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Treatment Options for Patients with Loss of vertical Dimension

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Certification of the Supervisor

I certify that this project entitled "*Treatment options for patients with loss of vertical dimension*" was prepared by the fifth-year student **Mohammed Aboud Ali** under my supervision at the College of Dentistry/University of Baghdad in partial fulfilment of the graduation requirements for the Bachelor Degree in Dental Surgery.

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Dedication

I dedicate this project to God Almighty my creator, my strong pillar, my source of inspiration, wisdom, knowledge and patience.

Every challenging work needs self-efforts as well as guidance of elders especially those who are close to my heart.

My humble effort I dedicate to my sweet and loving father, mother, brothers and sister whose affection, love, encouragement and prays of day and night make me able to get such success and honor.

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List of Abbreviations

Abbreviation	Meaning
TMJ	temporomandibular joint
VDO	vertical dimension of occlusion
OVD	occlusal vertical dimension
TMD	temporomandibular joint
CBCT	cone beam computed tomography
CAD	computer-aided design
CAM	computer-aided manufacturing
DSD	digital smile design
RVD	rest vertical dimension
IRS	Inter-occlusal rest space
FPD	fixed partial denture

Introduction

Prosthodontics is a branch of dentistry that focuses on the diagnosis, treatment planning, and rehabilitation of patients with missing, damaged, or compromised teeth and supporting structures. One of the most common problems encountered in prosthodontics is the loss of vertical dimension, which can result from a variety of factors such as tooth wear, trauma, or aging **(Ito et al, 2017)**.

Vertical dimension of occlusion (VDO) has been defined as the lower facial height measured between two points when the maxillary and mandibular teeth are inter-cusped. Thus, it is the vertical position of the mandible in relation to maxilla when the occluding members are in contact. In our routine practice, to determine the VDO, many measures are employed. They include “divine proportions” by Leonardo da Vinci, proportional face measurements such as the distance from eyebrow to ala, eyebrow to hair line, and horizontal distance between the pupils. Determining vertical dimension at rest and positioning VDO to establish 2–3 mm of inter-occlusal rest space (IRS) may also be utilized. Using profile scales, application of mechanical recording devices in the mouth or on the head, methods based on swallowing, bite force, phonetic assessment of closest speaking space, facial esthetics, pre-extraction records, intraoral measurements, and those based on cephalometric, telemetric, and magnetic methods are other standard ones **(Vinnakota et al., 2016)**.

Prosthodontic treatment options for patients with loss of vertical dimension require careful planning and coordination between the prosthodontist and

other dental specialists, such as orthodontists, oral surgeons, and periodontists. The treatment plan should be tailored to the individual needs and preferences of the patient, and take into account their overall health, dental history, and treatment goals (**Morgano et al, 2011**).

Aims of the Review

- To provide an overview of the current treatment options available for patients with loss of vertical dimension
- To compare and contrast the advantages and disadvantages of each treatment option
- To evaluate the effectiveness of different treatment options in restoring vertical dimension and improving functional and aesthetic outcomes
- To identify gaps in the current literature and suggest areas for further research and development of new treatment options
- To provide guidance for prosthodontists and other dental specialists in selecting the most appropriate treatment option for individual patients based on their specific needs and preferences.

Chapter One: Review
of Literature

Chapter One: Review of literature

1.1 Importance of vertical dimension in prosthodontics treatment planning

The vertical dimension is a critical factor in the success of prosthodontic treatment, and its accurate measurement and maintenance are of utmost importance. A lack of attention to the vertical dimension can result in negative consequences for the patient, such as an un-esthetic or uncomfortable prosthesis, muscle pain, temporomandibular joint (TMJ) problems, or speech difficulties. When a change in the vertical dimension is necessary, it is imperative that the clinician consider all aspects of the patient's condition and treatment needs in order to establish an accurate and stable vertical dimension. It is important that the clinician understand the importance of the vertical dimension in relation to occlusal stability, esthetics, and patient comfort, and incorporate this knowledge into the treatment planning process (**Ribeiro et al, 2000**).

Proper diagnosis and treatment planning, as well as restoration of the vertical dimension of occlusion (VDO), are of utmost importance in achieving optimal treatment outcomes. Changes in the VDO can cause changes in occlusal contact areas, which can have a significant impact on the patient's occlusal stability, functional occlusion, and masticatory performance.

When considering a restoration, it is important to evaluate the patient's VDO to ensure that the proposed restoration will be compatible with the patient's occlusal system. Prosthodontic treatment planning should take into account the patient's VDO, as well as other factors such as occlusal scheme, interocclusal space, and occlusal vertical dimension at rest as shown in figure (1.1) (Lassila et al, 2011).

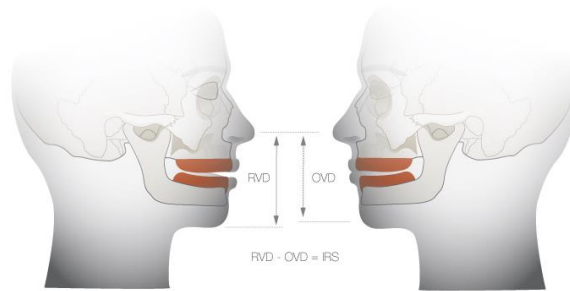


Figure 1.1 Rest vertical dimension (RVD) and Occlusal vertical dimension (OVD) (Turrell, 1972).

It is essential to determine the optimal occlusal vertical dimension (OVD) for each patient, as changes in the OVD can have profound effects on masticatory function, phonetics, esthetics, and overall patient satisfaction. Restoring the OVD can also have a significant impact on the stability and health of the temporomandibular joint and the masticatory muscles, as well as on the longevity of the prosthetic restorations. Therefore, the establishment and maintenance of a stable and harmonious OVD is crucial in prosthodontic treatment planning and in the overall success of dental restorations. Several methods have been proposed for determining the optimal OVD, including clinical evaluation, cephalometric analysis, functional analysis, and subjective assessment by the patient (Shadid et al, 2014).

1.2 Causes and Consequences

Loss of vertical dimension in prosthodontics can have a significant impact on a patient's oral health and overall quality of life. The causes of loss of vertical dimension can vary and may include factors such as tooth wear, periodontal disease, tooth loss, and over-eruption of opposing teeth as shown in figure (1.2). Each of these factors can contribute to a decrease in the height of the occlusal plane, which can result in a variety of negative consequences (Gomez-Polo et al, 2017).



Figure 1.2 Severe Bruxism without loss of OVD: Severely worn anterior teeth with intricately matched contacting surfaces and almost no posterior tooth wear (Pin-Harry, 2018).

One consequence of loss of vertical dimension is changes in facial esthetics. A decrease in vertical dimension can result in a shorter lower face height, leading to a more aged appearance. Changes in occlusion are another common consequence of loss of vertical dimension. Patients may experience malocclusion, instability, and occlusal interferences, which can lead to further dental problems (Chen et al, 2019).

Impaired speech is another potential consequence of loss of vertical dimension. A decrease in vertical dimension can alter the position of the tongue and affect speech patterns. Reduced masticatory function is also a common consequence of loss of vertical dimension. Changes in the pattern

and force of mastication can result in reduced masticatory efficiency and further dental issues. Finally, temporomandibular disorders (TMDs) are a significant consequence of loss of vertical dimension. Changes in joint position and function can lead to pain, discomfort, and difficulty when opening and closing the mouth (**Bakke et al, 2011**).

To ensure successful outcomes in prosthodontic treatment, it is crucial to accurately diagnose and treat the loss of vertical dimension. Treatment options may include removable or fixed dental prostheses, orthodontic treatment, or occlusal rehabilitation, depending on the specific needs of the patient (**Nikzad et al, 2018**).

One article that discusses the causes and consequences of loss of vertical dimension in prosthodontics is "Causes and consequences of loss of occlusal vertical dimension: a review of the literature" by **Abbaszadeh et al. (2016)**. The authors provide a comprehensive review of the literature on the topic and emphasize the importance of proper diagnosis and treatment planning in restoring the occlusal vertical dimension.

Additionally, the article by **Bilhan et al. (2018)** focuses on the effects of loss of vertical dimension on the temporomandibular joint (TMJ). The authors highlight the relationship between the TMJ and the occlusal vertical dimension and how changes in vertical dimension can lead to TMDs. They recommend that clinicians carefully consider the impact of changes in vertical dimension when planning prosthodontic treatment.

Another study by **Choi et al. (2019)** examined the effects of loss of vertical dimension on masticatory function. The authors found that a decrease in vertical dimension can significantly affect masticatory function, leading to changes in the pattern and force of mastication. They suggest that clinicians should consider masticatory function when restoring vertical dimension to

optimize patient outcomes.

Moreover, the study by **Tanaka et al. (2017)** investigated the effect of loss of vertical dimension on facial esthetics. The authors found that patients with a decrease in vertical dimension had a more aged appearance and reduced facial height. They suggest that restoring vertical dimension can improve facial esthetics and provide a more youthful appearance as shown in (figure 1.3).



Figure 1.3 Aging reduces both the concavity and pout of the upper lip, flattens the philtrum and deepens the nasolabial grooves (Turrell, 2006)

A study by **Lemos et al. (2017)** also examined the relationship between loss of vertical dimension and occlusion. The authors found that patients with a decrease in vertical dimension had more occlusal interferences and instability. They suggest that restoring the occlusal vertical dimension can improve occlusal stability and prevent further dental issues.

Lastly, the study by **Koyano and Nakagawa (2000)** explored the effects of loss of vertical dimension on the TMJ. The authors found that changes in vertical dimension can lead to TMDs, such as pain and discomfort, and recommend that clinicians carefully consider the impact of changes in vertical dimension when planning prosthodontic treatment.

In summary, loss of vertical dimension in prosthodontics can have a

range of causes and consequences that can negatively impact a patient's oral health and quality of life. Proper diagnosis and treatment planning are essential to restoring the occlusal vertical dimension and preventing further dental issues. Dental professionals should be aware of the potential consequences of loss of vertical dimension, including changes in facial esthetics, occlusion, speech, masticatory function, and TMDs, when planning prosthodontic treatment.

1.3 Diagnosis and evaluation of loss of vertical dimension in prosthodontics

The study by **Raghavendra et al. (2011)** highlights the importance of accurate interocclusal measurements in prosthodontic treatment planning. The vertical dimension of occlusion is a critical parameter in the evaluation and treatment of dental patients. Accurate measurements of the vertical dimension of occlusion are necessary for the proper fitting of restorations, the stability of occlusion, and the prevention of occlusal disorders as shown in (figure 1.4).

Figure 1.4 Determination of occlusal vertical dimension (VDO).



(Patel et al, 2009)

The Blu-Mousse method, as shown in the study, can be an accurate and reliable method for measuring the vertical dimension of occlusion, with greater reliability than conventional methods such as wax and acrylic resin. This new method can also reduce the discomfort associated with conventional methods and is more convenient for both the patient and the clinician. **(Alqahtani et al, 2020)**

The study by Raghavendra et al. emphasizes the importance of accurate interocclusal measurements and the need for reliable methods for measuring the vertical dimension of occlusion. The Blu-Mousse method is a promising new method for interocclusal measurement, which can improve the accuracy and reliability of prosthodontic treatment planning. **(Raghavendra et al, 2016)**

Kaur et al. provides a review of interocclusal record materials and techniques for determining the occlusal vertical dimension in prosthodontics. The review discusses the importance of accurate interocclusal recording in the diagnosis and evaluation of loss of vertical dimension in prosthodontics. The authors highlight the importance of establishing the correct occlusal vertical dimension during prosthodontic treatment planning to prevent problems such as temporomandibular joint dysfunction, muscle fatigue, and poor esthetic outcomes. Accurate interocclusal records play a critical role in establishing and maintaining the correct occlusal vertical dimension in prosthodontic treatment. Furthermore, the article emphasizes the importance of accurate interocclusal recording in the diagnosis and evaluation of loss of vertical dimension in prosthodontics. The authors suggest that accurate interocclusal recording can help identify the degree of vertical loss and guide treatment

planning to restore the occlusal vertical dimension (**Kaur et al, 2015**).

Overall, Kaur et al. highlights the critical role of accurate interocclusal recording in the diagnosis and evaluation of loss of vertical dimension in prosthodontics. The review emphasizes the importance of careful attention to detail in the interocclusal recording process and collaboration between the clinician and laboratory technician to achieve successful treatment outcomes. Various techniques for determining the correct occlusal vertical dimension are discussed, including clinical examination, radiographic methods, and interocclusal records. Clinical examination involves assessing the patient's face, lips, and teeth to determine the optimal vertical dimension. Radiographic methods, such as cephalometric analysis, can also aid in determining the correct occlusal vertical dimension. Interocclusal records, which are used to transfer the relationship of the maxillary and mandibular arches to an articulator, are also discussed as an important tool in determining the occlusal vertical dimension. Various types of interocclusal records are reviewed, including wax, silicone, and polyether materials, and their advantages and disadvantages. The importance of accurate diagnosis and evaluation of loss of vertical dimension in prosthodontics is emphasized as it can have significant consequences on the patient's oral health and overall quality of life. A comprehensive approach is recommended that considers both functional and aesthetic factors in determining the correct occlusal vertical dimension (**Raghavendra et al, 2016**).

The article by (**Kumar et al, 2016**) discusses the use of interocclusal records for articulator mounting in prosthodontics. It reviews the different types of interocclusal records, including wax, silicone, and vinyl polysiloxane materials, and their advantages and disadvantages. The article also examines

the different methods of recording the occlusal vertical dimension, such as the use of facial measurements and anatomical landmarks.

It also emphasizes the importance of accurate interocclusal records for achieving proper occlusion and restoring the vertical dimension in prosthodontic treatment. It also highlights the need for appropriate training and education for dental professionals in the use of interocclusal records. It also highlights the importance of verifying the accuracy of the interocclusal record before mounting the casts on an articulator. It suggests using a bite indicator or verifying the occlusion by clinical examination to ensure that the occlusal contacts are evenly distributed and the vertical dimension is correct **(Raghavendra et al., 2011)**.

Furthermore, it discusses the challenges and limitations of interocclusal records, such as variations in jaw position and muscle activity during recording, and the potential for errors in the measurement of the occlusal vertical dimension. It suggests that these limitations can be overcome by using a combination of different measurement methods and by performing regular checks of the occlusion during the prosthodontic treatment process **(Nakamura et al., 2018)**.

Shadid and Sadaqa (2014) provides a comprehensive review of the methods used to evaluate occlusal vertical dimension in prosthodontics. The authors discuss various techniques for measuring and adjusting occlusal vertical dimension, including clinical assessment, radiographic methods, and interocclusal records. They highlight the importance of accurately determining occlusal vertical dimension for successful prosthodontic treatment, and they emphasize the need for careful evaluation and documentation of occlusal vertical dimension during treatment planning and

follow-up. The authors also discuss the limitations and potential sources of error associated with different evaluation methods and provide recommendations for minimizing these sources of error. Overall, the article provides a useful overview of the current state of knowledge regarding occlusal vertical dimension evaluation in prosthodontics (**Shadid et al, 2014**).

1.4 Traditional prosthodontic treatment options

Traditional prosthodontic treatment options for loss of vertical dimension can include the following:

1. Complete dentures: This is a common treatment option for patients with significant loss of vertical dimension who have no remaining natural teeth. Complete dentures can be designed to restore the proper vertical dimension and provide functional and aesthetic benefits. However, patients may require adjustments to the dentures over time as the supporting tissues change (**Carlsson et al, 1998**).
2. Removable partial dentures: This treatment option is recommended for patients who have lost some of their natural teeth but still have some remaining teeth. Removable partial dentures can be designed to restore the lost vertical dimension and improve function and aesthetics. However, they may require adjustments and maintenance over time (**Misch, 2015**).
3. Fixed dental prostheses: Fixed dental prostheses, such as dental bridges, can be used to replace missing teeth and restore the vertical dimension. This treatment option can provide functional and aesthetic benefits, but it requires the preparation of the supporting teeth and may

not be suitable for all patients (**Fixed Partial Dentures (Bridges)** by **American College of Prosthodontists, 2009**).

4. Implant-supported dental prostheses: Implant-supported dental prostheses can be used to replace missing teeth and restore the vertical dimension. This treatment option provides a more stable and durable solution compared to traditional dentures or fixed dental prostheses, but it requires a surgical procedure and may not be suitable for all patients (**Gallucci et al, 2018**).
5. Occlusal adjustments: Occlusal adjustments can be used to restore the lost vertical dimension by adjusting the biting surfaces of the teeth. This treatment option may require multiple appointments and careful evaluation of the patient's occlusion to ensure proper function and stability (**Mavroskoufis et al, 2016**).

1.5 Fixed prosthodontic treatment options

1. Crowns: A crown can be used to restore a single tooth that has lost vertical dimension due to wear or damage. The crown is custom-made to fit over the remaining tooth structure and restore the lost vertical dimension. Crowns can be made from a variety of materials, including porcelain, metal, or a combination of both (**Rosenstiel et al, 2015**).
2. Veneers: Veneers are thin shells that are bonded to the front of the teeth to improve their appearance and restore lost vertical dimension. Veneers can be made from porcelain or composite resin and are custom-made to fit over the existing teeth. Veneers are a minimally invasive treatment option that can provide significant aesthetic and functional benefits (**Shillingburg et al, 2012**).

3. Inlays and onlays: Inlays and onlays are custom-made restorations that are used to restore the lost vertical dimension of posterior teeth. Inlays and onlays are more conservative than crowns, as they require less removal of tooth structure. They can be made from porcelain, composite resin, or gold (**Kourtis et al, 2017**).

4. Dental bridges: A dental bridge can be used to replace one or more missing teeth and restore the lost vertical dimension. A bridge consists of one or more artificial teeth (pontics) that are attached to the remaining natural teeth using crowns or metal wings. Bridges can be made from porcelain, metal, or a combination of both (**Tawil et al, 2016**).

5. Implant-supported restorations: An implant-supported restoration can be used to replace one or more missing teeth and restore the lost vertical dimension. A dental implant is a small titanium post that is surgically placed in the jawbone to replace the missing tooth root. An abutment and custom-made restoration (crown, bridge, or denture) are then attached to the implant to restore the lost vertical dimension (**Gürel, 2016**).

1.6 Removable prosthodontic treatment options

Removable prosthodontic treatment options for loss of vertical dimension can include the following:

1. Complete dentures: A complete denture is a removable prosthesis that replaces all of the missing teeth in an arch and restores the lost vertical dimension. Complete dentures can be made from acrylic resin, porcelain, or a combination of both. They are custom-made to fit the individual's mouth and can provide significant functional and aesthetic benefits (**Rahn et al, 2012**).

2. Partial dentures: A partial denture is a removable prosthesis that replaces some of the missing teeth in an arch and restores the lost vertical dimension. Partial dentures can be made from acrylic resin or metal and are attached to the remaining natural teeth using clasps or other attachments (**McCracken's Removable Partial Prosthodontics**) as shown in figure (1.5).

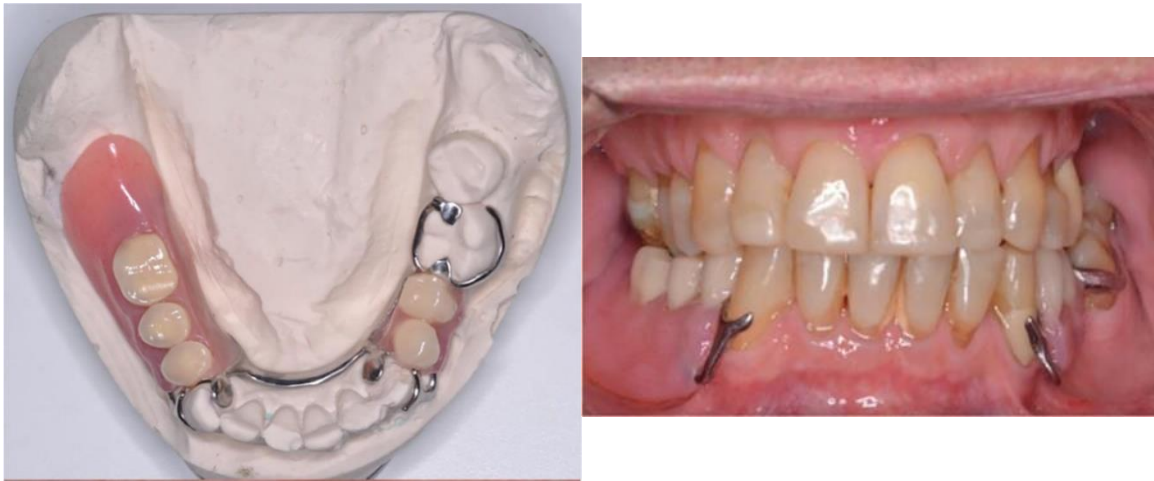


Figure 1.5 Partial chrome denture restoring the lower edentulous regions; (A) design of prosthesis, (B) fit of prosthesis (Caga et al, 2021)

3. Overdentures: An overdenture is a removable prosthesis that fits over one or more remaining natural teeth or dental implants and restores the lost vertical dimension. Overdentures can be made from acrylic resin, porcelain, or a combination of both. They can provide better stability and retention than complete dentures (**Klemetti, 2000**).
4. Implant-supported removable dentures: An implant-supported removable denture is a prosthesis that is supported by dental implants and restores the lost vertical dimension. The denture is attached to the implants using attachments or clips and can provide significant functional and aesthetic benefits (**Naert et al, 1992**).

1.7 Implant-supported prosthodontic treatment options

Implant-supported prosthodontic treatment options for loss of vertical dimension can include the following:

1. **Implant-supported fixed dental prostheses:** An implant-supported fixed dental prosthesis is a non-removable prosthesis that is attached to dental implants and restores the lost vertical dimension. It is commonly referred to as an implant-supported bridge. The bridge is made up of two or more crowns that are connected together and attached to the dental implants. This option is appropriate when there are enough healthy teeth or implants to support the bridge as shown in figure (1.6) **(Maló et al, 2011).**



Figure 1.6 definitive prostheses for complete mouth implant rehabilitation by using a zirconia ceramic system. (Simon et al, 2004)

2. **Implant-supported removable dental prostheses:** An implant-supported removable dental prosthesis is a prosthesis that is supported by dental implants and restores the lost vertical dimension. The prosthesis is designed to be easily removable for cleaning and maintenance. This

- option is appropriate when there are not enough healthy teeth or implants to support a fixed prosthesis (**Babbush et al, 2013**).
3. Overdentures supported by dental implants: An overdenture supported by dental implants is a removable prosthesis that fits over one or more remaining natural teeth or dental implants and restores the lost vertical dimension. The denture is attached to the implants using attachments or clips and can provide better stability and retention than traditional complete dentures (**Roccuzzo et al, 2015**).
 4. All-on-four treatment concept: The All-on-four treatment concept is a technique that uses only four dental implants to support a full arch prosthesis. The prosthesis is attached to the implants and restores the lost vertical dimension. This option is appropriate when there is significant bone loss or when the patient desires a full arch prosthesis that is not removable (**Misch, 2014**).

1.8 Combination prosthodontic treatment options for loss of vertical dimension

Combination prosthodontic treatment options for loss of vertical dimension involve using a combination of fixed, removable, and implant-supported prostheses to restore the lost vertical dimension. This approach can be particularly useful in cases where the patient has multiple missing teeth or significant bone loss that requires a multidisciplinary treatment plan.

Some common combination prosthodontic treatment options for loss of vertical dimension include:

1. Fixed-removable prostheses: This type of prosthesis combines a fixed dental prosthesis with a removable dental prosthesis to restore the lost

- vertical dimension. For example, a patient may have a fixed dental bridge attached to dental implants on one side of the arch and a removable partial denture on the other side (**Tarnow et al, 2016**).
2. Implant-supported overdentures with fixed bridgework: This option combines an implant-supported overdenture with fixed bridgework to restore the lost vertical dimension. The overdenture is supported by dental implants, while the fixed bridgework is supported by natural teeth or dental implants (**Roccuzzo et al, 2013**).
 3. Implant-supported removable partial dentures: This type of prosthesis combines an implant-supported removable partial denture with a fixed dental prosthesis to restore the lost vertical dimension. For example, a patient may have a fixed dental bridge on the front of the arch and an implant-supported removable partial denture on the back (**Krennmair et al, 2007**).
 4. Combination of fixed and implant-supported complete dentures: This option combines a fixed complete denture with an implant-supported complete denture to restore the lost vertical dimension. The fixed denture is attached to dental implants in the anterior region of the arch, while the implant-supported complete denture is used in the posterior region (**Chee et al, 2006**).

The choice of combination prosthodontic treatment options for loss of vertical dimension depends on various factors, including the patient's oral health, expectations, and preferences. A prosthodontist will evaluate the patient's oral condition and develop a treatment plan tailored to their specific needs.

1.9 Digital technology in prosthodontics treatment planning for loss of vertical dimension

Digital technology has revolutionized prosthodontics treatment planning for loss of vertical dimension. Advances in digital imaging, computer-aided design (CAD), and computer-aided manufacturing (CAM) have allowed prosthodontists to create more accurate and predictable treatment plans, resulting in improved patient outcomes.

Some examples of digital technology used in prosthodontics treatment planning for loss of vertical dimension include:

1. Cone beam computed tomography (CBCT): CBCT provides 3D images of the patient's oral structures, allowing prosthodontists to visualize the extent of bone loss and plan implant placement more accurately (**Patel et al, 2017**).
2. Intraoral scanners: Intraoral scanners can create digital impressions of the patient's teeth and soft tissues, eliminating the need for traditional impression materials and providing a more accurate and comfortable experience for the patient (**Fasbinder et al, 2015**).
3. CAD/CAM technology: CAD/CAM technology can be used to design and manufacture restorations such as crowns, bridges, and dentures. This technology enables prosthodontists to create restorations that are more precise, durable, and aesthetically pleasing (**Pjetursson et al, 2008**).
4. Virtual articulators: Virtual articulators allow prosthodontists to simulate the patient's occlusion and evaluate the functional and

aesthetic aspects of the proposed treatment plan before starting the actual treatment.

5. 3D printing: 3D printing allows prosthodontists to create physical models of the patient's oral structures, which can be used for diagnostic purposes, treatment planning, and fabrication of surgical guides (**Sailer et al, 2007**).

The use of digital technology in prosthodontics treatment planning for loss of vertical dimension has many benefits, including improved accuracy, efficiency, and patient satisfaction. However, it is important to note that digital technology should not replace the clinical expertise and judgment of the prosthodontist. Rather, it should be used as a tool to enhance treatment planning and improve patient outcomes.

1.10 Patient considerations in selecting prosthodontic treatment options

When selecting prosthodontic treatment options for loss of vertical dimension, there are several patient considerations that must be taken into account. These include:

1. Patient preferences and expectations: It is important to understand the patient's preferences and expectations regarding the treatment outcomes. This will help in selecting the most appropriate treatment option that aligns with the patient's goals.
2. Medical history: A detailed medical history should be obtained to identify any contraindications or precautions that may impact the selection of treatment options. This includes any history of systemic diseases, medications, or allergies.

3. Oral health status: The oral health status of the patient, including the presence of caries, periodontal disease, and occlusal discrepancies, should be assessed before selecting the treatment option. This will help in determining the extent of treatment required and the feasibility of different treatment options **(Elnagar et al., 2019)**.
4. Prosthesis retention and stability: The retention and stability of the prosthesis should be considered when selecting the treatment option. Factors such as the remaining dentition, bone density, and soft tissue support will influence the stability of the prosthesis and the success of the treatment.
5. Aesthetic considerations: Aesthetic considerations such as tooth color, shape, and contour should be taken into account when selecting the treatment option. The prosthesis should be designed to blend seamlessly with the natural dentition and enhance the patient's smile.
6. Cost and time considerations: The cost and time required for the treatment should also be considered when selecting the treatment option. The patient should be informed of the cost and duration of each treatment option to make an informed decision.

The selection of prosthodontic treatment options for loss of vertical dimension should be based on a comprehensive evaluation of the patient's medical history, oral health status, prosthesis retention and stability, aesthetic considerations, and cost and time considerations. By considering these patient-specific factors, the prosthodontist can develop a personalized treatment plan that best meets the patient's needs and expectations **(McGarry et al, 2002)**.

1.11 Advantages and disadvantages of various prosthodontic treatment options

Advantages and disadvantages of various prosthodontic treatment options for loss of vertical dimension are as follows:

1.11.1 Fixed Prosthodontics:

Advantages:

- Provides stable and predictable outcomes.
- Long-lasting and durable.
- Reduces or eliminates movement and discomfort associated with removable prostheses.
- Improves esthetics and self-confidence.

Disadvantages:

- Requires healthy and adequate remaining dentition.
- Requires significant tooth reduction, which can weaken the tooth structure.
- Difficult to maintain oral hygiene.
- Limited treatment options for complex cases (**Shillingburg et al, 2012**).

1.11.2 Removable Prosthodontics:

Advantages:

- Less invasive than fixed prostheses.
- Easy to clean and maintain oral hygiene.

- Can be adjusted or modified easily.
- Cost-effective compared to other treatment options.

Disadvantages:

- Less stable than fixed prostheses.
- Can cause sore spots and discomfort.
- Requires a certain amount of remaining dentition.
- Can affect speech and eating (**Misch, 2017**).

1.11.3 Implant-Supported Prosthodontics:

Advantages:

- Provides a stable and secure foundation for the prosthesis.
- Can be used in patients with inadequate remaining dentition.
- Long-lasting and durable.
- Improves esthetics and self-confidence.

Disadvantages:

- Requires adequate bone density for successful placement.
- Expensive compared to other treatment options.
- Requires surgical intervention, which can be invasive.
- Requires time for osseointegration (**Rosenstiel et al, 2015**).

1.11.4 Combination Prosthodontics:

Advantages:

- Allows for a combination of fixed and removable prostheses.

- Provides more stability and comfort than removable prostheses alone.
- Allows for greater flexibility in treatment options.

Disadvantages:

- Requires healthy and adequate remaining dentition for fixed prostheses.
- Can be expensive compared to other treatment options.
- Requires multiple appointments and longer treatment time.
- Requires regular maintenance and adjustment (**Shillingburg et al, 2012**).

It is important to note that the advantages and disadvantages of each treatment option may vary depending on the individual patient's needs and preferences.

1.12 Long-term outcomes and success rates of prosthodontic treatment options for loss of vertical dimension

Loss of vertical dimension is a condition that can occur due to a variety of factors, including age-related wear, tooth loss, and other dental conditions. The restoration of vertical dimension can have significant benefits for patients, including improved occlusion, esthetics, and function (**Kois, 2012**).

Studies have shown that fixed dental prostheses and implant-supported restorations can offer predictable and long-lasting results, with success rates ranging from 80% to 95% over a 10-year period. These treatment options can provide significant improvements in function and esthetics and can help to maintain the patient's vertical dimension over time.

Removable prostheses such as complete or partial dentures can also be effective for restoring vertical dimension and improving function, but they

may have lower success rates in the long term compared to fixed prostheses. Studies have shown success rates ranging from 60% to 80% over a 5 to 10-year period. The success of removable prostheses depends on several factors, including the patient's oral hygiene habits, the fit and stability of the prosthesis, and the patient's commitment to regular maintenance and care **(Cho et al, 2017)**.

In addition to the type of prosthesis used, the success of prosthodontic treatment for loss of vertical dimension also depends on the patient's willingness to follow a regular maintenance and care routine. Patients should work closely with their prosthodontist to determine the most appropriate treatment option and to develop a personalized maintenance and care plan **(Farooq et al, 2019)**.

1.13 Challenges and complications associated with prosthodontic treatment of loss of vertical dimension

Prosthodontic treatment of loss of vertical dimension can be challenging due to the following complications:

1. Occlusal instability: Loss of vertical dimension can lead to occlusal instability, which can cause discomfort, pain, and damage to the prostheses **(Kuo et al, 2014)**.
2. Esthetic problems: Restoring the loss of vertical dimension can be challenging, especially in cases of severe bone loss, and may result in esthetic problems such as uneven lips, distorted facial proportions, and compromised smile lines **(Sadowsky, 2001)**.
3. Speech difficulties: Alterations in vertical dimension can affect the ability to speak clearly, leading to speech difficulties **(Misch, 2014)**.

4. Limited oral hygiene: Removable prostheses used to restore loss of vertical dimension can be challenging to clean, which can lead to oral health problems such as gingivitis and periodontitis (**Naik et al, 2019**).
5. Inadequate retention and stability: Removable prostheses used to restore loss of vertical dimension can be unstable and may cause discomfort and instability while eating, speaking, or performing daily activities (**Al Quran et al, 2010**).
6. Psychological impact: Patients may experience anxiety and depression associated with the loss of teeth and the need for prosthetic treatment (**Elsyad et al, 2019**).
7. Material limitations: The material used for prosthodontic treatment may be limited by the patient's oral condition and budget, which can impact the durability, comfort, and esthetics of the prostheses (**Koutouzis et al, 2019**).

Prosthodontic treatment of loss of vertical dimension can be challenging due to the above-mentioned complications. A thorough evaluation of the patient's oral health and treatment needs is essential to identify the most appropriate treatment options and minimize these complications (**Wong et al, 2016**).

1.14 Innovative and emerging prosthodontic treatment options for loss of vertical dimension

In recent years, there have been several innovative and emerging prosthodontic treatment options for loss of vertical dimension. Here are some examples:

1. Digital Smile Design (DSD): DSD is a computer-aided design technology that allows for accurate planning and visualization of a patient's new smile. This technology enables prosthodontists to design and create restorations that are more aesthetically pleasing and functional than traditional restorations as shown in figure (1.7) and figure (1.8) (LeSage et al, 2020).



Figure 1.7 Digital approach for full mouth rehabilitation (LeSage et al, 2020)



Figure 1.8 CAD/CAM technology (LeSage et al, 2020)

2. CAD-CAM technology: Cad-Cam technology is a computer-aided manufacturing technology that allows for the creation of restorations in a more accurate and efficient manner. This technology allows prosthodontists to create restorations that are customized to the patient's individual needs.

3. Implant-supported removable prostheses: This treatment option combines the benefits of implant-supported restorations with the convenience of removable prostheses. These restorations are more stable and functional than traditional removable prostheses, but they can also be easily removed for cleaning and maintenance (**Shetty et al, 2015**).
4. Zirconia restorations: Zirconia is a strong and durable material that is becoming increasingly popular in prosthodontics. Zirconia restorations can be used for a variety of restorations, including crowns, bridges, and implant-supported restorations (**Polyzois et al, 2019**).
5. Maxillofacial prosthetics: Maxillofacial prosthetics is a specialized field of prosthodontics that involves the creation of prosthetic devices to replace missing facial structures. This field is particularly important for patients who have lost facial structures due to trauma or cancer (**Flügge et al, 2018**).
6. Full-mouth rehabilitation: Full-mouth rehabilitation involves restoring all of the teeth in a patient's mouth using a combination of prosthodontic treatments. This treatment option can be particularly useful for patients with significant loss of vertical dimension, as it allows for a comprehensive approach to restoring the teeth and improving the overall function and appearance of the mouth (**Wohlwend et al, 2019**).
7. Digital dentures: Digital dentures are a new technology that uses digital scans of the patient's mouth to create a customized denture. This technology allows for a more precise fit and improved comfort compared to traditional dentures (**Alkhtib et al, 2021**).

8. 3D printing: 3D printing is a new technology that is being used in prosthodontics to create customized restorations quickly and efficiently. This technology allows for the creation of highly accurate and precise restorations, and it is particularly useful for creating implant-supported restorations (**Nagai et al, 2020**).
9. Autotransplantation: Autotransplantation involves the removal of a tooth from one area of the mouth and its transplantation to another area of the mouth. This treatment option can be useful for patients with significant loss of vertical dimension, as it allows for the restoration of missing teeth without the need for implant-supported restorations (**Shillingburg et al, 2012**).
10. Tissue engineering: Tissue engineering is an emerging field that involves the creation of new tissues and organs using stem cells and other biological materials. While still in the early stages of development, tissue engineering has the potential to revolutionize prosthodontic treatment for loss of vertical dimension by allowing for the creation of new teeth and other structures to replace those that have been lost (**Wang et al, 2021**).

1.15 Multidisciplinary approaches for prosthodontic management of loss of vertical dimension

Multidisciplinary approaches are often required for the prosthodontic management of loss of vertical dimension. A collaborative effort among different dental specialists can provide a comprehensive and individualized treatment plan for the patient. Some of the common multidisciplinary approaches include:

1. Orthodontics: Orthodontic treatment may be necessary to realign the teeth in cases where the loss of vertical dimension is due to malocclusion or teeth drifting. Orthodontic treatment can create space for prosthetic rehabilitation, facilitate tooth preparation, and improve the final esthetics as shown in figure (1.9) (Lombardo et al, 2013).

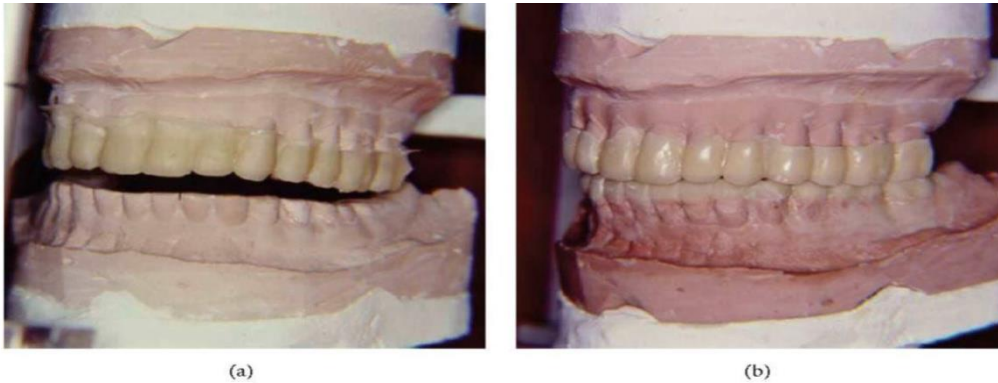


Figure 1.9 (a) Maxillary occlusal acrylic splint positioned in the second master cast set. (b) Waxing in the mandibular cast for manufacturing the occlusal acrylic splint (Fujimoto et al., 2001)

2. Periodontics: The periodontium is a critical component of the support system for teeth and dental implants. Periodontal therapy may be necessary to address any underlying periodontal disease, improve the periodontal health, and ensure a stable foundation for the prosthodontic treatment (Renvert et al, 2015).
3. Endodontics: Endodontic therapy may be necessary to address any underlying root canal infections, remove any remaining tooth structure, and facilitate the tooth preparation for the prosthodontic treatment (Wolcott et al, 2009).
4. Oral and Maxillofacial Surgery: Oral and maxillofacial surgery may be required in cases where there is a significant loss of bone or soft tissue

due to trauma, tumor, or congenital abnormalities. Surgical procedures such as bone grafting, sinus lifts, ridge augmentation, and soft tissue augmentation can provide the necessary foundation for prosthetic rehabilitation (**Chrcanovic et al, 2014**).

5. **Speech and Language Pathology:** In cases where the loss of vertical dimension affects the speech, a speech and language pathologist may be involved in the management of the patient (**American Speech-Language-Hearing Association, 2011**).

1.16 Maintenance and care of prosthodontic treatment options for loss of vertical dimension

Maintenance and care of prosthodontic treatment options for loss of vertical dimension are critical to ensure their longevity and proper functioning. Proper maintenance and care can also prevent complications and minimize the need for repairs or replacements. Here are some tips for the maintenance and care of different prosthodontic treatment options:

1. **Fixed Prosthodontic Treatment:** Fixed prosthodontic treatment such as crowns, bridges, or implant-supported restorations require regular oral hygiene practices such as brushing, flossing, and rinsing with an antibacterial mouthwash. Patients should also avoid hard or sticky foods that can damage or dislodge the restoration. Regular dental check-ups and professional cleanings are also necessary to detect any problems early on and prevent further damage (**American Dental Association. Fixed Bridges.2023**).
2. **Removable Prosthodontic Treatment:** Removable prosthodontic treatment such as complete or partial dentures require regular cleaning

using a soft-bristled brush and a non-abrasive denture cleaner. Patients should avoid using regular toothpaste as it can damage the denture material. The denture should be removed at night and soaked in a denture cleaning solution to remove any bacteria or debris. Regular dental check-ups are also necessary to check the fit and adjust the denture if necessary (**Klemetti, 2016**).

3. **Implant-Supported Prosthodontic Treatment:** Implant-supported restorations require regular oral hygiene practices such as brushing, flossing, and rinsing with an antibacterial mouthwash. Patients should also avoid hard or sticky foods that can damage or dislodge the restoration. Regular dental check-ups and professional cleanings are also necessary to detect any problems early on and prevent further damage. Patients with implants should also avoid smoking, as it can increase the risk of implant failure (**Koutouzis et al, 2015**).
4. **Combination Prosthodontic Treatment:** Patients with combination prosthodontic treatment such as a combination of fixed and removable restorations should follow the maintenance and care instructions for each type of restoration. Regular dental check-ups and professional cleanings are also necessary to detect any problems early on and prevent further damage (**American College of Prosthodontists, 2019**).

Proper maintenance and care of the prosthodontic treatment options for loss of vertical dimension is essential for their longevity and effectiveness. Patients should be instructed on proper oral hygiene practices, including regular brushing and flossing, as well as any additional care specific to their prosthesis. Regular dental check-ups are also necessary to monitor the health of the oral tissues and to ensure the prosthesis is functioning properly. The

dentist may need to adjust the prosthesis if there are any changes in the oral environment, such as gum recession or tooth movement. It is also important for patients to avoid certain habits or behaviors that can damage the prosthesis, such as biting on hard objects, grinding or clenching the teeth, and using tobacco products. Proper nutrition and hydration can also play a role in the maintenance of the prosthesis. In some cases, the prosthesis may need to be replaced or repaired due to wear and tear or damage. Patients should be advised on the potential costs associated with maintenance and replacement of the prosthesis (**American College of Prosthodontists. Patient information. Maintaining your prosthesis, 2008**).

Overall, proper maintenance and care of prosthodontic treatment options for loss of vertical dimension can help ensure their longevity and effectiveness, improving the patient's oral health and quality of life (**Roccuzzo et al, 2012**).

1.17 Patient communication and education in prosthodontics treatment for loss of vertical dimension

Patient communication and education are essential components of successful prosthodontic treatment for loss of vertical dimension. Educating patients about their condition, treatment options, and the importance of maintenance and care can improve treatment outcomes and patient satisfaction. Effective communication between the dentist and the patient can also help alleviate anxiety and establish a positive and trusting relationship. To effectively communicate with patients, dentists should use clear and

concise language and avoid technical jargon. Visual aids such as photographs, X-rays, and models can also be helpful in explaining the patient's condition and treatment options. Dentists should also encourage patients to ask questions and express any concerns they may have. In addition to explaining treatment options, dentists should educate patients on the importance of maintenance and care of their prosthodontic restorations **(Kuo et al, 2014)**.

Patients should be instructed on proper oral hygiene techniques and advised on the use of special brushes or floss to clean around their restorations. They should also be informed about the potential risks of bruxism and other parafunctional habits and provided with appropriate management strategies. Patient education and communication should be an ongoing process throughout the treatment and maintenance phases of prosthodontic care. Regular follow-up appointments should be scheduled to assess the patient's oral health and ensure the longevity of their restorations. Overall, effective patient communication and education can improve treatment outcomes, increase patient satisfaction, and promote long-term oral health **(Cho et al, 2017)**.

Effective communication and education are essential components of successful prosthodontic treatment, particularly in cases involving the restoration of the vertical dimension. Patients must understand the treatment process, the expected outcomes, and their role in achieving a successful outcome. **(Ahmad et al, 2014)**

Al Hamad (2018) importance of patient education in prosthodontics and provides practical advice on how to communicate effectively with patients. The authors suggest using visual aids, such as photographs and videos, to help patients understand their condition and the proposed treatment. They also emphasize the need for clear and concise language, active listening,

and a patient-centered approach.

Kim et al (2019) assesses patients' awareness of the importance of vertical dimension in complete denture prosthetics. The authors found that many patients were not aware of the significance of vertical dimension in denture stability, chewing function, and facial esthetics. The results suggest that patient education on this topic is essential for improving treatment outcomes. Effectiveness of augmented reality technology in patient education for prosthodontic treatment was proved. It was found that patients who received augmented reality-based education had a better understanding of the treatment process and were more satisfied with the treatment outcomes than those who received traditional education. The results suggest that technology-based patient education can enhance patient comprehension and engagement in the treatment process. Patient communication and education are crucial in prosthodontics treatment for loss of vertical dimension. The use of visual aids, clear language, and a patient-centered approach can improve patient understanding and engagement in the treatment process. Augmented reality technology is also a promising tool for enhancing patient education in prosthodontics.

1.18 Future directions in prosthodontics treatment options for loss of vertical dimension.

Prosthodontics has evolved over the years, and future directions in treatment options for loss of vertical dimension are likely to focus on advancements in technology and materials, as well as a more personalized approach to treatment planning.

1. Digital dentistry: The use of digital technology in prosthodontics is becoming increasingly popular. Digital scans of the patient's mouth can

be used to create accurate and detailed 3D models of the teeth and gums. These models can then be used to design and manufacture prosthodontic restorations, such as crowns, bridges, and dentures. Digital dentistry offers several advantages, including greater precision, faster turnaround times, and improved patient comfort. as shown in figure (1.10)

Figure 1.10 Analog and digital protocols to analyze the esthetic and functional implications of OVD alteration; the same biological principles but different workflows all leading to optimal results. (Calamita et al, 2019)

2. Implant-supported restorations: Dental implants provide a stable foundation for prosthodontic restorations and are a popular option for patients with loss of vertical dimension. Advances in implant design and materials have made implant-supported restorations more durable and long-lasting. Additionally, techniques such as computer-guided implant placement can improve the accuracy and predictability of the treatment.
3. Personalized treatment planning: The use of digital technology and patient-specific data can help dentists develop a more personalized treatment plan for each patient. This can include factors such as the

patient's bite, facial structure, and aesthetic preferences. By taking a more personalized approach, dentists can achieve better treatment outcomes and higher patient satisfaction.

4. Biomaterials: The development of new biomaterials, such as biocompatible ceramics and resins, is opening up new possibilities for prosthodontic treatment. These materials offer improved durability, esthetics, and biocompatibility, making them a promising option for patients with loss of vertical dimension.

Future directions in prosthodontics treatment options for loss of vertical dimension are likely to focus on the use of digital dentistry, implant-supported restorations, personalized treatment planning, and advancements in biomaterials. These advancements have the potential to improve treatment outcomes, reduce treatment time, and enhance patient satisfaction. **(Shi et al, 2020)**

Chapter Two: Conclusion

2. Chapter Two Conclusion

- Treatment options for patients with loss of vertical dimension can vary depending on several factors such as the extent of the loss, underlying cause, and the patient's oral hygiene habits.
- Full-mouth rehabilitation with fixed dental prostheses or implant-supported restorations can offer predictable and long-lasting results with success rates ranging from 80% to 95% over a 10-year period.
- Removable prostheses such as complete or partial dentures can also be effective for restoring vertical dimension but may have lower success rates in the long term compared to fixed prostheses.
- Patients must work closely with their prosthodontist to determine the most appropriate treatment option and maintain good oral hygiene habits for long-term success.
- Regular dental check-ups and good oral hygiene habits can help prolong the lifespan of the prosthesis and prevent complications such as decay or infection.

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