa thicknesses (<2 mm and ≥2 mm). In test group B, the results showed 1.38 ± 1.57 mm and 0.38 ± 0.36 mm, for the respective subgroups (p=0.05), while in control group C, they were 1.17 ± 0.92 mm and 0.29 ± 0.66 mm (p=0.01).

III.4.3.7. Implant Primary Stability (ISQ)

Two studies (45,55) asserted the primary stability of implants, revealing that all implants achieved it, with no difference was observed between both groups.
Moreira et al. (2021) correlated various ISQ measurements based on the study's timelines: at the moment of implant insertion, during impression taking, at 6 months and at 12 months. For these timeframes the results were: 79.6 and 82.6; 81.6 and 79.9; 79.4 and 79.7; 80.2 and 81.3. It was established that the protocol for abutment placement did not influence the fluctuation of ISQ values.
Santos et al. (2020) described the measurement of ISQ values at three points in the study: upon the surgery time, 6 months after surgery and 12 months after surgery. For these timeframes the results were: 78.36 ± 8.13 and 77.18 ± 9.30; 76.54 ± 9.41 and 79.67 ± 8.18; 76.51 ± 12 and 80.07 ± 9.01 – for both the control and test groups, correspondingly. No statistical significance throughout the study period was found (*p*=0.731).

III.4.4. Patient Satisfaction

Assessing patient satisfaction with the overall treatment is integral to evaluating treatment outcomes, guiding clinical decision-making, planning continuing care, improving practice performance and promoting patient-centered care.
Two studies (15,62) made this assessment, finding that the prostheses' functionality and aesthetics left all patients very satisfied, with each expressing a willingness to undergo the same procedure again.

Table 4: *Findings from the selected studies*

AUTHOR	YEAR	TYPE	OUTCOMES
Moreira et al.	2021	RCT	**Primary outcome**: data related with vertical bone level changes at 6 and 12 months after surgery **Secondary outcome**: other clinical parameters (implant mobility, bleeding on probing, probing depth, plaque index)
Borges et al.	2020	RCT	**Primary outcome**: the effect of the independent variables on MBC at T4
Santos et al.	2020	RCT	**Primary outcome**: changes in bone level 6 and 12 months after implant placement between the test (definitive abutment (DEF)) and control (healing abutment (HEA)) groups **Secondary outcome**: changes in bone level 6 and 12 months after implant placement between the 1 mm high abutment group and 2 mm abutment group
Borges et al.	2018	RCT	**Primary outcome**: early MBL when comparing different modalities of surgical approach for the implant and abutment insertion **Outcome variables**: mean values, standard deviation, median, and 95% confidence interval
Molina et al.	2016	RCT	**Primary outcome**: radiographic assessment of vertical bone level changes **Secondary outcome**: clinical status of peri-implant tissues, changes in soft tissues margin, papilla filling, patient-related outcomes and adverse events were assessed 6 and 12 months after loading
Luongo et al.	2015	RCT	**Primary outcome**: prosthesis failure, implant failure and any complication and adverse event **Secondary outcome**: peri-implant marginal bone level changes assessed on periapical radiographs, implant stability, recessions, the height of the keratinised mucosa and patient satisfaction
Grandi et al.	2014	RCT	**Primary outcome**: implant failures, complications and marginal peri-implant bone level changes
Koutouzis et al.	2013	RCT	**Primary outcome**: marginal bone level changes from the time of implant placement to the 6-month follow-up examination
Degidi et al.	2013	RCT	**Primary outcome**: if the nonremoval of abutments placed at the time of surgery would improve bone and gingival healing around single immediately restored implants placed in postextraction sockets
Grandi et al.	2012	RCT	**Primary outcome**: absence of radiographic radiolucency, swelling or pain at the implant site at the time of follow-up examinations at 6 and 12 months after surgery and bone-level changes proximal to the implants measured on periapical radiographs
Canullo et al.	2010	RCT	**Primary outcome**: marginal bone loss at 36 months

III.5. Quality Assessment

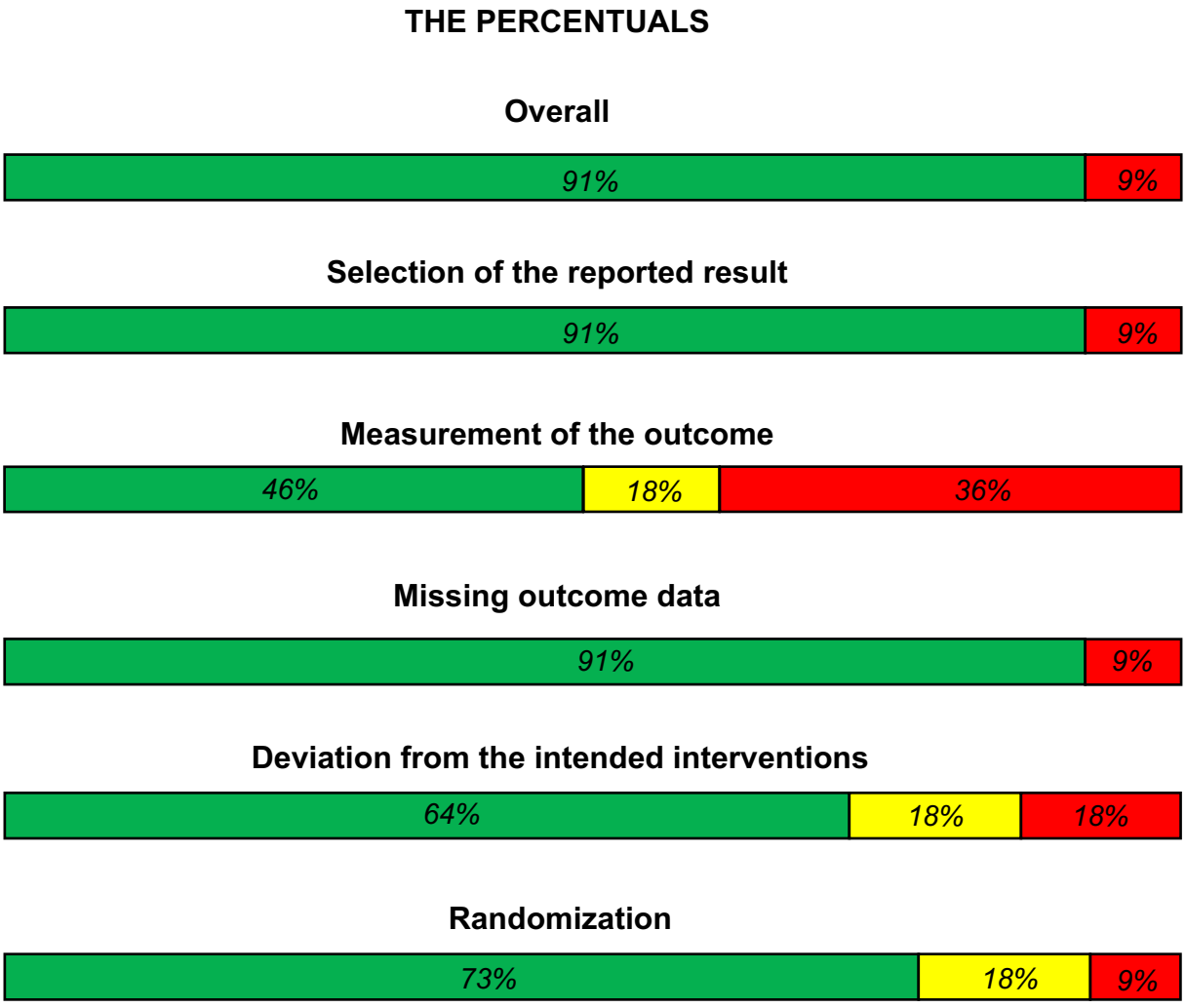
The risk of bias in RCTs was appraised utilizing a revised Cochrane risk-of-bias tool for randomized trials (RoB2) (59).

The domains of the tool (RoB2) are: randomization process, deviation from intended interventions, missing outcome data, outcome measure, and selection of reported outcomes.

Table 5: *Risk of bias assessment using The Cochrane Risk of Bias 2 (RoB 2) tool*

References	Randomization process	Deviations from the intended interventions	Missing outcome data	Measurement of the outcome	Selection of the reported result	Overall
Moreira et al. (2021)	+	+	+	+	+	+
Borges et al. (2020)	+	+	+	−	+	+
Santos et al.	+	+	+	?	+	+
Borges et al. (2018)	+	−	+	+	+	+
Molina et al.	+	+	+	−	+	+
Luongo et al.	+	+	+	−	+	+
Grandi et al. (2014)	?	+	+	+	+	+
Koutouzis et al.	?	−	−	−	?	−
Degidi et al.	+	?	+	+	+	+
Grandi et al. (2012)	+	+	+	?	+	+
Canullo et al.	?	?	+	+	+	+

Table 6: *Overall Risk of bias assessment using The Cochrane Risk of Bias 2 (RoB 2) tool*



III.6. Clinical Outcomes

III.6.1 Predictable Aesthetic Outcomes

Two studies (37,63) found that employing definitive abutments during implant placement was linked to improved aesthetics and enhanced preservation of bone and soft tissue integrity. One study (15) disagreed, stating that the relation between the disconnections and reconnections and aesthetic impact remains to be tested.
One study (14) added that the use of graft material to bridge the space between the implant and the inner buccal bone wall improves aesthetic outcome (67).

III.6.2. Complications

Four studies (5,15,62,63) presented mechanical and biological occurrences. The test group experienced more mechanical complications whereas the control group suffered more biological complications. All reported complications were promptly addressed on the same day, resulting in rapid relief and positive outcomes.

III.6.2.1. Prosthetic Complications

In Borges et al. (2020) one subject from test group A encountered prosthetic issues, including ceramic chipping at one implant site. Additionally, crown loosening occurred in two subjects from test group B and one subject from control group.

Molina et al. (2016) documented crown movement resulting from screw loosening at the 6-month follow-up in one patient from the control group and two patients from the test group. At 12-month recall, one patient from the control group and one patient from the test group experienced screw loosening, again necessitating re-tightening.

In Luongo et al. (2015), two patients from the test group encountered debonding of provisional restorations at 2,5 and 10 weeks, as well as 4 and 7 weeks after immediate loading. Despite this, the only notable issues reported were patient discomfort and disappointment.

Grandi et al. (2014) noted one complication in the control group, involving abutment screw loosening after three weeks of healing.

III.6.2.2. Biological Complications

In Borges et al. (2020) observed periimplantitis in two implants, one from test group B and the other from the control group. Therapeutic interventions involved flap elevation, excision of inflamed tissue, decontamination of the implant surface, and subsequent closure of the flap to address both occurrences.

Santos et al. (2020) documented the failure of four implants within the initial two months following the procedure, yielding a survival rate of 98.42%, although the specific cause of failure was not specified.

Borges et al. (2018) noted one implant failure in the control group in the first month of healing due to early osseointegration failure.

Molina et al. (2016) reported the failure of one implant in the test group one-week post-surgery due to the occurrence of osseointegration failure and the loss of an additional implant in the control group after the first month of healing.

Luongo et al. (2015) described complications in three patients from the control group: one case of alveolar infection, which was treated with local antimicrobial irrigation and removal of the infected graft; one instance of palatal wound dehiscence, which healed spontaneously; and during the final crown placement, a fistula emerged, yet it was resolved within a week following the disconnection and cleansing of the definitive abutment.

Grandi et al. (2014) documented one complication in test group, characterized by peri-implant mucositis.

III.6.2.3. No Complications

Five studies (14,37,55,64,65) reported a 100% success rate, indicating that throughout the follow-up assessments, all implants displayed successful osseointegration and remained clinically stable, devoid of any related complications.

4. RESULTS OF META-ANALYSIS

IV. Results of Meta-Analysis

The meta-analysis used 10 articles to examine 4 variables: gender, age and vertical bone changes at 6 and 12 months. In this analysis, the random effects model was employed. Effect measurement in meta-analysis (68) is crucial for gauging treatment efficacy, intervention impact and disparities between variables or groups (69). The “difference in means” method is particularly advantageous when studies use different units of measurement. It involves dividing the difference in means of each study by its standard deviation to normalize the data. This normalization process makes it easier to compare and interpret effect sizes or outcomes across studies (69).

IV.1. Gender

Figure 2 shows the gender distribution based on studies that reported the number of men and women. The number of women was calculated relative to the total. Based on these results, Cochran’s Q ($p=0.98>0.05$) and $I^2=0\%$, indicate homogeneity among the studies regarding gender. The *forest plot* suggests that within each study, there is a balanced representation of men and women in both the control and experimental groups. Overall, however, women tend to predominate.

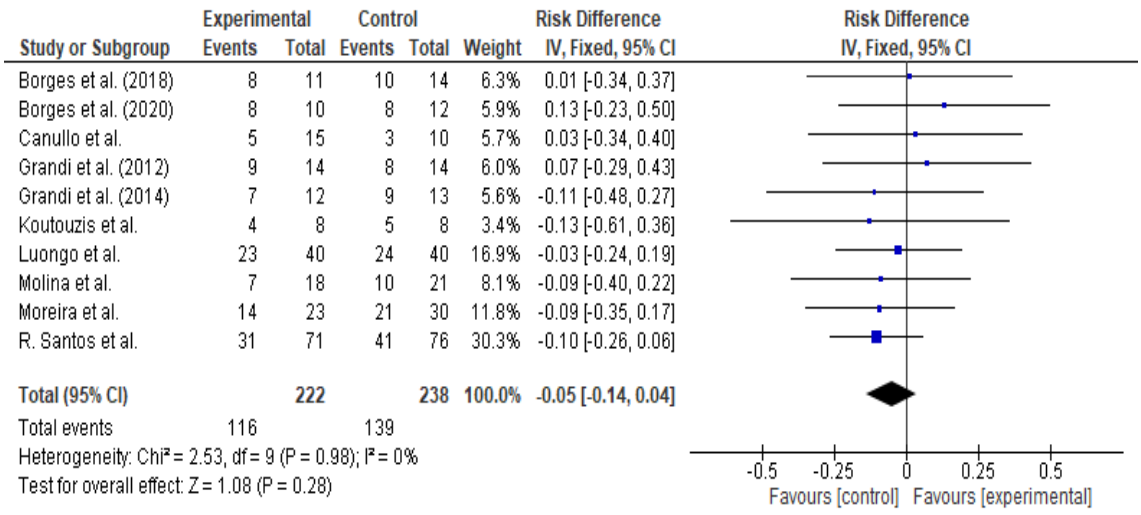


Figure 2: *Results of meta-analysis for the gender.*

IV.2. Age

Regarding the results depicted in figure 3, Cochran's Q (p=0.29>0.05) and I^2=19%, indicate homogeneity among studies concerning age. According to the *forest plot*, the age tends to be inferior in the test group.

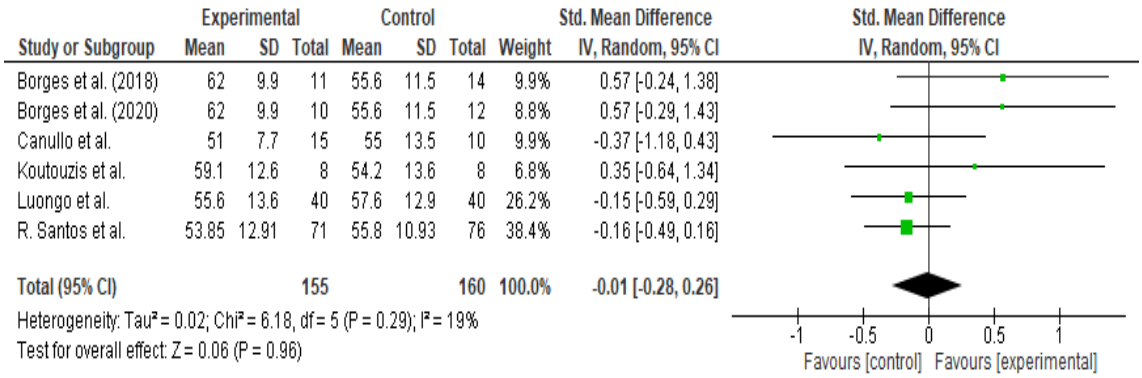


Figure 3: *Results of meta-analysis for the age.*

IV.3. Vertical Bone changes (6 months)

The results in figure 4, with Cochran's Q (p<0.001) and I^2=91% indicate significant heterogeneity among studies regarding vertical bone changes. The forest plot reveals that across all studies, outcomes are consistently lower in the experimental group, indicating lesser bone loss in this group. Moreover, the meta-analysis effect of 1.37 (CI 95% [0.26; 2.47]) is statistically significant (p<0.05). Thus, we can infer that the observed outcomes are attributable to the intervention conducted.

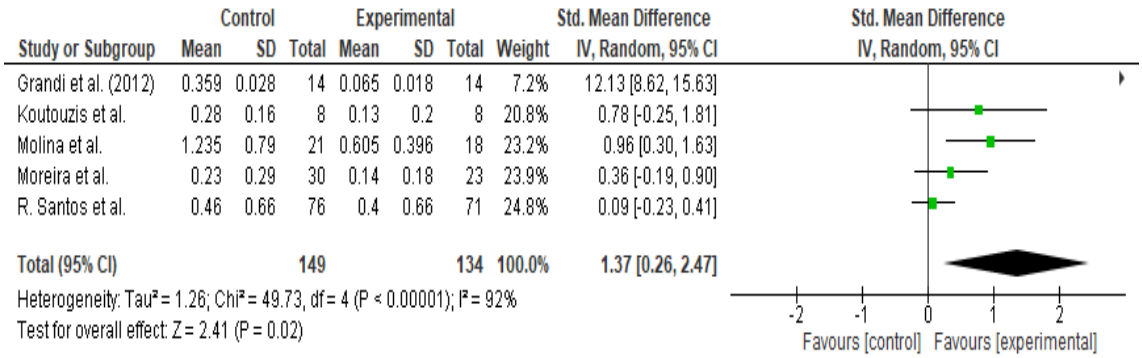


Figure 4: *Results of meta-analysis for Vertical Bone changes (6 months)*

It's noteworthy that excluding the Grandi 2012 study removes the significance of heterogeneity, thereby concluding homogeneity among studies concerning vertical bone changes, as depicted in figure 5.

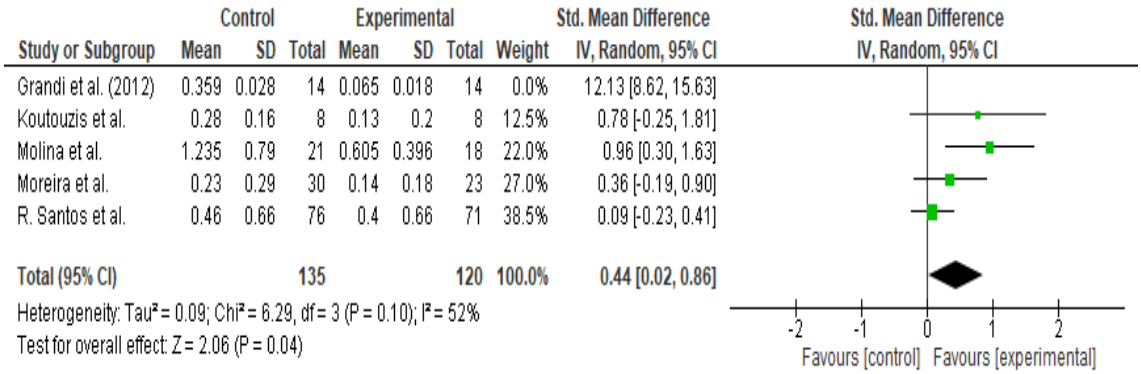


Figure 5: *Results of meta-analysis for Vertical Bone changes (6 months), after study exclusion*

IV.4. Vertical Bone changes (12 months)

The results in figure 6, I^2=94%, indicate a significant heterogeneity among studies regarding vertical bone changes (12 months). By the *forest plot*, it is evident that the outcomes in all studies favor the experimental group, indicating lesser bone loss in this group. The meta-analysis effect of 1.98 (CI 95% [0.76; 3.19]) is statistically significant (p<0.05). We can therefore infer that the results are a direct result of the intervention.

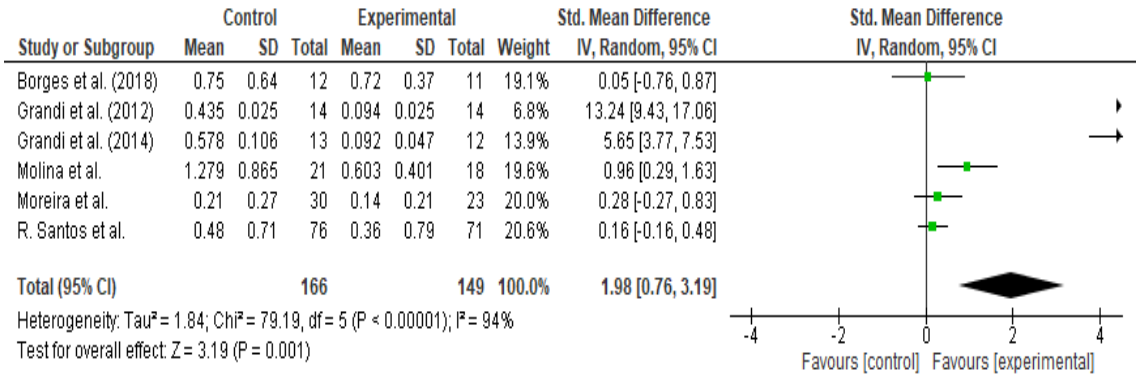


Figure 6: *Results of meta-analysis for Vertical Bone changes (12 months)*

The studies carry similar weight in this analysis, except for the Grandi studies, which contribute less. Upon removing the Grandi studies from 2012 and 2014, the heterogeneity diminishes, leading to homogeneity among studies regarding vertical bone changes, as illustrated in figure 7. Additionally, the meta-analysis effect of 0.33 (CI 95% [-0.02; 0.67]) is not statistically significant (p=0.06).

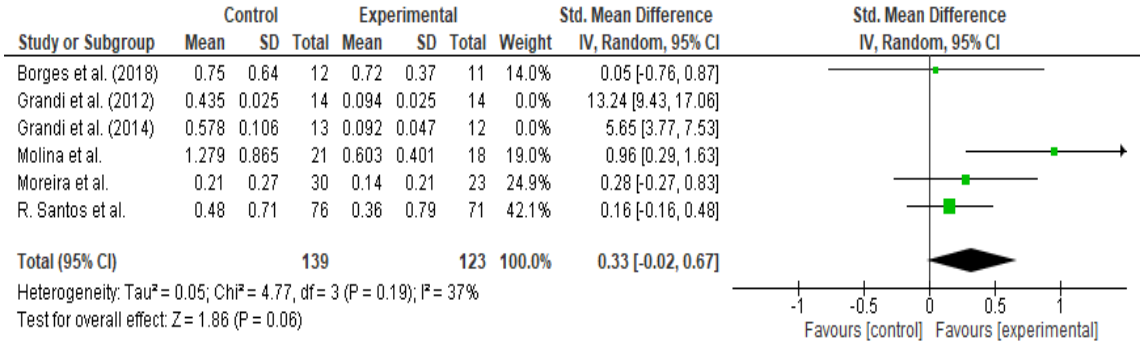


Figure 7: *Results of meta-analysis for Vertical Bone changes (12 months), after study exclusion*

5. DISCUSSION

V. Discussion

The aim of this systematic review and meta-analysis was to evaluate the influence of the OAOT protocol in dental implant treatments on clinical outcomes, specifically its effects on survival rates, success rates and peri-implant outcomes including MBL, in comparison to the conventional protocols. This study collected data from all RCTs that investigated the use the of one-time insertion concept in at least one test group.

In implant dentistry, it is commonly assumed and accepted that MBL occurs primarily within the first year following implant placement (42), attributed to advancements in implant platforms, improved techniques, and optimized implant placement relative to the bone crest. Presently, the observed MBL around dental implants is significantly lower than previously reported. Earlier literature indicated that MBL around implants at 1 year ranged between 1.6 to 2.0 mm (70,71). However, studies have revealed an average MBL of only 0.68 mm at the 12-month examination (34). Adopting various strategies and techniques early in the implant treatment process is essential for minimizing MBL. As the initial rates of MBL offer valuable insights by signaling the potential risk of implant failure and emphasizing the need for early interventions that are essential to improve the chances of long-term success.

MBL can vary based on the bone characteristics surrounding the implant site, commonly occurring around the implant neck, particularly in implants inserted into natural bone (17). The literature outlines several common determinants affecting MBL surrounding dental implants, including the establishment of the biological width (18–20), the height of the abutment (21) and the thickness of soft tissue (22,23). For the evaluation of the correlation of KM thickness and MBL, Borges et al. conducted studies in 2018 and 2020 (5,61). In the 2018 study, a significant difference in KM thickness was observed within test group A, challenging previous literature that suggest KM dimensions have little impact on MBL over time. The study found significant differences between two subgroups categorized by their mucosa thickness (<2 mm and ≥2 mm), with measurements of 0.38 ±

0.15 mm and 0.80 ± 0.35 mm, respectively (p=0.016). Additionally, patients exhibited superior bone maintenance compared to conventional protocols, despite expectations. In the 2020 study, at the 3-year mark, a statistically significant difference in KM thickness emerged within both test group B and control group C for subgroups categorized by mucosa thicknesses (<2 mm and ≥2 mm). In test group B, the results showed 1.38 ± 1.57 mm and 0.38 ± 0.36 mm, for the respective subgroups (p=0.05), while in control group C, the related results were 1.17 ± 0.92 mm and 0.29 ± 0.66 mm (p=0.01). These findings emphasize the critical role of soft tissue in these locations, demonstrating that variations in KM thickness are associated with differences in MBL, emphasizing the role of keratinized tissue quantity in bone maintenance around implants.

Historically underestimated, the abutment heigh is gaining recognition as a pivotal factor in maximizing success rates in implant dentistry (21). This emphasizes the significance of increasing the gap between the crown and bone to ensure a more consistent outcome for bone preservation (17) through vertical mismatch. Santos et al. (2020) (45) highlighted the effect of abutment height on bone resorption, acknowledging a correlation between taller abutments and decreased bone loss. The study used various abutments heights and found that in the 1mm abutment group, bone loss was 0,45 ± 0,78 mm, whereas in the 2mm abutment group, it was 0,41 ± 0,70 mm (*p*=0.02 mm). These findings suggest that abutment height influences bone loss around dental implants (21,42,45,61,72). Additionally, the cited studies discuss factors affecting esthetic outcomes in dental implant procedures, including challenges in assessing buccal bone loss, decisions regarding abutment height and the variety of implant diameters.

Multiple studies have shown that employing shorter abutments resulted in significantly greater bone loss when compared to implants to implants fitted with lengthier abutments. Abutments implanted concurrently with the implantation process are typically adjusted in height based on the thickness of the surrounding soft tissue. Thus, the height of the abutment is indicative of the initial thickness of the soft tissue within the surrounding area (34). Vertical mismatching has more pronounced effect on preserving bone around the implant than differences in

width, as it moves away from the gap and, consequently, the contaminated area of the bone ridge (73). Additionally, the impact of height on bone and soft tissues force distribution differs from changes in width (21).

It is crucial to factor in a patient's overall health, as it significantly influences prognosis (17). Increased MBL fosters bacterial colonization, accelerating peri-implantitis progression. After the initial lesion formation, compromised bone support around the implant and a favorable bacterial environment lead to rapid deterioration (17). MBL tends to worsen over time in patients with periodontitis, regardless of its cause (74). The synergistic effects of smoking and a previous history of periodontitis could result in an additional 2.37mm of bone loss, compared nonsmokers without periodontal issues (34). Over a 9 years period, in patients with history of periodontal disease, implant-related bone loss was increased by 1.19mm, compared to those without. Moreover, evidence suggests that patients with existing or ongoing periodontitis face higher risks of implant failure and biological complications (75–77).

Canullo et al. (2010) examined the influence of platform switching on the preservation of crestal bone, indicating that bone resorption is predominantly associated with biological aspects, like the reestablishment of biological width rather than biomechanical factors such as platform switching (78). Three studies included in our final selection (5,55,61) mention the influence of the subcrestal position of dental implants and its potential impact on bone structure and remodeling, referring that this positioning may lead to different patterns of bone remodeling compared to implants placed at the bone level.

The platform-switching concept involves intentionally moving the cellular inflammatory response and oral microflora away from the crestal bone, to maintain bone density and preserve the biological width (44). By doing so, this strategy safeguards the implant-abutment connection, protects peri-implant marginal bone from damage caused by connective tissue inflammatory infiltrate by preventing its migration towards the bone. Consequently, the loading stress in the crestal part of the bone is minimized and instead, it is shifted towards the axial axis of the implant (43,79). Additionally, implants with external connections tend to exhibit higher rates of MBL than those with internal connections (80), with the

design of the connection being one of the most influential factors affecting MBL (81). Therefore, in short to medium term, marginal bone levels are more effectively preserved when an internal interface connection is utilized, rather than to external connections (82).

OAOT protocol streamlines treatment, minimizing both duration and patient discomfort by bypassing the requirement for a second-stage surgery or suppressing the needed stages in a conventional protocol. This approach is closely related to the concept of immediate load by placing a single abutment at the time of implant surgery and not removing it thereafter. This stable environment is conducive to immediate loading, where the dental prosthesis is placed on the implant shortly after surgery, enhancing overall patient satisfaction, improved function, phonetics, and esthetics (83,84). Six studies included in our selection (5,14,15,37,63,65) found that the introduction of the one-time abutment placement is linked to reduced bone loss during the healing phase and enhanced stability of healed soft and hard tissues. Our meta-analysis variable of bone level changes at 6 and 12 months post abutment placement align with the findings above mentioned and showed reduced bone loss in the test group, likely due to the implementation of the OAOT protocol. Contrasting, five studies (45,55,61,62,64) found that changes in the level of bone around implants were equivalent to those that have had recurrent detachment and reattachment of abutments and second-stage surgery in control groups. Moreira et al. disconnected and reconnected the abutment a minimum of 3 times during the period from the time of initial implant placement to the final abutment connection (p = 0.442; test group: 0.14 ± 0.18 mm and control group: 0.23 ± 0.29 mm) and between the 6 and 12 months intervals (p = 0.330; test group: 0.14 ± 0.21 mm and control group: 0.21 ± 0.27 mm) (55). Santos et al. (2020) used a healing abutment, which they removed at least three times over the course of a year, resulting in measurements of 0.36 ± 0.79 mm in the test group and 0.48 ± 0.71 mm in control group (45). Borges et al. 2018 control group was a second stage surgery group. The abutments remained in place after connection, which could account for the reduced range of bone loss from surgery to the 1 year follow-up seen for Group C - 0.75 ± 0.64 mm, in contrast to the test groups where abutments were placed on the same day (61). Luongo et al. (2015) placed the

definitive abutments 3 months post-loading and repositioned them at least three times. Four months post-loading, peri-implant marginal loss was -0.08 ± 0.16 mm in test group and -0.09 ± 0.20 mm in control group (difference = 0.01; 95% CI: -0.07, 0.09; P = 0.97) (62). Koutouzis et al. (2013) performed two disconnections and reconnections of the abutment in the control group. This did not result in adverse alterations in the size of the peri-implant mucosa (3 to 6 months: test group -0.11 ± 0.3 mm, control group 0.06 ± 0.2 mm) nor did it show statistically significant differences in vertical bone level changes from placement to the 6-month follow-up (test group -0.13 ± 0.20 mm, control group -0.28 ± 0.16 mm) (64).

While this research offers valuable perspectives on the integration of the OAOT protocol, it is crucial to recognize specific constraints that may affect the interpretation and generalization of the reported findings. Three studies (14,62,63) have indicated that the limited size of the sample population could potentially undermine the dependability of the findings, while two studies (62,64) highlight the limited duration of follow-up period as unreliable, given that longer observational periods may lead to an increased bone loss. Moreover, one study (15) suggests that the control group's decreased incidence of abutment disconnections were associated with improved outcomes. Two studies (37,64) note that operators assessing outcomes were aware of patient allocation, suggesting its possible influence. One study (37) managed radiographic assessment, while another (64) handled all aspects, except for radiographic assessment.

Our systematic review and meta-analysis is distinguished by its meticulous selection criteria that prioritize studies adhering to rigorous research methodologies, particularly RCTs. This approach enhances the credibility and reliability of our findings by ensuring a high level of methodological rigor and scientific validity across the synthesized literature. The assessment of overall bias risk demonstrated a well-balanced distribution across low, medium, and high-risk categories. Among the 11 chosen publications, 10 were identified as low-risk, with only one falling into the high-risk category. However, our investigation also faces limitations, which we have openly disclosed. Despite the protocol under scrutiny having been introduced for some time, its long-term

effectiveness has not been extensively documented in the literature due to its limited implementation. To address this gap, we included 11 articles that met our predefined inclusion criteria. Within these selected studies, we observed significant variability in terms of the evaluated variables and assessment techniques. These variations often lacked objectivity, repeatability and comparability. This variability posed challenges in conducting a comprehensive meta-analysis, as only four variables could be analyzed across a total of 5 to 6 articles for each variable at 6 and 12 months, respectively. Furthermore, due to the diversity in evaluation techniques and variables, considerable effort was dedicated to interpreting and standardizing the data into universally applicable parameters, facilitating the grouping of a larger number of publications**.**

6. CONCLUSION

VI. Conclusion

Implementing the OAOT protocol in implant dentistry shows potential benefits such as decreased bone resorption during the healing phase and enhanced support for surrounding soft and hard tissue adjacent to the implant. However, additional research and in-depth studies are necessary to completely grasp the effectiveness, potential complications, and its applicability in diverse clinical settings and patient demographics.

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8. ATTACHMENTS

ID	Title	Status	Last edited
CRD42024493033	One-abutment one-time insertion and related outcomes: a systematic review of the literature with meta-analysis To enable PROSPERO to focus on COVID-19 registrations during the 2020 pandemic, this registration record was automatically published exactly as submitted. The PROSPERO team has not checked eligibility.	Registered	06/02/2024

Figure 8: *Certificate of registration on PROSPERO*

Membros do Júri das Provas Públicas

Presidente: Miguel Agostinho Beco Pinto Cardoso, Professor Auxiliar

Arguente: Sérgio Allegrini Junior, Professor Auxiliar Convidado

Orientador: Tiago Gonçalves Ferreira Borges, Professor Auxiliar

Data das provas públicas: 23 / 07 / 24

Classificação: 18 valores

Validação e confirmação pelos serviços escolares:

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