GRADUATION PROJECT

Degree in Dentistry

ESTHETIC COMPLICATIONS IN IMPLANT DENTISTRY

Madrid, academic year 2024/2025

Identification number: 76

ABSTRACT

Introduction: Implant placement in the anterior maxilla presents distinct esthetic challenges due to the high visibility of the region and the sensitivity of peri-implant soft tissues. Common esthetic issues include midfacial recession, papilla loss, and asymmetry, often influenced by surgical technique and timing; **Objectives:** This study compares immediate and delayed implant placement in the esthetic zone, focusing on esthetic outcomes. It also evaluates how soft tissue augmentation and provisionalization affect peri-implant tissue stability. Included studies were published in the last 10 years, focused on anterior maxillary implants, and featured comparison groups; **Methods:** A literature review was conducted, selecting 15 clinical studies. Each study compared immediate vs. delayed implant placement or different augmentation and provisionalization protocols. Key parameters analysed included the Pink Esthetic Score (PES), tissue thickness, bone stability, and patient satisfaction; **Results:** Immediate placement showed greater early tissue remodelling, while delayed placement led to more predictable initial healing. Long-term esthetic outcomes were often similar. Techniques like connective tissue grafting (CTG) and socket shield (SST) improved soft tissue stability. Immediate provisionalization aided early soft tissue shaping but showed minimal long-term advantage over delayed; **Conclusions:** Both implant protocols can achieve favourable esthetic results. Immediate placement requires precise tissue management but offers similar outcomes to delayed placement when properly planned. A tailored approach, combining surgical accuracy, augmentation, and provisionalization timing, is key to esthetic success.

KEYWORDS

Dentistry, dental implants, esthetic, immediate implant placement, delayed implant placement, provisionalization.

RESUMEN

Introducción: La colocación de implantes en el maxilar anterior presenta desafíos estéticos debido a la alta visibilidad de la zona y la sensibilidad de los tejidos blandos periimplantarios. Las complicaciones comunes incluyen recesión gingival, pérdida de papilas y asimetrías, influenciadas por la técnica quirúrgica y el momento de la colocación; **Objetivos:** Este estudio compara la colocación inmediata y diferida de implantes en la zona estética, evaluando los resultados estéticos. Además, analiza cómo la aumentación de tejidos blandos y la provisionalización afectan la estabilidad periimplantaria. Se incluyeron estudios de los últimos 10 años, centrados en el maxilar anterior y con grupos comparativos; **Métodos:** Se realizó una revisión bibliográfica con 15 estudios clínicos que compararon la colocación inmediata y diferida, o diferentes protocolos de aumentación y provisionalización. Se analizaron parámetros como el Pink Esthetic Score (PES), grosor tisular, estabilidad ósea y satisfacción del paciente; **Resultados:** La colocación inmediata mostró más remodelado tisular temprano, mientras que la diferida permitió una cicatrización más predecible. Los resultados estéticos a largo plazo fueron similares. Técnicas como el injerto de tejido conectivo (CTG) y socket shield (SST) mejoraron la estabilidad tisular. La provisionalización inmediata favoreció la forma tisular inicial, sin diferencias estéticas duraderas frente a la diferida; **Conclusiones:** Ambos protocolos logran buenos resultados si se planifican adecuadamente. La colocación inmediata exige mayor manejo tisular, pero puede igualar los resultados de la diferida. Un enfoque individualizado es clave para el éxito estético.

PALABRAS CLAVES

Odontología, implantes dentales, estética, colocación inmediata de implantes, colocación diferida de implantes, provisionalización.

INDICE

1. INTRODUCTION

In the last decades the implication of dental implants has completely revolutionized restorative dentistry, offering to the patient with missing tooth a firmly valuable option in restorative treatments (1). Dental implants nowadays are one of the best available options in terms of esthetic, resistance, functionality and durability (2). They offer to the patient a fixed rehabilitation of a single or multiples missing teeth, giving the patient receiving it a feeling which is close to a real tooth, thanks to their direct connection and fusion with the maxillary or mandibular bone (2). In short terms they consist of a screw that can be realized with different materials like surface modified titanium or zirconium which the dentist inserts through a complex surgery inside the bone tissue of the patient, which will stimulate a process of osteointegration of the implant that assure a firm union between them. This screw is precisely inserted directly inside the bone of the patient and simulate in this way the "root" of the natural tooth that is missing. A prosthetic crown will complete the functionality of the implant (2,3).

1.1. The esthetic zone:

The implants placed in the "esthetic zone", which generally is considered the anterior sextant of the upper arch, are particularly challenging for a dental professional. This is usually determined by the high esthetic demands of the patient and the visibility of this specific area (4). The placement of an implant in this area requires meticulous attention to plenty of different factors to not affect the smile harmony of the patient, the health of the soft tissue. In fact, the biological soft tissues in this area are usually thinner and so more fragile. This characteristic makes their management more challenging and may include many possible complications compared to the posterior sectors. Any minimal inaccuracy in the placement of an implant in the esthetic zone could significantly affect the overall esthetic result. Patients that require or want an implant in the upper anterior sextant are usually searching for perfection in terms of esthetic, especially nowadays. They are usually highly aware of their appearance and are less likely to tolerate even minor and apparently imperceptible imperfections (4,5).

1.2. Esthetic Complications:

Esthetic complications in the context of dental implants refer to a broad variety of challenges that primarily concern the visual and esthetic outcomes of the implant and the surrounding oral tissues. These complications are particularly significant as they influence both

the functionality and the psychological well-being of the patient (6). In implant dentistry, esthetic issues are often divided into two principal groups: those associated with the patient's biological tissues and those relating to the prosthetic components.

1.2.1.Complications Related to Patient's Tissues:

The focus of this study is the esthetic complications related to the patient's tissues, which often are a direct consequence of wrong or imprecise surgical techniques, inadequate soft tissue management, or pre-existing anatomical deficiencies. This type of complications may manifest in various forms, including gingival recession, asymmetry and deficient interproximal papillae, also known as black triangles.

1.2.1.1. Gingival Recession:

This term refers to the apical migration of the gingival margin, leading to root exposure. In case this complication appears corresponding to an implant it could cause the exposure of the implant margin, usually caused by insufficient soft tissue volume. This condition reduces the natural appearance of the restoration (7).

1.2.1.2. Asymmetry:

Refers to an uneven appearance between the implant site and adjacent natural teeth or soft tissue structures. This issue can involve discrepancies in gingival contour, mucosal margins, or implant positioning, which are especially noticeable in the anterior esthetic zone. (7,8)

1.2.1.3. Deficient Interproximal Papillae:

It consists in an inadequate filling of the interdental space. A loss or a retraction of the gingival papilla leading to an open gingival embrasure, also called black triangles. This complication compromises the natural esthetic outcome of the implant and, particularly between the central incisors, are contemplated one of the worst esthetic complications that undesirably affect the smile esthetic. (7–9)

All these problems can result from wrong or imprecise surgical procedure, anatomical defect of the patients and variations in the healing response of the latter. Correcting and control all

these complications requires experience, knowledge and a deep understanding of soft tissue dynamics. All this needs to be complemented with surgical precision in the placement of the implants, and careful post-operative management or treatment depending on the case (7,10)

1.2.2.Prosthetic defects:

This category includes esthetic concerns related to the prosthetic superstructure placed over one or multiple implants. Common issues include colour discrepancy, in the case when the prosthetic tooth does not match the adjacent natural teeth in colour or translucency. Other common defects may regard an improper prosthetic Shape, or an incorrect inclination. In both these cases the form of the prosthesis deviates from the natural anatomy, creating an unnatural appearance, modifying in most of the cases the harmony of the patient smile and compromising both function and esthetic (10). Prosthetic complications, while important, fall outside the scope of this review and will not be further explored here.

1.2.3.Clinical and Patient Implications:

Esthetic complications, principally those resulting from surgical procedures, have major role for a correct result and the long-term success of the dental implant. Any of this complication can impact harmfully on osseointegration and implant stability. Additionally, esthetic failures often lead to decreased patient satisfaction, which is a significant factor that the dentist must take in consideration in nowadays dentistry (2,11). Patient satisfaction with dental implants, mostly in esthetic areas, is influenced by several factors, including the harmony of the prosthetic restoration with the natural dentition and, most of all, the patient's expectations (11). Research indicates that enhancements in oral health-related quality of life (OHRQoL), such as esthetic outcomes or others like masticatory function, meaningly enhance satisfaction levels (12). Furthermore, the use of certified tools like the OHIP-14 questionnaire to measure patient satisfaction, emphasises that psychological and social benefits, such as enhanced self-esteem and confidence, play an equally important role in determining overall satisfaction with implant-supported rehabilitations (12). The work of the dentist must be specifically designed on each patient and needs to be directed on achieving results that not only restore a person’s ability to chew and speak but also ensure they feel confident and satisfied with the appearance of their smile (11,12).

1.3. The peri-implant phenotype:

Since the term phenotype refers to the visible appearances of an organism, the peri-implant phenotype can be defined as all the morphologic, structural, dimensional and biological characteristics of the tissues that enclose an implant (13). It includes both soft tissue components and bone components, being particularly similar to the periodontal phenotype (8). The peri-implant phenotype is a factor of extreme relevance in the functional and esthetic outcomes of dental implants. Is crucial to consider all the parameter that it includes for a healthy and esthetic result (8,13).

1.3.1.Keratinized Mucosa Width (KMW):

The keratinized mucosa (KM) around dental implants consists in a defensive barrier that in a healthy state avoid bacterial penetration and maintains implant health (13,14). It includes the tissue that goes from the mucogingival junction until the mucosal margin and, to be healthy and functional, needs to be fixed and inserted (13). The parameters for a healthy KM are discussed in the literature, but generally a KMW of at least 2 mm is associated with reduced plaque accumulation and ensure better tissue stability and esthetic (8,13,14). A lack of sufficient KM can lead to inflammation, discomfort, and soft tissue recession, which may compromise esthetics and functionality of the implant itself (15). Recent evidence also highlights that an adequate KMW supports peri-implant soft tissue sealing, contributing to long-term implant survival (8,15).

1.3.2.Mucosal Thickness (MT):

The mucosal thickness (MT) of peri-implant tissues, considered in a horizontal dimension, defines both integrity and visual results of soft tissues around implants (8). Studies emphasize that thicker soft tissues are more resistant to recession and other possible defects (13,16) while on the other hand, a thin biotype increases the risk of complications like soft tissue retraction (16,17). The MT can be increased through soft tissue augmentation procedures to obtain better outcomes and to compensate underlaying bone defects (17,18).

1.3.3.Supracrestal Tissue Height (STH):

Supracrestal tissue height, or biological width, goes from the mucosal margin to the limit of the bone crest in a coronal direction. A stable STH normally is considered from about 3 mm all around the implant (13,16,19). The STH can be commonly defined as “short” (<3 mm) or “tall” (>3 mm), and has a critical impact on the patterns of bone loss (8,13,19). If altered can menace the maintenance and increase susceptibility to peri-implantitis, particularly in patients with a history of periodontal disease (20).

1.3.4.Peri-Implant Bone Thickness (PBT)

Literature refers with this term to the horizontal dimension of the bone plate that surrounds and embed the implant (8,21). The thickness of the PBT is fundamental for the support of the implant itself and the soft tissue around it. The academic threshold to define the minimum PBT is currently set at 2 mm (8,13,22). A thin bone plate (<2 mm) increases drastically the prospect of bone remodeling and loss after implant uncovering (21,22). In these cases, advanced surgical technique of bone augmentations, like GBR (Guided Bone Regeneration), can be used in deficient areas (23).

1.4. Objective assessment for esthetic outcome:

With the objective to evaluate the esthetic results of implant restorations, especially in the esthetic zone, multiples indices have been created to evaluate and measure in a standardized and objective way specific relevant characteristics (24). Among the most relevant in the literature there are the Pink Esthetic Score (PES) and the Papilla Presence Index (PPI). The PES includes the soft tissue’s appearance around the implant, and its total range goes from 0 to 14. Higher the score, lower the deviation from the contralateral tooth that is usually taken as a reference (24,25). The PPI, on the other hand, focuses on the interproximal papillae grading it with a score from 0 to 4, where 0 means absence and 4 means hyperplastic papilla, being 3 the ideal score (25). The Peri-Implant and Crown Index (PICI) associates implant and crown evaluations, while the PES/WES system integrates soft tissue (pink) and crown (white) assessments for a wider analysis. The Implant Crown Esthetic Index (ICAI) reports a detailed scoring system about crown esthetic (25,26).

1.5. Importance of correct implant positioning:

To reduce the possibility of having an esthetic complication in patients receiving an implant, a crucial impacting factor is to obtain a correct three-dimensional implant positioning, particularly in the esthetic zone (27). Precise placement minimizes the functional and the esthetic complications, increasing also long-term prognosis. An adequate 3D positioning needs to considerate several parameters including the depth, the inclination, the distance from the cortical bone, from the adjacent teeth and, in case of adjacent implants, the distance between them (5,27). Mistakes in the positioning could cause bone resorption and soft tissue recession or could impede the proper formation of a healthy and harmonious interproximal papilla. Studies underlines that an appropriate preoperative planning is the key for a correct positioning, and it should include the help of digital and technological tools such as cone beam computing tomography (CBCT) to increase the precision of the work (28,29). Furthermore, recently, many steps forward were done in the guided implant placement, which could become one day the way to minimize or to eliminate mistakes in the dental implant positioning (30).

1.6. Immediate and delayed implants:

Implant placement timing can affect treatment outcomes and is mainly classified into immediate implant placement (IIP) and delayed implant placement (DIP). Immediate implant placement refers to the insertion of an implant directly into the extraction socket, immediately after tooth removal, during the same surgery (31). This method is particularly favourable due to its reduced treatment duration, fewer surgical interventions, and potential for soft and hard tissue preservation (32). However, concerns regarding increased risks of esthetic complications, such as soft tissue recession and buccal bone loss, have led to a more cautious case selection for IIP, particularly in patients with thin gingival biotypes or insufficient bone volume (33).

Delayed implant placement, on the other hand, involves allowing the complete healing of the extraction site before implant insertion, typically after a period that goes from a few weeks to several months (34). This time allows a proper soft tissue maturation, bone remodelling, and the complete disappearance of possible infection, often providing a more stable peri-implant environment (31). DIP is often chosen by dentists when there is an active infection in the extraction sockets or when primary stability cannot be ensured during immediate placement (32). However, the extended treatment duration and additional surgical procedures may be serious disadvantages for some patients (33).

The decision between immediate and delayed implant placement is crucial and should be made based on multiple factors such as bone quality, soft tissue conditions, esthetic implications, and the presence of infection or defects (34). Both options are possible and each case should be evaluated singularly, considering for each patient all the specific advantages and disadvantages of the case (31,33).

1.7. Soft tissue management:

A qualified dentist surgeon must be able to find a solution in case of an existing esthetic defect of an implant, especially related to soft tissues (35). The management of the patient's soft tissue nowadays represent a valuable option to treat and solve esthetic defects around dental implants. Many different techniques have been developed with this objective, such as free gingival grafts, soft tissue grafts and flap techniques. These procedures usually are used to increase the amount of keratinized mucosa in cases where is needed to improve deficiencies (7,17,35).

1.8. Provisionalization:

Provisionalization is a key step in implant therapy that plays an essential role in shaping the soft tissue architecture around the implant, particularly in the esthetic zone, where the appearance of the peri-implant mucosa is a critical factor (36). The use of a temporary prosthesis following implant placement helps to guide the formation of the emergence profile, protect healing tissues, and maintain function and esthetic while awaiting the final restoration (37). Based on the timing of its placement, provisionalization is classified into immediate and delayed (38).

Immediate provisionalization (IP) refers to the placement of a temporary prosthesis within the first 24 hours following implant surgery, often before complete osseointegration has occurred (39). This technique is commonly applied when maintaining the natural gingival contour and papilla architecture is a priority, particularly in the anterior maxillary region, where esthetic is highly significant (40). A key consideration for IP is the requirement of primary stability, as the implant must be able to withstand any functional forces that could interfere with healing (37).

In contrast, delayed provisionalization (DP) involves waiting for a healing period before placing the temporary prosthesis, allowing for soft tissue adaptation and initial implant stabilization (36). This approach is often used when additional bone or soft tissue augmentation is needed, or when the conditions of the implant site do not allow for immediate functional loading (38). DP is also considered when a more controlled soft tissue healing process is preferred before shaping the final emergence profile (39).

The decision to use immediate or delayed provisionalization depends on several clinical factors, including implant stability, soft tissue conditions, patient esthetic demands, and overall treatment planning (40). Regardless of the chosen approach, provisionalization remains an essential component of implant therapy, as it helps to preserve soft tissue contours and prepare the site for the definitive restoration (36–38).

1.9. Justification:

The motivation for conducting this review lies in the increasing demand for predictable esthetic outcomes in implant dentistry, especially in the anterior maxilla where patient expectations are highest (11). Despite numerous advances in surgical and prosthetic techniques, esthetic complications remain a frequent challenge, often linked to the timing of implant placement and the management of peri-implant soft tissues (31). By systematically comparing immediate and delayed implant protocols and evaluating the influence of soft tissue augmentation and provisionalization, this work aims to clarify which strategies most effectively minimize esthetic complications (39). Understanding these dynamics is essential for guiding clinical decisions and improving patient satisfaction, making this review relevant and necessary in the context of current dental practice.

2. OBJECTIVE

The primary objective of this thesis is to investigate and analyse which are the most common esthetic complications associated with dental implants placed in the anterior sextant of the superior maxilla and to compare immediate implant placement with delayed implant placement in terms of esthetic outcomes. Additionally, this research aims to evaluate how soft tissue augmentation techniques and provisionalization can help minimize esthetic complications, ensuring an adequate implant integration and patient satisfaction.

The research is guided by the following PICO question: In patients receiving dental implants in the esthetic zone, how do immediate implants compare to delayed implants in terms of esthetic outcomes, and how can soft tissue augmentation techniques and provisionalization reduce esthetic complications?

- P (Population): Patients receiving dental implants in the esthetic zone.
- I (Intervention): Immediate implant placement.
- C (Comparison): Delayed implant placement.
- O (Outcome): Esthetic complications and how they can be minimized through soft tissue augmentation techniques and provisionalization.

Through this analysis, the thesis will provide a general view into prevention and management strategies for esthetic complications, focusing on achieving predictable esthetic results in implant dentistry while considering both clinical success and patient-reported outcomes.

3. MATERIAL AND METHODS

For this thesis, a detailed literature review was conducted to obtain and analyse information on esthetic outcomes and complications in dental implants. The primary database used was PubMed, especially for the results, while other databases like Google Scholar, Scopus, and Web of Science, chosen for their reliable collections of biomedical and dental research, were used for the rest of the information needed.

The search focused on articles published in the last ten years to ensure the inclusion of current and relevant studies. Keywords such as dental implants, esthetic outcomes, immediate implants, delayed implants, peri-implant phenotype, keratinized mucosa, soft tissue management and provisionalization were combined using Boolean operators like AND, OR and NOT to refine the search results. Filters were applied to limit the search to English-language studies, ensuring accessibility and comprehension.

Studies were included if they focused on esthetic, peri-implant tissue parameters, or related surgical treatments. Articles not directly relevant, not specifically related to the topic, or unavailable in full text were excluded. Additionally, the reference sections of selected studies were manually reviewed to find any other useful research.

The process involved multiple steps. First, abstracts and titles were screened for relevance. Then, full texts of the selected studies were reviewed in detail, with a critical look at their methodologies and findings. This approach helped ensure only high-quality, evidence-based data was used to address the objectives of this research.

The definitive search equation for the results of this project is: (((((implants in anterior maxilla) NOT (posterior)) NOT (mandibular)) AND (immediate implants)) OR (delayed implants)) AND (provisionalization). Starting from this search equation the following prisma flow chart was created.

To ensure the relevance, quality, and comparability of the included studies, the following criteria were applied during the selection process:

3.1. Inclusion Criteria:

- Studies published within the last 10 years.
- Articles that included a comparison between immediate and delayed implant placement, or between different timing of provisionalization.
- Studies focused exclusively on implants placed in the anterior maxilla (esthetic zone).
- Clinical studies with measurable esthetic outcomes (e.g., Pink Esthetic Score, patient satisfaction, tissue volume changes).

3.2. Exclusion Criteria:

- Studies published more than 10 years ago.
- Articles lacking a comparison group.
- Studies involving implant placement in the posterior maxilla or mandibular arches.
- Meta-analyses, narrative reviews, and case reports.

4. RESULTS

The focus of this study is to evaluate the esthetic complications associated with immediate and delayed implant placement in the esthetic zone, analysing both options and how their outcome could be affected by techniques of soft tissue augmentations and by provisionalization. The reviewed studies provide reliable results basing on peri-implant tissue health and esthetic outcome, according to both objective clinical assessment (like PES and WES) and patient satisfaction. The review was managed in accordance with the PRISMA statement (41).

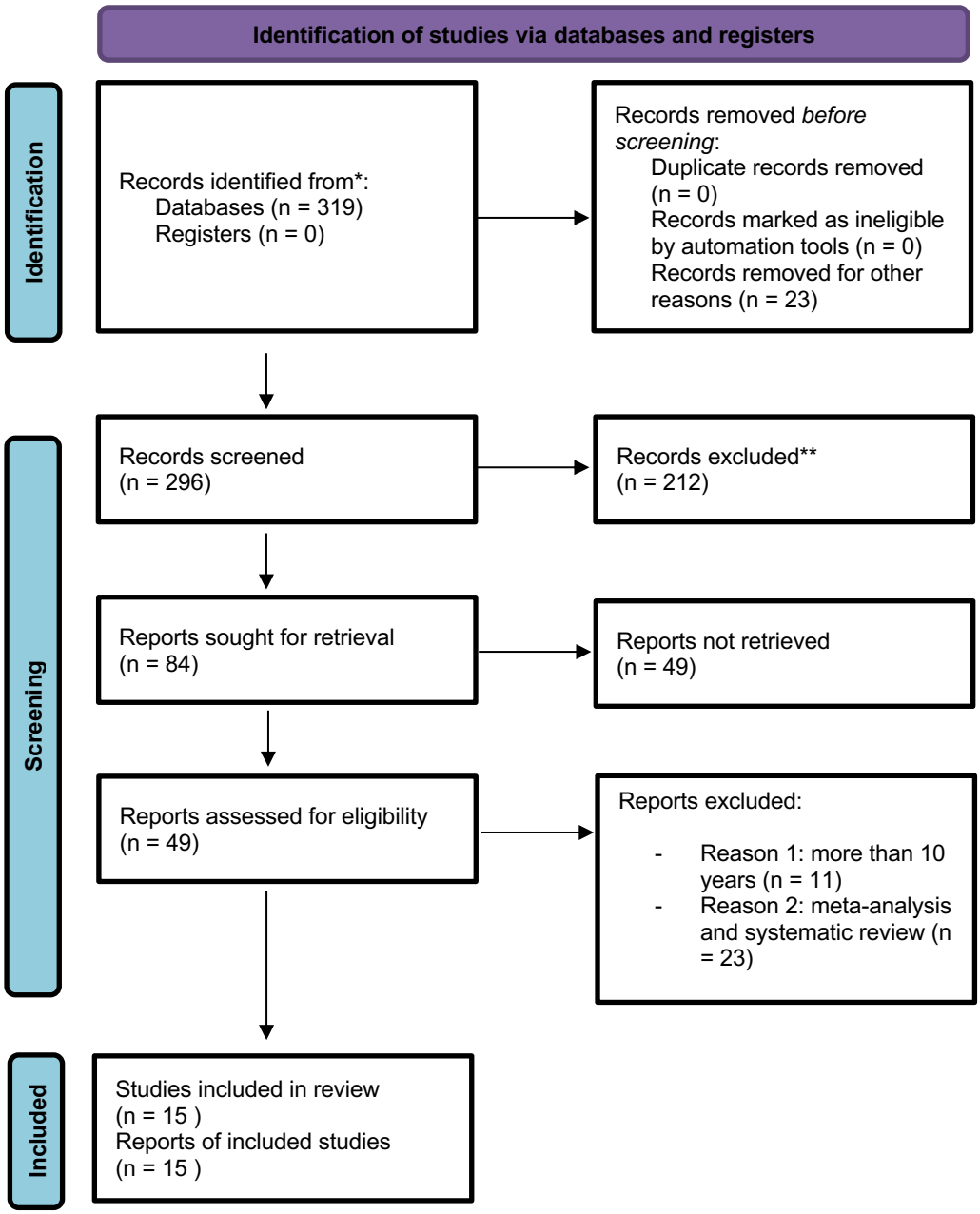

Figure 1: PRISMA 2020 flow diagram.

In this review, 15 studies were analysed, including many different methodological designs to evaluate esthetic outcomes in implant dentistry. Among them, seven were prospective studies, including two prospective clinical trials, two prospective observational studies, two prospective cohort studies, and one long-term prospective study. Additionally, three randomized controlled trials (RCTs) and four experimental studies were included to assess the impact of different interventions on esthetic outcomes. Lastly, one retrospective observational study contributed further insights into long-term results. This diverse range of study designs provides a comprehensive evaluation of how implant placement timing, soft tissue augmentation, and provisionalization influence esthetic outcomes.

4.1. Number of Groups Evaluated in the Intervention:

The intervention groups in the selected studies primarily consist of immediate implant placement (IIP) with or without adjunctive procedures, such as soft tissue augmentation (connective tissue grafting, socket shield technique) and immediate or delayed provisionalization.

4.2. Number of Groups Assessed in the Comparison:

The comparison groups generally include delayed implant placement (DIP), where implants are placed after a healing period following tooth extraction. In some studies, the comparison groups also include delayed provisionalization protocols or different augmentation techniques, allowing for a direct evaluation of how timing and peri-implant tissue management affect esthetic outcomes.

4.3. Immediate vs. Delayed Implant Placement:

The comparison between immediate implant placement (IIP) and delayed implant placement (DIP) has been widely studied by literature in terms of peri-implant tissue remodeling, bone stability, and esthetic outcomes.

The following table summarizes nine studies that compare immediate implant placement and delayed implant placement in terms of esthetic outcomes.

Table 1: Results summary of Immediate vs Delayed implants

Author (year)	Population	N° of patients	Groups	Results
Tonetti et al., 2017 (42)	Patients requiring single tooth extraction in the anterior and premolar areas	106	Immediate post-extraction implant placement vs. Delayed implant placement after 12 weeks of healing	Immediate implant placement increases complexity and risk of suboptimal esthetic outcomes; should be limited to selected cases.
Parvini et al., 2022 (43)	Patients receiving single implants in the anterior esthetic zone	30	Immediate implant placement (Type 1) vs. Delayed implant placement (>4 months after extraction, Type 4)	Immediate implants in the esthetic zone experience more tissue loss than delayed implants. Marginal tissue remodeling should be considered when planning immediate placement.
Shah et al., 2021 (44)	Patients receiving immediate implants in the maxillary anterior area	30	Immediate implant placement with adjunct pretreatment (Photofunctionalization or Platelet-Rich Plasma) vs. Immediate implant placement without pretreatment (control)	Pretreatment with PF or PRP improves implant stability but does not significantly impact esthetic outcomes or marginal bone loss.
Sanchez-Perez et al., 2021 (45)	Patients receiving immediate implants in the upper anterior maxilla	20	Immediate implant placement with two different implant designs (control vs. experimental) vs. No comparison with delayed implants	Both implant designs provide good stability, bone maintenance, and esthetic outcomes in immediate implant placement cases.
Meijer et al., 2024 (46)	Patients with failing teeth in the esthetic zone and buccal bony defects ≥5 mm	40	Immediate implant placement with bone augmentation vs. Delayed implant placement after ridge preservation	Immediate implant placement in postextraction sockets with buccal bony defects is a viable option, with long-term outcomes comparable to delayed implant placement.
Fettouh et al., 2024 (47)	Patients receiving immediate implants in	39	Immediate implant placement + Bone graft vs. Immediate implant placement +	CTG significantly improves peri-implant soft tissue stability, reducing midfacial gingival margin alterations

	the anterior esthetic zone		Connective Tissue Graft (CTG) vs. Immediate implant placement + Customized Healing Abutment (CHA)	and total volume loss. CHA alone fails to provide adequate support for soft tissue.
Santhana-krishnan et al., 2021 (48)	Patients receiving immediate or delayed implants in the maxillary esthetic region	50	Immediate implant placement (IIP) with bone graft vs. Delayed implant placement (DIP) with socket preservation	Immediate implant placement preserves buccal bone thickness better than delayed implants with socket preservation, improving esthetic outcomes in the maxillary esthetic zone.
Santhana-krishnan et al., 2021 (49)	Patients receiving immediate implants in the anterior esthetic zone	75	Immediate implant placement (IIP) vs. Immediate implant with Socket Shield (SST) vs. Delayed implant placement (DIP)	The socket shield technique (SST) preserves buccal bone better and provides superior esthetic results compared to immediate and delayed implant placement.
Santhana-krishnan et al., 2024 (50)	Patients receiving immediate implants in the maxillary esthetic zone (single tooth)	75	Immediate implant placement (IIP) vs. Immediate implant with Socket Shield (SST) vs. Delayed implant placement (DIP)	SST could be the preferred choice for IIP when buccal bone thickness is <1 mm, as it showed less reduction in crestal bone thickness and superior esthetic results at 12 months.

4.3.1.Soft Tissue Remodeling:

Studies assessing soft tissue behavior following implant placement have reported differences in peri-implant tissue thickness and marginal remodeling. Parvini and colleagues, in a prospective observational study of 2022, found that immediate implants exhibited a reduction in peri-implant tissue thickness (-0.37 ± 0.31mm), while delayed implants resulted in a gain in tissue volume (0.84 ± 0.57mm, p=0.0452). The same study reported that marginal tissue remodeling was more pronounced in IIP (-0.42 ± 0.31mm) compared to DIP (0.80 ± 0.49mm, p=0.0274) (43).

In contrast, a long-term assessment by Meijer et al. of 2024 found that after 10 years, there were no significant differences in marginal bone levels, soft tissue parameters, or overall esthetic outcomes between immediate and delayed placement (46). Similarly, Tonetti in 2017 reported that although immediate placement presented more early soft tissue alterations, augmentation techniques reduced esthetic complications, being more similar to delayed placement outcome over time (42).

4.3.2.Bone Stability:

Regarding buccal bone thickness, studies have presented contrasting results. Santhanakrishnan et al. found that immediate placement resulted in a smaller reduction in buccal bone thickness (0.2 ± 0.02mm) compared to delayed placement (0.4 ± 0.1mm, $p<0.001$) (48).

Other research has focused on bone remodeling patterns. Sanchez-Perez et al. (2021) reported that delayed placement resulted in greater bone gain during the healing phase, whereas immediate placement showed early bone resorption before stabilizing over time (45). These findings contrast with the prospective observational study of Santhanakrishnan and colleagues, where buccal bone changes in IIP and DIP were not significantly different over time (48).

4.3.3.Esthetic Outcomes:

The Pink Esthetic Score (PES), as previously mentioned in the introduction, is widely used to assess soft tissue integration around implants. Studies have reported conflicting findings on whether IIP and DIP generate different PES scores. Santhanakrishnan in 2021 found no significant differences in PES between immediate and delayed placement (48). However, the same author in a different study of that year, observed that the Socket Shield Technique (SST) achieved the highest PES scores (PES = 13), compared to immediate placement (PES = 10) and delayed placement (PES = 9, $p<0.01$) (49).

In a similar study of 2024, Santhanakrishnan confirmed that SST preserved crestal bone thickness better than both IIP and DIP, resulting in higher esthetic scores (PES = 13 for SST, PES = 10 for IIP, and PES = 9 for DIP, $p<0.01$) (50).

4.3.4.Augmentation Influence:

The role of augmentation techniques in immediate implants has been analyzed to assess soft tissue volume and esthetic predictability. An experimental study of 2021 carried by Shah and colleagues, report that augmentation procedures, in this case photo functionalization and platelet rich plasma, clearly improved bone and implant stability, but it doesn't really show significant differences in terms of esthetic outcome (44). Regarding other types of augmentations materials and procedures, Fettouh et al. in 2024 reported that CTG led to the least midfacial gingival margin recession (-0.74mm), while bone grafting resulted in a slightly greater recession (-0.98mm), and CHA showed the highest recession (-1.54mm) (47).

4.4. The influence of Provisionalization on Soft Tissue:

Provisionalization plays an essential role in guiding soft tissue healing and maintaining peri-implant esthetics. The reviewed studies explored whether immediate provisionalization (IP) differs significantly from delayed provisionalization (DP) in terms of bone stability, soft tissue volume, and patient satisfaction.

Table 2: Studies about provisionalization included in the Results.

Study	***Population***	***N° of Patients***	***Groups Compared***
Donker et al., 2024 (51)	Patients receiving immediate implants in the maxillary esthetic zone	40	Immediate provisionalization vs. Delayed provisionalization
Slagter et al., 2021 (36)	Patients receiving single implants in the anterior maxilla	40	Immediate implant placement with IP vs. Immediate implant placement with DP
Chan et al., 2019 (52)	Patients receiving immediate implants in the anterior maxilla	40	Immediate placement with vs. without immediate provisionalization
Fu et al., 2023 (39)	Patients receiving immediate implants in the maxillary anterior zone	70	Immediate placement with provisionalization vs. Without provisionalization
Fawzy et al., 2023 (53)	Patients with delayed implants and thin gingival phenotype	20	Delayed implants with immediate temporization vs. Delayed implants without temporization

Wang et al., 2020 (54)	Patients receiving immediate implants in the maxillary anterior and premolar regions	40	Immediate implant placement with provisionalization vs. Immediate implant placement without provisionalization

4.4.1.Bone and Soft Tissue Stability:

Several studies found no significant differences in marginal bone loss (MBL) between immediate and delayed provisionalization. A prospective cohort study of 2024 reported that, after 10 years, the mean mesial and distal changes in marginal bone level were -0.47 ± 0.45 mm and -0.49 ± 0.52 mm in the IP group, and -0.58 ± 0.76 mm and -0.41 ± 0.72 mm in the DP group, with no statistical significance (p = 0.61; p = 0.71) (51). Similarly, a retrospective observational study carried by Slagter et al. of 2021, found that marginal bone level changes at 5 years were comparable between IP and DP, with mesial and distal bone loss at 0.71 ± 0.68 mm and 0.71 ± 0.71 mm for IP, and 0.49 ± 0.52 mm and 0.54 ± 0.64 mm for DP (p = 0.305 and p = 0.477) (36).

On the other hand, Wang and colleagues carried a randomized controlled trial which reported that IP resulted in better mid-facial soft tissue volume preservation at 12 months, while no significant differences were found in linear soft tissue resorption between groups (54).

4.4.2.Esthetic and Patient Satisfaction Outcomes

Esthetic outcomes were assessed using the Pink Esthetic Score (PES) and White Esthetic Score (WES). Donker and other authors reported that, after 10 years, PES/WES scores were 15.28 ± 2.32 for IP and 14.64 ± 2.74 for DP (p = 0.48), with no significant differences in esthetic indices (51). In the same way, Slagter found no statistically significant differences in PES/WES at 5 years between IP (15.44 ± 2.64) and DP (15.73 ± 2.15, p = 0.736) (36).

On the other hand, the experimental study carried by Fawzy and colleagues in 2023 evaluated delayed implants with and without immediate temporization and found that PES was slightly higher in the immediate temporization group (11.88 ± 1.13) than in the control group (11.33 ± 1.25), but also in this case the difference was not statistically significant (p = 0.365) (53). However, immediate temporization allowed for earlier provisional crown delivery, which improved patient comfort and esthetic predictability.

Regarding patient satisfaction, another prospective clinical study assessed the visual analogue scale (VAS) scores and found that patients in the immediate provisionalization group reported significantly higher satisfaction immediately after the surgery (VAS 8.3 ± 1.5) compared to the delayed group (VAS 5.7 ± 1.8, p = 0.027) (39). However, at definitive crown delivery and after 1 year, no significant differences in satisfaction were noted between the two groups (p = 0.694 and p = 0.826, respectively).

4.5. Summary of Results:

- Soft Tissue Remodeling: Immediate implants resulted in greater early peri-implant remodeling, whereas delayed implants resulted in initial soft tissue volume gain (42,43).

- Bone Stability: Buccal bone thickness reduction was less pronounced in immediate implants, though some studies reported no significant long-term differences between the two protocols (45,48).

- PES Scores: Some studies found no significant difference in PES scores between IIP and DIP, while others reported higher scores for SST-treated implants compared to both immediate and delayed placements (48,49).

- Augmentation Influence: CTG improved soft tissue stability and reduced recession in immediate implants, while CHA resulted in more pronounced recession (44,47).

- Provisionalization: Studies reported no major differences in bone levels between IP and DP, though immediate provisionalization was associated with better soft tissue volume preservation and higher patient satisfaction (39,51,54).

5. DISCUSSION

This review examined immediate and delayed implant placement and the impact of soft tissue augmentation and provisionalization on peri-implant esthetic. While the overall findings suggest that both protocols achieve comparable long-term outcomes, important differences emerge in early remodelling patterns, esthetic predictability, and patient satisfaction. These results align with or contradict previous literature, revealing key areas of consensus and debate

that help refine clinical decision-making and could give to the dentist different points of view to choose the best option in each clinical case.

5.1. Immediate vs. Delayed Implant Placement: Soft Tissue Stability and Bone Preservation

One of the most debated aspects in implant dentistry is whether immediate or delayed placement leads to superior esthetic and structural outcomes. A recurring theme in the literature is that immediate placement results in more pronounced early peri-implant remodelling, while delayed placement allows for greater soft tissue stabilization during healing (43,45).

Despite this initial discrepancy, several long-term studies, including a 10-year follow-up by Meijer and colleagues in 2024, found that after full osseointegration and tissue adaptation, there were no significant differences in esthetic indices, marginal bone levels, or peri-implant soft tissue parameters between IIP and DIP (46). This suggests that initial remodelling should not be seen as a definitive limitation of IIP but rather as a consideration that can be moderated with proper peri-implant tissue management strategies.

However, buccal bone resorption remains an issue, particularly in thin biotypes where immediate placement may lead to midfacial tissue collapse. Some authors argue that DIP minimizes this risk by allowing soft tissue maturation before implant placement (55). On the other hand, other authors noted that IIP, when combined with augmentation techniques, can limit alveolar ridge resorption by preserving natural tissue architecture (48).

The surgical approach may also influence esthetic success. Flapless techniques have been proposed to reduce peri-implant soft tissue recession compared to traditional flap surgeries. Some authors demonstrated that minimally invasive, touch-controlled implantation resulted in significantly lower midfacial gingival recession (2.38 ± 0.14 mm) compared to conventional flap surgery (3.05 ± 0.10 mm, $p=0.023$) (56). These findings emphasize that implant placement timing alone is not the only determinant of esthetic success, and that the surgical approach can play a critical role.

5.2. Soft Tissue Augmentation: Does It Compensate for Peri-Implant Remodelling?

The use of soft tissue augmentation techniques has been widely investigated as a strategy to counteract peri-implant remodelling in IIP. Among these, connective tissue grafting (CTG) and the Socket Shield Technique (SST) have shown promising results.

A clear point of consensus is that CTG enhances soft tissue thickness and reduces gingival recession, especially in IIP cases where early contraction is more pronounced (44,47). However, the amount and durability of this effect are debated. While some studies report a sustained improvement in PES/WES scores over time (40), others found that CTG was less effective in maintaining long-term volumetric soft tissue stability (55). This discrepancy may be due to variations in tissue biotype, implant positioning, and the extent of initial peri-implant bone resorption.

Meanwhile, SST has been described as a superior technique for preserving buccal bone integrity compared to conventional IIP. Santhanakrishnan in 2021 reported that SST-treated implants exhibited significantly better buccal bone preservation (0.05 ± 0.02mm) than IIP (0.2 ± 0.1mm) and DIP (0.4 ± 0.1mm, $p<0.01$) (49). However, Wittneben noted that SST's success is dependent on the initial buccal bone thickness, suggesting that it may not provide uniform benefits across all cases (57).

These findings reinforce an important clinical takeaway—augmentation strategies should not be applied universally but tailored to each case based on tissue biotype, implant site, and initial ridge dimensions. The combination of augmentation and proper surgical technique likely determines the ultimate esthetic outcome more than either intervention alone.

5.3. Provisionalization: A True Advantage or only an Early Esthetic Benefit?

The timing of provisionalization has been widely debated. Some authors claim that immediate provisionalization (IP) enhances early soft tissue adaptation, while others argue that long-term PES scores remain comparable to delayed provisionalization (DP) (36,51).

One consistent trend across studies is that IP improves early mid-facial soft tissue contour preservation (54). However, the significance of this early benefit in long-term esthetic stability remains controversial. A meta-analysis by Sutariya and colleagues in 2022 found a statistically

significant improvement in PES with IP (MD = 1.54, 95% CI: 0.82–2.27, $p < 0.0001$) (40). However the same study reported that IP did not significantly impact PES/WES scores after 1 year ($p > 0.05$) (40).

Patient satisfaction is another area of mixed findings. While Fu in 2023 found that IP patients reported higher early postoperative satisfaction (VAS 8.3 ± 1.5) compared to DP (VAS 5.7 ± 1.8, $p = 0.027$), this difference disappeared at the 1-year follow-up ($p = 0.826$) (39). This suggests that the esthetic advantage of IP may be more psychological in nature—patients may perceive immediate restoration as a superior option, even if the long-term difference is negligible.

These results highlight that provisionalization should be approached as part of a broader esthetic strategy rather than as an isolated intervention. The medical history, patient expectations, and peri-implant tissue characteristics should dictate whether immediate or delayed provisionalization is the better choice.

5.4. Clinical Implications and Future Research Directions:

Future research should aim to develop standardized esthetic assessment criteria to enhance comparability between studies, ensuring that outcomes are evaluated using consistent and reliable methods. Additionally, further investigations should explore the combined effects of augmentation and provisionalization on soft tissue stability, particularly in different clinical conditions where variations in biotype and implant site characteristics may influence outcomes. Another critical area for future study is the long-term impact of immediate and delayed implant placement. Research extending beyond 10 years is necessary to determine whether the differences observed in early peri-implant remodelling translate into meaningful esthetic or structural advantages over time. As implant dentistry continues to advance, a key priority will be refining case selection protocols and individualized treatment planning, allowing clinicians to tailor interventions to each patient's specific needs, ultimately optimizing esthetic results and long-term stability.

6. CONCLUSIONS

This documental review aimed to evaluate the esthetic outcomes associated with immediate and delayed implant placement in the anterior maxillary region, an area of high esthetic sensitivity where minor changes in soft tissue architecture can significantly affect the final visual result. In particular, the study investigated how soft tissue augmentation and provisionalization techniques contribute to the prevention of esthetic complications and to the overall stability of peri-implant tissues.

The literature reviewed confirmed that both immediate and delayed implant placement protocols can achieve esthetically successful results when properly planned and executed. However, differences were observed, especially in the early phases of healing. Immediate implant placement (IIP) is associated with a higher degree of early soft tissue remodelling, including midfacial mucosal contraction and potential recession, particularly in patients with thin gingival biotypes. This early remodelling does not necessarily compromise long-term esthetic results, but it introduces a greater need for soft tissue management techniques to preserve tissue contours and avoid complications.

Delayed implant placement (DIP), on the other hand, allows for initial healing and soft tissue maturation before the implant is placed, which often results in more predictable soft tissue outcomes. While this protocol may extend the overall treatment time and require multiple surgical interventions, it appears to reduce the likelihood of early soft tissue collapse and can be advantageous in cases with compromised bone or thin biotypes. Nevertheless, the long-term esthetic differences between IIP and DIP appear minimal when appropriate augmentation and prosthetic strategies are employed.

Soft tissue augmentation techniques emerged as an essential component in minimizing esthetic complications in immediate implant cases. Procedures such as connective tissue grafting (CTG) have shown consistent benefits in improving soft tissue volume and reducing the risk of midfacial recession. In situations where thin biotypes are present or where buccal bone is deficient, CTG can help maintain tissue contour, support the peri-implant mucosa, and improve the overall Pink Esthetic Score (PES). Similarly, alternative techniques such as the socket shield technique (SST) and vestibular socket therapy have demonstrated potential in preserving both soft and hard tissues, although their success depends largely on surgical expertise and site-specific factors.

The analysis also considered the impact of provisionalization timing on esthetic outcomes. Immediate provisionalization (IP) offers distinct advantages in the early shaping of peri-implant soft tissues, particularly in the anterior maxilla where the emergence profile and mucosal symmetry are critical. Several studies suggest that IP can positively influence patient satisfaction, as it provides an immediate esthetic solution and helps maintain soft tissue architecture during healing. However, other findings indicate that the long-term esthetic outcomes between immediate and delayed provisionalization (DP) do not differ significantly, especially when final prosthetic contours are managed carefully.

Taken together, these findings underscore the importance of a personalized, multidisciplinary approach to implant treatment in the esthetic zone. There is no universal solution that guarantees optimal esthetic outcomes across all cases. Instead, the choice between immediate and delayed implant placement, as well as decisions regarding augmentation and provisionalization, should be based on a thorough assessment of the patient's soft tissue biotype, bone morphology, esthetic expectations, and clinical risk factors.

In addition, this review highlights the need for further research to address current limitations in the literature. Many of the included studies varied in terms of sample size, follow-up duration, surgical techniques, and outcome measurement tools. Long-term, well-controlled clinical trials using standardized esthetic assessment criteria would provide more reliable data and help clinicians make more informed decisions regarding timing, technique, and prosthetic planning.

In conclusion, the prevention of esthetic complications in implant dentistry is not only dependent on the timing of implant placement, but on the careful integration of surgical and prosthetic elements, guided by individual patient factors. When managed correctly, both immediate and delayed protocols can deliver high esthetic standards and long-lasting success in the anterior maxilla.

7. SUSTAINABILITY

The findings of this project contribute to the sustainability of clinical practices in implant dentistry from a social, economic, and environmental perspective. By emphasizing minimally invasive techniques, proper case selection, and evidence-based decision-making, this research supports strategies that reduce the need for corrective treatments, thereby lowering the economic burden on both patients and healthcare systems.

Moreover, adopting protocols such as immediate provisionalization and the use of bio-compatible grafting materials can contribute to more resource-efficient workflows, minimizing clinical time, materials waste, and patient visits—an important consideration under SDG 12: Responsible Consumption and Production (58).

From a social sustainability standpoint, improving esthetic outcomes through individualized treatment planning enhances patient confidence, mental well-being, and quality of life, directly linking to SDG 3: Good Health and Well-being. This reinforces the ethical responsibility of oral health professionals to prioritize not only functional rehabilitation but also the psychological and social dimensions of patient care (58).

Ultimately, sustainable implant dentistry is achieved through the integration of clinical excellence with long-term responsibility towards both individuals and society.

8. REFERENCES

1. Block MS. Dental Implants: The Last 100 Years. J Oral Maxillofac Surg. 2018;76(1):11-26.
2. Zohrabian VM, Sonick M, Hwang D, Abrahams JJ. Dental Implants. Semin Ultrasound CT MR. octubre de 2015;36(5):415-26.
3. Glied A, Mundiya J. Implant Material Sciences. Dent Clin North Am. enero de 2021;65(1):81-8.
4. Blatz MB, Chiche G, Bahat O, Roblee R, Coachman C, Heymann HO. Evolution of Aesthetic Dentistry. J Dent Res. 1 de noviembre de 2019;98(12):1294-304.
5. Testori T, Weinstein T, Scutellà F, Wang HL, Zucchelli G. Implant placement in the esthetic area: criteria for positioning single and multiple implants. Periodontol 2000. 2018;77(1):176-96.

6. Ramanauskaite A, Sader R. Esthetic complications in implant dentistry. Periodontol 2000. febrero de 2022;88(1):73-85.

7. Thoma DS, Cosyn J, Fickl S, Jensen SS, Jung RE, Raghoebar GM, et al. Soft tissue management at implants: Summary and consensus statements of group 2. The 6th EAO Consensus Conference 2021. Clin Oral Implants Res. 2021;32(S21):174-80.

8. Wang I ching (izzie), Barootchi S, Tavelli L, Wang H lay. The peri- implant phenotype and implant esthetic complications. Contemporary overview. enero de 2021 [citado 23 de noviembre de 2024]; Disponible en: http://deepblue.lib.umich.edu/handle/2027.42/167131

9. AL-Omiri MK, Atieh DWA, Abu-Awwad M, Al Nazeh AA, Almoammar S, Hassan SAB, et al. The knowledge regarding the impacts and management of black triangles among dental professionals and laypeople. Sci Rep. 12 de mayo de 2024;14:10840.

10. Sailer I, Karasan D, Todorovic A, Ligoutsikou M, Pjetursson BE. Prosthetic failures in dental implant therapy. Periodontol 2000. 2022;88(1):130-44.

11. Wang Y, Bäumer D, Ozga AK, Körner G, Bäumer A. Patient satisfaction and oral health-related quality of life 10 years after implant placement. BMC Oral Health. 14 de enero de 2021;21(1):30.

12. Varghese T, Varghese A, Manickam P, Hussin FNB, Nabilah N. Patient Satisfaction with Implant and Implant Supported Prosthesis: A Literature Review. 2024;

13. Avila-Ortiz G, Gonzalez-Martin O, Couso-Queiruga E, Wang H. The peri-implant phenotype. J Periodontol. marzo de 2020;91(3):283-8.

14. Giannobile WV, Jung RE, Schwarz F, Groups of the 2nd Osteology Foundation Consensus Meeting. Evidence-based knowledge on the aesthetics and maintenance of peri-implant soft tissues: Osteology Foundation Consensus Report Part 1-Effects of soft tissue augmentation procedures on the maintenance of peri-implant soft tissue health. Clin Oral Implants Res. marzo de 2018;29 Suppl 15:7-10.

15. Thoma DS, Gil A, Hämmerle CHF, Jung RE. Management and prevention of soft tissue complications in implant dentistry. Periodontol 2000. febrero de 2022;88(1):116-29.

16. Liu Z, Li C, Liu Y, Zeng J, Chu H, Chen P, et al. The clinical significance and application of the peri-implant phenotype in dental implant surgery: a narrative review. Ann Transl Med. 30 de agosto de 2023;11(10):351.

17. Thoma DS, Naenni N, Figuero E, Hämmerle CHF, Schwarz F, Jung RE, et al. Effects of soft tissue augmentation procedures on peri-implant health or disease: A systematic review and meta-analysis. Clin Oral Implants Res. marzo de 2018;29 Suppl 15:32-49.

18. Hutton CG, Johnson GK, Barwacz CA, Allareddy V, Avila-Ortiz G. Comparison of two different surgical approaches to increase peri-implant mucosal thickness: A randomized controlled clinical trial. J Periodontol. 2018;89(7):807-14.

19. Parpaiola A, Cecchinato D, Toia M, Bressan E, Speroni S, Lindhe J. Dimensions of the healthy gingiva and peri-implant mucosa. Clin Oral Implants Res. junio de 2015;26(6):657-62.

20. Maia LP, Reino DM, Muglia VA, de Souza SLS, Palioto DB, Novaes AB. The influence of the periodontal biotype on peri-implant tissues around immediate implants with and without xenografts. Clinical and micro-computerized tomographic study in small Beagle dogs. Clin Oral Implants Res. 2015;26(1):35-43.

21. Díaz-Sánchez M, Soto-Peñaloza D, Peñarrocha-Oltra D, Peñarrocha-Diago M. Influence of supracrestal tissue attachment thickness on radiographic bone level around dental implants: A systematic review and meta-analysis. J Periodontal Res. diciembre de 2019;54(6):573-88.

22. Monje A, Chappuis V, Monje F, Muñoz F, Wang HL, Urban IA, et al. The Critical Peri-implant Buccal Bone Wall Thickness Revisited: An Experimental Study in the Beagle Dog. Int J Oral Maxillofac Implants. 2019;34(6):1328-36.

23. Thoma DS, Bienz SP, Figuero E, Jung RE, Sanz-Martín I. Efficacy of lateral bone augmentation performed simultaneously with dental implant placement: A systematic review and meta-analysis. J Clin Periodontol. junio de 2019;46 Suppl 21:257-76.

24. Hof M, Umar N, Budas N, Seemann R, Pommer B, Zechner W. Evaluation of implant esthetics using eight objective indices—Comparative analysis of reliability and validity. Clin Oral Implants Res. 2018;29(7):697-706.

25. Afrashtehfar KI, Assery MKA, Bryant SR. Aesthetic Parameters and Patient-Perspective Assessment Tools for Maxillary Anterior Single Implants. Int J Dent. 2021;2021(1):6684028.

26. Cosyn J, Thoma DS, Hämmerle CHF, De Bruyn H. Esthetic assessments in implant dentistry: objective and subjective criteria for clinicians and patients. Periodontol 2000. 2017;73(1):193-202.

27. Chen ST, Buser D, Sculean A, Belser UC. Complications and treatment errors in implant positioning in the aesthetic zone: Diagnosis and possible solutions. Periodontol 2000. 2023;92(1):220-34.

28. Esquivel J, Meda RG, Blatz MB. The Impact of 3D Implant Position on Emergence Profile Design. Int J Periodontics Restorative Dent. 2021;41(1):79-86.

29. Macrì M, D'Albis V, D'Albis G, Forte M, Capodiferro S, Favia G, et al. The Role and Applications of Artificial Intelligence in Dental Implant Planning: A Systematic Review. Bioengineering. agosto de 2024;11(8):778.

30. Fang Y, An X, Jeong SM, Choi BH. Accuracy of computer-guided implant placement in anterior regions. J Prosthet Dent. mayo de 2019;121(5):836-42.

31. Buser D, Chappuis V, Belser UC, Chen S. Implant placement post extraction in esthetic single tooth sites: when immediate, when early, when late? Periodontol 2000. 2017;73(1):84-102.

32. Ebenezer V, Balakrishnan K, Asir RVD, Sragunar B. Immediate placement of endosseous implants into the extraction sockets. J Pharm Bioallied Sci. abril de 2015;7(Suppl 1):S234-237.

33. Bassir SH, Kholy KE, Chen CY, Lee KH, Intini G. Outcome of Early Dental Implant Placement Versus Other Dental Implant Placement Protocols: A Systematic Review and Meta-analysis. J Periodontol. mayo de 2019;90(5):493-506.

34. Patel R, Ucer C, Wright S, Khan RS. Differences in Dental Implant Survival between Immediate vs. Delayed Placement: A Systematic Review and Meta-Analysis. Dent J. 15 de septiembre de 2023;11(9):218.

35. Mari R, Nath AR, Peter MR, Vyloppillil R, Balakrishnan B, Suresh R. Periodontal Approaches to Esthetic Dentistry: A Review on Current Trends. J Contemp Dent Pract. 1 de febrero de 2022;23(2):251-67.

36. Slagter KW, Raghoebar GM, Hentenaar DFM, Vissink A, Meijer HJA. Immediate placement of single implants with or without immediate provisionalization in the maxillary aesthetic region: A 5-year comparative study. J Clin Periodontol. febrero de 2021;48(2):272-83.

37. Qi M, Deng S, Tan Z. Clinical study to assess influence of immediate provisionalization and various implant morphologies on implant stability: A prospective clinical study. Front Surg. 6 de enero de 2023;9:1095741.

38. Meng HW, Chien EY, Chien HH. Immediate Implant Placement and Provisionalization in the Esthetic Zone: A 6.5-Year Follow-Up and Literature Review. Case Rep Dent. 15 de septiembre de 2021;2021:4290193.

39. Fu PS, Tseng FC, Lan TH, Lai PL, Chen CH, Chen JH, et al. Immediate implant placement with and without provisionalization: A comparison of a one-year longitudinal study. J Dent Sci. julio de 2023;18(3):1361-7.

40. Sutariya PV, Mehta SP, Upadhyay HH, Pathan MR, Patel SR, Bhatia YA. The soft tissue esthetic outcome with and without immediate provisionalization in immediate implants: A systematic review and meta-analysis. J Indian Prosthodont Soc. 2022;22(1):2-12.

41. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 29 de marzo de 2021;372:n71.

42. Tonetti MS, Cortellini P, Graziani F, Cairo F, Lang NP, Abundo R, et al. Immediate versus delayed implant placement after anterior single tooth extraction: the timing randomized controlled clinical trial. J Clin Periodontol. 2017;44(2):215-24.

43. Parvini P, Müller KM, Cafferata EA, Schwarz F, Obreja K. Immediate versus delayed implant placement in the esthetic zone: a prospective 3D volumetric assessment of peri-implant tissue stability. Int J Implant Dent. 25 de noviembre de 2022;8:58.

44. Shah SA, Singh BP, Rao J, Kumar L, Singh M, Singh PK. Biological and esthetic outcome of immediate dental implant with the adjunct pretreatment of immediate implants with platelet-rich plasma or photofunctionalization: A randomized controlled trial. J Indian Prosthodont Soc. 2021;21(4):348-55.

45. Sanchez-Perez A, Nicolas-Silvente AI, Sanchez-Matas C, Molina-García S, Navarro-Cuellar C, Romanos GE. Primary stability and PES/WES evaluation for immediate implants in

the aesthetic zone: a pilot clinical double-blind randomized study. Sci Rep. 8 de octubre de 2021;11:20024.

46. Meijer HJA, Slagter KW, Gareb B, Hentenaar DFM, Vissink A, Raghoebar GM. Immediate single-tooth implant placement in bony defect sites: A 10-year randomized controlled trial. J Periodontol. febrero de 2025;96(2):151-63.

47. Fettouh AIA, Ghallab NA, Ghaffar KA, Elarab AE, Abdel-Aziz NG, Mina NA, et al. Effect of soft tissue volume on midfacial gingival margin alterations following immediate implant placement in the esthetic zone: a 1-year randomized clinical and volumetric trial. BMC Oral Health. 19 de octubre de 2024;24(1):1256.

48. Santhanakrishnan M, Ramesh N, Kamaleeshwari R, Subramanian V. Variations in Soft and Hard Tissues following Immediate Implant Placement versus Delayed Implant Placement following Socket Preservation in the Maxillary Esthetic Region: A Randomized Controlled Clinical Trial. BioMed Res Int. 4 de octubre de 2021;2021:5641185.

49. Santhanakrishnan M, Subramanian V, Ramesh N, Kamaleeshwari R. Radiographic and Esthetic Evaluation Following Immediate Implant Placement with or without Socket Shield and Delayed Implant Placement Following Socket Preservation in the Maxillary Esthetic Region – A Randomized Controlled Clinical Trial. Clin Cosmet Investig Dent. 19 de noviembre de 2021;13:479-94.

50. Santhanakrishnan M, Subramanian V, Arul D, Marimuthu SV. Evaluation of Timing of Implant Placement in Maxillary Esthetic Zone with Type I Extraction Sockets- A Randomized Controlled Trial. Clin Cosmet Investig Dent. 6 de diciembre de 2024;16:481-98.

51. Donker VJJ, Raghoebar GM, Slagter KW, Hentenaar DFM, Vissink A, Meijer HJA. Immediate implant placement with immediate or delayed provisionalization in the maxillary aesthetic zone: A 10-year randomized trial. J Clin Periodontol. 2024;51(6):722-32.

52. Chan HL, George F, Wang IC, Suárez López del Amo F, Kinney J, Wang HL. A randomized controlled trial to compare aesthetic outcomes of immediately placed implants with and without immediate provisionalization. J Clin Periodontol. 2019;46(10):1061-9.

53. Fawzy M, Hosny M, El-Nahass H. Evaluation of esthetic outcome of delayed implants with de-epithelialized free gingival graft in thin gingival phenotype with or without immediate temporization: a randomized clinical trial. Int J Implant Dent. 13 de febrero de 2023;9:5.

54. Wang I, Chan H, Kinney J, Wang H. Volumetric facial contour changes of immediately placed implants with and without immediate provisionalization. J Periodontol. julio de 2020;91(7):906-16.

55. Van Nimwegen WG, Raghoebar GM, Zuiderveld EG, Jung RE, Meijer HJA, Mühlemann S. Immediate placement and provisionalization of implants in the aesthetic zone with or without a connective tissue graft: A 1-year randomized controlled trial and volumetric study. Clin Oral Implants Res. julio de 2018;29(7):671-8.

56. Li W, Ruan N, Tian Y, Li S, Boldbaatar D, Badral B. Advantages of using touch-controlled, minimally invasive implantation technique on soft tissue in the aesthetic zone of maxillary anterior teeth. Medicine (Baltimore). 13 de diciembre de 2024;103(50):e40051.

57. Wittneben JG, Molinero-Mourelle P, Hamilton A, Alnasser M, Obermaier B, Morton D, et al. Clinical performance of immediately placed and immediately loaded single implants in the esthetic zone: A systematic review and meta-analysis. Clin Oral Implants Res. 2023;34(S26):266-303.

58. Miluska.Jara. Objetivos y metas de desarrollo sostenible [Internet]. Desarrollo Sostenible. [citado 23 de abril de 2025]. Disponible en: https://www.un.org/sustainabledevelopment/es/sustainable-development-goals/