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MEDIAN MANDIBULAR FLEXURE" (MMF) AN ENIGMA IN THE PROGNOSIS OF PROSTHODONTIC TREATMENT-A REVIEW

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ABSTRACT

"Median Mandibular Flexure" (MMF) an enigma in the Prosthodontic treatment of full mouth rehabilitation cases, has its tone impact on the prognosis of the prosthesis. MMF could lead to challenging problems with both conventional & implant supported prosthesis by increasing the stresses in prosthesis & abutment. MMF may also contribute for impression distortion, poor fit of fixed & removable prosthesis, pain during function, fracture of screws & implant, loosening of cemented prosthesis & resorption around implants.

The contributing factors for MMF are found to be the action of muscles & ligaments during excessive opening. It is a proven fact that this phenomenon of MMF causes stress concentration in the symphisis region, thereby affecting the otherwise successful prosthodontic treatment. The suggested procedure to overcome this problem is by making impressions in rest position of mandible, using non-rigid connector, and division of prosthesis. Mandibular Flexure is an invisible problem which has to be considered for a better prognosis of the prosthesis.

INTRODUCTION

Median Mandibular Flexure (MMF) an enigma in the Prosthodontic treatment of full mouth rehabilitation cases, has its tone impact on the prognosis of the prosthesis. MMF could lead to challenging problems with both conventional & implant supported prosthesis by increasing the stresses in prosthesis & abutment. MMF may also contribute for impression distortion, poor fit of fixed & removable prosthesis, pain during function, fracture of screws & implant, loosening of cemented prosthesis & resorption around implants.

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REVIEW OF LITERATURE

Anatomy of Mandible & Muscle Attachments

The human skeleton is bilaterally symmetrical. The skull is an expanded and modified cranial end of the axis. Osseocartilagenous sesamoid bones develop in some tendons and ligaments. All these elements are collectively termed the “skeleton”. The mandible is the largest, strongest and lowest bone in the face has a horizontally curved body, convex forwards and two broad rami ascending posteriorly. Mandibular body is ‘u’ shaped, has internal and external surfaces separated by upper and lower borders. Mandibular ramus is quadrilateral with two surfaces, four borders and two processes. Few authors [**1-8]** believe that the muscles involved in the mandibular flexure, apart from Lateral pterygoid and mylohyoid, are the platysma and superior constrictor of pharynx. These muscles play an important role because of their peculiar attachment to the mandible. Lateral pterygoid originate from the pterygoid bones and attach upon the necks of the condyles—in a favorable position to bend the mandible. Mylohyoid originates from the mylohyoid groove on the medial surface of the mandible and insert to each other and to the hyoid bone. Platysma gets itself attached to the inferior surface of the mandible anteriorly and the superior constrictor gets itself attached to the medial surface posteriorly.

Median Mandibular Flexure (MMF) During Opening & Closing of Jaw

[2] stated that “the bending force is exerted mainly by the medial components of force of the obliquely arranged external pterygoid muscles. If the two external pterygoids are forcefully contracted the mandibular condyles are pulled medially and the mandible is measurably deformed." **[3]** made an analysis of arch-width changes, as manifested by differences in cross arch distance on casts of impression made in closed and extreme open positions and demonstrated in vivo reduction of the width of the mandibular arch during forced opening and protrusion.

[4] were in the view that contracting muscles are much the larger agent of pressure, even at weight bearing joints, especially in active movements. Bell in 1956 studied the properties of living bone at macroscopic and microscopic and ultra structural levels especially in relation to mechanical factors. Its intimate blend of hard, inorganic and resilient organic components, resistant almost equally to compression and tensions, differs from most materials used by man, which are usually better in one aspect than the other. **[5]** showed lines of stress at the symphysis caused by squeezing the condyles at the insertion of the external pterygoids. They concluded that the external pterygoids contract in an almost frontal plane during opening and protrusion of the mandible pull the condyles together and this contraction causes flexure, presumably around the mandibular symphysis, with a resultant sagittal movement of the posterior segments. **[6]** used a caliper like device to measure the Mandibular arch width changes between the lingual surfaces of second molars and second bicuspids and found that during opening and closing jaw movements, the muscles of the floor of the mouth and the two lateral pterygoid muscles exert a contracting force upon the mandible, causing a flexure which results in arch width changes.

[7] in his studies has shown a contra lateral tooth movement during chewing and tooth movement during an "open clench exercise" and he suggested that distortion of the mandible would be the cause of such movement between adjacent posterior teeth. **[8]** in their in vivo study proved the reduction of width of the Mandibular arch during forced opening and protrusion and also demonstrated that degree of flexure depends on amount of opening. **[9]** demonstrated changes in Mandibular arch width on diagnostic casts made from compression taken at various openings of the mandible with elastomeric impression materials also found varying tooth positions in relation to the sagittal plane and that a rotational or torquing force also may be present. **[10]** measured Mandibular flexure during jaw movements using intra-oral strain gauges on a bimetallic strip attached between the Mandibular first molars.

Factors Contributing to MMF

1. Physical Properties of Mandible & Musculature

2. Age

3. Bone density

4. Muscle strength

5. Mandible cross section

6. Structure of the cancelous bone

7. Shape of the mandible

[11] found that mandibular flexure occurred around molar and premolar areas also suggested that the amount of flexure might be related to certain physical properties of the mandible and musculature (such as age, bone density and musculature strength) other than size or degree of opening alone. **[12]** have shown in their study that the width of the mandible in is progressively reduced as the mouth opens. They have also shown that the mandible flexure occurs when the mouth opens beyond 28% of maximal mouth opening. **[13]** measured the degree of mandibular flexure during forced opening of the jaws with various fixed splints in place was Significant results indicate that: (1) all splints tested reduce the amount of mandibular flexure; (2) the reduction of measured mandibular flexure cannot be explained solely by tooth movement, rather it is indicative of a limitation of bony flexure by fixed splints; (3) extensive mandibular splints flex during forced opening; and (4) fixed prostheses involving many teeth do not completely inhibit mandibular flexure. Inhibition of mandibular flexure apparently increases as more teeth are splinted and more rigid attachments are used. **[14]** reported that the rigidity of the mandible is dependent on the Mandibular cross section al area, the cortical thickness the structure of the cancellous bone, the properties of the bone and the shape of the jaw. Labiolingual thickness is the most important factor associated with increased resistance to Mandibular flexure. **[15**] reported that flexure of mandible is even present with muscular activity alone and demonstrated that during clenching not only occlusal load is placed on the mandible but also it causes flexure of the mandible. The object of this study was to measure any Mandibular flexure occurring in the horizontal plane, when R.A.P. recordings were made with an 'anterior jig' (Lucia, 1964), chin-point guidance and patient applied muscle force. The rationale for the experimental method was that any arch-width change noted at the tooth level reflected a flexure of the mandible. Ten subjects participated and the mean lateral flexure of the mandible in the horizontal plane was 0.073 +/- 0.028 mm. As a corollary to the study, mean medial flexure of the mandible in wide opening movements was found to be 0.093 +/- 0.044 mm, which was consistent with earlier workers' results. On the basis of the results obtained, restorations constructed to muscle-R.A.P. recordings could conceivably present as occlusal interferences and, indeed, articulators may require modification so as to allow for mandibular resilience. **[16]** in their study drew the following conclusions. The width of the mandible is influenced by intrinsic and extrinsic forces. Maximal opening, protrusion, and biting forces cause the mandible to decrease in arch width. A horizontal retruding force on the mandible for centric relation records caused an increase in arch width. The amount of mandibular arch width change during impression making can be minimized by preventing any protrusive movement and/or opening beyond 20 mm.

Problems Associated with MMF

1. Increased stress in dental prosthesis and abutment

2. Impression distortion

3. Poor fit of the prosthesis

4. Pain during function

5. Fracture of screw and implant

6. Resorption around implant.

[17] used stereoscopic intra-oral radiography in an effort to measure bone loss associated with Osseo-integrated implants that were placed between the mental foramen and supported fixed restorations with posterior cantilevers. More crestal bone loss was found around the anterior than the posterior implants. One possible interpretation is that the main point of flexure restricted by the splint is demonstrating micro damage in the region of the symphysis. **[18]** has demonstrated in his study the existence of a rotational aspect to Mandibular flexure by means of photographic comparisons; also the importance of this movement in relation to anatomic considerations, periodontal therapy, restorative dentistry and implant supported prostheses is discussed. **[19]** found a relative displacement between implants of up to 420 microns and force transmission between linked implants of up to 16 N with jaw movement. They noted that the forces were much less in lateral excursions than in opening and protrusion. The authors reported wide variation between subjects and an increased tendency for relative displacement when implants were widely separated in thin mandibles, especially at the symphyseal area. They suggested that this condition could be implicated in some patterns of implant failure, such as screw loosening. **[20]** has pointed out that when posterior rigid, fixated implants were splinted to each other in a full arch restoration, they were subjected to considerable bucco lingual force on opening due mandibular flexure. Also the flexure introduces lateral stresses to the implants, causing bone loss around implants, loss of implant fixation, material fracture, unretained restorations and discomfort on opening. He concludes that complete cross-arch splinting of posterior molar rigid, fixated implants should be avoided in the mandible and the best option was to use a non-rigid connectors anteriorly or segment the restoration in 2 or more independent prostheses. **[21]** have reported that the mandibular body and the dental arch distort during jaw movements because of contraction of the jaw muscles. In the study the relative position between two-biointegrated implants approx. 10 mm apart was measured during maximum opening and protrusive movements of the jaw using a magnetic sensor system. Mandibular distortion was evaluated as the change in the sensor signal. In all participants the distal implant deviated to the lingual side relative to the mesial implant and the deviation with jaw protrusion was larger than that with opening movement. The linear displacement of the two implants ranged from 8 to 25 microns during maximum opening and from 10 to 37 microns during jaw protrusion. Further investigation is required to establish the mechanism of this mandibular distortion, which may be of relevance to implant therapy.

MMF AS AN SEX INDICATOR

[22] have found that in the skeleton, male and female characteristics lie along a continuum of morphologic configurations and metric values. Size alone is not the best indicator of sex. In contrast, morphologic differences that arise from genetically sex-linked growth and development allow better separation of the sexes. This study presents a new morphologic indicator of sexual dimorphism in the human mandible. A sample of 300 mandibles from adults of known sex primarily from the Dart collection was analyzed. Of these, 100 were found to have obvious bony pathologies and/or excessive tooth loss ("pathologic" sample). Thus, the normative sample consisted of 200 individuals (116 males, 84 females). Examination of morphologic features led to the discovery of a distinct angulation of the posterior border of the mandibular ramus at the level of the occlusal surface of the molars in adult males. Flexure appears to be a male developmental trait because it is only manifest consistently after adolescence. In most females, the posterior border of the ramus retained the straight juvenile shape. If flexure was noted, it was found to occur either at a higher point near the neck of the condyle or lower in association with gonial prominence or eversion. In the normative sample, overall prediction accuracy from ramus shape was 99%. When the "pathologic" sample was analyzed separately, 91.0% were correctly diagnosed. Because the African samples were overwhelmingly black, this trait was also tested on American samples (N = 247) of whites (N = 85), Amerinds (N = 66), and blacks (N = 96) that included a mix of healthy individuals and those with extensive tooth loss and evidence of pathology. The results were nearly identical to those of the "pathologic" African sample, with accuracies ranging from about 91% in whites and blacks to over 92% in Amerinds. Total accuracy for all African and American samples combined (N = 547) is 94.2%. In conclusion, at 99%, sexing from the shape of the ramus of a healthy mandible is on a par with accuracy attainable from a complete pelvis. Moreover, there is no record that any other single morphologic or metric indicator of sex (that has been quantified from the adult skeleton) surpasses the overall accuracy attained from the more representative mixed sample produced by combining all groups assessed in this study. The usefulness of this trait is enhanced by the survivability of the mandible and the fact that preliminary investigations show that the trait is clearly evident in fossil hominids. **[23]** identified a single morphological feature of the mandible, the presence or absence of a distinct flexure or angulation of the posterior margin of the mandibular ramus at the level of the occlusal plane, which appears to be an extraordinarily accurate predictor of sex. Using only this feature, Loth and Henneberg were able to predict sex with 94% accuracy in a large sample of mandibles. In this article, we report the results of a blind test of mandibular ramus flexure as a predictor of sex. In our blind test, only 62.5% of the mandibles were correctly sexed, and virtually identical results were obtained when the same sample of mandibles was examined by a second observer. Overall, our results demonstrate that: 1) the association between ramus flexure and sex is weak; 2) the predictive accuracy of Loth and Henneberg's method is better than chance for only one sex, males; and 3) the method is based on a trait that cannot be reliably or consistently identified. **[24]** assert that they have discovered a single morphologic indicator of sexual dimorphism in the human mandible that rivals the predictive accuracy of the complete pelvis at 94.2% for all samples (99% for healthy samples). To test the accuracy of their method, mandibles (n = 150) from the Tepe Hissar collection were assessed for the presence or absence of mandibular ramus flexure. These results were then compared to a separate sex assessment based on morphologic indicators from the corresponding skull and innominates (where possible) to yield an overall accuracy of only 78.2%. As a means of independent assessment, the mandibular results were also compared with Krogman's ([1940] Racial Types from Tepe Hessar, Iran, from late fifth to early second millennium, BC. Amsterdam: Koninkliijke Nederlandsche Akademie van Wetenschappen) assessment of sex based on craniofacial measurements and morphologic indicators from the skull. This comparison produced an even lower accuracy of 67.2%. Such results question the predictive potential of mandibular ramus flexure as a single indicator of sexual dimorphism and suggest caution when applying this method, especially in the case of fragmentary forensic and fossil remains. **[25**]described as a highly reliable method of sex identification, mandibular ramus flexure is a morphological trait expressed on the posterior border of the ramus at the occlusal plane. In a blind test, 158 mandibles were examined for the presence of flexure as defined by Loth and Henneberg, resulting in 79.1% accuracy, which is well below the reported 91-99% accuracy. Twenty-five of these mandibles were assigned the ambiguous score of 0, an outcome of a +1 score for one side, and a -1 score for the other. Seventeen mandibles were examined twice to measure intraobserver error. Only 64.7% of the scores were duplicated in the second session, suggesting difficulty in consistent identification of flexure. Low overall accuracy, an invalid scoring system, and high intraobserver error indicate that mandibular ramus flexure is an unreliable technique for estimation of sex.

PROCEDURES TO OVERCOME MMF

1. Split prosthesis

2. Non-rigid connectors

3. Distal cantilever

4. Impression making in physiological rest position

5. Using closed bite double arch impression technique.

[26] reported that there is a possible correlation between mandibular flexure and the discomfort experienced by a patient rehabilitated with implant-supported restoration for the mandibular arch during function. The recovery from pain and symptoms was achieved only after splitting the prosthesis into three sections. This case report serves to remind clinicians of the importance of following biological concepts as the key to a successful result.

DISCUSSION

Modern prosthodontics demand of the clinicians more than the technical skills alone. Prosthodontics is considered as one of the modalities of treatment of diseased dental structures not only fitting with the prostheses required but also preventing and elimination of diseases as well as to provide function and comfort to the diseased personalities. In taking view of the above factor, the fitting of the prostheses depends upon mainly 2 phenomena such as Biological and Mechanical.

Biological phenomenon is associated with the configuration of the tissues at the time of recording to its variability during its function, whereas Mechanical phenomenon deals with the structural design of the prostheses. Dental prostheses comprises of rigid to non-rigid materials fitting onto not only rigid structures but also non-rigid resilient tissues. It is considered that fitting of the prostheses on non-rigid areas may be yielding to its optimum level, and also tissue gets adapted to suit the requirements. However the rigid areas do not yield to the extent required for precise fitting of the prostheses. These unyielding areas include not only rigid dental tissues such as teeth but also the bone. The alveolar process of the jawbones is attached with the teeth on which the prostheses are likely to be fitted. However the position of the teeth has to depend on the bone factor to which they are attached. The alveolar bone, which forms the part of the compact jawbones along with the teeth attached move as single component during function. The dynamic function of the jawbones is purely related to the Mandibular area as this bone is attached to the cranium with a movable Tempero-mandibular joint. It has been viewed by many authors that the bone yields to the functional needs of the individual. More than that the movement of the mandible is by stretching of the ligaments and tendons along the muscular spindles change its position to suit for the function. The molding and yielding of the, supposed to be, rigid bone takes place even to the application of pressure by tendons and ligaments. There are certain viewers and authors who feel that the very shape of the mandible is like a ‘U’ shaped frame or a bow, which has to be stretched by various attachments of muscles at different places. This makes one to have a tendency to think the ‘U’ shaped frame of Mandible is likely to change its shape through extended pressure by the attachments of the tendons, ligaments and muscles.

The Prosthodontic consideration in such alteration of the shape with the pulling pressure by the associated and attached structures may change the shape, is that this phenomenon can also affect the relative position of the teeth which are attached to the mandible. When Prosthodontic treatment is required an analog of the oral tissues has to be made from the impressions made by opening the mouth. The required amount of opening totally depends on the clinician’s objective requirement. Further it is anatomical situations that the opening and closure is dictated by musculature. It is also frequently noticed that there are pressure spots of the tissue-supported denture in the tissue on which it is supported at the time of fitting or within a short range of duration of service in spite of taking into consideration the accuracy and dimensional stability of the impression and die materials. On occasions it has been found that fixed prostheses advised in complete mouth rehabilitation, partial fixed prostheses and also removable cast partial dentures, at the crossing areas of dental arches as difficulty in its accuracy of fit to the supporting teeth. It is usual tendency to interpret that the misfit of the prostheses may be due to variability of dental procedures not with consideration to the altered position of supporting tissues. The procedures or precautions to prevent this problems are by using a split prosthesis using two or three splits to prevent stress concentration in midline, even using a non-rigid connector prevents these stresses. The other method is by making the impressions in stress free method that is in physiological rest position or opening not more than 29 mm.

CONCLUSION

“Median Mandibular Flexure” (MMF) an enigma in the Prosthodontic treatment of full mouth rehabilitation cases, has its tone impact on the prognosis of the prosthesis. MMF could lead to challenging problems with both conventional & implant supported prosthesis by increasing the stresses in prosthesis & abutment. So required modifications has to be made in our treatment planning and techniques for a successful prognosis of the prosthesis and well being of the patient.

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