An analysis of mandibular flexure on mouth opening for dentate subjects – in vivo study

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CERTIFICATE

Certified that this dissertation **"AN ANALYSIS OF MANDIBULAR FLEXURE ON MOUTH OPENING FOR DENTATE SUBJECTS - IN VIVO STUDY"** is the work of **Dr.H. SUNIL SURESH.,** postgraduate student of M.D.S., Branch VI- Prosthodontics, RAGAS Dental College & Hospital, Chennai, during the period of 2002-2005.

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TABLE OF CONTENTS

INTRODUCTION

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. It is with above consideration that a study has been taken up with following objectives in mind:

1. Dimensions of the arch width in closed mouth condition.
2. Dimensions of the arch width in open mouth condition.
3. Alteration of Mandibular arch width during impression making.

REVIEW OF LITERATURE

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[28] 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.

Koch in 1917 has stated that in compression it has large margins of safety for weight bearing and for impact.

Bell et al in 1941 [1] found that the tensile strength of the bone resembles cast iron, but with only a third of its weight, breaking stress being respectively 15.5 and 18 metric tons per square inch; about 2400 to 3000 kg per cm square. In flexibility bone resembles steel more than iron, but only has half the strength of steel.

Bell et al in 1941, Williams and Svensson in 1968 [1] 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.

DeBrul EL and **Sicher in 1954** [4] 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.

Jung in 1952, 1959 [19] 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.

Weinmann and **Sicher in 1955** [33] 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."

Mc Dowell and **Regli in 1961** [25] 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.

Picton in 1962 [30] 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.

Osborne J and **Tomlin HR in 1964** [28] 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.

Regli and **Kelly in 1967** [30] 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.

Burch.JG and **Borcher.G in 1970** [2] measured Mandibular flexure during jaw movements using intra-oral strain gauges on a bimetallic strip attached between the Mandibular first molars.

Goodkind RJ, Heringlake CB in 1973 [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.

De Marco, T. J, and **Paine, S in 1974** [6] 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.

Bradley Fischman in 1976 [8] 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.

Hylander WH in 1979 [17] 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.

Omar R, Nise MD in 1981 [27] 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.

Gates GN, Nicholls JI in 1981 [10] 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.

Grant AA in 1986 [12] in their study measured two aspects of mandibular movements. Using a small accelerometer, peak peripheral acceleration on opening the mouth was found to average 2.54 +/- 0.4 G.

Average angular velocities for both opening and closing actions were similar at approximately 1.9 rad/s; and the average maximum angular velocities were 4.63 +/- 1.45 rad/s during opening, and 3.24 +/- 1.15 rad/s during closing. Medial distortion of the mandible in the horizontal plane was measured. It was shown that medial approximation of the two halves of the mandible occurs on opening the mouth, protrusion of the tongue, protrusion of the mandible and when medially directed forces are applied to the ramus of the mandible. Divergence of the two sides occurs with laterally directed forces. During speech, complex medial distortion involving divergence and convergence occurs.

Lindquist L, Rockler B, Carlson G, in 1988 [23] 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.

Bradley Fischman in 1990 [9] 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.

Hobkirk JA and Schwab J in 1991 [15] 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.

Korioth TW, Hannam AG in 1994[21] measured localized corpus and dental arch distortions directly on human and animal mandibles suggest complex deformation patterns at other mandibular sites during functional loading. To describe these, they simulated selected static bites on a three-dimensional finite element computer model of the human jaw. Five clenching tasks were modeled: intercuspal position, left group function, left group function plus balancing contact, incisal clenching, and right molar clenching. Under conditions of static equilibrium and within the limitations of the current modeling approach, the human jaw deforms elastically during symmetrical and asymmetrical clenching tasks. This deformation is complex, and includes the rotational distortion of the corpora around their axes. In addition, the jaw also deforms parasagittally and transversely. The degree of distortion depended on each clenching task, with actual deformations being relatively small and ranging from 0.46 mm to 1.06 mm for the tasks modeled when all sites were taken into account. The predicted overall narrowing of the dental arch is consistent with clinical reports in the literature during similar, although not identical, static jaw function. The predicted regional deformations of the upper condylar surfaces imply differential loading at their upper surfaces. Although still constrained to forceful static biting conditions, the simulated mandibular and dental arch distortions should be taken into consideration in the design and testing of prosthetic devices in the lower jaw.

Korioth TW, Hannam AG in 1994[22] suggested differential, functional loading of the mandibular condyles by several human morphologic studies and by animal strain experiments. To describe articular loading and the simultaneous forces on the dental arch, static bites on a three-dimensional finite element model of the human mandible were simulated. Five clenching tasks were modeled: in the intercuspal position; during left lateral group effort; during left lateral group effort with balancing contact; during incisal clenching; and during right molar clenching. The model's predictions confirmed that the human mandibular condyles are load bearing, with greater force magnitudes being transmitted bilaterally during intercuspal and incisal clenching, as well as through the balancing-side articulation during unilateral biting. Differential condylar loading depended on the clenching task. Whereas higher forces were found on the lateral and lateroposterior regions of the condyles during intercuspal clenching, the model predicted higher loads on the medial condylar regions during incisal clenching. The inclusion of a balancing-side occlusal contact seemed to decrease the forces on the balancing-side condyle. Whereas the predicted occlusal reaction forces confirmed the lever action of the mandible, the simulated force gradients along the tooth row suggest a complex bending behavior of the jaw.

Horiuchi M, Ichikawa T, Noda M, Matsumoto N in 1997 [16] 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.

Loth SR, Henneberg M. in 1998 [24] 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.

Donnelly SM, Hens SM, Rogers NL, Schneider KL in 1998 [7] Loth and Henneberg 1996 (Am. J. Phys. Anthropol. 99:473-487) 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.

Misch CE in 1999 [26] 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 to 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.

Haun SJ in 2000 [13] **----** Loth and Henneberg ([1996] Am J Phys Anthropol 99:473-485) 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.

Hill CA in 2000 [14] 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 (Loth and Henneberg [1996] Am. J. Phys. Anthropol. 99:473-485). 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.

De Oliveira RM, Emtiaz S in 2000[5] 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.

Chen DC, Lai YL, Chi LY, Lee SY in 2000[3] in their study documented a decrease in mandibular arch width during forced opening.

This study investigated the mandibular deformation during mouth opening, and searched for contributing factors related to this phenomenon. Sixty-two dental students volunteered for this study. A linear variable differential transducer (LVDT) was cemented on the mandibular first molars to record mandibular deformation during mouth opening. Proposed factors including geometric factors of the mandible such as lower gonial angle, mandibular length, symphyseal width and height were measured from cephalometric analysis. Densitometric analysis was performed to detect symphyseal area and bone density. The changes in width between the mandibular first molars ranged from 20 to 437 micron, which was negatively correlated to the symphyseal width, area, and bone density. Where the lower gonial angle had a positive influence, the arch width changed during mouth opening. A multifactorial model showed a significant correlation between the set of predictor variables (symphyseal area, bone density, and mandibular length) and mandibular deformation.

Tylmann[32] **2001** has also advocated closed mouth impressions (Closed Bite Double Arch Method) for fixed restorations to minimize the effect of physical deformation of the mandible during opening and to enable a precise fit of the restoration.

Lower rigidly connected long span bridges supported by natural abutments or implants sometimes become loose, come off, or fracture after a period of usage. Many reasons have been discussed for these failures. However, few researchers have shown the influence of mandibular elastic deformation on the abutments, although this influence is likely to produce a distortion force between the abutment and prosthesis. **Jiang T, Ai M** study **in 2002** [18] measured the elastic deformation of the human mandibular arch during clenching on pivots by using charge-coupled device (CCD) cameras and an image analyzing system. When the subjects clenched on the canines (unilaterally or bilaterally) or bilateral second molars, no mandibular deformation was found; whereas when the subjects clenched on the unilateral second molars, the mandibular arch on the non-pivot side moved upward and inward and the straight line distances between the right and left measurement points decreased by 0.2 mm. The magnitude of deformation is smaller than the depressible limit of periodontal membrane. This suggests that the influence of mandibular deformation on the connected prosthesis is negligible in the case of the natural root supported long span bridge but should probably be considered in the case of the implant supported bridge.

Kemkes-Grottenthaler A, Lobig F, Stock F. in 2002[20] have found recently, two mandibular traits--ramus flexure and gonial eversion--have come under close scrutiny (Loth & Henneberg 1996, 2000). The present study investigates the reliability of these two traits when each is applied as a single and independent indicator of sex, including the question of repeatability. The investigation was designed to give insights into possible confounding factors such as age and remodeling after tooth loss. Two samples, one of forensic (N = 153) and one of archaeological provenance (N = 80), were examined. The forensic sample was evaluated by a single observer while the archaeological sample was independently scored by three different observers. The results document that age and localized tooth loss seriously reduce the accuracy of these traits. For ramus flexure, male accuracy was only 66%; while female accuracy was even lower (32%). Overall accuracy was 59%. It is believed that the original scoring system devised by Loth and Henneberg (1996) creates an inherent bias in favor of males. For gonial eversion, a similar picture emerged (75.4% for males, 45.2% for females and 69.3% overall accuracy). Furthermore, both indicators are prone to intra- as well as inter-observer bias. While both possess some merit as sex indicators, they show marked functional and adaptive responses and may not be suitable for all samples.

Zarone F, Apicella A, Nicolais L, Aversa R, Sorrentino R in 2003[34] discussed the biomechanical effect of mandibular functional flexure on stress build-up in implant-supported fixed restorations. The relative deformations and stress distributions in six different designs of implant-supported prosthetic systems (six or four implants, with or without distal cantilevers, cross-arch or midline-divided bar into two free-standing bridges) were analyzed by a three-dimensional finite element (FE) model of a human edentulous mandible. A significant amount of stress in the more distal implants and the superstructure at the symphysis arises as a consequence of mandible functional flexure. The analysis of the stress distributions generated by the different restorative patterns suggests that a division of the superstructure at the level of the symphysis significantly restores the natural functional flexure of the mandible.

Paez CY, Barco T, Roushdy S, Andres C. in 2003[29] When an edentulous mandible is restored with 4 or more implants connected by a metal bar and retained with screws, mandibular flexure may cause screw loosening and unnecessary stresses and strains on the prosthesis and implants. Separating the prosthesis at the midline can relieve these stresses and strains. This article describes the separation of a hybrid mandibular denture at the midline.

CONCLUSION

The following conclusions were made from this study:

1. The degree of mandibular flexure during forced opening of the jaws was noticeable in the in vivo study.
2. The width of the mandible decreases during wide mouth opening movements.
3. The mean amount of flexure for

   ‘U’ shaped arch------ 0.1160 mm.

   ‘V’ shaped arch------ 0.1864 mm.
4. The measurement of change for each arch ranged from

   ‘U’ shaped arch------ 0.02 mm- 0.85 mm.

   ‘V’ shaped arch------ 0.01 mm- 1.03 mm.
5. No significant difference in the degree of flexure among gender, age group selected and the different arch configurations of mandibular arch.
6. The minimal and optimal mouth opening of the subjects for whom the prostheses is required for the impression procedures.

SUMMARY

Based on the documented evidences of recent articles, a study has been taken up to measure the amount of flexion of the mandible during mouth opening. To conduct this study, a total number of 40 subjects have been selected. These subjects had full dentition (few missing third molars). All the teeth present in the dental arch has no erosion, attrition, and also periodontally healthy without any mobility present. The 40 subjects selected for the study were in the age group of 20- 25 years, they were further divided into two batches based on the arch

configurations- 20 subjects, 10 males and 10 females with ‘U’ shaped arch and 20 subjects 10 males and 10 females with ‘V’ shaped arch. Mandibular impressions were made for all the subjects and molar bands were fabricated for all in 36 and 46 molar regions and loops were attached to them on the buccal surface. Then the device was made to fit the loop of the molar bands of each subjects. Then the subjects were instructed to open the mouth slowly to the maximal inter- incisal distance (average – 5 cm). The readings were noted at this maximal inter incisal distance. Five trials were made and the mean of the five trials was calculated as the mandibular flexure movement for that patient. Procedure was repeated for all forty subjects and readings were tabulated. The range of flexure for ‘U’ shaped subjects (10 males & 10 females) was 0.02 mm – 0.085mm with a mean value of 0.1160mm and for ‘V’ shaped arch subjects (10 males & 10 females) was 0.01 mm – 1.03mm with a mean value of 0.1864mm.The statistical analysis showed that there was no significant difference among ‘U’ shaped and ‘V’ shaped arches, male and female subjects and among age groups selected. The degree of mandibular flexure was measured in one plane by using this in-vivo study but this does not rule out the existence of flexure in the other two planes.

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