

**Ministry of Higher Education  
& Scientific Research  
University of Baghdad  
College of Dentistry**



## **Bite raising appliance**

A Graduation Project Submitted to the Council of the College of Dentistry at University of Baghdad (Department of Prosthodontics), in Partial Fulfillment of the Requirements for the Bachelor Degree in Dental Surgery (B.D.S)

By:

**Aya Fawzi Rashid**

Supervised by:

**Lecturer. Dr. Hasanain Kahtan  
B.D.S., M.Sc, Ph.D. (Prosthodontics)**

2022 A.D.

1443 A.H.

## **Certification of the supervisor**

I certify that this project entitled "**Bite Raising Appliance** " was prepared by "**Aya Fawzi Rashid** " under my supervision at the College of Dentistry / University of Baghdad in partial fulfillment of the graduation requirements for the Bachelor Degree in Dental Surgery.

Signature

**Dr. Hasanain Kahtan**

**B.D.S., M.Sc, Ph.D. (Prosthodontics)**

2022 April

# Dedication

*At first, I thank God for all the blessings  
and success in every step of my life .*

*To my father , who always stands by my side  
and supports me .*

*To my mother , my angel who never left me  
alone in my hard times.*

*To my brother and sister , who give the meaning  
of joy to my life.*

*To my beloved friends , who make my life easier  
and funnier.*

*I dedicate this work to you , and without you I  
could never made it .*

*Finally, a special thanks to my supervisor for  
his guidance and support .*

**Aya**

# Acknowledgment

First, "**Alhamdulillah,**" for giving me the strength and patience to accomplish this work, and I pray that His blessings on me will last the rest of my life.

Thanks to **Prof. Dr. Raghad Abdul Al-Razaq**, dean of college of dentistry, University of Baghdad for his continuous support to the students.

Deep appreciation and respectful regards to **Prof. Dr. Abdulbasit Ahmed**, head of Prosthodontics department, college of dentistry, university of Baghdad, for facilitating the commencement of this project and providing all the support at his disposal.

My sincere gratitude and most profound respect go to my supervisor **Lecturer. Dr. Hasanain Kahtan**, for his guidance, kindness, high ethics, support, and continuous helpful advice throughout my study.

## List of contents

Title	Page No.
Certification of the supervisor	II
Dedication	III
Acknowledgment	IV
List of contents	V
List of Figures	VII
List of Tables	IX
List of Abbreviations	X
Introduction	1
Aim of the review	3
Chapter One : Review of Literature	4
1.1 Vertical dimension	5
1.1.1 occlusal vertical dimension	6
1.1.2 Clinical assessment of vertical dimension	7
1.1.3 Increasing vertical dimension	8
1.1.4 Effects of Increasing Vertical Dimension	9
1.1.5 Indications for Increasing OVD	10
1.1.6 Reasons of loss of OVD	11
1.1.6.1 Erosion	11
1.1.6.2 Abrasion	12
1.1.6.3 Attrition	13
1.1.6.4 Complete Denture Wearing	13
1.1.6.5 Sever class II deep bite	14
1.2 bite raising appliance	14
1.2.1 Soft Bite Raising Appliances (BRAs)	15
1.2.2 Hard Bite Raising Appliances	16
1.3 The Dahl Concept and the Dahl Appliance	17
1.4 Overlay removable partial dentures (ORPDs)	18

1.5 Bite raising tooth supported and implant-supported overdenture	21
1.6 CAD/CAM: Applications for transitional bonding to restore occlusal vertical dimension	22
1.6.1 The role of transitional bonding	23
1.6.2 Transitional bonding using CAD/CAM	24
1.7 The Use of Bite Raisers in Orthodontic Treatment	25
1.8 Types of Oral appliance for Treatment of TMD	26
1.8.1 Flat Plane Stabilization Appliance (Michigan splint)	26
1.8.2 Anterior Bite Plane: Mini Anterior Appliances	28
1.8.3 Anterior Repositioning Appliance (Orthopedic Repositioning Appliance)	29
1.8.4 Neuromuscular Appliances (NMA)	30
1.8.5 Posterior Bite Plane Appliance (Mandibular Orthopedic Repositioning Appliances)	30
1.8.6 Pivot Appliances	32
1.8.7 Hydrostatic Appliance	33
Chapter Two : Summary	34
2.1 Summary	35
Chapter Three : Conclusion	37
3.1 Conclusion	38
References	39

## List of Figures

<b>Figure</b>	<b>Name</b>	<b>Page NO.</b>
Figure 1.1	Rest vertical dimension (RVD) and Occlusal vertical dimension (OVD).	5
Figure 1.2	Erosive wear clearly visible on the palatal aspect of the maxillary anterior teeth	11
Figure 1.3	Cupping visible on theocclusal of the posterior teeth	12
Figure 1.4	Abrasion due on excessive brushing	12
Figure 1.5	Advanced attrition of teeth. In advanced stages, pulp chamber/root canal system might be visible	13
Figure 1.6	Sever class II deep bite	14
Figure 1.7	The night guard was fabricated with soft material	15
Figure 1.8	hard custom teeth night guard is for heavy to severe teeth grinding	16
Figure 1.9	A removable cobalt-chromium partial bite-raising appliance	18
Figure 1.10	Maxillary Overlay removable partial denture	20
Figure 1.11	Mandibular Overlay removable partial denture	20
Figure 1.12	tooth-supported overdenture	21
Figure 1.13	Facially driven treatment planning, oriented by the Digital Smile Design	25
Figure 1.14	Michigan splint As it covers all the teeth of one jaw it is also referred to as a full-coverage splint.	27
Figure 1.15	An anterior bite plane	29
Figure 1.16	This neuromuscular orthotic is an anatomical mandibular appliance designed to orthopedically realign the mandible to the cranium	30
Figure 1.17	Posterior Bite Plane Appliance	31

Figure 1.18	posterior pivot	32
Figure 1.19	Hydrostatic Appliance	33



## List of Tables

<b>Table</b>	<b>Name</b>	<b>Page NO.</b>
Table 1.1	Advantages and disadvantages of using overlay RPD in restoring vertical dimension	19

## List of Abbreviations

<b>TSL</b>	Tooth surface loss
<b>TW</b>	tooth wear
<b>NCTSL</b>	Non-Carious Tooth Surface Loss
<b>OVD</b>	Occlusal vertical dimension
<b>ICP</b>	intercuspal position
<b>CR</b>	Centric Relation
<b>TMDs</b>	temporomandibular disorders
<b>VDR</b>	vertical dimension at rest
<b>3D</b>	three-dimensional
<b>TMD</b>	temporomandibular dysfunction
<b>TMJs</b>	temporomandibular joints
<b>ORPDs</b>	Overlay removable partial dentures
<b>CAD/CAM</b>	Computer aided design and computer aided manufacturing

# INTRODUCTION

Tooth surface loss (TSL), or tooth wear (TW), is an irreversible loss of dental hard tissue, due to non-carious causes, which usually interact to produce destruction (**Bassiouny, 2012**). It is an insidious and cumulative multifactorial process involving destruction of enamel and dentine which can threaten tooth survival and the oral health related quality of life of affected individuals (**Al-Omiri et al. 2006 ; Bomfim, 2010**).

Despite the overall trends towards improved oral health and reduced dental caries incidence over the last decades, epidemiological evidence supports the contention that TW is increasing in severity and prevalence, not only amongst older people who are living longer and retaining more teeth, but also amongst those in the early decades of their adult life (**Van't Spijker et al., 2009; Eaton, 2011**).

TSL may be considered physiological or pathological. Pathologic wear occurs when the normal rate of wear is accelerated by endogenous or exogenous factors (**Verrett, 2001**). Pathological TSL represents unacceptable levels of dental hard tissue loss, it is characterized by abnormal destruction, which may require treatment (**Van't Spijker et al., 2009, Bartlett et al., 2011**). Tooth wear caused by parafunction is estimated to progress three-times faster than physiologic wear (**Verrett, 2001**). Physiological TSL occurs as a result of mastication and adjustment, which is required for the teeth to function correctly (**Verrett, 2001**).

Tooth wear can be classified into two categories: mechanical wear caused by attrition or abrasion, and chemical wear caused by erosion (**Verrett, 2001**).

In the majority of patients, TSL is accompanied by dento-alveolar compensation (**Dawson, 2008**). The vertical dimension of occlusion (VDO) is

maintained by tooth eruption and alveolar bone growth. As teeth are worn, the alveolar bone undergoes an adaptive process and compensates for the loss of tooth structure to maintain the VDO. Therefore, VDO should be conservative and should not be changed without careful approach (**Jahangiri and Jang, 2002; Dawson, 2008**). These physiological compensatory processes ensure that, for the majority of patients, occlusal contacts are maintained in order to maintain the efficacy of the masticatory apparatus (**Dawson, 2008**).

One of the most important aspects in facial appearance involves the occlusal vertical dimension, as the esthetics of the face is affected by facial form and facial height (**Orenstein et al., 2015**). When a patient presents decreased OVD, its facial appearance is aged due to the decrease of the lower third of the face, lips intrusion, drop of the nose and can also bring phonetic and masticatory disorders, possible involvement of the temporomandibular joint (TMJ) and mastication muscles (**Humel et al.,2012; Orenstein et al.,2015**). OVD must be recovered before any definitive restorative procedure is executed, it must be done gradually at the beginning of treatment. Temporary acrylic resin crowns or even interim removable prosthesis should be used for initial adaptation, particularly in determining a stable and functional occlusal vertical dimension (**Bachhav and Aras,2010; Humel et al.,2012**). After creation of an optimum maxillomandibular relationship and restitution of a restorative space and adapting for the new OVD, the treatment plan can evolve into a definitive rehabilitation (**Soares et al., 2005**).

## **Aim of the Review**

This review attempts to:

1. Understand the etiology of compromising OVD and how it is assessed.
2. Focus on the possible methods to restore it by different bite raising appliances.

**Chapter one**  
**Review of Literature**

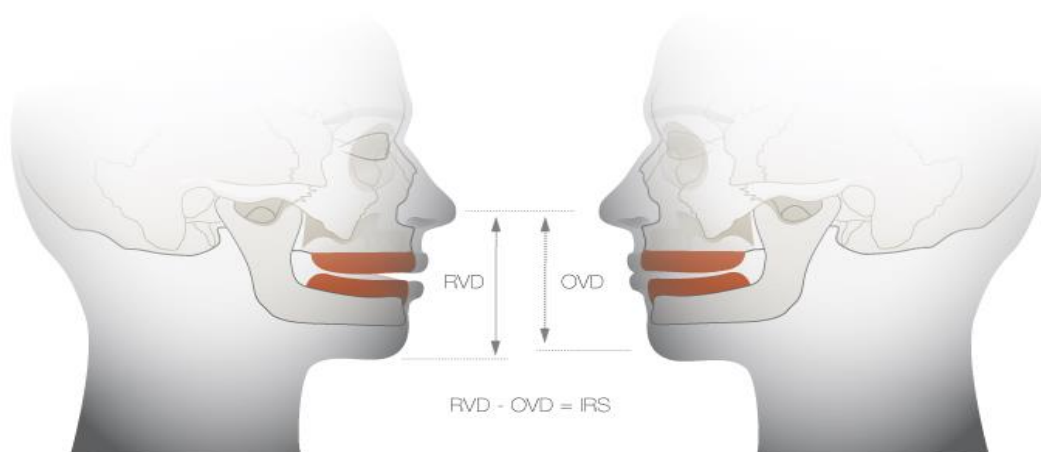
# Review of Literature

## 1.1 Vertical dimension

At the onset, few prosthodontic terms will be demonstrated. Vertical dimension of occlusion refers to the distance between two selected anatomic or marked points (usually one on the tip of the nose and the other on the chin) when the teeth in maximal intercuspal position (**The glossary of prosthodontic terms , 2017**).

Vertical dimension at rest or the physiological rest position is the postural position of the mandible when an individual is resting comfortably in an upright position and the associated muscles are in a state of minimal contractual activity (**The glossary of prosthodontic terms , 2017**).

Interocclusal rest distance or the freeway space is the difference between the rest vertical dimension and the occlusal vertical dimension (**The glossary of prosthodontic terms , 2017**).



**Figure 1.1: Rest vertical dimension (RVD) and Occlusal vertical dimension (OVD). (Vertical dimension | FOR.org, n.d.)**

Centric Relation (CR) is a maxillomandibular relationship, independent of tooth contact, in which the condyles articulate in the anterior-superior position against the posterior slopes of the articular eminences. In this position, the mandible is restricted to a purely rotary movement; from this unstrained, physiologic, maxillomandibular relationship, the patient can make vertical, lateral or protrusive movements; it is a clinically useful, repeatable reference position (**The glossary of prosthodontic terms , 2017**).

Centric Occlusion (CO) is the occlusion of opposing teeth when the mandible is in centric relation (**The glossary of prosthodontic terms , 2017**).

### **1.1.1 Occlusal vertical dimension (OVD)**

The vertical dimension when the mandibular teeth are occluding with the maxillary teeth is defined as the occlusal vertical dimension (OVD). The OVD for dentate individuals is mainly determined by the remaining dentition, hence loss of tooth substance might influence the OVD. A loss of OVD can significantly affect patient function, comfort and aesthetics (**Turner and Missirlian, 1984**). Several authors have commented on the dynamic nature of the dentoalveolar complex and masticatory system (**Dawson, 2008**). So, whilst the loss of OVD is a possible consequence of tooth wear, the original OVD can be preserved by a dentoalveolar compensatory mechanism involving the extrusion of worn teeth. (**Dawson, 2008**). Increasing the OVD from the clinical perspective has been reported to facilitate the treatment of patients presenting with generalized and complex dental abnormalities such as generalized tooth wear and significant occlusal irregularities (**Johansson et al. 2004**). However, there is still considerable debate in the literature about treatment modalities used to increase OVD. Some authors have assumed that the OVD is constant throughout an individual's life, and any alteration of the OVD will subsequently interfere with the physiology of the masticatory system and the patient's ability



to adapt (**Turner and Missirlian, 1984**) .The reported consequences of increasing the OVD are hyperactivity of the masticatory muscles, elevation in occlusal forces, bruxism and Temporomandibular disorder ( TMDs) (**Turner and Missirlian, 1984**). On the contrary, other authors have reported that such symptoms are transitory (**Ormianer and Palty, 2009**). It is a generally believed concept that vertical dimension at rest (VDR) and occlusion (OVD) are constant throughout life. Now it is understood that VDR and OVD are changeable and adaptable to certain extent. Clinically, it can be stated that vertical dimension is not as constant as believed earlier. It is accepted that there is a progressive loss of OVD due to attrition and loss of tooth structure. But this is a wrong conception. Dawson and Thompson stated that loss of VD is compensated by tooth eruption, alveolar bone expansion and muscle action (**Dawson, 2008**) . After loss or alteration of OVD, muscles tend to restore OVD to its original level by tooth intrusion or extrusion. This can be interrelated with the fact that muscles tend to dominate and determine the skeletal form and function in accordance with Functional matrix theory. The OVD increase will result in effort by the musculature to establish the original vertical dimension, is also true. Ramford, showed that OVD will return to the pre-treatment levels by intrusion of the posterior teeth and anterior teeth extrusion(**Ramfjord and Blankenship,1981**). It can be affirmed from the above interpretations that OVD is preserved by the adaptive mechanism of stomatognathic system. So the term ‘to restore lost OVD’ is a misnomer and any such attempt will be actually ‘bite raising’ resulting in increased OVD.

### **1.1.2 Clinical assessment of vertical dimension**

A variety of clinical methods had been developed to determine the acceptable VDO, including the use of vertical dimension of rest and freeway space, closest speaking space method, swallowing ,pre-extraction records, facial analysis. None of them has been shown to be scientifically more accurate than

any other and each method has its own limitations . Among these methods, the vertical dimension of rest is frequently used to determine the VDO in dental clinic. (**Chander and Venkat 2011**).

### **1.1.3 Increasing vertical dimension**

Changing the occlusal vertical dimension (OVD) has been one of the most controversial issues of restorative dentistry. The OVD should not be considered an immutable reference, but rather a dynamic dimension within a zone of physiological tolerance that can be altered as long as the dentist respects the envelope of function. However, vertical changes in the relationship between the maxilla and mandible may have some biological, biomechanical, esthetic, and three-dimensional (3D) functional implications because the initial references of maximum intercuspation and anterior tooth relationships must be reconstructed and adjusted in a new dimension of space (**Calamita et al., 2019**). A clinical demand must be confirmed before the OVD is changed. To be predictable and provide a low-risk outcome. Vertical dimension alterations should not provide long-term deleterious esthetic, functional, biomechanical or biological implications, as long as the horizontal components of rehabilitations such as equilibrated and stable maxillomandibular and anterior tooth relationships are respected. Objective and subjective parameters should be rationally incorporated to minimize the margin of error. In relation to the method of increasing OVD, the studies that increased OVD with fixed prostheses (**Abduo,2012**) indicated less symptom severity than the studies that increased OVD with a removable appliance (**Abduo and Lyons, 2012**). This outcome could be attributed to the fixed prostheses having the advantages of being fixed in the mouth, mimicking natural tooth morphology, minimizing bulkiness with reduced interference with speech and improved overall comfort. In addition, the fixed nature of the prosthesis may enhance patient compliance and acceptance of the treatment. Therefore, whenever possible, the increase in

OVD should be performed for TMD-free patients with fixed restorations rather than with a removable appliance. Removable appliances could be a source of patient maladaptation due to factors other than increased OVD. The use of a removable splint to increase OVD for TMD-free patients is not indicated as it might generate signs and symptoms related to splint wearing rather than OVD increase (**Abduo and Lyons, 2012**).

#### **1.1.4 Effects of Increasing Vertical Dimension**

Many articles and systematic reviews conclude that OVD alteration is a common and safe procedure once the clinician understands and respects some individual variables. Abduo , concluded that, whenever indicated, a permanent increase of the OVD of up to 5 mm is a safe and predictable procedure without detrimental consequences, and that the associated signs and symptoms are self-limiting, with a tendency to resolve within 2 weeks(**Abduo,2012**) . Moreno-Hay and Okeson , stated that the stomatognathic system has the ability to adapt rapidly to moderate changes in the OVD (**Moreno-Hay and Okeson ,2015**). In some patients, mild transient symptoms may occur, but mostly they are self-limiting and without major consequences. These authors found no indication that permanent OVD alteration produces long-lasting temporomandibular dysfunction (TMD) symptoms. Many other articles , have reported the effect of OVD alterations on the temporomandibular joints (TMJs), the neuromuscular system, the teeth, and phonetics ( **Misch,2000 ; Abduo and Lyons,2012; Moreno-Hay and Okeson ,2015**). The majority of these studies concluded that the effects on the above-mentioned structures were well accepted once the 3-position maintained from healthy, adapted, and stable TMJs; once the interocclusal contacts are bilateral and simultaneous and the teeth are receiving axial loads; and once the position of the anterior teeth permits adequate phonetics and a path of closure into the new 3D position. Although a greater increase cannot be assumed to be hazardous, it should be stated that a greater

increase in the OVD implies significant escalation in the rehabilitation complexity that might be difficult to justify. Since any restorative material can be applied on the occlusal surface in a space of 2mm (**Hemmings et al.,2000**), a 4mm interarch space will be adequate for comprehensive rehabilitation. Subsequently, an OVD increase greater than 5mm inter-incisal is rarely indicated from the clinical perspective. When OVD is increased within or equal to the pre-existing VDR position, muscle activity/tonus is kept to minimal levels and hence there is no muscular tendency to rebound. If OVD is increased above VDR, muscles tend to re- establish the original dimension by compressing tooth into the socket results in tooth mobility, bone resorption, tooth intrusion, strain or fatigue of muscles and bruxing tendency (**Abduo and Lyons,2012**). Harper , documented that increase in OVD leads to encroachment of freeway space causing exaggerated respiratory problems (**Harper, 2000**). The inference that can be arrived at by studying the effects of altering OVD is that any attempt to restore OVD in excessively worn dentition results in increasing the OVD. This increase will ultimately lead to adaptive recoil of muscles resulting in tooth intrusion and OVD will return to pre-treatment level.

### **1.1.5 Indications for Increasing OVD**

From the literature appraisal, it is understood that OVD should not be increased in a few specific conditions like full occlusal rehabilitation situations where space for restoration can be achieved by crown lengthening and foundation restorations, to reduce face wrinkles, muscle dysfunction, extracapsular TMJ disorders, and upper respiratory tract distress syndrome. (**Chander and Venkat, 2011**) The indications for bite raising are:

- 1- Inadequate space for the restoration.
- 2- For temporarily relieving the symptoms in intracapsular TMJ disorders (**Chander and Venkat, 2011**).

## 1.1.6 Reasons of loss of OVD

### 1.1.6.1 Erosion

Dental erosion is defined as the dissolution of dental hard tissue caused by non-bacteriogenic acids (Mehta et al., 2012). It is caused by the chronic exposure of dental hard tissues to acidic substrates which may be of an intrinsic or extrinsic source. The distribution and severity of TSL lesions that are initiated by erosion depend on how the acidic materials came into contact with the tooth surface. For example, erosion caused by gastro-oesophageal regurgitation disorder (GERD) occurs on the palatal aspect of the upper anterior teeth and usually does not affect the lower posterior teeth as the tongue protects them. When erosion is caused by prolonged holding and swishing acidic drinks, the labial aspects of tooth surface are more likely to be affected first (Johansson et al., 2004). Erosive lesions typically manifest as bilateral concave defects without the chalkiness or roughness normally associated with bacterial acid decalcification. In its early stages, erosion affects the enamel layer, resulting in a shallow, smooth, glazed surface; after dentin exposure will occur (Fig.1.3). Evidence of “cupping” of both the occlusal surface of posterior teeth and incisal edges of the anterior teeth is usually found (Fig.1. 4). (Mehta et al., 2012)



**Figure 1.2: Erosive wear clearly visible on the palatal aspect of the maxillary anterior teeth.(Mehta et al., 2012)**



**Figure 1.3: Cupping visible on the occlusal of the posterior teeth. (Mehta et al., 2012)**

#### **1.1.6.2 Abrasion**

Abrasion is the physical wear of tooth structure through an abnormal mechanical process independent of occlusion. A common cause of abrasion is the habit of overzealous tooth brushing. Lesions are typically rounded or ‘V’ shaped ditches seen on the buccal/labial surfaces in the region of the cemento-enamel junction. Notching of the incisal edges on maxillary central incisor teeth is often seen as a result of habits such as the biting of pins, tacks, nails (Fig.1.5). (Mehta et al., 2012)



**Figure 1.4: Abrasion due on excessive brushing. (Tooth Wear - Causes and Prevention, n.d.)**

### 1.1.6.3 Attrition

Attrition is the wearing away of tooth structure as a result of tooth-to-tooth contact, as in mastication, with possible abrasive substance intervention (Mehta et al., 2012). It is most commonly observed to occur on the incisal and occlusal contacting surfaces. The early clinical manifestation of attrition is the appearance of a small polished facet on a cusp or ridge, or the slight flattening of an incisal edge; as the lesion progresses, there is a tendency towards the reduction of the cusp height and flattening of the occlusal inclined planes, with concomitant dentine exposure (Mehta et al., 2012).



**Figure 1.5: Advanced attrition of teeth. In advanced stages, pulp chamber/root canal system might be visible. (Mehta et al.,2012)**

### 1.1.6.4 Complete Denture Wearing

The decrease in occlusal vertical dimension is a characteristic of complete denture wearers (Marin and Leite, 2015). The long-time use of the same complete denture can result in jaw displacement due to abrasion of the artificial teeth and residual ridge resorption, causing a decrease of the OVD (Mays,2003; Abduo and Lyons,2012). The decrease of the OVD can compromise the aesthetic and cause morphologic changes in the complete denture wearers. It leads to hyperactivity or hypoactivity of the masticatory muscles, increase or decrease in masticatory force, temporomandibular disorders, decreased facial height as a result of mandibular ridge resorption and a downward and forward rotation of the mandible , increasing mandibular prognathism (Marin and Leite et al., 2015). These complications can significantly affect the function and

comfort as well as the phonetics and esthetic of the patient (**Ormianer and Palty,2009; Abduo and Lyons,2012** ).

#### **1.1.6.5 Sever class II deep bite**

Class II deep bites are problems associated with growth and habit and are usually hereditary. Class II deep-bite patients have some common clinical characteristics. The most common is a deep mento-labial sulcus over a prominent chin, other characteristics could be described as follows: aging effect of poor profile on the patient, pressure of lower incisors on palatal tissue or upper incisors on labial tissue, and improper anterior guidance (**Ergun and Yucel, 2014**).



**Figure 1.6: Sever class II deep bite .( Abuaffan, 2016)**

## **1.2 Bite raising appliance**

The appliance is made from hard or soft acrylic and usually fits over the lower teeth. It is designed to stop the upper and lower teeth from touching when patient close his mouth. The bite-raising appliance used to help patient with temporomandibular (Jaw) dysfunction (TMD). This is a group of conditions which affect the chewing system (**Chander and Venkat, 2011**).



### 1.2.1 Soft Bite Raising Appliances (BRAs)

Are probably the most commonly prescribed splint for bruxism and TMD, albeit perhaps the least effective. The soft guard (**Figure 1.7**), will protect the teeth by separating and preventing them from coming into contact. After a short period, the guards will deteriorate and need replacing. It is also common for patients to bite through them. It is also believed that patients who clench during sleep will often clench more on the soft splint, sometimes leading to an increase in initial symptoms. The rationale for using soft splints is that the soft resilient material may help in distributing the heavy load associated with parafunctional habits (**Okeson, 2003**). Soft splints have some advantages, such as their relative simplicity, reversibility, noninvasiveness, and cost. These splints could be made to fit either the maxillary or mandibular arch and often are inserted immediately (**Okeson, 2003**). Owing to their soft and resilient material features, soft splints easily distribute the heavy loads encountered during parafunctional activities, and they have been associated with a high degree of patient tolerance (**Okeson, 2003**).



**Figure 1.7: The night guard was fabricated with soft material. (Soft Night Guard — Westbrook, n.d.)**

## 1.2.2 Hard Bite Raising Appliances

Hard splints (**Figure 1.8**), are thought to reduce TMD symptoms by altering the occlusal equilibrium, changing the afferent impulses to the central nervous system, improving the vertical dimension, correcting the condylar position, and aiding cognitive awareness (**Dylina, 2001**). Littner et al. reported that hard splints offer more successful outcomes than soft splints for patients with functional disorders of the masticatory system (**Littner et al, 2004**). However, other studies have shown that both soft and hard appliances are equally beneficial in improving masticatory muscle pain in the short term (**Dylina, 2001**).



**Figure 1.8: hard custom teeth night guard is for heavy to severe teeth grinding. It is made from a firm, durable plastic (elasticized acrylic) and it's approximately 1.5mm in thickness. (Hard Night Guard - Heavy Grinding, n.d.)**

### 1.3 The Dahl Concept and the Dahl Appliance

The Dahl Concept refers to the relative axial tooth movement that is observed when a localized appliance or localized restorations are placed in supra-occlusion and the occlusion re-establishes full arch contacts over a period of time. This concept can be achieved with a Dahl appliance, which refers to any interim restoration or prosthesis which deliberately introduces supra-occlusion of selected teeth with disclusion of the remainder. It can either be a removable appliance or a fixed appliance, typically in the form of a composite resin restoration. The concept was originally proposed by Dahl in 1975 to create space in the treatment of anterior localized tooth wear (**Dahl et al., 1974**). It involved the wearing of a removable chrome-cobalt appliance with an anterior bite plate that separated the posterior teeth (**Figure 1.9**). Initially the posterior teeth were discluded, but rather than use restorative means to reestablish the posterior occlusion, it was allowed to reestablish by itself over time. Dahl stated that this reestablishment of posterior occlusion was due to a combination of both intrusion of anterior teeth and eruption of posterior teeth, which usually occurred over a period of about 4 to 6 months (**Poyser et al., 2005**). Over time, with the availability of newer techniques and materials, the technique has been adapted to become a useful adjunct for restorative dentistry (**Poyser et al., 2005**). In addition, by increasing the VDO, the incisal guidance angle is reduced, providing a favorable biomechanical situation.



**Figure 1.9: A removable cobalt-chromium partial bite-raising appliance.**  
(poyser et al.,2005)

#### **1.4 Overlay removable partial dentures (ORPDs)**

Treatment options for patients with severe attrition resulting in reduced occlusal vertical dimension are often limited to fixed prosthesis to reestablish proper occlusal vertical dimension and functional occlusion. In some cases, such as when there are limited finances, minimal esthetic concerns, and medical considerations fixed prosthesis may not be the ideal treatment option. Overlay removable partial dentures (ORPDs) can be used as a provisional or interim prosthesis as well as permanent prosthesis in these cases. Overlay removable partial dentures (ORPDs), are often referred to as an RPD that has part of their components covering the occlusal surface of the abutment teeth to restore them into a functional occlusion (**Patel and Bencharit,2009**). Unlike conventional overdentures that only a few millimeters of coronal tooth structure of the abutment teeth are left supragingivally, there is usually at least one-third or half

of tooth structure remaining in ORPD situation (**Figure 1.10 and Figure 1.11**). This remaining tooth structure is often visually exposed contributing to esthetic challenge compared to the conventional overdenture where the abutment teeth are completely covered (**Windchy and Morris, 1998**).

**Table 1.1: Advantages and disadvantages of using overlay RPD in restoring vertical dimension. (Windchy and Morris, 1998)**

Advantages	Disadvantages
Cost effective	Possibility of caries if patient doesn't maintain proper oral hygiene
Short treatment time	Potential maintenance issues associated with acrylic resin fracture and discoloration
Minimally invasive	Future difficulty in restoring teeth under the framework while maintaining the fit of the framework



**Figure 1.10: Maxillary Overlay removable partial denture.( Patel and Bencharit,2009)**



**Figure 1.11: Mandibular Overlay removable partial denture.( Patel and Bencharit,2009)**



## 1.5 Bite raising tooth supported and implant-supported overdenture

Overdenture treatment uses a removable complete denture that overlies retained teeth, tooth roots, or dental implants ( **Figure 1.12**).This treatment is not a new concept and practitioners have successfully employed existing tooth structures or retained roots to assist with complete denture treatment for more than a century (**Morais et al.,2003**). For many years, traditional complete denture designs have been modified to gain additional support and stability from a few retained and suitably prepared natural teeth. Mericske-Stern et al attested to the effectiveness of such tooth-supported complete dentures or overdentures as alternative to complete dentures. Roots maintained under the denture base preserves the alveolar ridge, provide sensory feedback and improve the stability of the dentures (**Mericske-Stern et al.,1994**).



**Figure 1.12: tooth-supported overdenture A) Initial case; B) Intraoral view after five-years to begin the prosthetic rehabilitation with five short-coping cemented; C) Front view of cemented copings; D) Intraoral view after prosthetic rehabilitation.( Schuh et al.,2014)**

Morais et al. reported that overdenture treatment with the use of implants has become popular for edentulous elderly patients who are maladaptive to complete dentures (**Morais et al.,2003**). Although the biologic basis of implants installed in the bone is different from roots surrounded by a periodontal membrane, but the prosthetic concept is similar. Tactile sensation for implant is reduced because of the absence of periodontal receptors. However, oral function with overdentures supported by roots or implants is comparable and does not seem to depend on the presence of a periodontal membrane. They are a preferable alternative to treatment with conventional complete denture, the main advantages are decreased resorption of the residual ridges; psychological benefits for the patients and maintenance of masticatory efficiency (**Schuh et al.,2014**).

## **1.6 Applications for transitional bonding to restore occlusal vertical dimension**

A stable and comfortable occlusion is a cornerstone of long-term oral health and the foundation of durable esthetic, restorative, periodontal, and prosthodontic treatments. When rehabilitating a patient to correct the effects of tooth wear, attrition, and/or erosion, decay, structural damage, alignment issues, and/or temporomandibular joint (TMJ) disorders, determining the ideal centric relation (CR) position and vertical dimension of occlusion (VDO) is critical to restoring occlusal balance. In particular, CR and VDO are essential for establishing a functional and healthy occlusion, ideal restoration proportions and smile design, and treatment planning esthetic and prosthodontic restorations for long-term durability (**Palmer,2012**). Transitional bonding is an interim prototype or provisional phase, that uses direct composite or indirect restorations to trial function and esthetics prior to the fabrication of the definitive restorations.



### **1.6.1 The role of transitional bonding**

The author defines transitional bonding as the use of bonded interim prostheses or prototype restorations executed using either direct composites or indirectly fabricated Provisionals to reestablish esthetics, speech, functional stability (eg, eating, breathing), and occlusion that are sequentially transitioned into the definitive restorations. Not only do transitionally bonded prototypes/prostheses create a stable occlusion in CR with anterior coupling, but also, they enable verification of the patient's desired outcomes, which can then be sequentially transitioned into the definitive restorations. Overall, the additive nature of transitional bonding for establishing CR and VDO presents several advantages for clinicians and patients (**Palmer,2012**). These include easier and simpler procedures, more manageable and predictable results, and greater cost-effectiveness. Today's direct composites demonstrate significant improvements over previous products (ie, strength, handling characteristics, durability, lower polymerization shrinkage rates) and are considered among the most versatile restorative materials available (**Fortin and Vargas,2000; LeSage,2007; Sensiet et al., 2007**). Additionally, their minimally invasive nature allows greater preservation of sound tooth structure (**Palmer,2012**). Unfortunately, direct restorative techniques have traditionally presented clinical challenges (**Fasbinder, 2002; Christensen, 2006**). These have included isolation, contamination, and individual patient characteristics and clinician abilities that have affected predictability of the restorative protocol (**Fasbinder,2002 ;Christensen,2006**). Likewise, transitional indirect restorations may also cause significant issues, including chipped, broken, or lost temporaries when trial therapy ranges from 3 to 6 months.

## 1.6.2 Transitional bonding using CAD/CAM

Computer-aided-design and computer-aided-manufacturing (CAD/CAM), **(Figure 1.13)** can make transitional bonding easier, more efficient, more manageable, and more predictable. Highly accurate, efficient, and predictable for fabricating well-fitting frameworks in fewer steps than traditional laboratory processes **(Fasbinder,2010; Abduo et al., 2010)**, When definitive restorations are CAD/CAM fabricated, they have demonstrated survival rates comparable to traditional hand-fabricated restorations **(Wittneben et al.,2009)**. CAD/CAM transitional bonding interim prototypes/prostheses are highly homogeneous compared to direct restorations, which increases long-term stability, biocompatibility, and wear resistance. Because these restorations can be milled extremely thin for placement on occlusal surfaces, little to no tooth preparation is required, contributing to a minimally invasive and additive rehabilitation approach **(Stumbaum et al.,2010; Litzenburger et al.,2013; Vailati and Carciofo,2016; Schlichting et al.,2016)**. Transitional bonded prostheses are significantly important to providing patients with an interim therapy to determine if the proposed esthetic outcome and occlusal scheme will function as expected, or if adjustments are needed prior to the delivery of the definitive long-term restorations. CR and VDO are essential for establishing a functional and healthy occlusion, ideal restoration proportions and smile design, and treatment planning esthetic and prosthodontic restorations for long-term durability.



**Figure 1.13: Facially driven treatment planning, oriented by the Digital Smile Design. ( Coachman and Calamita, 2012;Coachman and Calamita, 2017)**

## **1.7 The Use of Bite Raisers in Orthodontic Treatment**

Bite raising is a fairly old and commonly practiced concept in the field of orthodontics. A bite plane is an artificial surface especially fabricated either anteriorly or posteriorly to provide a plane against which the teeth of the opposing arch can contact when brought together for occlusion such that full closure of the jaws is prevented. The bite is thus said to be raised. The orthodontic correction of deepbite, openbite, scissorbite and crossbite often requires temporary bite opening which serves to eliminate occlusal interferences, improve CR-CO (centric relation-centric occlusion) discrepancy, provide unhindered tooth movement by preventing unwanted breakages of the orthodontic brackets (**Proffit and Fields ,2013; Pativetpinyo et al.,2018**). These are most commonly used orthodontic auxiliary and are often described as 'bite plates', 'bite planes', 'bite blocks', 'bite raisers', 'bite ramps', 'occlusal build ups', 'disarticulators' and 'bite turbos'. They can be removable or fixed (**Pativetpinyo et al.,2018**), and can be placed in the anterior or posterior segment of the mouth with respect to either maxillary or mandibular arches depending on the individual treatment need. Removable bite plates though convenient depend largely on patient cooperation and require frequent adjustments to account for orthodontic tooth movements. They can easily be

lost or broken and sometimes swallowed by the patient as well (**Kravitz et al.,2018**). They may also lead to the creation of plaque accumulation areas resulting in poor oral hygiene and high risk of dental caries( **Batoni et al.,2001; Kharbanda,2019**). Gagging due to over-extended bite plates and ulcers in the oral cavity due to sharp ends are amongst the common problems caused by the removable plates. Banded bite plates provide a fixed alternative, but they are less accommodating of tooth movements and can cause soft-tissue irritation.Fixed bite-turbos are hygienic, minimizes bulkiness, reduce interference with speech and is less intrusive on the tongue space when compared to the conventional acrylic plates (**Pativetpinyo et al.,2018**).

## **1.8 Types of Oral appliance for Treatment of TMD**

According to the glossary of prosthodontic terms (**The glossary of prosthodontic terms , 2017**) , occlusal Splint defined as a removable artificial occlusal surface used for diagnosis or therapy affecting the relationship of the mandible to the maxillae. Occlusal appliances may be used in different ways for occlusal stabilization, prevent wear of the dentition, or to for treatment of TMJ disorders (**Deshpande and Mhatre,2010**) .

### **1.8.1 Flat Plane Stabilization Appliance (Michigan splint)**

Also known as the gnathologic splint, Michigan splint, or muscle relaxation appliance ( **Figure 1.14**). This appliance is generally fabricated for the maxillary arch but, for esthetics and avoid interference with a speech;some clinicians have recommended that it could be placed for the mandibular arch. Turp et al Concluded that, based on their systematic review, no differences in reduction of symptoms whatever the appliance placed either for maxilla or mandible(**Türp et al., 2004**). The purpose of stabilization appliance as outlined by the American Academy of Orofacial Pain guidelines is to “provide joint stabilization, protect the teeth, redistribute the occlusal forces, relax the elevator

muscles, and decrease bruxism.” Additionally, it is stated that “wearing the appliance increases the patient’s awareness of jaw habits and help salter the rest position of the mandible to a more relaxed, open position” (De Leeuw, 2013) . The occluding surface of the appliance should be occluding uniformly, evenly, and simultaneously with the opposing dentition. Many practitioners recommended the incorporation of canine- protected occlusion to disocclud the posterior teeth during eccentric movements. Some investigators preferred this design in asymptomatic individuals and reported that this concept is more effective in reducing muscle activity ( Türp et al., 2004) . However, other studies have shown no differences in muscle activity in healthy subjects (Conti et al.,2006) or in TMD symptom reduction by applying the canine protected occlusion to the appliances (Conti et al.,2006) . The muscle relaxation appliance is the most commonly used type of occlusal appliance, and it has the least adverse effects to the oral structures when properly fabricated (Srivastava et al.,2013) .



**Figure 1.14 : Michigan splint** As it covers all the teeth of one jaw it is also referred to as a full-coverage splint.( Michigan Splint,n.d.)

### **1.8.2 Anterior Bite Plane: Mini Anterior Appliances**

It's an oral appliance that engaged only 2-4 maxillary incisors (**Figure 1.15**). Different designs of mini anterior appliances include the Nociceptive Trigeminal Inhibition Tension Suppression System (NTI), the Anterior Midline Point Stop (AMPS) devices, and the Best Bite. All made of hard acrylic resin that are either developed directly at chairside or produced in prefabricated designs commercially. The commercial types of these appliances require custom fitting at chairside by relining the tooth born side with acrylic resin or hard elastic impression materials to fit on the maxillary incisors, after that the occluding surface is adjusted to allow 2-4 mandibular incisors to contact a platform. The purpose of this appliance is to disengage the posterior teeth, thus eliminating the influences of the posterior occlusion on the masticatory system. The anterior bite plane thought to be effective in treating TMDs and headaches (**Jokstad et al.,2005**) . The possibility of adverse occlusal changes occurring with a mini anterior appliance with continuous and long-term use is of major concern. The design of the appliance only covers the maxillary anterior teeth, leading to the potential for overeruption of the posterior teeth resulting in an anterior open bite. Furthermore of the intrusion maxillary anterior teeth which retain the appliance could exaggerate the problem of an anterior open bite. It also is possible that the one point design for occlusal contact with the lower anterior teeth may create unfavorable mobility of these teeth, or instead the maxillary anterior teeth supporting the appliance could be displaced by the occlusal forces. Furthermore, there is a possibility of a serious life-threatening event owing to the small size of these devices, in which the device may be swallowed; reports of such distressing events have been recorded (**Jokstad et al.,2005**) .



**Figure 1.15 : An anterior bite plane. (Spear, n.d. )**

### **1.8.3 Anterior Repositioning Appliance (Orthopedic Repositioning Appliance)**

The intent of this appliance, is to alter the maxillomandibular relationship so that a more anterior position assumed by the mandible. Acrylic guiding ramp added to the anterior third of the maxillary appliance that direct the mandible into a more forward position, up on closing. This type of appliance designed to be used in treating patients with anterior disk displacement with reduction. It was supposed that by altering the mandibular position in this manner, the anteriorly displaced disks could return back to its normal position (recaptured), to stabilized condyle-disk relationship a new comprehensive dental or surgical occlusal procedures (Türp et al., 2004). With long term use of this appliance, there are permanent and irreversible occlusal. so the anterior bite plane appliance should be used with caution only for short periods of time as a temporary therapeutic measure to relieve internal derangements pain ( Türp et al., 2004).



### **1.8.4 Neuromuscular Appliances (NMA)**

Neuromuscular dentistry (NMD) , ( **Figure 1.16** ) have Advocated that by use of jaw muscle stimulators with jaw-tracking machines to produce an occlusal appliance that is at the ideal vertical and horizontal position of the mandible in relation to the cranium (**Jokstad et al.,2005**) . The data regarding this concept are scarce in the literature. Proponents of this methodology recommended dental reconstruction at the new jaw relationship after using these appliances.



**Figure 1.16 : This neuromuscular orthotic is an anatomical mandibular appliance designed to orthopedically realign the mandible to the cranium . (Chan LVI Neuromuscular Orthotic L, Splints, Mandible Realignment, n.d.)**

### **1.8.5 Posterior Bite Plane Appliance (Mandibular Orthopedic Repositioning Appliances)**

These appliances made to be worn on the lower arch. The design consist of a bilateral hard acrylic resin table, creates a disocclusion of the anterior teeth, located over the mandibular molars and premolars and connect with a lingual metal bar ( **Figure 1.17**). These appliances intended to produce vertical



dimension and horizontal maxillomandibular relationship changes. Moreover, some authors reported that this type of appliance able to enhance athletic performance by increase overall physical strength (**Klasser and Greene, 2009**). however, no scientific evidence to support this claim (**Conti et al.,2006**) . Posterior bite plane appliances were supposed to produce an “ideal” maxillomandibular relationship, and should be followed by occlusal procedures to maintain that relationship permanently. The major concern regarding posterior bite plane design is that occlusion only on posterior teeth that allow overeruption of the anterior teeth or intrusion of the opposing posterior teeth, Eventually lead to a posterior open bite (**Gelb and Gelb, 1991**).



**Figure 1.17 : Posterior Bite Plane Appliance . (TMJ Splints - True Function Laboratory, n.d.)**

### 1.8.6 Pivot Appliances

The pivoting device is fabricated with hard acrylic resin that covers the maxillary or mandibular arch with a single posterior occlusal contact, placed as far posteriorly as possible, in each quadrant ( **Figure 1.18**). These appliances reduce intra-articular pressure by condylar distraction as the mandible fulcrums around the pivot, resulting in an unloading of the articular surfaces of the joint. The pivoting appliance was suggested for patients with internal derangements or with osteoarthritis (**Klasser and Greene, 2009**) .Nevertheless, studies have concluded that there is no distractive effect on the TMJ by occlusal pivots and instead of that can actually lead to compression of the joint (**Seedorf et al., 2007**). A modified version of this appliance with a unilateral pivot placed in the posterior region so that when the mandible close on this pivot this will load the contra lateral joint and slightly distract the ipsilateral joint. Unfortunately, a potential adverse effect with the use of this modified appliance may cause occlusal changes as a posterior open bite in pivot area (**Klasser and Greene, 2009**) .



**Figure 1.18 : posterior pivot . (Dental Articles | Practice Management, Clinical Resources - Spear Education, n.d.)**

### 1.8.7 Hydrostatic Appliance

A bilateral water-filled plastic chamber attached to an acrylic palatal appliance, and the patient's posterior teeth occlude with water filled chambers ( **Figure 1.19**). This appliance originally designed by Lerman (**Lerman, 1974**) . Latter on a modified design, retained under the upper lip, was suggested. The mode of mechanism of this appliance depends on the concept that the mandible finds its ideal position automatically as the appliance was not directing where the jaw should be. No evidence support this claims till now.



**Figure 1.19 : Hydrostatic Appliance . (Vanlioglu et al., 2012)**

## **Chapter two**

### **Summary**

## 2.1 Summary

- The therapeutically designed OVD should be considered a flexible parameter that can be modified to meet the clinical goals established by the dentist and the patient. The alteration of the OVD should be the minimum necessary to harmonize dentofacial esthetics, provide space for the planned restorations, and improve the occlusal relationships. **(Calamita et al.,2019)**
- Both forms of occlusal splints (soft and hard) improved TMJ symptoms in patients with MPD or ID of the TMJ. However, the soft occlusal splints exhibited superior results after 4 months of use. **(Kamble et al., 2012)**
- The Dahl technique used a segmental anterior appliance, which allowed for intrusion of worn maxillary or mandibular anterior teeth, or eruption of maxillary or mandibular posterior teeth. Any of those possibilities creates room to restore the worn anterior teeth, but unfortunately doesn't necessarily position the previously worn teeth where you may want them **(Kashyap, 2012)** . The slight bulkiness of the cingulum areas is initially a mild hindrance to speech and comfort, but this is overcome within 1 to 2 weeks. The potential shortcoming of this technique is the failure of all or some of the posterior teeth to reestablish occlusion. However, Gough and Setchell showed a 96% success rate. **(Cough and Stechell,1999)**
- The overlay removable partial denture is a cost-effective and efficient treatment for loss of occlusal vertical dimension. However, its disadvantages include compromised esthetics and potential maintenance issues associated with acrylic resin fracture and discoloration, poor oral hygiene also increases the risk of caries or periodontal disease. **(Ganddini et al., 2004)**

- Functional complications were more frequent in cases of restorations supported completely by implants. A longer period of adaptive parafunctional activity was reported with these prostheses due to the lack of sensory feedback from the periodontal ligament; consequently, more mechanical complications can occur on implant restorations after an increase in the OVD (**Hsieh et al, 2010**).
- Bite raiser is a valuable tool which helps in minimizing challenges of orthodontic therapy. (**Singh et al., 2021**)
- The use of bite raising appliance in the management of TMJ disorder was found to be satisfactorily effective in alleviation of pain symptom. This nonsurgical treatment modality is greatly helpful for patients presenting with the complaint Temporomandibular dysfunction. (**Datarkar et al., 2016**)

# **Chapter three**

## **Conclusion**

### **3.1 Conclusion**

The evaluation of the concepts and bite raising procedure affirms that OVD is preserved in all situations by the adaptive mechanisms of alveolus, periodontium, TMJ and teeth. Bite rising can be done to rehabilitate an extremely worn dentition with lack of space for restoration and as a temporary symptom reliever in intra-capsular TMJ problems. Any attempt to restore OVD in worn dentition will always result in its increase. Any increase in OVD within

the VDR will get accommodated and a new VDR will get established without any unfavorable symptoms.

There are different types of occlusal appliances, each one has its special design, indication and precautions that should be followed so that clinicians strongly advised to thoroughly understand the masticatory system dynamics and perform a comprehensive examination to the TMJ and its related structures to be able to choose correct appliance perfectly with fewer complications.

## References

(A)

- Abduo, J. and Lyons, K. (2012). Clinical considerations for increasing occlusal vertical dimension: a review. *Australian dental journal*, 57(1), pp.2-10.



- Abduo, J.(2012).Safety of increasing vertical dimension of occlusion: a systematic review. *Quintessence Int* b;43:369–380.
- Abduo, J., Bennani, V., Waddell, N., Lyons, K.,Swain, M. (2010). Assessing the fit of implant fixed prostheses: a critical review. *Int J Oral Maxillofac Implants* 25(3):506-515.
- Abuaffan, A. (2016). D2 Malocclusion with Complete Deep Bite. *Annals of Clinical and Laboratory Research*, 4(2).
- Al Quran, F.A. and Kamal, M.S. (2006). Anterior midline point stop device (AMPS) in the treatment of myogenous TMDs: comparison with the stabilization splint and control group. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 101: 741-747.
- Al-Omiri, M. K., Lamey, P. J., and Clifford, T. (2006) Impact of tooth wear on daily living. *International Journal of Prosthodontics*, 19(6).
- Al-Zarea, B.K. (2012).Tooth surface loss and associated risk factors in northern saudi arabia. *ISRN dentistry*.

## (B)

- Bachhav, V.C. and Aras, M.A. (2010). Altering occlusal vertical dimension in functional and esthetic rehabilitation of severely worn dentition. *J Oral Health Res*, 1(1), pp.2-8.
- Bartlett, D. W., Fares, J., Shirodaria, S., Chiu, K., Ahmad, N., and Sherriff, M. (2011). The association of tooth wear, diet and dietary habits in adults aged 18–30 years old. *Journal of dentistry*, 39(12), 811-816.
- Bartlett, D. W., Fares, J., Shirodaria, S., Chiu, K., Ahmad, N., and Sherriff, M. (2011). The association of tooth wear, diet and dietary habits in adults aged 18–30 years old. *Journal of dentistry*, 39(12), 811-816.
- Basker, R.M., Davenport, J.C. and Tomlin, H.R. (2002). Prosthetic treatment of the edentulous patient. 4th ed. *Blackwell Co* , pp. 32–53.

- Bassiouny, M.A.( 2012). Effect of sweetening agents in acidic beverages on associated erosion lesions. *Gen Dent* 60:322–330.
- Batoni, G., et al. (2001). Effect of removable orthodontic appliances on oral colonisation by mutans streptococci in children. *The European Journal of Oral Sciences* 6: 388-392.
- Bomfim, D. I. (2010). Quality of life of patients with different levels of tooth wear. Master In Science, *Eastman Dental Institute At The University Of London*.
- Briggs, P., Bishop, K. and Kelleher, M. (1996). Management of tooth wear. *British Dental Journal*, 181(4), pp.123–123.
- Burke, F.T. (2014). Information for patients undergoing treatment for toothwear with resin composite restorations placed at an increased occlusal vertical dimension. *Dental Update*, 41(1), pp.28–39.

### (C)

- Calamita, M., Coachman, C., Sesma, N., and Kois, J. (2019). Occlusal vertical dimension: treatment planning decisions and management considerations. *Int J Esthet Dent* 14(2), 166-181.
- Christensen, G.J. (2006).Is now the time to purchase an in-office cad/cam device? *J Am Dent Assoc.*;137(2):235-238.
- Coachman, C., and Calamita, M. (2012). Digital smile design: a tool for treatment planning and communication in esthetic dentistry. *Quintessence Dent Technol*, 35, 103-111.
- Coachman, C., Calamita, M.A. and Sesma, N. (2017).Dynamic documentation of the smile and the 2D/3D Digital Smile Design process. *Int J Periodontics Restorative Dent* 37: 183–193.
- Conti, P. C. R., dos Santos, C. N., Kogawa, E. M., Conti, A. C. D. C. F., and de Araujo, C. D. R. P. (2006). The treatment of painful

temporomandibular joint clicking with oral splints: a randomized clinical trial. *The Journal of the American Dental Association*, 137(8), 1108-1114.

- Goldstein, R. E., Curtis Jr, J. W., Farley, B. A., Siranli, S., and Clark, W. A. (2018). Abfraction, abrasion, attrition, and erosion. *Ronald E. Goldstein's Esthetics in Dentistry*, 692-719.

## (D)

- Dahl, B.L., Krogstad, O. and Karlsen, K. (1974).An alternative treatment in cases with advanced localized attrition . *J oral Rehabil* ;2:209-214.
- Datarkar, A., Daware, S. and Dande, R. (2016). Utility of Vacuum Pressed Silicon Sheet as a Bite Raising Appliance in the Management of TMJ Dysfunction Syndrome. *Journal of Maxillofacial and Oral Surgery*, 16(3), pp.342-346.
- Dawson, P.E. (2008) .Functional Occlusion - From TMJ to smile design. 1st ed. *New York: Elsevier Inc* pp. 430–452.
- De Leeuw, R. and Pain, O. (2013) .Guidelines for assessment, diagnosis, and management. (5th ed), *Quintessence Publishing Co, Inc, Chicago*.
- Dentagama.com. n.d.*Michigan Splint*. [online] Available at: <<https://dentagama.com/news/michigan-splint>> [Accessed 30 April 2022].
- Deshpande, R.G. and Mhatre, S. (2010) .TMJ disorders and occlusal splint therapy A Review. *International Journal of Dental Clinics* 2: 22-29.
- Dylina, T.J. (2001).A common-sense approach to splint therapy. *J. Prosthet. Dent* 86:539–545.

## (E)

- Eaton, K. A. (2011) The adult dental health survey 2009. *Primary Dental Care*, (3), 99-100.
- Ergun, G. and Yucel, A.S. (2014). Full-Mouth Rehabilitation of a Patient with Severe Deep Bite: A Clinical Report. *Journal of Prosthodontics*, 23(5), pp.406-411.

### (F)

- Fasbinder, D.J. (2010). Materials for chairside CAD/CAM restorations. *Compend Contin Educ Dent* 31(9):702-4-708-9.
- Fenn, H.R., Liddlelow, K.P., Gimson, A.P. and MacCregor, A.R. (1989). *Clinical Dental prosthetics*. 3rd ed. *Butterworth-Heinemann Ltd*, pp. 290–304.
- Ferro, K. J., Morgano, S. M., Driscoll, C. F., Freilich, M. A., Guckes, A. D., Knoernschild, K. L., ... & Twain, M. (2017) The glossary of prosthodontic terms. *J prosthet dent*, 117(5S), e1-e105.
- Fiorelli, G. and Melsen, B. (1996) .Biomechanics in Orthodontics--On CD-ROM . *American Journal of Orthodontics and Dentofacial Orthopedics*3: 334.
- For.org.n.d.. *Vertical dimension | FOR.org*. [online] Available at: <<https://www.for.org/en/treat/treatment-guidelines/edentulous/diagnostics/clinical-assessment/vertical-dimension>> [Accessed 30 April 2022].
- Fortin, D. and Vargas, M.A. (2000).The spectrum of composites: new techniques and materials. *J Am Dent Assoc* 131:265-30S.

### (G)

- Ganddini, M.R., Al-Mardini, M., Graser, G.N. and Almog, D.(2004) Maxillary and mandibular overlay removable partial dentures for the

restoration of worn teeth. *The Journal of prosthetic dentistry*, 91(3), pp.210-214.

- Gelb, M.L. and Gelb, H. (1991) Gelb appliance: mandibular orthopedic repositioning therapy. *Cranio Clin Int* ,1: 81-98.
- Gopi Chander, N. and Venkat, R.(2011) An Appraisal on Increasing the Occlusal Vertical Dimension in Full Occlusal Rehabilitation and its Outcome. *The Journal of Indian Prosthodontic Society*, 11(2), pp.77-81.
- Gough, M.B. and Setchell, D.J. (1999) A retrospective study of 50 treatments using an appliance to produce localised occlusal space by relative axial tooth movement. *Br Dent J* ,187:134-139.
- Güth, J. F., and Dent, M. (2012). CAD/CAM-generated high-density polymer restorations for the pretreatment of complex cases: a case report. *Quintessence Int*, 43, 457-467.

## (H)

- Harper, R.P.(2000) Indications for altering occlusal vertical dimension. *Quintessence Int* ,31:275–280.
- Hemmings, K.W., Darbar, U.R. and Vaughan, S. (2000) Tooth wear treated with direct composite restorations at an increased vertical dimension: Results at 30 months. *The Journal of Prosthetic Dentistry*, 83(3), pp.287–293.
- Hsieh, W.W., Luke, A., Alster, J. and Weiner, S.( 2010) Sensory discrimination of teeth and implant-supported restorations. *International Journal of Oral & Maxillofacial Implants*, 25(1),pp.146-52.
- Humel, M.M., Takahashi, J.M., Paulillo, L.A., Mesquita, M.F. and Martins, L.R.(2012) Direct restorative treatment of anterior weared teeth after re- establishment of occlusal vertical dimension: a case report. *Gerodontology*, 29(4), pp.299-307.

## (J)

- Jahangiri, L. and Jang, S. (2002) Onlay partial denture technique for assessment of adequate occlusal vertical dimension: a clinical report. *J Prosthet Dent*, 87:1–4.
- Johansson, A. K., Lingström, P., Imfeld, T., and Birkhed, D. (2004). Influence of drinking method on tooth-surface pH in relation to dental erosion. *European journal of oral sciences*, 112(6), 484-489.
- Jokstad, A. and Mo, A., Krogstad, B.S. (2005) Clinical comparison between two different splint designs for temporomandibular disorder therapy. *Acta Odontol Scand*, 63: 218-226.

## (K)

- Kashyap, R. (2012) Modified Dahl's Appliance. *Journal of Advanced Oral Research*, 3.
- Kharbanda, O.P. (2019) *Orthodontics: Diagnosis of and Management of Malocclusion and Dentofacial Deformities-E Book*. Elsevier Health Sciences.
- Klasser, G.D. and Greene, C.S. (2009) Oral appliances in the management of temporomandibular disorders. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* ,107: 212-223
- Kravitz, N.D., et al. (2018). Resin bite turbos. *Journal of Clinical Orthodontics*: JCO9 456-461.

## (L)

- Lerman, M.D. (1974) The hydrostatic appliance: a new approach to treatment of the TMJ pain-dysfunction syndrome. *J Am Dent Assoc*, 89: 1343-1350.

- LeSage, B. (2019). CAD/CAM: Applications for transitional bonding to restore occlusal vertical dimension. *Journal of Esthetic and Restorative Dentistry*, 32(2), pp.132-140.
- LeSage, B.P. (2007) Aesthetic anterior composite restorations: a guide to direct placement. *Dent Clin N Am*, 51(2):359-378.
- Lin, W.S., Harris, B.T., Zandinejad, A. and Morton D. (2014) Use of digital data acquisition and CAD/CAM technology for the fabrication of a fixed complete dental prosthesis on dental implants. *J Prosthet Dent*, 111(1):1-5.
- Littner, D., Perlman-Emodi, A. and Vinocuor E. (2004) Efficacy of treatment with hard and soft occlusal appliance in TMD. *Refuat Hapeh Vehashinayim*, 21(3):52–58. 94.
- Litzemberger, A.P., Hickel, R., Richter, M.J., Mehl, A.C. and Probst, F.A. (2013) Fully automatic CAD design of the occlusal morphology of partial crowns compared to dental technicians' design. *Clin Oral Investig*, 17(2):491-496.
- Lorneparkdental.com .n.d. *Tooth Wear - Causes and Prevention*. [online] Available at: <<https://www.lorneparkdental.com/site/blog-master/2019/04/08/tooth-wear-causes-and-prevention>> [Accessed 30 April 2022].

### (M)

- Magnusson, T., Adiels, A.M., Nilsson, H.L. and Helkimo, M. (2003) Treatment effect on signs and symptoms of temporomandibular disorders-- comparison between stabilisation splint and a new type of splint (NTI). *A pilot study. Swed Dent J*, 28: 11-20.

- Marin, D.O.M., Leite, A.R.P., de Oliveira Junior, N.M., Compagnoni, M.A., Pero, A.C. and Arioli Filho, J.N. (2015) Reestablishment of occlusal vertical dimension in complete denture wearing in two stages. *Case reports in dentistry*, pp.1-5.
- Mays, K.A. (2003). Reestablishing occlusal vertical dimension using a diagnostic treatment prosthesis in the edentulous patient: a clinical report. *Journal of Prosthodontics*, 12(1), pp.30-36.
- Mehta, S., Banerji, S., Millar, B. and Suarez-Feito J. (2012) Current concepts on the management of tooth wear: part 1. Assessment, treatment planning and strategies for the prevention and the passive management of tooth wear. *Brit Dent J*, 212:1; 17-27.
- Mericske-Stern R, Steinlin Schaffner T, Marti P, Geering AH. (1994). Peri-implant mucosal aspects of ITI implants supporting overdentures. A five-year longitudinal study. *Clin Oral Implants Res* 5:9–18.
- Misch, C.E. (2000) Objective vs subjective methods for determining vertical dimension of occlusion. *Quintessence Int*, 31: 280–282.
- Morais, J.A., Heydecke, G., Pawliuk, J., Lund, J.P. and Feine, J.S. (2003) The effects of mandibular two-implant overdentures on nutrition in elderly edentulous individuals. *J Dent Res*, 82:53–58.
- Moreno-Hay, I., Okeson, J.P. (2015) Does altering the occlusal vertical dimension produce temporomandibular disorders? A literature review. *J Oral Rehabil*, 42: 875–882.

### (O)

- Orenstein, N.P., Bidra, A.S., Agar, J.R., Taylor, T.D., Uribe, F. and Little, M.D. (2015). Changes in Lower Facial Height and Facial Esthetics with Incremental Increases in Occlusal Vertical Dimension in Dentate Subjects. *International Journal of Prosthodontics*, 28(4), pp. 363-70.



- Ormianer, Z. and Palty, A. (2009). Altered vertical dimension of occlusion: a comparative retrospective pilot study of tooth-and implant-supported restorations. *International Journal Implants*, 24(3),pp.497-501.

(P)

- Palmer, K.M. (2012) Use of additive dentistry decreases risk by minimizing reduction. *Compend Contin Educ Dent*, 33(5):346-350.
- Patel, M. B., and Bencharit, S. (2009). A treatment protocol for restoring occlusal vertical dimension using an overlay removable partial denture as an alternative to extensive fixed restorations: a clinical report. *The open dentistry journal*, 3, 213.
- Pativetpinyo, D., et al. (2018) Immediate effects of temporary bite-raising with light-cured orthodontic band cement on the electromyographic response of masticatory muscles. *Journal of Applied Oral Science* 26.
- Perioimplantadvisory.com. n.d.. *Opening vertical dimension: how do you do it?*. [online] Available at: <<https://www.perioimplantadvisory.com/restorative-dentistry/article/16412025/opening-vertical-dimension-how-do-you-do-it>> [Accessed 1 May 2022].
- Poyser, N., Porter, R., Briggs, P., Chana, H. and Kelleher, M. (2005). The Dahl Concept: past, present and future. *British Dental Journal*, 198(11), pp.669-676.
- Prasad, S., Kuracina, J. and Monaco, E.A. (2008) Jr Altering occlusal vertical dimension provisionally with base metal onlays: a clinical report. *J Prosthet Dent* 100:338–342.
- Pro Teeth Guard n.d.. *Hard Night Guard - Heavy Grinding*. [online] Available at: <<https://www.proteethguard.com/custom-night-guard-for-teeth-grinding-hard/>> [Accessed 1 May 2022].
- Proffit, W.R. and Fields, H.W. (2013) Treatment in preadolescent children: what is different. *Contemporary orthodontics*. 5th St. Louis: Mosby Elsevier, 410.

## (R)

- Ramfjord, S. P., & Blankenship, J. R. (1981). Increased occlusal vertical dimension in adult monkeys. *The Journal of Prosthetic Dentistry*, 45(1), 74-83.
- Roy, A. S., Singh, G. K., Tandon, P., & De, N. (2013). An interim bite raiser. *Int J Orthod Milwaukee*, 24(2).

## (S)

- Schlichting, L.H., Resende, T.H., Reis, K.R. and Magne, P. (2016) Simplified treatment of severe dental erosion with ultrathin CAD/CAM composite occlusal veneers and anterior bilaminar veneers. *J Prosthet Dent*, 116:474-482.
- Schuh, C., Skupien, J. A., Pereira-Cenci, T., and Boscato, N. (2014) Five-year of tooth-supported overdenture as prosthetic solution for elderly patients: A case series. *Revista Odonto Ciência*, 29(1).
- Seedorf, H., Scholz, A., Kirsch, I., Fenske, C., and Jüde, H. D. (2007) Pivot appliances—is there a distractive effect on the temporomandibular joint?. *Journal of Oral Rehabilitation*, 34(1), 34-40
- Sensi, L.G., Strassler, H.E. and Webley, W. (2007) Direct composite resins. *Inside Dent* 3:76.
- Singh, G., Gupta, H., Rathi, A., Bisht, D., Goyal, V., Kumar Singh, R. and Dhawan, S.(2021) The Use of Bite Raisers in Orthodontic Treatment - A Review of Literature. *Acta Scientific Dental Sciences*, 5(4), pp.219-228.
- SML. n.d.. *Chan LVI Neuromuscular Orthotic L, Splints, Mandible Realignment*. [online] Available at: <<https://www.smlglobal.com/chan-lvi-neuromuscular-orthotic-l>> [Accessed 1 May 2022].
- Soares, C.J., Pizi, E.C.G., Fonseca, R.B., Martins, L.R.M. and Neto, A.J.F. (2005) Direct restoration of worn maxillary anterior teeth with a

combination of composite resin materials: a case report. *Journal of Esthetic and Restorative Dentistry*, 17(2), pp.85-91.

- Spear, F., n.d.. *Tooth Wear Appliances: Anterior Bite Planes - Spear Education*. [online] Speareducation.com. Available at: <<https://www.speareducation.com/spear-review/2012/08/tooth-wear-appliances-anterior-bite-planes>> [Accessed 1 May 2022].
- Speareducation.com. n.d.. *Dental Articles | Practice Management, Clinical Resources - Spear Education*. [online] Available at: <<https://www.speareducation.com/spear-review?page=213>> [Accessed 1 May 2022].
- Spijker, A.V., Rodriguez, J.M., Kreulen, C.M., Bronkhorst, E.M. and Bartlett D.W.,et al. (2009) Prevalence of tooth wear in adults. *International Journal of Prosthodontics* (1).
- Srivastava, R., Jyoti, B. and Devi, P. (2013) Oral splint for temporomandibular joint disorders with revolutionary fluid system. *Dent Res J (Isfahan)*, 10: 307-313.
- Stumbaum, M., Konec, D., Schweiger, J. and Gernet, W. (2010) Reconstruction of the vertical jaw relation using CAD/CAM. *Int J Comput Dent*, 13(1):9-25.

## (T)

- True Function Laboratory. n.d. TMJ Splints - True Function Laboratory. [online] Available at: <<https://www.truefunction.com/tmj-splints/>> [Accessed 12 May 2022].
- Turner, K. A., & Missirlian, D. M. (1984) Restoration of the extremely worn dentition. *The Journal of prosthetic dentistry*, 52(4), 467-474.

- Türp, J. C., Komine, F., and Hugger, A. (2004) Efficacy of stabilization splints for the management of patients with masticatory muscle pain: a qualitative systematic review. *Clinical oral investigations*, 8(4), 179-195.

### (V)

- Vailati, F. and Carciofo, S. (2016) CAD/CAM monolithic restorations and full-mouth adhesive rehabilitation to restore a patient with a past history of bulimia: the modified three-step technique. *Int J Esthet Dent*, 11(1):36,65.
- Vanlioglu, B., Evren, B., Gözneli, R., Yildiz, C., Özkan, Y. and Gözler, S., 2012. The effect of temporary hydrostatic splint on occlusion with computerized occlusal analysis system. *Indian Journal of Dental Research*, 23(5), p.617.
- Van't Spijker, A., Rodriguez, J. M., Kreulen, C. M., Bronkhorst, E. M., Bartlett, D. W., and Creugers, N. H. (2009). Prevalence of tooth wear in adults. *The International Journal of Prosthodontics*, vol. 22, no. 1, pp. 35–42.
- Verrett, R.G. (2001) Analyzing the etiology of an extremely worn dentition. *J Prosthodont*, 10:224-33.
- Vibhute, P.J., et al. (2006) Temporary bite-raising crowns. *Journal of Clinical Orthodontics*, 40.4:224.
- Vibhute, P.J., Srivastava, S. and Hazarey, P.V. (2006). Temporary bite-raising crowns. *Journal of clinical orthodontics: JCO*, [online] 40(4), pp.224–230; quiz 231. Available at: <https://pubmed.ncbi.nlm.nih.gov/16636436/> [Accessed 30 Jun. 2021].

### (W)

- Westbrook. n.d.. *Soft Night Guard — Westbrook*. [online] Available at: <<https://www.westbrookdentallab.com/soft-night-guard#>> [Accessed 1 May 2022].
- Windchy, A.MI and Morris, J.C. (1998) An alternative treatment with the overlay removable partial denture: a clinical report. *J Prosthet Dent*, 79:249–53.
- Wittneben, J.G., Wright, R.F., Weber, H.P. and Gallucci, G.O.(2009) A systematic review of the clinical performance of CAD/CAM single-tooth restorations. *Int J Prosthodont*, 22(5):466-471.

### (Z)

- Zarb, G.A., Bolender, C.L. and Eckert, S.E. (2004) Prosthodontic treatment for edentulous patients: complete dentures and implant-supported prostheses. *12th ed. St. Louis: Mosby* ,pp. 123–159.