Print ISSN: 2321-6379
Online ISSN: 2321-595X

Review Article

Median Mandibular Flexure

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Abstract

Mandibular flexure is a multifactorial phenomenon that occurs instantaneously and concurrently with jaw movements. The mandibular flexure can affect the prognosis and treatment outcome for various dental and implant-related procedures. Therefore, it is very important to take appropriate measures and adopt correct technique that helps negate the flexural movement of the jaw during any prosthetic rehabilitation. Mandibular flexure occurs during unilateral loading and extra strain is transmitted at the bone-implant interface. However, the amount of strain introduced by mandibular flexure alone may not be significant enough to stimulate bone modeling or remodeling.

Key words: Centric relation, Mandibular flexure, Occlusal mounting

INTRODUCTION

Median mandibular flexure (MMF) is a functional elastic deformation characterized by medial convergence of hemimandibles during jaw opening and protrusive movements.

The muscles, ligaments, and tendons attached to mandible exert force on the bone which causes a change in the shape of mandible at different levels of movement of jaws.

The muscles responsible for this event are:
1. Lateral pterygoid: Main muscle responsible
2. Mylohyoid
3. Platysma
4. Superior constrictor of pharynx.

These muscles, being originated medially, pull the mandible medially during different kinds of jaw movement. Since mandible is a "U" shaped bilaterally symmetrical bone, this bending force of muscles during excessive mouth opening and protrusive movement causes stress concentration in symphysis region which in turn changes mandibular arch width. Dental arch width and facial form are important factors for determining success and stability of orthodontic treatment.

Access this article online

www.ijss-sn.com

Month of Submission : 06-2020
Month of Peer Review : 07-2020
Month of Acceptance : 08-2020
Month of Publishing : 08-2020

Three basic types of facial morphology exist; short, average, and long. Those with long faces have excessive vertical facial growth which is usually associated with an anterior open bite, increased sella-nasion mandibular plane angle, increased gonial angle, and increased maxillary/mandibular plane angle. The short face types have reduced vertical growth that is accompanied by a deep overbite, reduced facial heights, and reduced sella-nasion mandibular plane angle. Between the two types lies the average face. The mandible has a property to flex inwards around the mandibular symphysis with a change in shape and decrease in mandibular arch width during opening and protrusion of the mandible. The mandibular deformation may range from a few micrometers to more than 1 mm. The movement occurs because of the contraction of lateral pterygoid muscles that pulls mandibular condyles medially and causes a sagittal movement of the posterior segments.[1]

MMF is the mandibular deformation characterized by the property of mandible to flex inward during opening and protrusion movements of the jaw with a reduction in the width of the mandibular arch. These movements occur in the frontal plane of the mandible and are caused by the contraction of lateral pterygoid muscles. The mandible flexes around the mandibular symphysis with medial pull on the mandibular condyles and sagittal movement of

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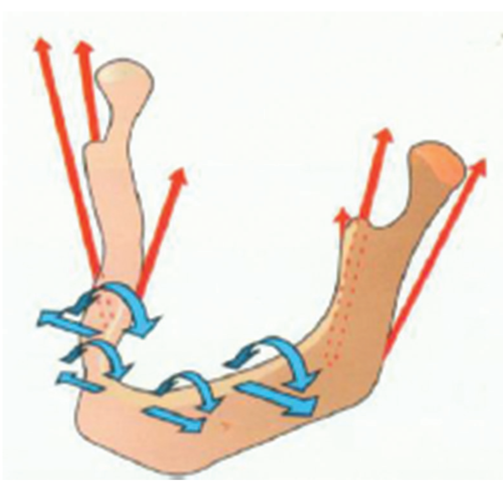
the posterior segments. The deformation of mandible during flexure is so minimal that it is often overlooked and considered to have no practical significance. However, this trivial amount of mandibular deformation has emerged as a significant factor that can influence the prognosis and treatment outcomes for various dental and implant-related procedures.

MMF MECHANISM

The contraction of the two pterygoid muscles: Medial and lateral pterygoid have the same effect where the mandible flexes around the mandibular symphysis with medial pull on the mandibular condyles and sagittal movement of the posterior segments.

Internal pterygoid muscles due to the orientation of its fibers determine the principal vertical direction of mandible displacement (lower fibers insertion on the internal gonion; upper fibers, insertion on the posteroinferior extremity of the maxillary tuberosity and palatine pyramidal process). Furthermore, secondary propulsion and laterality movements are realized. A number of authors consider that rotation of the horizontal mandibular ramus to the midline and the slightly mandibular translation toward the front is due to the pterygoid internal muscles obliqueness (front, from the inside out, and sagittal, from anterior to posterior). The distortion of the mandible occurs early in the opening cycle, and the maximum changes may occur with as little as 28% opening or about 12 mm of mandibular movement.



The mandible being a single bone along with the muscle attached to it is able to perform various complex movements. The medial mandibular flexure (MMF) is a deformation of the mandible resulting from these movements performed during normal physiological functions such as talking and chewing. The muscle action during these movements makes both mandibular rami approach toward each other.

The MMF has become an important aspect in dentistry, especially in the field of conventional and over implants prostheses. When the use of conventional fixed prosthesis was started, as a means of rehabilitating lost teeth, a lot had been studied on this topic. There was a need, in many cases, to extend the metallic structure to regions distally to the mental foramen when the patient did not agree with the rehabilitation through removable dentures.

There are several studies about the possible consequences of bilateral rigid connection with distal extension in conventional prostheses. Some dentists associate MMF with muscle pain, limited mouth opening, absence of prosthesis passivity, bone loss and prosthesis fractures. With the onset of implantology, the replacement of fixed dentures in mandible by implant-supported fixed prostheses became a reality and with it the demand to resolve the problem of medial mandibular flexure.

MMF is a multifactorial phenomenon. The mandible changes its shape through the extended pressure caused by the contraction of various muscles and ligament attachments.

The pull applied by these attached structures not only causes alteration of the shape of mandible with a reduction in arch width but also affects the relative position of the teeth which are located on the mandibular arch. The most important factor causing mandibular deformation is the contraction of external or lateral pterygoid in a frontal plane during opening and protrusion of the mandible. A "U-" or horseshoe-shaped mandible is considered as a curved beam that is subjected to bilateral and unilateral loading. The lateral pterygoid contraction pulls the condyle and condylar neck medially and produces bending torque in the mandible.[2]

According to Hylander, the bending force was exerted mainly by the medial component of force exerted by the obliquely arranged lateral pterygoid symphyseal bone torque by bonding strain gauges to the symphysis of an adult Macaca fascicularis and postulated that the functional contraction of the lateral pterygoid muscle caused a high strain in the symphyseal region and the symphyseal bending occurred by adduction of the mandible during mouth opening.

BASED ON HIS WORK, FOUR PATTERNS OF JAW DEFORMATION DURING MANDIBULAR FLEXURE WERE POSTULATED

Symphyseal Bending

This type of bending is associated with medial convergence or corporal approximation: This type of strain is associated with contraction of the lateral pterygoid muscle during jaw opening movements.[1]

Dorsoventral Shear

This produces a shear force in the sagittal plane [Figures 1 and 2]. It is a result of the vertical components of muscle forces from the lateral pterygoid muscles and the reaction forces at the condyles. The magnitude of the shear force is dependent on the points of application. During symmetrical loading, the amount of shear force is equal on both sides of the mandible; however, during unilateral loading, the amount of deformation differs between the working and balancing sides.[1]

Corporal Rotation

It occurs during rotation of the body of the mandible, usually during the lower stroke of mastication. The resultant force causes the narrowing of the dental arch.[1]

Anteroposterior Shear

It occurs as a result of contraction of the lateral components of the jaw elevating muscles. It occurs late in the power stroke, and the bending moment increases from the posterior to the anterior region.

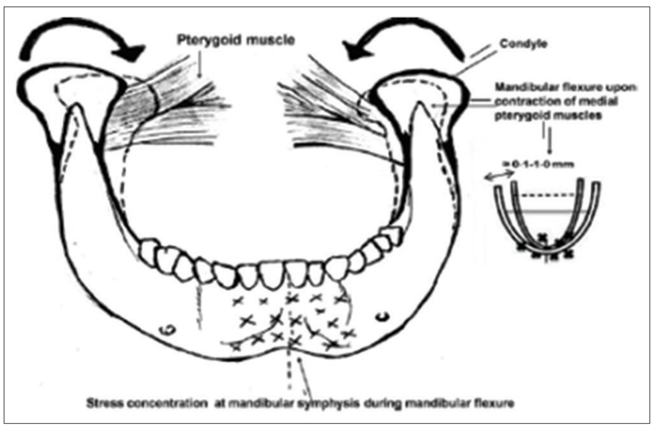


Figure 1: Medical rotation of the mandible and decrease in arch width during mandibular flexure caused by contraction of lateral pterygoid muscle

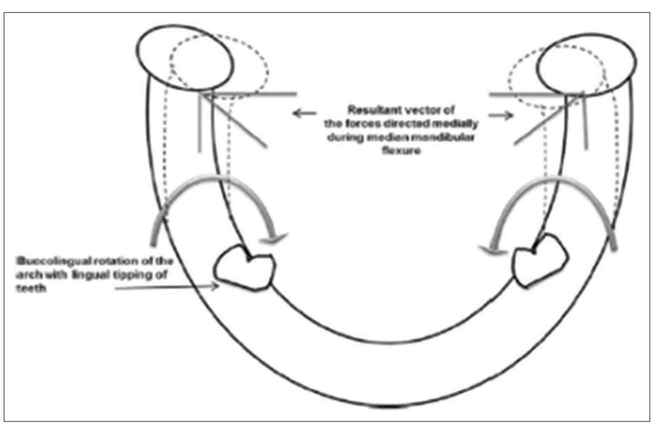


Figure 2: Bucco-lingual tipping of the teeth in lower arch and stress concentration at mandibular symphysis area during mandibular flexure

RELEVANCE OF MMF IN CD PATIENT

Following prosthetic procedures and guidelines should be followed to reduce the effect of MMF:

Considerations in Impression Making

As musculature strongly influences the amount of mouth opening and closure, the effect of MMF cannot be precluded in the impression-making process. Moreover, the changes in mandibular width due to the application of pressure on the rigid bone during various procedures for prosthesis reconstruction cannot be neglected.[3] The strong influence of MMF may lead to inaccurate construction of fixed prostheses and removable prosthesis at the time of placement. The usual tendency is to attribute the misfit of the prostheses to the variability of dental procedures without considering the influence of MMF.

The medial convergence of the mandible due to contraction of the muscles by the conventional open mouth impression technique may alter the accuracy of the master cast and result in compromised prosthesis. Moreover, when impressions are obtained with mandible at a position of maximum mouth opening, the teeth will be recorded in a more lingual position than they would actually be found at rest or in occlusion. If an impression of the lower arch is made in such a position, the removable prosthetic appliance fabricated on the corresponding cast would be physiologically acceptable only when the mouth is open. When the mandible is closed, the denture would not fit the outwardly expanding arch as it was constructed on a constricted arch form. Such an ill-fitting denture applies pressure on teeth and the accommodating structures in the immediate vicinity.

Considerations while Recording Centric Relation (CR)

Mandibular flexure occurring either during patient-guided CR registrations or during function may influence the fit of the prosthesis and make it difficult for the clinician to achieve good occlusal contact.[4] This is further complicated by the use of rigid dental casts mounted within rigid articulators. This often results in severe discrepancies as a closed-mouth CR record may not accurately fit onto a dental cast made from an open mouth impression technique. Second, the framework of a fixed dental prosthesis fabricated on a cast made from an open mouth impression technique would not fit accurately in patients' mouth. Such prosthesis would have occlusal interferences and result in pain when the patient applies a biting force. Therefore, a "closed-mouth" impression technique and a dentist-guided CR recording technique should be used to reduce such discrepancies. Tylmann (2001) supported a closed bite double arch method to avoid mandibular flexure effects with open mouth techniques.

Considerations while Occlusal Mounting

Mandibular flexure in the horizontal plane often results in discrepancies between cusp tip indentations in the jaw registration records and cusp tip location on the dental casts. The articulation of the casts is affected due to the lingual movement of mandibular teeth. This type of occlusal mount will not represent the correct occlusal relationship. The restorations fabricated to such recordings could present with occlusal interferences and articulators may require modification so as to allow for mandibular resilience.

RELEVANCE OF MMF FOR FIXED PARTIAL DENTURE (FPD) PATIENTS

In contrast to the flexure of the mandible, there may be flexure of the FPD framework during function. This may result in the intrusion of teeth. All beams flex as forces are placed on them. As an FPD is placed in function, the framework can flex. As discussed earlier, one of the functions of the PDL is to act as a shock absorber for the teeth. When natural teeth are used as abutments on both ends of a fried partial denture, mandibular flexure and flexure of FPD frameworks do not result in intrusion of teeth. Lack of intrusion can be attributed to the fact that the teeth have PDLs to absorb the forces.

RELEVANCE OF MMF FOR IMPLANT PATIENT

Mandibular flexure potentially affects the accuracy of different stages of implant treatment, including osseointegration of the surrounding bone, implant prosthesis fabrication, strain distribution within the framework during mastication, and crestal bone around implants.[5] The flexural forces cause lateral stresses on the implant body resulting in bone loss around implants, loss of implant fixation, material fracture, and discomfort on mouth opening.

Therefore, it is essential to consider MMF while planning any implant-supported prosthesis. MMF causes microdamage at the crestal region and poor osseointegration due to micromovements around implants. Fischman (1990) explained the importance of rotational aspect of mandible on the osseointegration of implants.[6,7] Hobkirk and Schwab (1991) have also confirmed that the posterior implants could be subjected to stress-induced microdamage at the bone-implant interface in cantilever situations due to mandibular flexure. Relative displacement of up to 420 μ and force transmission of up to 16 N between linker implants with jaw movements is possible during mandibular flexure. The forces were more during the opening and protrusive movements than lateral excursion.

The following procedure should be adopted to reduce the effect of mandibular flexure while placing implants: Impressions should be made with the patient's mouth in a partially closed unstrained mandibular position; short spans of fixed prosthesis are advisable whenever possible; large spans of porcelain should be avoided. At sites where implant size or bone quality is compromised, posterior mandibular osseointegrated implants should be free-standing with a short span of fixed prosthesis or related to tooth abutments through stress breakers. Thus, fixed implants and non-rigid connectors with the splitting of the restorations should be avoided in the mandible as two or more independent prosthesis are more favorable when implants are placed in the anterior region.

CONCLUSION

Mandibular flexure is a multifactorial phenomenon that occurs instantaneously and concurrently with jaw movements. The mandibular flexure can affect the prognosis and treatment outcome for various dental and implant-related procedures. Therefore, it is very important to take appropriate measures and adopt the correct technique that helps negate the flexural movement of the jaw during any prosthetic rehabilitation.

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How to cite this article: Saha A, Raj N, Ajanpeni, Tambolkar R, Bumb P. Median Mandibular Flexure. Int J Sci Stud 2020;8(5):19-22.

Source of Support: Nil, **Conflicts of Interest:** None declared.