Review Article

EFFECT OF OCCLUSIVE FORCES ON CAVITY AND RESTORATION

Atul Jain [1], Anjali Sharma [2], Rachana Bahuguna [3], Arif Siddiqui [4], Samra Shafique [5], Abbas Ansari [6]

Professor & Head [1] Post Graduate [2,4,5,6] Professor [3]

1,2,6- Department of Conservative Dentistry and Endodontics, Teerthanker Mahaveer Dental College & Research Centre, Moradabad, Uttar Pradesh, India

3- Department of Pedodontics & Preventive Dentistry, Teerthanker Mahaveer Dental College & Research Centre, Moradabad, Uttar Pradesh, India

4- Department of Periodontology and Implantology, Teerthanker Mahaveer Dental College & Research Centre, Moradabad, Uttar Pradesh, India

5- Department of Conservative Dentistry and Endodontics, Rama Dental College, Kanpur, Uttar Pradesh, India

Abstract

Occlusion is the vital need of a successful restoration but unfortunately it is not recorded leading to failed restorations. Occlusion undergoes transformation throughout life. Hence, the force experienced by the tooth is different at every stage of the life. The restoration should be done keeping in mind the occlusal changes that will occur with advancing age. This article is an attempt to discuss occlusive conditions as related to occlusion with changes in occlusion at different stages of life.

Key Words : Occlusion , static occlusion, dynamic occlusion, direct restoration, indirect restoration

INTRODUCTION

Occlusion is one of the most important parameter, to be considered while carrying out restorations. Unfortunately it is not recorded due importance, during the restorative procedure, consequently resulting in failed restorations. The term occlusion stands for the contact of teeth in opposing dental arches when the jaws are closed (static occlusal relationships) and during various jaw movements (dynamic occlusal relationships).[1]

The occlusive process is dynamic, that is, it tends to undergo transformation throughout the lifetime of an individual. [2] Right from the time of eruption of the deciduous teeth, till the loss of last permanent tooth in the oral cavity, occlusion undergoes subtle modification. Hence the restoration carried out at a particular stage, in the individual's life, encounters, changed vector of forces, a few years down the line. As a result of these changed conditions, the margins of the restoration, which might have been adequate, in resisting the challenges of the oral cavity, may fail. [3] Thus keeping in consideration, the present and the probable future changes, in the occlusion as related to the lifespan of the planned restoration assumes importance.

Not only the restorative material but the type of restoration, is guided by the changed occlusal forces, displaying a variety of effects on the planned restoration. Hence considering the stress situation of the tooth to be restored, along with the type of the restoration and material used is paramount. This article is an attempt, to discuss the occlusive conditions as related to a restoration, with the potential changes in occlusion at different age-landmarks of an individual.

Different types of restorations:

Restorations can be classified as direct and indirect. Direct restorations, are the ones carried out entirely within the oral cavity, in a single sitting. Silver amalgam, composite, direct filling gold and glass ionomer cement are generally used. These involve lesser loss of tooth structure, can be completed in single appointment and are economical.[4] These may result in poor marginal fit, do not provide strength to the tooth and less resistant to wear over time. [5]

Indirect restorations, involve step/s outside the oral cavity. They include crowns, bridges, inlays, onlays, veneers, etc. Ceramics, metal alloys and composites are generally used. Advantages of indirect restorations are longevity, good marginal fit, provide strength to the tooth and more resistant to wear over time due to fracture, wear or discoloration. [5] They result in greater tooth structure loss, expensive and cannot be completed in a single appointment. [5]

Occlusion:

The contact between the teeth, when the mouth is closed is known as static occlusion. It includes protrusive occlusion, centric occlusion, right and left lateral occlusion. These relations should be balanced with that of very first simultaneous contact of all the teeth in both the arches. The inclines of the cusp should be such that there should be no interference while gliding of the teeth from centric positions to eccentric occlusion. Also, there should be no introduction of tipping or rotating forces while gliding.

The contact of the teeth when the jaw is moving is known as dynamic occlusion. It is mainly concerned with the opening and closing of the jaws. The tooth contact and the jaw movements are such that the teeth can easily glide over the teeth of the opposite jaw. Free movements are the movements which occur when the teeth are not in contact.

Labially directed force is applied by the tongue, whereas lingually directed force is applied by the cheeks. Hence the buccolingual and the labiolingual forces become equal. This is

known as neutral position. Occlusal contact and the proximal contacts with the adjacent teeth help in maintaining normal alignment of the teeth.

The contacts made when the mandible is moving forward, backward, side wards or at an angle is known as dynamic occlusion. Teeth provide anterior guidance whereas TMJ provides posterior guidance. Types of anterior guidance are canine guidance, group function, working side interference, non working side interference. Canine guidance is good for coping lateral forces. When teeth slide laterally, with multiple opposing teeth in contact on the working side, sharing load equally, it is known as group function.

Stress pattern of teeth

Each tooth has a unique stress distribution pattern. To prevent failure of the restoration, stress distribution pattern of the involved tooth/ teeth needs to be considered while designing the restoration. Stress concentration and stress bearing areas of anterior teeth are-

a) During excursive movements of the mandible, the junction of the clinical root and the clinical crown bear shear stress. It bears tension and shear stress on the loading side and shear and compressive forces on the non loading side.
b) Incisal edge bears shear and tensile forces in case of normal occlusion. In cases of edge to edge occlusion, high compressive forces are faced by the incisal edge. These stresses will be further increased, if these incisor edges are involved in dis-occlusive mechanism.
c) The lingual marginal ridges and the axial angles are subjected to concentrated shear stress. On the loading side compressive stresses are borne and tensile stress on the opposite side.
d) The distal side of the canine bears special stress distribution pattern, compressive loading occurs due to anterior component of force on the junction of anterior and posterior teeth and micro lateral movement of the canine while performing excursive movements.
e) If the canine is the part of the occlusion during mandibular excursion or is the protector of occlusion, it bears concentrated shear stress.
f) The compressive stresses occur on the lingual concavity of upper anteriors. Furthermore, shear and tensile stresses are present during mandibular protrusion. The incisal edges also face the same stress distribution pattern during mandibular protrusion and sometimes at the protrusive border of the mandible.

In posterior teeth, stress concentration and stress bearing areas are following-

a) Shear and compressive stresses are faced by the tooth at axial angles on the functional side where as shear and tensile stresses are faced on the non-functional side.

b) Concentrated compressive stresses are borne by the facial, occlusal, lingual concavity of the tooth especially in the presence of opposite cuspal element in both static and dynamic occlusion.
c) High stress and compressive forces are borne by the tooth at the junction of clinical root and clinical crown during lateral excursion on the contacting side whereas non contacting side bears stress and tension.
d) Compressive stresses are faced by the cusp tips especially on the functional side.
e) Compressive and high tensile stresses are borne by the crossing ridges and the marginal ridges of the tooth.

Forces experienced by teeth:

During mastication and closure, the elevator muscles of the jaw develop the main forces of mastication. The force of mastication while eating foods, such as meat and carrot ranges from 70 – 150 Newton or 16 – 34 lbf.[6] The masticatory forces in some individuals can be as high as 500 – 700 Newton or 110 – 160 lbf. [7] The mechanoreceptors of the periodontal tissues, affect the amount of force experienced by the teeth. So, when the periodontal support decreases, the force threshold of these receptor decreases. This changes the amount of force experienced during biting. This loss of periodontal support systems results in decrease in the sensibility and the control of biting force. The bite force experienced by the patients suffering from temporomandibular disorders is lower as compared to healthy individuals. [8]

Retention form of Restoration:

Frictional retention is affected by 4 factors-

a) The contact area between the tooth and the restorative material. Greater frictional retention is produced with greater surface area. It is directly proportional to surface area prepared, depth, width and length of the walls.
b) Proximity. Frictional retention is increased when restoration comes in close contact with the tooth surface during insertion.
c) Surface involved or opposing walls. Greater frictional retention and more stable restorations are formed, when greater surface area or more opposing walls are prepared.
d) Non Parallelism and parallelism. Greater retention is produced with parallel opposing walls. Irrespective of frictional component of retention, greater locking of the tooth prepared to restorative material is produced with higher divergence of extra coronal walls and higher convergence in intra coronal preparation walls.

To enhance retention following design features are helpful-

a) To prevent proximal displacement of the entire restoration, occlusal dovetail along with lingual and facial self retaining grooves is necessary.
b) In order to prevent proximal displacement of proximal portion of restoration, lingual and facial grooves are incorporated.
c) To prevent occlusal displacement of the restoration, mortise shape is prepared.

Resistance form of Cavity:

To make the tooth more resistant, following features in the cavity design are helpful-

a) Cementum should never be made as a part of the cavity wall. The junction of dentin and cementum is very irregular. So, the cementum should be removed and then the dentin should be smoothened.
b) Any cracks in dentin and enamel should be treated passively while designing restoration otherwise they may act as shear lines and may lead to further spread of the fracture.
c) Planes and floors should be made at right angle to the direction of loading to resist masticatory forces and to avoid shearing stresses.
d) Walls of the preparation should be made parallel to the direction of loading forces in order to avoid shearing stresses.
e) Mortise shape has highest resistance to loading forces. Definite walls and floors should be made with line and point angles to avoid shear stresses.
f) Leaving sufficient tooth structure or increasing the volume of the restoration will decrease development of shear stresses.
g) The outline form should be made such that there should be minimum exposure of the restorative material to occlusal loading to minimize stress.
h) Junction of different parts of the restoration and preparation which may act as fulcra or may act as shear line should be rounded.
i) Flatten pulpal floor resist masticatory forces and avoid splitting of the tooth into buccal and lingual components but this may expose the pulp in deep caries. To avoid this problem, make pulpal floor at 2 different levels. On ideal depth level (1.5mm) and other at the carious cone level.

Factors governing direct or indirect restoration:

The amount of tooth structure loss, position of tooth in the arch, patient's age, economic background of the patient, occlusal forces, aesthetics, preservation of hard structures of teeth, caries index, longevity (wear resistance), oral hygiene, material handling properties, secondary caries, diagnosis, cavity design, patient's preference and treatment time are the factors that govern the decision regarding choice of type and material of restoration.

DISCUSSION

Occlusal forces can be destructive, lead to disruption of the restoration, resulting in fracture. Restorative dentistry, aims to design the cavity and the resultant restoration in a manner that best resists these forces. As and when, the former are not followed, failure of the restoration, along with loss of remaining tooth structure results. Vasudeva and Bogra found increase in the stress concentration at the cervical area, which disrupted the cervical enamel in cases of amalgam restoration at high occlusal loading.[9] Grimaldi & Hood found increase in secondary caries and microleakage, due to formation of intermittent gaps between hard tissues and restoration margins, as a result of increased deformation of the cusps under loading.[10] Vasudeva et al also found decrease in the level of the stress in the absence of a restoration and composites with lower modulus flex with the tooth structure and thereby decreases the chances of bond failure.[9]

Depending upon the type of defect and the amount of remaining tooth structure, type of restoration and the restorative material is selected.[11] Although direct restorations are preferred, they cannot be employed universally. Situations that demand reinforcement of the remaining tooth structure is best achieved with indirect restorations. Kuijs et al found that ceramic, direct and indirect composites provide good fatigue resistance in cases of cusp replacing restorations.[12] Magne and Knezevic found that ceramic restorations have higher fatigue resistance than resin composite restoration.[13] Indirect restorations can be metallic or non – metallic. Situations demanding aesthetics are best restored with ceramics or indirect composites. Tribst et al found that indirect resins with high elastic modulus, concentrate stress in the restoration, generating less strain at the cusps and protecting the tooth.[14] Nandini found that Indirect composites are an esthetic alternative for posterior tooth restorations.[15]

The defects in both anterior and posterior teeth, which are limited in extend should be restored with direct restorations. Earlier, amalgam was the preferred direct restoration for posterior teeth but owing to concerns regarding mercury toxicity, they have been more or less phased out. Composite are the preferred direct restorative materials, in the contemporary restorative setup. Along with being aesthetic, they bind the remaining tooth structure and are resistant to the occlusive forces.[16] Deliperi found that adopting specific curing schemes and layering technique, protects the bonded composite resin from occlusal loading stress and polymerization shrinkage.[17] Soares et al found that better results are obtained in MOD cavities, restored with direct composite resins than indirect composites and ceramics.[18] Soares et al also found that MOD cavities restored with direct resin composite provide better biomechanical performance than the laboratory processed resin and ceramic restorations.[18]

Since the occlusion undergoes modifications, throughout the lifetime, the stress pattern experienced by each tooth, tends to have effect on the restoration, a few years, after their placement. For a restoration to be successful for a lifetime, cavity design and the restorative material used should be carried out keeping these factors in consideration. Sapkota and Gupta found that every tooth has a unique stress pattern, and every location on a tooth has its own stress distribution pattern. In order to prevent restoration from failure, we need to recognize them prior to designing a restoration.[19] Each restoration needs to be retained through either physical or chemical means or a combination of the two. Keeping in view the ideal occlusion, certain design modifications have been suggested, in various studies. Gorucu et al found that floor of the class II cavity, should be slightly wider than the occlusal, to prevent vertical displacement of the restorative material, retention grooves should be made to prevent horizontal displacement of proximal part of the restoration.[20] He also found that in case of maxillary molars, when oblique ridge is not involved, an occlusal dovetail,

prevents displacement of proximal portion of the restoration. Slot cavity can also be prepared, when there is no caries in the occlusal area. This requires, the placement of the retention grooves at the line angles, to prevent horizontal displacement of the restorative material.[20] In cases of mesio-occluso- distal cavity with loss of one or more cusps, retention can be achieved by placement of amalgam pins. In case of class III restoration, ½ mm bevel should be prepared, to improve bonding and sealing. [21] In cases of class III restorations, gingivoaxial groove should be made with bevel on the cavosurface margin to improve retention. [21] In case of class IV cavity, all over bevel should be made to improve retention. [22] In cases of class V amalgam restoration, occluso- pulpal and cervico-pulpal grooves should be made to enhance retention. [23] In cases of composite, ½ mm all over bevel should be prepared to improve sealing and bonding.

The resistance form of the cavity has to be considered as well otherwise the potential of the fracture of the tooth is high. Chun et al found that the fracture resistance of the tooth can be enhanced by preserving the marginal ridge.[28] Shivakumar et al found faulty interrelationship between marginal ridge, contact area, gingival and the embrasure, results in proximal decay.[29] Sharhbaf S found that fracture resistance of the teeth can be preserved by preserving a mesial marginal ridge with thicknesses of 2 mm, 1.5 mm and 1 mm in endodontically-treated, composite restored maxillary premolars.[30] Kantardzic et al found lower stress values of restorative material and dental tissues when palatal cusps were reduced. This cavity design results in better biomechanical behaviour of tooth-restoration complex and it provides long-lasting clinical results.[31] Mondelli RF et al in found that when the premolars are restored with direct composite resin, the cuspal height should be reduced by 2mm to increase the fracture resistance of the tooth.[32] The axiopulpal line angles in case of amalgam restoration should be rounded in order to prevent stress concentration in the restoration. Also the gingival cavosurface margin should be bevelled to remove unsupported enamel that may fracture under mastication, thus leading to gap formation in a critical area. Leinfelder found that "minimal invasion" is better than aggressive design for aesthetic class III restorations.[33]

CONCLUSION

Occlusion should be kept as one of the basic parameters in restorative dentistry, for comprehensive patient care and providing a biologically functional restoration. A restoration becomes the part of the stomathognathic system, after it is placed into the tooth. Hence, the restoration should never disturb the occlusion but it should conform to the existing occlusal plane. For a successful restoration, the forces acting on it need to be understood.

The purpose of the restoration is to maintain the continuity and integrity of the dental arch, during mastication and closure. Therefore, the cavity preparation should be made such that it can resist these stresses, without failure of the restoration. For this, we should understand, how to resist these forces and also the nature of these forces. Both retention and resistance form are essential for a successful restoration.

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Corresponding author
Dr. Anjali Sharma,
Post Graduate
Department of Conservative Dentistry and Endodontics,
Teerthanker Mahaveer Dental College & Research Centre,
Moradabad, Uttar Pradesh, India
Email Id: anjali357512@gmail.com
Contact No. 7017996796

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