Chapter

Strategic Implants under Existing Partial Removable Dentures, Why, How Many, and Which Type?

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Abstract

Inserting strategic implants under existing removable partial dentures requires a comprehensive understanding of removable prosthodontic basics and possible designs, as well as a thorough understanding of implant therapy. Prior to the widespread adoption of implants as standard prosthetic therapy, remaining roots were preserved and used to minimize bone resorption under the removable denture. Root-supported overdentures become less common after the overwhelming clinical studies that emphasize dental implants' reliability and high success and survival rate. Fixed prostheses cannot be used to treat a severely decreased dentition unless a significant number of implants can be inserted, sufficient bone quantity and quality are available, and the patients can afford the treatment. On the other hand, using strategic implants under existing RPD upgrades the design to a more favorable support type. It improves patient satisfaction with the RPD in speaking, chewing, retention, stability, and RPD support. This improvement could be reached earlier if the patient received immediate loading. Strategic implants can also improve chewing ability, stabilize the occlusion, increase bite force and improve patient oral health-related quality of life. Moreover, better distribution of occlusal forces that may reduce bone resorption may be gained. Furthermore, strategic implants can improve comfort, confidence, and esthetics by reducing the RPD size and removing the retainers from the esthetic zone.

Keywords: strategic implants, mini-implants, immediate loading, delayed loading, removable partial dentures, implant-assisted removable partial dentures, patient satisfaction

1. Introduction

Dental implant service is a life-changing treatment modality for many patients. Giving our patients a fixed restoration is a very rewarding procedure, especially if the patients have difficulties: gage reflex, bulky prostheses, lack in retention, stability, or support. Unfortunately, this is not applicable for all patients, especially patients who cannot afford multiple implants or bone grafting. By considering the strategic implants under the existing removable partial denture (RPD), we make implant treatment simple and affordable for more patients.

The removable partial denture (RPD) is the dental prostheses that the patient, who suffers the absence of some but not all the natural teeth, can readily insert and remove from his/her mouth. The prostheses restore the missing teeth as well as the gingiva and the missing bone if needed. Removable partial dentures (RPDs) are indicated for patients with a long edentulous span, too long for a fixed prosthesis. The RPD is indicated for a patient with no posterior abutment to support a fixed prosthesis, and the cantilever bridge is contraindicated. Also, it is preferred if excessive alveolar bone loss is encountered, especially in the esthetic zone. Those patients who are not indicated for bone grafting or unable to afford the costly treatment are good candidates for the removable denture (RD). The acrylic flang is a good approach to compensate for the bone and soft tissue deficiency within a short fabrication time and a less aggressive approach. Moreover, this treatment option allows the patient to remove his prostheses for easier intraoral access, subsequently, better oral hygiene. The RD enables the dentist to repair or adjust the prostheses easily.

On the other hand, RD is less secure with limited retention and stability than fixed prostheses. RD metal clasp may compromise the final esthetic result. It may act as a gum stripper and accelerate alveolar bone resorption. These drawbacks in the RD can be managed by upgrading the RD using strategic implants, which are "the implants that change the prosthetic support type to a more favorable configuration" [1].

In this chapter the folllowing points is going to be discussed:

1. Classification as a systematic approach for communication and planning:
   - Kennedy classification system
   - Steffel classification and modified Steffel classification
   - Implant-Corrected Kennedy (ICK) Classification System for Partially Edentulous Arches
   - Strategic mini dental implants (MDI) and standard dental implant (SDI) under existing RPD, how many implant?
   - The abutment prosthetic value
2. Immediate and delayed restoration/loading, what is the difference?
3. Why strategic implant?
4. Mini-implant-assisted removable partial denture
5. Conclusion

2. Classification as a systematic approach for communication and planning

A classification is a systematic approach in which the items or units are categories in groups or subgroups according to specific criteria. This approach facilitates the

discussion regarding the most suitable treatment options, eases the communication between the dentist and the technician. The classification also allows for visualization and differentiation between the RPD support types: tooth-supported, tooth tissue-supported, tissue-supported, implant-supported, implant tissue-supported, and implant tooth-supported.

2.1 Kennedy classification system

In 1925 Dr. Edward Kennedy introduced his approach of categorizing partially edentulous arches into four classes. He categorized the partially edentulous arches in a way that considered the edentulous area position in the arch and if it was surrounded with teeth or not. This approach was beneficial in visualizing the cases and reaching the decisions regarding the RPD designs.

The following is the Kennedy classification:

Class I: Edentulous free-end areas located on both sides (bilateral), posterior to the remaining teeth (**Figure 1**).

Class II: Edentulous free-end area located on one side (unilateral), posterior to the remaining teeth (**Figure 2**).

Class III: Edentulous bounded area with natural teeth remaining both anterior and posterior to it (**Figure 3**). The area is located on one side (unilateral).

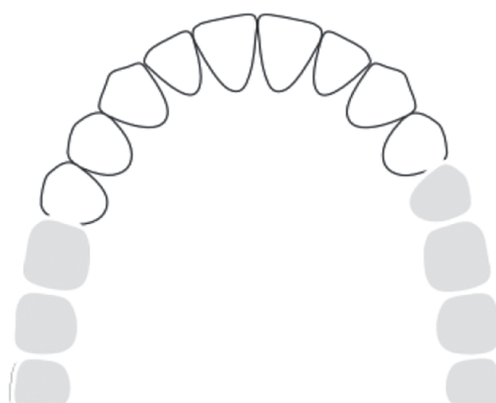

Figure 1.
Class I maxillary arch.

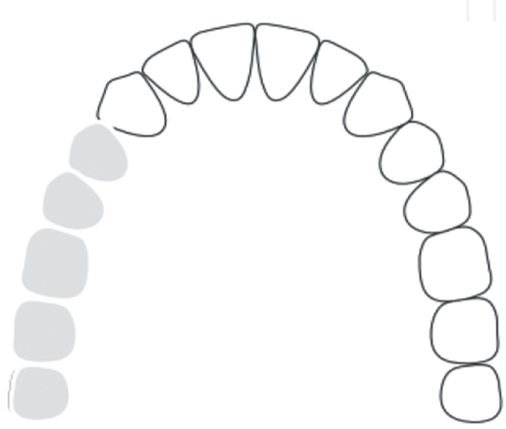

Figure 2.
Class II maxillary arch.

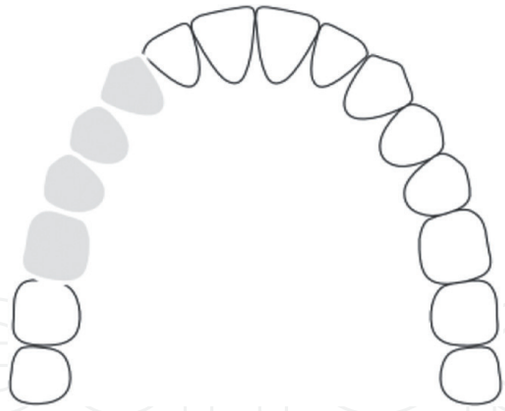

Figure 3.
Class III maxillary arch.

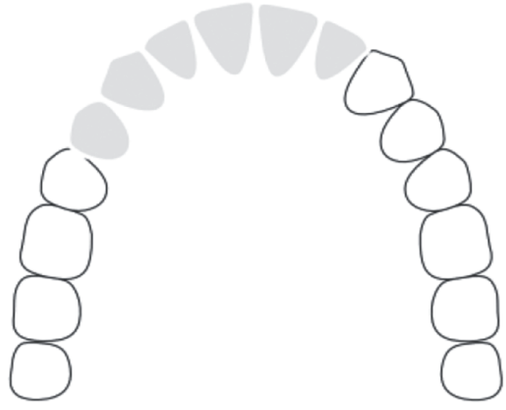

Figure 4.
Class IV maxillary arch.

Class IV: Edentulous bounded area with natural teeth remaining posterior to it. The area is located anteriorly and crossing the mid-line (**Figure 4**).

In 1965 Applegate's added eight rules to the classification. The rules can be summarized by the following: The categorization (classification) is always determined by the most posterior edentulous region (or regions). Any additional edentulous area (other than those that define the categorization) is considered a modification (**Figures 6** and 7). If the teeth posterior to the edentulous area are not used to support the RPD, the edentulous area is classified as a free end (**Figures 5** and 7), and vice versa (**Figures 6** and 7). If the posterior free end edentulous region is not going to receive artificial teeth, it will not be considered in the classification (**Figures 6–8**), and vice versa. Putting the design and the structure of the RPD into consideration is a cornerstone in giving the correct RPD classification. Subsequently, the classification will be the start point making the best clinical decision regarding the number and the position of strategic implants under the RPD.

2.2 Steffel classification

In 1962 Steffel described six support possibilities that can be encountered in RPD [2]. He labeled the classification categories from A to F based on the fulcrum, and the number and distribution of the abutments, **Figure 9**. The fulcrum line is a hypothetical line formed between abutments, teeth or implants. The RPD may rotate somewhat around the fulcrum during function.

Figure 5.
No rest is going to be costructed on # 38 or 37 → the arch has two free end areas → Class I mandibular arch.

Figure 6.
Direct retainer is going to be constructed on 37. No artificial teeth is going to replace 46, 47 or 48 → no free end → Class III mod 1 mandibular arch.

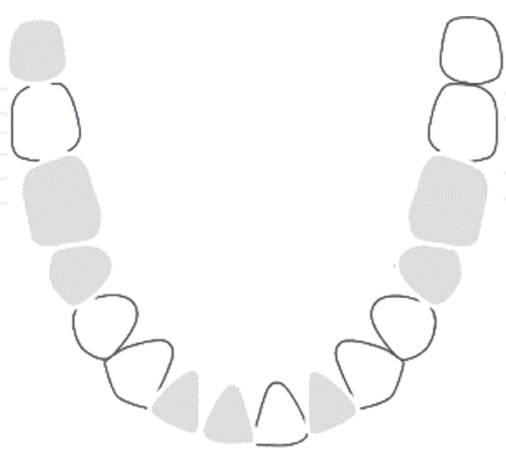

Figure 7.
No artificial teeth is going to replace, 48. Direct retainer is going to be constructed on 37 but not on 47 → one free end → Class II mod 3 mandibular arch.

In this chapter, we suggest a modification to this classification to simplify the communication and decision-making regarding the strategic implant under the existing RPD. In the modification, B, C, and D will be labeled together.

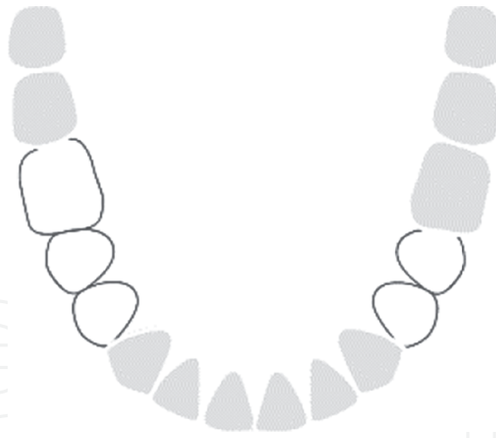

Figure 8.
No artificial teeth is going to replace, 38, 37, 36, 47 or 48. Class IV mandibular arch.

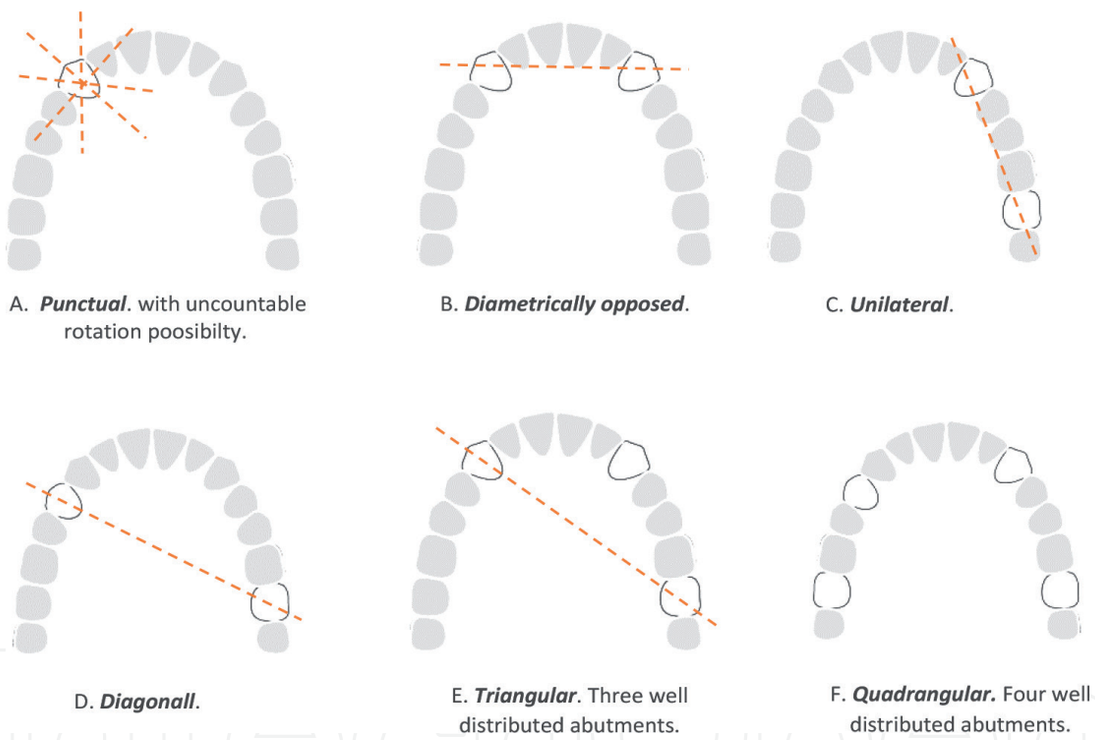

Figure 9.
Steffel classification.

The following is the *modified Steffel classification:*

- Punctual-support, only one abutment.
- Linear-support, two abutments; separated with edentulous area or at least one tooth.
- Triangular-support, three well-distributed abutments; separated with edentulous area or at least one tooth. One of the abutments should be on the opposite quadrant.
- Quadrangular-support, two well-distributed abutments on every quadrant.

Providing the patient with a stable prosthesis is a crucial target for the dentist. However, the RPD is not rigidly attached to the intraoral hard (teeth) and soft (mucosa) tissues, which have different levels of compressibility and mobility. Subsequently, the chewing and occlusal forces may generate different levels of tissue stress and prosthesis mobility. Both (stress and mobility) should be within the physiological level and cause no harm or trauma. Achieving this critical goal depends on the clinician's understanding of the biomechanics and the different design solutions. The RPD design should consider the unique nature of each clinical case and counter the expected RPD movement in response to loading. The design also should minimize the potentially destructive forces that may affect the supporting tissues; teeth, mucosa, and bone. That can be achieved by avoiding a long lever system, good selection for the RPD supporting elements, and wide symmetrical distribution of the functional forces [3, 4]. Many of the previous points (if not all) can be achieved (fully or partially) by delivering an RPD with quadrangular-support type.

According to the modified Steffel classification, there are four types of prosthetic support: punctual, linear, triangular, and quadrangular. The RPD support improves gradually as the classification change from I to IV. Classification IV provides the best support to the RPD with the highest resistance of rotation. The strategic implant aims to change the prosthetic support type to a more favorable configuration. *Delivering an RPD with a better support type can be considered the start point in a multifactorial process for deciding the number, type, and position of strategic implants.*

2.3 Implant-corrected kennedy (ICK) classification system for partially edentulous arches

One of the simple classification systems for RPD supported with implants or implants and natural teeth is Implant-Corrected Kennedy (ICK) classification system for partially edentulous arches by Al-Johany et al. [5]. The ICK is based on the Kennedy classification system and the Applegate eight rules (Applegate–Kennedy system) [6]. According to the ICK classification system coding guidelines, the Kennedy classification comes first, followed by the number of modification spaces (Applegate rules). Finally, round brackets enclose # followed by the implant's or implants' position will be added, **Figures 10–18**.

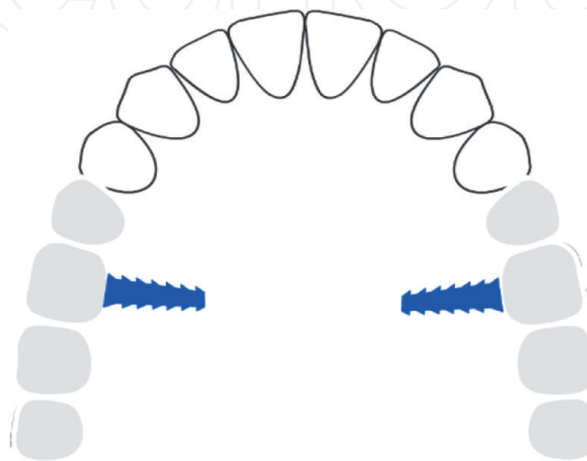

Figure 10.
ICK I (# 25).

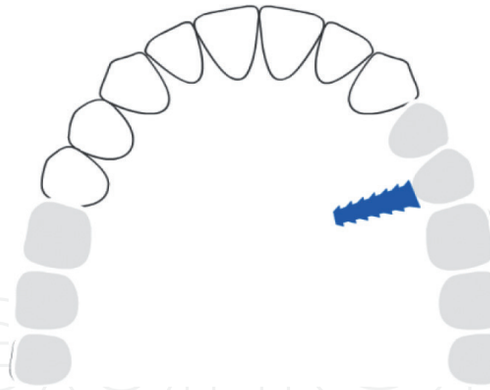

Figure 11.
ICK II mod 2 (# 33, 36). Direct retainer is going to be constructed on 28.

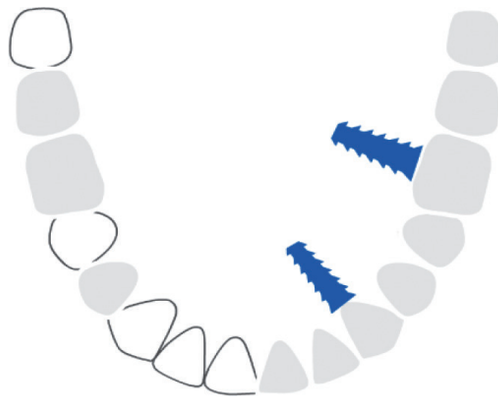

Figure 12.
ICK II mod 3 (# 13, 23). Direct retainer is going to be constructed on 28.

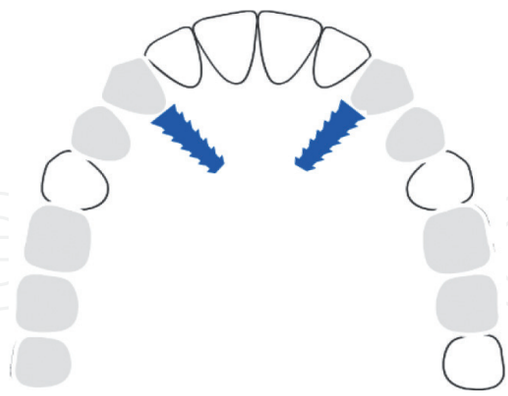

Figure 13.
ICK II mod 1 (# 16, 13, 23).

2.4 Strategic mini dental implants (MDI) and standard dental implant (SDI) under existing RPD, how many implant?

Meeting our patient's expectations is a priority. That cannot be reached if the dentist did not provide the patient with a full straightforward clarification for the treatment plan. The clarification should cover the advantages, disadvantages, risks, time, cost, and alternatives. The explanation should be done in a way that helps both the patient first and the dentist second to reach the decision that best matches the patients' needs, health

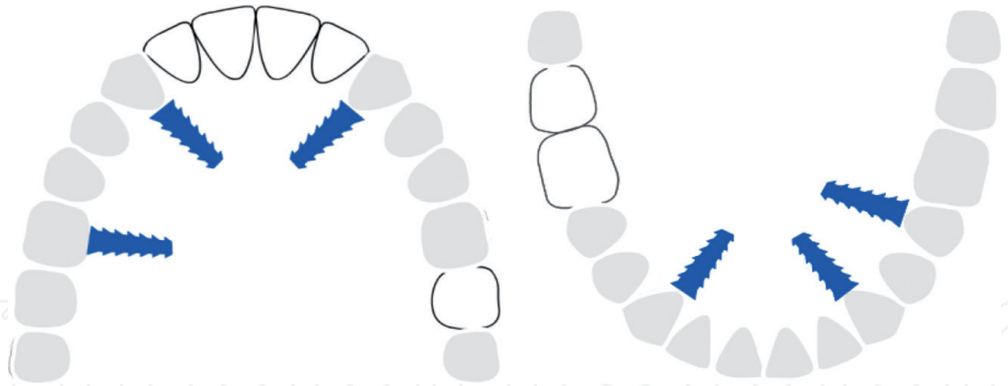

Figure 14.
ICK II (# 35, 33, 43).

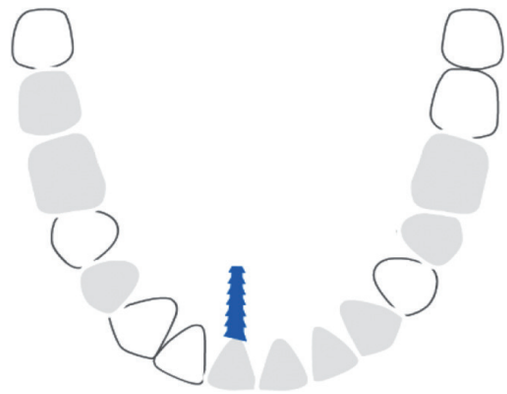

Figure 15.
ICK III mod 3 (# 41).

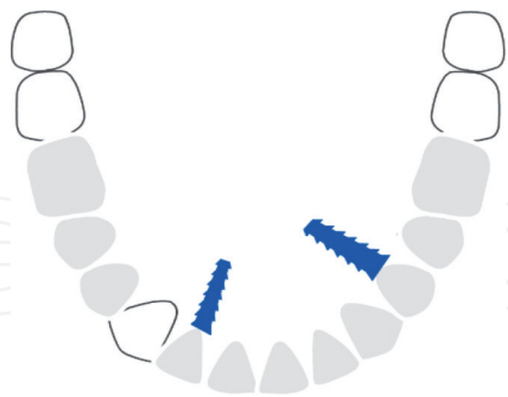

Figure 16.
ICK III mod 1 (# 34, 42).

status, and financial ability, as well as respect the patient's chief complaint and consideration. Generally speaking, teeth-implant- or implant-supported removable dentures reduce (and in many cases eliminate) traditional denture problems [1, 7–9]. It helps the dentist widen his options to meet the patient's needs and expectations by inserting one or few implants in strategic positions, but how many implants?

The needed number of mini dental implants (MDIs) or standard dental implants (SDIs) under existing RPD is a multifactorial process (see paragraph 2.5) and taken on the quadrant level. To give the patient an RPD with acceptable retention, stability,

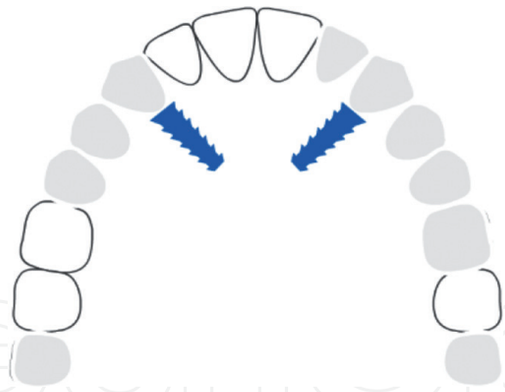

Figure 17.
ICK III mod 1 (# 13, 23).

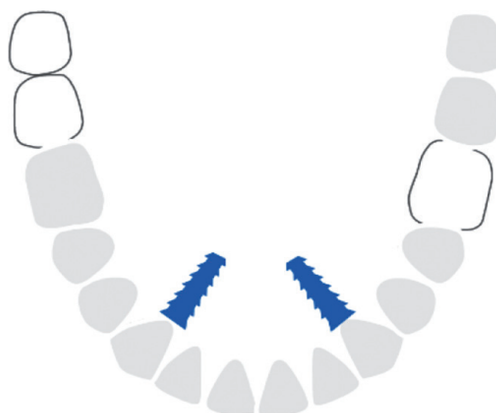

Figure 18.
ICK IV (# 33, 43). Direct retainers are going to be constructed on 36 and 47. No artificial teeth are going to replace 37 or 38.

and support, the abutments should be well distributed. Two abutments on every quadrant in symmetrical position as possible are needed. On every quadrant, the sum of the abutments prosthetic value should be ≥2, **Table 1** and **Figure 19**. *The abutment prosthetic value is defined as the importance of the tooth or implant from a specific prosthodontic point of view,* (see paragraph 2.5). The availability of several abutments on both sides allows a wide distribution of stress, improving bilateral stabilization, support, and stability [2]. Many studies reported the positive impact of more abutments and wide distribution [10–13]. Although putting two implants in the lower edentulous jaw is widely accepted in the literature,[14] achieving a quadrangular-support type needs at least two MDIs or two SDIs in every quadrant. In the edentulous upper jaw, which generally has less bone density than the lower jaw,[15] two SDIs or three MDIs in every quadrant are needed [16].

For partially edentulous patients, the abutments can be implants or natural teeth and should be well-distributed with a sum of the prosthetic value ≥2 on quadrant level.

Deciding the number of the strategic implants can be started with Table 1, but it will be finished after a comprehensive evaluation of the case, see paragraph 2.5.

2.5 The abutment prosthetic value

In the course of formulating the prosthodontic plan, not all teeth or abutments have the same prosthetic value. The prosthetic value stands for the importance of the tooth

		The abutments prosthetic value
Teeth	Upper or lower incisor or lateral incisor	0–0.5*
	Upper or lower canine	1.3**
	Upper or lower premolar or molar	1***
MDI	Upper MDI	0.5–0.7****
	lower MDI	1
SDI	Upper Standard Implant	1
	Lower Standard Implant	1

**The numbers represent the prosthetic value if abutment rest is planned; if not, the value will be 0.*
***If the four natural anterior abutment teeth are missing (11, 12, 13, 14), strategic implant/s is recommended even if all posterior teeth are available, and vice versa.*
****If there is no space (edentulous area or at least one natural tooth) between the abutment teeth, the prosthetic value will decrease to 0.5 for each abutment.*
*****Bone quality impacts the MDI prosthetic value.*

Table 1.
The prosthetic value of the available teeth and the planned MDIs and SDIs. The recommendations are on the quadrant level.

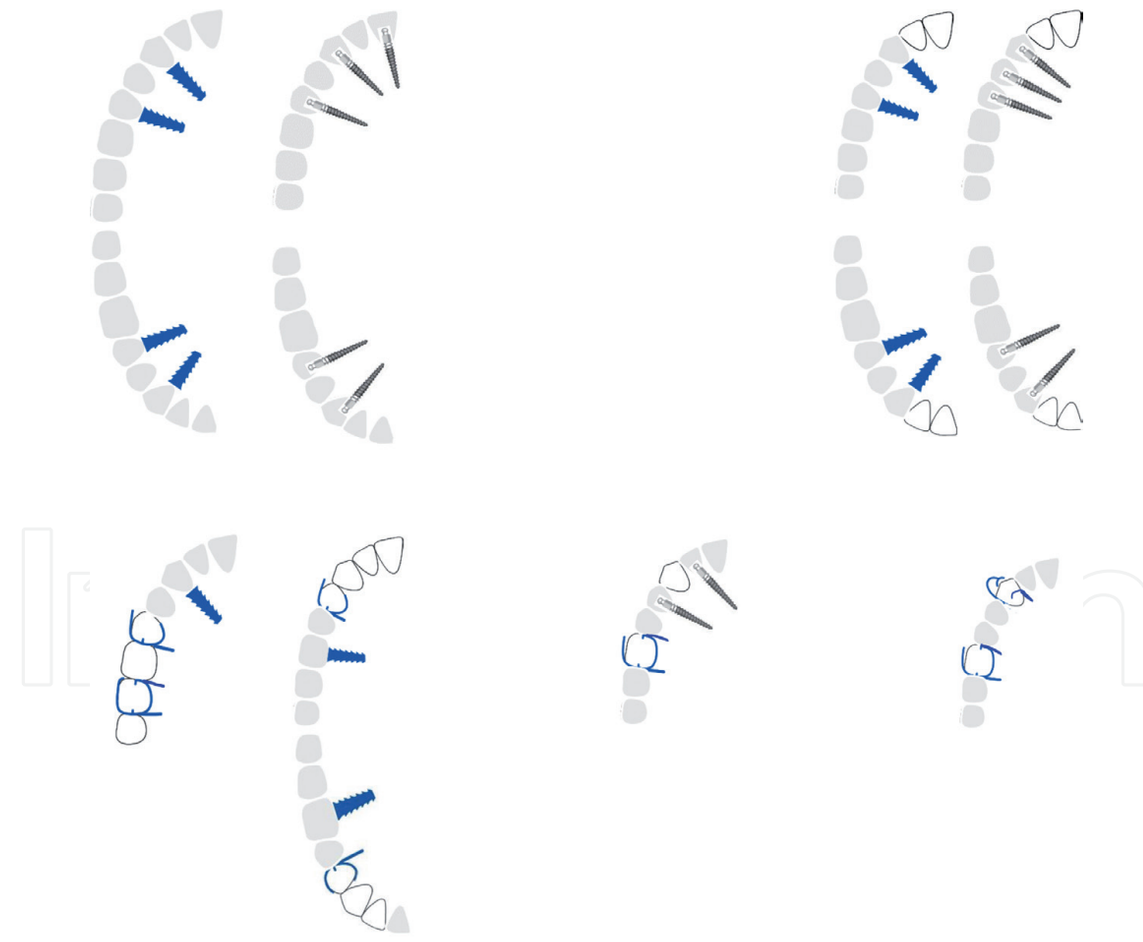

Figure 19.
(A1 upper jaw and A2 lower jaw to G1 upper jaw): The recommended number of strategic standard implants (SDIs) or mini dental implants (MDIs) under existing RPD.

or implant from a specific prosthodontic point of view. The last first molar (#36) in **Figure 20** has a very high prosthetic value than the lateral incisor #32. Extracting #36 shifts the treatment modality (if an implant is not feasible) from fixed partial denture to

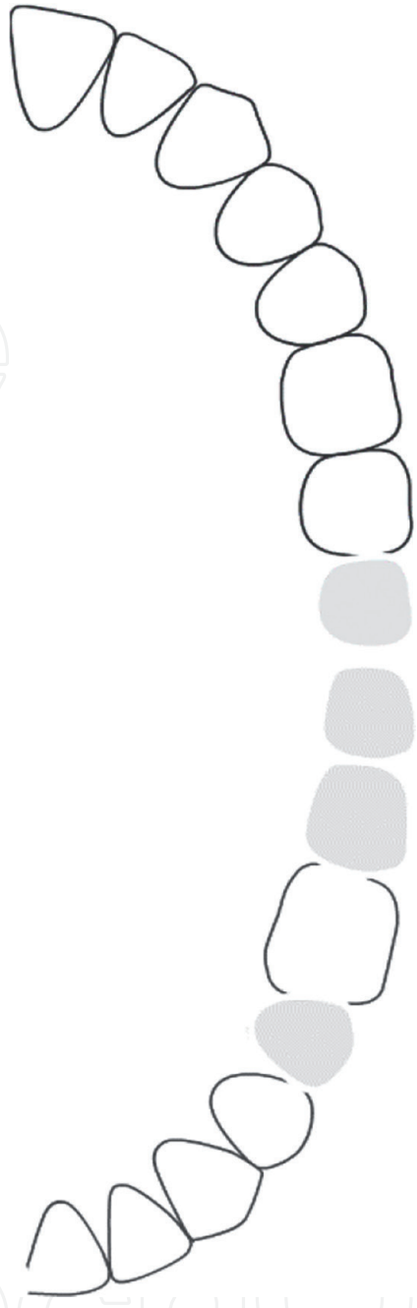

Figure 20.
The #36 has a very high prosthetic value because the extracting change the treatment modality (if implant is not feasible) from fixed partial denture to removable partial denture.

removable partial denture. Suppose the dentist changes his prosthodontic point of view by selecting RPD as a treatment modality. In that case, the prosthetic value of #36 will be reduced a little for this specific treatment modality. However, the prosthetic value for the same tooth (#36, **Figure 20**) and the same treatment modality (RPD) will be very high if the patient has a knife-edge thin, sensitive mucosa. Usually, this type of patient can tolerate tooth-tooth-supported RPD better than tooth tissue-supported RPD. Therefore, it can be concluded that: *estimating the prosthetic value of an abutment is a multifactorial assessment*. This estimation includes the intraoral, extraoral, and general health status and many other factors like esthetics.

The hidden #23 MDI under the saddle (**Figure 21**) has a very high esthetic value as it helps the dentist avoid metal clasp in the esthetic zone. In some cases,

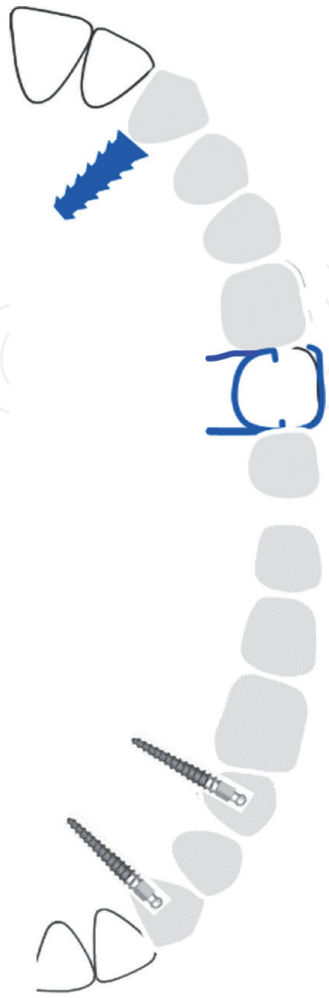

Figure 21.
The SDI #23 and MDI #33 have very high esthetic value as they help the dentist avoiding anterior metal clasps. #27 and MDI 35 have relatively high prosthetic value as they shift the RPD from tooth tissue supported to more implant tooth-supprted or implat implant-supported RPD.

strategic implants enable the dentist to reduce or remove the flange to achieve a better esthetic result by reducing lip protrusion. In other cases, it gives the dentist the ability to minimize the RPD size (palate, **Figure 24**) and increase patient acceptance.

The prosthetic value (importance) for each abutment is estimated according to **Table 1** and mainly the following points: [11, 12, 17, 18].

- Periodontal status, mobility, and bone level around the abutment.
- Crown-root ratio.
- Tooth vitality, size of the defect (caries), size, and type of the restoration.
- The shape and number of the abutment roots.
- Occlusion, parafunctional activity and opposite jaw status: natural teeth, implant, fixed partial denture, complete denture, or partial denture.

3. Immediate and delayed restoration/loading, what is the difference?

In 1981 Albrektsson et al. suggested a protocol in which the implants are left to heal in situ for at least 3 to 4 months without loading [19]. He considered the non-loading phase a crucial period to achieve successful osseointegration and avoid fibrous tissue formation between the implant surface and the bone. On the other hand, many clinical studies proved that immediate restoration, immediate loading, or early loading are acceptable treatment modalities [20, 21]. These studies were in response to the social and psychological needs of many patients. The immediate or early treatment modalities aim to reduce the overall recovery time between the surgical intervention and the insertion of the final restoration. These approaches are known as immediate restoration protocol, immediate loading protocol, and early loading protocol.

Patients typically are uncomfortable and, in many cases, refuse to stay without their RPD for a long time, especially if it restores a lot of missing teeth or teeth in the esthetic zone. The immediate protocols can reduce the patient concerns related to the final restoration by reducing the waiting period. In some cases, a temporary restoration is immediately delivered to give the patient a hint on the form, size, and position (in some cases, the shade) of the final restoration. Moreover, the second surgical intervention can be averted through immediate protocols. To achieve a good success rate in this treatment modality, a good understanding of the topic, terminology, limitation, and biology is essential. These topics will be discussed in other chapters, but it is crucial to clarify a few terms.

The loading can be classified into four categories:

- Conventional loading: The implants are left without loading for around two to three months.

- Delayed loading: If the loading on the implant is applied after the conventional loading time, it is classified as delayed. That can be indicated if the tissue needs more healing time, such as external sinus lift with bone grafting. In such cases, the final restoration and implant loading may be applied after six to nine months.

- Early loading: The implant is loaded by placing dental restoration in contact with opposing dentition at any time after one week but within two months after implant insertion.

- Immediate loading: The dental restoration is inserted intraorally and placed in contact with opposing dentition within one week after the surgical intervention.

The timing of dental restoration can also be categorized to:

- Conventional restoration in which the implant is left without temporary or final restoration for around two to three months.

- Immediate restoration: The temporary or final restoration is placed within one week after surgical intervention.

- Early restoration: The temporary or final restoration is placed any time after one week but within two months after implant insertion.

- Delayed restoration: If the dental restoration is placed intraorally after the conventional loading time, the restoration is classified as delayed restoration.

According to the previous classifications, the dentist has different types of intervention. For example, he can go for immediate restoration with conventional loading or implement early restoration with delayed loading.

In the case of the strategic implant under existing RPD, there are seven scenarios: immediate restoration with one of the four loading types, or early restoration with early, conventional, or delayed loading. The decision regarding the best approach is multifactorial: age, esthetic expectations, oral hygiene level, bone quality and quantity, and treatment expenses. According to the 2018 census supported by the International Team for Implantology (ITI), the most critical factors that may impact the loading protocol selection are patient-related factors, especially patient's general health, implant primary stability (ISQ), bone grafting, the size and shape of the implant, and the doctor skills and experience [22]. Moreover, the ITI tried to unify the two classifications (loading and restoration timing) to make it less complicated for the clinician and easier for the researchers to perform clinical studies and compare their results. They described four protocols:

a. Immediate loading: Within one week after implant placement, dental implants are linked to a prosthesis in occlusion with the opposing arch.

b. Immediate restoration: Within one week after implant placement, dental implants are linked to the dental restoration and are kept out of occlusion.

c. Early loading: Between one week and two months following implant placement, dental implants are linked to the prosthesis.

d. Conventional loading: dental implants are linked to the prosthesis after two months of implantation.

4. Why strategic implant?

Improving dental treatment output by using implants to enhance the functional performance of the complete denture is a well-known approach in prosthodontics. The McGill Consensus Statement stated that the first option in treating the lower jaw edentulous patient should be two implants retained overdenture and not lower jaw conventional complete denture (CD) [23]. Overwhelming scientific evidence supports the statement [23]. The evidence emphasized the superiority of two implants retained overdenture treatment modality on the conventional CD in many aspects, such as patients' chewing efficiency, positive modification in patients' diet, patients' satisfaction with the CD stability, retention, and comfort as well as quality of life [23]. Although a lot of scientific evidence highlighted the positive impact of inserting implants under existing RPD, no similar Consensus Statement is available regarding implant-retained or implant-assisted removable partial denture [24–26].

Not all patients are suitable for implant-supported fixed dental prostheses. For example, many patients are unwilling to have an extra surgical intervention (bone grafting, sinus lifting, bone splitting, or expansion). Other patients are not suitable for such intervention because they are medically compromised or do not have

adequate financial flexibility. As an alternative to inserting multiple implants, the dentist can improve the quality of the prosthodontic treatment by changing the support type of the RPD to the quadrangular-support type. The improvement can be achieved by inserting one/two standard implants or one/two/three mini-implants per quadrant to reach a symmetrical quadrangular-support type. The prostheses will be tooth implant-supported RPD instead of tooth tissue-supported RPD. This prosthodontic approach is affordable to many patients.

Figure 22.
Upgrading the existing clasp retained lower RPD by inserting strategic mini-implants, immediate restoration with immediate loading/soft material. A- Intraoral image with lower RPD before implantation. B- Partial edentulous lower jaw before implantation. C- Tissue surface of the RPD before implantation. D- Four strategic mini-implants in the interforaminal region, tooth 32 was extracted. E- Tissue surface of the RPD after implantation, soft relining in the areas opposing the implants' head. F- Tissue surface of the RPD after 4 months, the matrix pick-up (housings). G- Intraoral image with lower RPD after the housing, clasps in esthetic zone were removed.

The strategic implant is "the implant that can change the prosthetic support type to a more favorable configuration" [1]. It is a reliable way of treatment with an implant survival rate of 91.7–100% [4]. Also, it can support both the RPD and the other abutments effectively. In two clinical studies with 2 and 3 years follow-up, the survival rate of the natural teeth abutments was 100% [9, 24].

Moreover, it can improve the survival rate of the RPD. The 10-year survival rate of RPDs; clasp-retained removable partial dentures, conical crown-retained dentures, or a combination of conical crown and clasp-retained dentures is 71.3% [27]. On the other hand, clinical studies with observation periods between 1 and 12.2 years reported survival rates of 90–100% for the implant-assisted removable partial denture prostheses [7, 28–31]. This remarked difference in the survival rate plays an essential role in formulating the prosthodontic plan.

Many clinical studies have shown that implant placement in strategic locations under an existing RPD can enhance chewing efficiency, dental health-related quality of life, and patient satisfaction with speaking and eating, as well as RPD retention, stability, and support [1, 8, 32]. Above that, it gives the dentist the ability to reduce the tissue coverage and reduce the size of the RPD, which can positively impact the patient's acceptance of the RPD, especially if he suffers hyperactive gag reflex, **Figure 24**. Also, it can improve the final esthetic result by avoiding the traditional metal clasp, **Figures 19** and **22**.

Unfortunately, inserting a standard implant under the existing RPD is not always feasible. The patient may have a very narrow bone that prevents inserting a standard implant without bone grafting. A procedure that is not suitable or acceptable by some patients. In this case, mini-implants can be considered a good alternative, **Figures 22** and **25** [1, 8, 16].

5. Mini-implant-assisted removable partial denture

In 1976, the U.S. Food and Drug Administration (FDA) approved the 3 mm root-form dental implant. With time, dental implants proved to be a predictable and reliable prosthodontic treatment modality with a high success rate [33–35]. After 21 years, the approval was cleared for implants less than 3 mm. The approval widens the spectrum of the patients treated with dental implants, particularly the cases with reduced bone width.

In literature, there is no standardization regarding the terminology of dental implant diameter [36]. For example, some authors considered the implants with diameters from 1.8 to 2.9 mm as small implants; others call them mini-implants [37]. Some authors defined the mini-implant as the implant with 2.2 mm [38]. Al-Johany et al. proposed a classification scheme and used four terms: Extra-narrow <3.0 mm, Narrow ≥3.0 mm to <3.75 mm, Standard 3.75 mm to <5 mm, and Wide ≥5 mm [36]. In this text, we will follow the lead of Resnik et al. and Schiegnitz et al. by considering the mini-implant as the implant with a diameter < 3.0 and the narrow-diameter implant as the implant with a diameter ≤ 3.5 [25, 37]. This implant type is mainly used in heavily atrophic jaws but with sufficient bone height. The mini-implant gives the dentist the ability to avoid bone augmentation procedure, which is considered a time and cost-consuming surgical intervention. Avoiding additional surgical procedures can reduce morbidity and possible complications such as nerve trauma, hemorrhage, postoperative pain, or infection [25]. The infection may lead to the failure of bone grafting [25]. Above that, it is less invasive than the standard implant as it requires a

smaller implant bed and no flap in a considerable number of cases [26]. Therefore, it is more appropriate for the compromised or elderly patients. Moreover, it is cost-effective and affordable. On the other hand, the small diameter of the implant may create a shear load to the crestal bone. That may increase the risk of bone resorption [37, 39]. Narrow -implant has been linked to biomechanical risk factors as implant fatigue or fracture, particularly when used in the canine area where high occlusal loads are applied or in parafunctional habits patients [40].

A systematic review and meta-analysis reported that mini-implants (diameter < 3.0 mm) performed substantially worse than standard diameter implants with survival rates of 94.7 ± 5% [25]. However, narrow implants with a diameter (3–3.5 mm) have a better survival rate of 97.7 ± 2.3% [25]. Therefore, some

Figure 23.
Narrow bone can be treated with bone grafting. Unfortunately, this is not always feasible. A- Biomechanically, the narrow implant is not always the best approach, see paragraph 5. B- Osteoplasty is used to insert a wider implant by increasing the bone width, which will impact the crown-implant ratio negatively and may place the implant near vital anatomical structure. C- One-piece mini-implant with ball attachment and preferable crown-implant ratio can be used to stabilize a complete removable denture or partial removable denture.

researchers believe the best approach for a thin bone is bone augmentation [37]. If this is not feasible, narrow implant, osteoplasty and standard implant, or one-piece mini-implant with ball attachment and removable denture can be considered, **Figure 23**.

The small diameter implant is used to replace missing individual teeth in the anterior region, lower and upper jaw [41, 42]. Mini-implant is used as an orthodontic implant or transitional or provisional implant to support interim prostheses during the healing period after extensive implantations or augmentations and bone grafting [43]. The one-piece mini-implant with ball attachment is used as assisting / anchoring element under the removable denture [1]. Strategic min-implant under existing RPD and CD proved to be a reliable and straightforward approach [1, 8, 44]. New studies reported that the one-piece mini-implant with ball attachment has a significant advantage on the final prosthodontic treatment [1, 8].

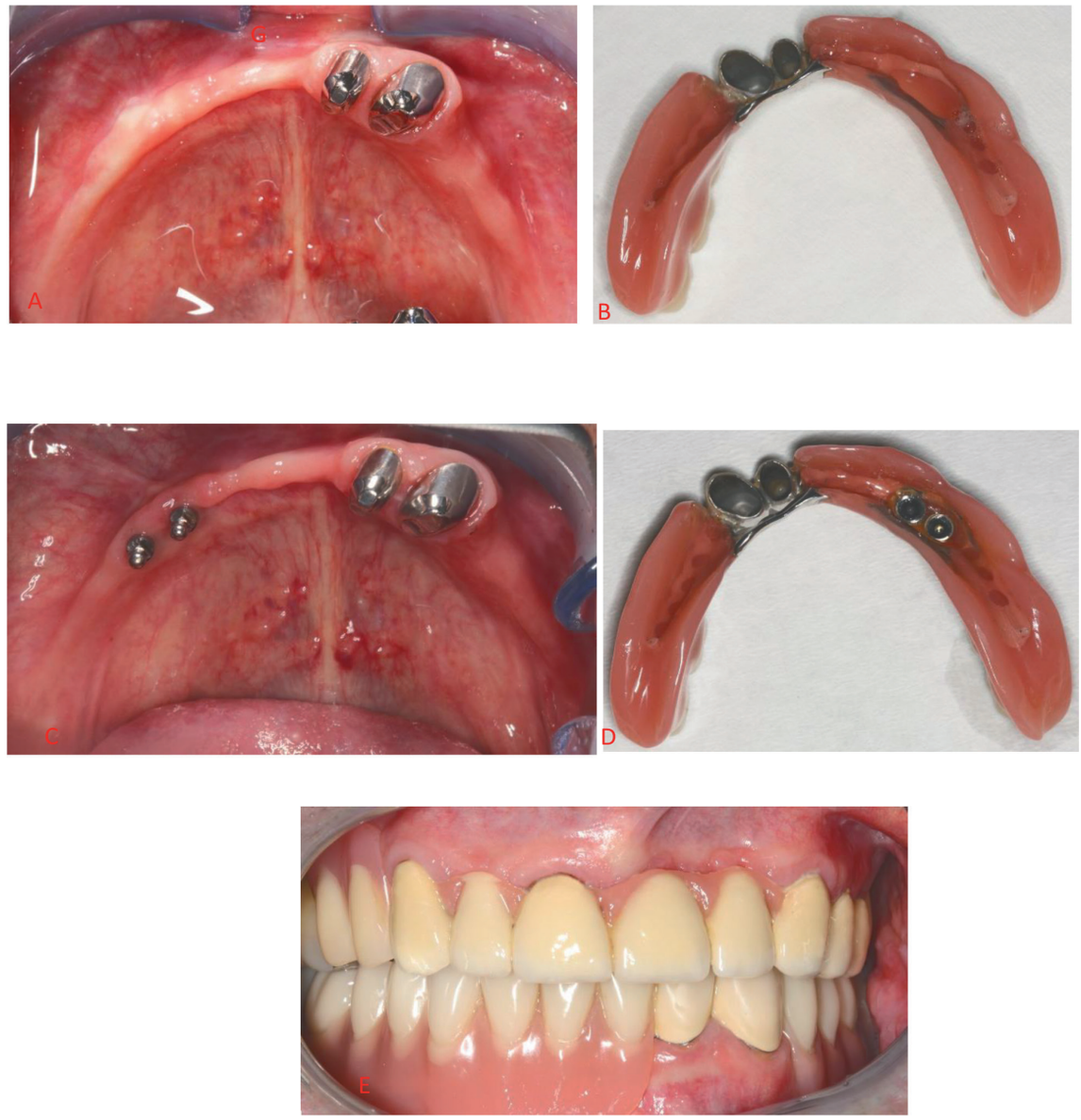

Figure 24.
Upgrading the existing double crown retained upper RPD by inserting strategic mini-implants, immediate restoration, and delayed loading. A- Partial edentulous upper jaw before implantation. B- Tissue surface of the RPD before implantation. C- Five strategic mini-implants. D- Tissue surface of the RPD after implantation, recesses (empty notches) against the mini-implants. E- Tissue surface of the RPD after 4 months, the matrix pick-up (housings). The palate coverage was reduced. F- Intraoral image with the RPD after the housing.

The one-piece implant mimics nature by having a solid unibody structure with no microgaps between the implant and the abutment. As a result, the possible biological complication (bone resorption) and structural flaw are reduced. Also, the flap or flapless single-stage surgery allows the dentist to implement immediate loading or immediate restoration [42]. Moreover, delayed loading is possible by preparing a recess against the mini-implant in the RPD's tissue surface. The treatment protocol can be conventional or delayed loading. However, the recess (cavity) distorts the fit of the RPD's, **Figure 24**.

On the other hand, if the mini-implants are inserted in a healthy, not compromised patent with insertion torque ≥35 Ncm, immediate loading can be considered.

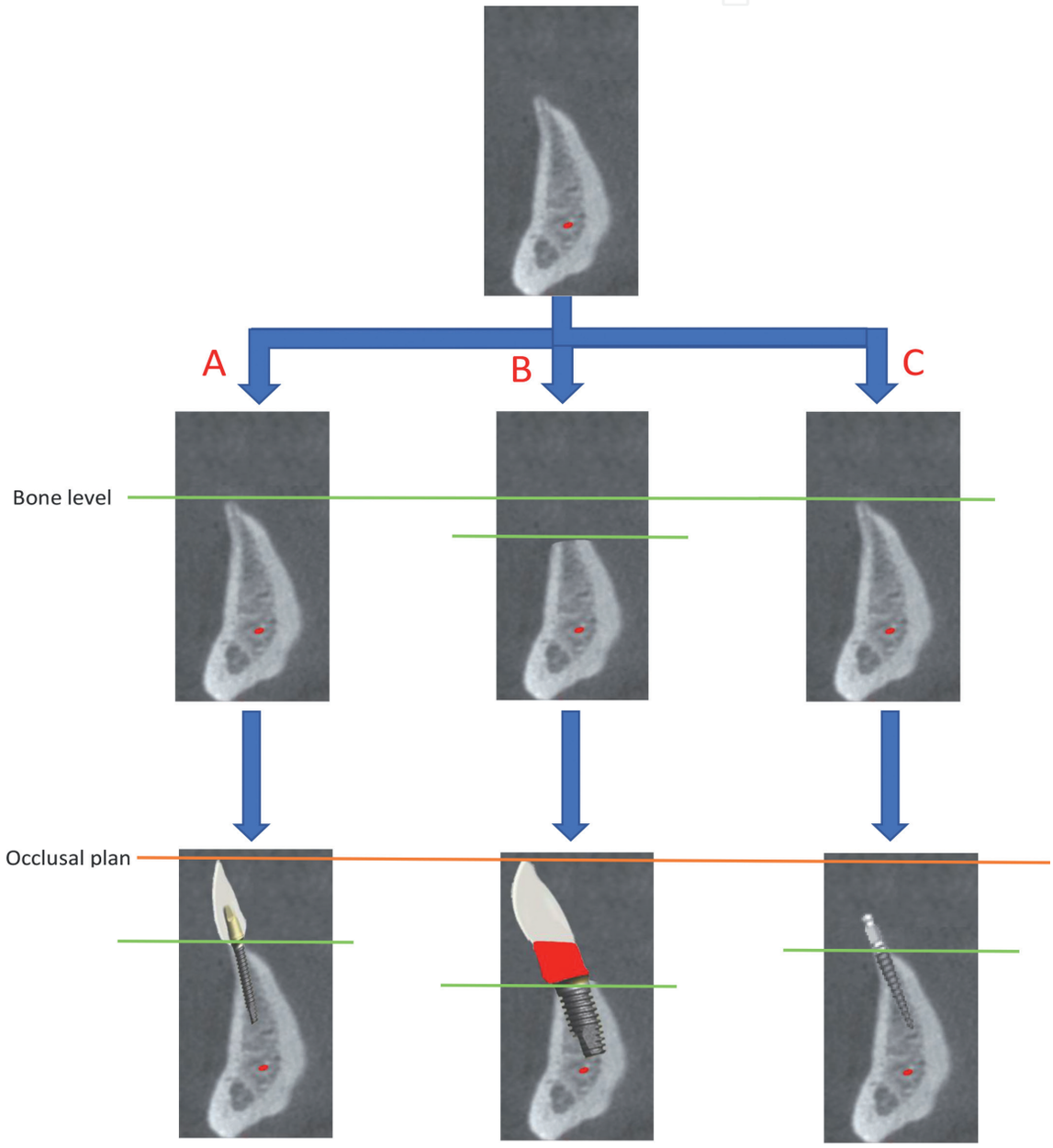

Figure 25.
Upgrading the existing double crown retained lower RPD by inserting strategic mini-implants, immediate restoration and immediate loading. A- Partial edentulous lower jaw before implantation. B- Tissue surface of the RPD before implantation. C- Two strategic mini-implants. D- Tissue surface of the RPD after implantation, the matrix pick-up (housings) inserted in the same implantation session. E- Intraoral image with the RPD in place after implantation.

The immediate restoration with immediate loading can be implemented through one of two forms:

- immediate loading using soft relining material, **Figure 22**.

- immediate loading using the matrix pick-up (housings), **Figure 25**.

After implantation, soft relining material can restore the fit of the RPD, ease tissue pressure, and give the patient a secure feeling because the relining material encircles the implant head and minimizes RPD rocking. If all mini-implants have a high insertion torque, the patient can receive the final restoration with matrix pick-up (housings). Subsequently, no additional session for adjusting the RPD is needed. In this approach, the patient can directly feel and recognize the significant improvement in the RPD in many domains especially, retention, support stability, and chewing [1, 8].

Studies proved that inserting strategic implants under existing RPD improves patient satisfaction on short- and medium-term follow-up (3-years) [1, 43]. The improvement can be explained by the symmetrical distribution of the abutments and the increased number of the rests/abutments [1, 17]. Gorai S, et al. study reported a correlation between the rests number and denture usage [17].

6. Conclusion

To sum it up, using strategic implants under existing RPD upgrade the design to more favorable support type and improve patient satisfaction with the RPD on several domains like speaking, chewing, retention, stability, and support of the RPD. This improvement could be reached earlier if the patient received immediate loading [1].

In many cases, after putting into consideration the patient's main complaint, expectation, desire, general health, intraoral/extraoral findings, evaluating the risks (do no harm) and the benefits of bone grafting and several implants, the dentist is able to provide his patient with one or few strategic standard or mini-implants that can satisfy the patients' needs *without overtreatment* "Less is more".

Strategic implants can also improve chewing ability, stabilize the occlusion, increase bite force and improve patient oral health-related quality of life. Moreover, better distribution of occlusal forces that may reduce bone resorption may be gained. Furthermore, strategic implants can improve comfort, confidence, and esthetics by reducing the RPD size and removing metal clasps from the esthetic zone.

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