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Evaluation of Change In Mandibular Width During Maximum Mouth Opening and Protrusion

Research Article

Minal Tulsani[1*], Subhabrata Maiti[2], Divya Rupawat[3]

[1] Postgraduate Student, Department of Prosthodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences Saveetha University, Chennai-600077, Tamilnadu, India.
[2] Senior Lecturer, Department of Prosthodontics, Saveetha Dental College And Hospitals, Saveetha Institute Of Medical And Technical Sciences, Saveetha University, Chennai-600077, Tamilnadu, India.
[3] Postgraduate Student, Department of Prosthodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences Saveetha University, Chennai-600077, Tamilnadu, India.

Abstract

Aim: The aim of this study is to measure change in the arch width at relative rest, maximum jaw opening and on protrusion in dentulous patients.
Material And Method: 140 patients were taken in this study. Indelible pencil was used to mark the reference point on the mesiobuccal cusp tip of the mandibular first molar. Digital vernier calliper was used to measure the inter first molar distance between the two marked reference points. Inter mandibular 1 molar distance will be recorded: Group 1: Normal, Group 2: Maximum mouth opening, Group 3: Protrusion. All the collected data was then tabulated and analysed and using SPSS Statistics software for windows, version 20.0. Statistical analysis test used was One way ANOVA and One-way multivariate analysis of variance (one–way MANOVA).
Results: Group 1 had a mean of 43.4262 ± 6.3675 and Group 2 had a mean of 43.0625 ± 6.344 and Group 3 had a mean of 42.4525 ± 6.32135. The mean square difference within Group 1 and Group 2 was 0.174. The values were statistically significant with p value of 0.047. The mean square difference within Group 1 and Group 3 was 0.080. The values were statistically significant with p value of 0.032. Medial Mandibular Flexure had a mean of 0.36375 ± 0.2637 and 0.97375 ± 0.311216 on Maximum mouth Opening (MMF-O) and on Protrusion (MMF-P) respectively.
Conclusion: This study concluded that there is change in the arch width at relative rest, maximum jaw opening and on protrusion. This showed that the median mandibular flexure occurs in significant amounts and can affect the prosthesis fabricated in the mandible, especially complete arch implant supported fixed prosthesis.

Keywords: Mandibular Flexure; Molar; Canine; Bicuspid; Deviation.

Introduction

Median mandibular flexure (MMF) is the mandibular deformation which leads to reduction in mandibular width due to its property to flex inward during wide opening and protrusion of the jaw [1]. In mandibular flexure there is lingual rotation and narrowing of the mandibular arch seen during opening and protrusion [2]. In 1984 Hylander et al., [3] classified the mandibular flexure as: anteroposterior shear, dorsoventral shear, symphyseal bending and corporal rotation. These patterns cause the mandible to flex inwards. These patterns are seen to occur during opening and closing, thus there can be change in inter-mandibular molar distances during maximum opening and closed mouth in all four patterns of mandibular flexure [4]. These movements occur in the frontal plane of the mandible and are caused by contraction of lateral pterygoid muscles [5, 6]. Due to medial pull of mandibular condyles and sagittal pull of the posterior segments, the mandible flexes around the symphysis [7-10]. The amount of

***Corresponding Author**:
Minal Tulsani,
Postgraduate Student, Department of Prosthodontics, Saveetha Dental College And Hospitals, Saveetha Institute Of Medical And Technical Sciences, Saveetha University, Chennai-600077, Tamilnadu, India.
Tel: +919921181287
E-mail: minaltulsani23@gmail.com

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mandibular flexure is more during forced opening compared to the protrusion of the jaw. An *in vivo* study done by Osbourne and Tomalin proved that there is mandibular flexure seen on opening and protrusion and that the degree of this flexure is dependent on the amount of mouth opening or protrusion done. Mandibular flexure can be evaluated using elastomeric impression materials, finite element analysis, strain gauge, transducers, customized callipers, etc [2, 10-12]. Mandibular flexure is important to evaluate as these deformations lead to stress on the bone of the mandible [12]. Distribution of this stress depends on quality and quantity of bone, shape of the mandible, amount of occlusal force, amount of force exerted by muscles. These factors along with gonial angle, mandible length, symphyseal bone width influence mandibular flexion.

The amount of mandibular flexure occurring in dentulous and edentulous mandible might vary. As there is variation in the size of the mandible and bone density in different populations it is difficult to analyse the mechanical properties of the human mandible. Though the amount of mandibular flexure is not known, this mandibular deformation has significant effect on the prognosis and outcome of various dental prosthesis specially tooth implant supported prosthesis or complete arch implant supported prosthesis. MMF can also influence many endodontic and periodontal procedures [7]. MMF is considered most important for implant prosthesis as any increase in occlusal load can lead to implant failure [13, 14]. This increase in stress can lead to bone loss around implant, fracture of dental implant, fracture of abutment screw, porcelain or acrylic chip off, screw loosening, pain in the jaw during mastication, etc. Bone loss around implants due to mandibular flexure was demonstrated by Fischman, which showed that there is comparatively more bone loss seen in anterior implants in complete arch splinted fixed restorations with distal cantilevers. According to this, mandibular flexure has more significant effect on anterior symphyseal region compared to posterior region in complete arch splinted fixed restorations, as these restorations are rigid than tooth and bone, they generate high stress concentrations on the bone and lead to bone loss around implants [15, 16]. Hobkirk and Havthoulas [16] confirmed the necessity of a device to permit dorsoventral shear especially when the mandible is thin in the symphyseal region, due to a mismatch in the torsional rigidity of the mandible and super structure.

Hence, mandibular flexure is seen to have a significant effect on the implant supported complete arch splinted fixed restorations. Previous studies have mainly involved the edentulous mandible for evaluation of the amount of mandibular flexure. The purpose of this study was to measure change in the arch width at relative rest, maximum jaw opening and on protrusion in dentulous patients in South India. The null hypothesis of this study was that there will be no change in arch width at relative rest, maximum jaw opening and on protrusion in dentulous patients.

Material and Method

Setting and Design

The present study is an in vivo, interventional trial involving human subjects. The study was presented before the institutional ethical and scientific review board and permission was obtained. The study protocol conformed to the ethical guidelines prescribed by the WHO and Helsinki declaration. The study was done from January 2020 to March 2020.

Sample size estimation

The sample size was estimated to be 140 patients using G power with inputs fed from a pilot study done with five samples in each group with Type I error of 0.05, test power of 90%, and effect size of 0.8.

250 patients who visited the Department of Prosthodontics, xxx dental college were assessed and 140 patients satisfying the following inclusion and exclusion criteria were selected for the study. Inclusion criteria were age within 20 to 50 years, both male and female, no missing teeth, all teeth completely erupted, second molar present on both sides of mandible, mandibular 1st molar present on both sides, normal occlusion, patients with willingness to participate in the study.

Exclusion criteria were patients undergoing orthodontic treatment done, OSMF patients, fixed partial denture present on any of the mandibular 1st molars, any or both mandibular first molars missing, grossly destructed mandibular first molar, root canal treated first molars at both side of arch, active periodontal disease in mandible, history of maxillofacial surgery, mandibular trauma, musculoskeletal or bone disorders, facial pain, temporomandibular joint pain and disorders, deviation of mandible, myalgias, facial lesions.

Informed consent: The selected subjects were clearly explained about the study protocols and informed consent was obtained from them for participation.

Outcome Measures

Indelible pencil was used to mark the reference point on the mesiobuccal cusp tip of the mandibular first molar. Digital vernier-calliper was used to measure inter first molar distance between the two marked reference points at three different positions of the mandible. Inter mandibular 1 molar distance was recorded at three positions of the mandible which were considered as groups:

Group 1: Normal
Group 2: Maximum mouth opening
Group 3: Protrusion

All the collected data was then tabulated and analyzed and usingSPSS Statistics software for windows, version 20.0. Statistical analysis was done using one way analysis of variance (one-way ANOVA), One-way multivariate analysis of variance (one–way MANOVA) and then Tukey's Honestly Significant Difference (HSD) test for comparison among groups at the 0.05 level of significance.

Results

The patients enrolled in this study had an equal distribution of male and female patients. Group 1 had a mean of 43.4262 ± 6.3675 and Group 2 had a mean of 43.0625 ± 6.344 and Group 3 had a mean of 42.4525 ± 6.32135 (Table 1, Figure 1). The mean square of between Group 1 and Group 2 was 49.926. The val-

ues were statistically significant with p value of 0.047. The mean square of between Group 1 and Group 3 was 46.663. The values were statistically significant with p value of 0.032 (Table 2). One-way multivariate analysis of variance (MANOVA) results for mandibular flexure in maximum mouth open and protrusion has been represented in Table 3. Medial Mandibular Flexure had a mean of 0.36375 ± 0.2637 and 0.97375 ± 0.311216 on Maximum mouth Opening (MMF-O) and on Protrusion (MMF-P) respectively.

Discussion

The results of the present study showed that the molars had the highest mean deviations when the mandible was wide open and in protrusion. There was no deviation seen in between males and females. These results were contradictory to study done by Wolf et al., [5] In his study higher deviation was seen in females when compared to males, this can be due to demographic variation. When deviation was checked at canine, premolar and molar regions, molar showed the highest range of deviation and canine showed lowest level of deviation. These deviation occur in the frontal plane of the mandible and are caused by contraction of pterygoid muscles [5, 6]. There is contraction of medial and lateral pterygoid muscles when the mouth is open widely and when the mandible is moved to do excursive movement. The movement of the mandible to the contralateral side is due to unilateral contraction of pterygoid muscles. And when both side pterygoid muscles are contracted simultaneously the mandible flexes inwards[17].

Few factors from the geometric facial factors have found to have significant effect on the mandibular flexure, hence the influence of the overall geometric factors on mandibular flexure is not known. For example, some in vivo studies observed that the highest values of mandibular deformation occurred in subjects with lower symphysis height [18, 19]. A study done by Chen et al [20], showed that there is comparatively more MMF seen in patients with increased mandibular length, small gonial angle and thin bone in symphysis area. In a study done by Prasad et al, [21] showed medial mandibular flexure on protrusion is maximum in Brachyfacial type and minimum in Dolichofacial type and maximum values of medial mandibular flexure in all 3 groups was seen during maximum mouth opening. Nasby et al., did a study which showed that MMF is more in patients with high angle mandibles.

Burch et al., in 1970 evaluated the amount of mandibular flexure occurring during various jaw activities using strain gauge. Mandible was seen to flex for about 0.6mm during protrusion and 0.4mm during wide opening of mouth [17, 22]. A study done by Zarone et al, [23] showed that the range of medial convergence during opening and protrusive movements, varying between 0.0 and 1.5 mm and 0.1 and 1.5 mm, respectively. In a study done by Alvarez Arenal et al., [24] mandibular flexure varied according to the amount of occlusal force applied. The results showed

Table 1. Table showing mean and standard deviation of all groups.

	Mean	Std. Deviation	Std. Error Mean
Group 1	43.426	6.368	2.251
Group 2	43.063	6.344	2.243
Group 3	42.453	6.323	2.236

Figure 1. Bar graph representing mean of all three groups.

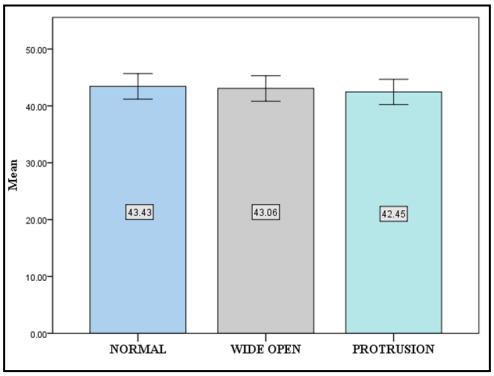

Table 2. One way ANOVA results for mandibular flexure in maximum mouth open and protrusion.

	Dependent Variables	Sum of Squares	df	Mean Square	F	Sig.
Group 1	Group 2	281.556	6	46.926	269.612	.047*
	Group 3	279.795	6	46.633	582.907	.032*

Table 3:One-way multivariate analysis of variance (MANOVA) results for mandibular flexure in maximum mouth open and protrusion.

Effect		Value	F	df	Sig.	Partial Eta Squared
Group 1	Pillai's Trace	0.999	269.612	6	.047*	0.999
	Wilks' Lambda	0.001	269.612	6	.047*	0.999
	Hotelling's Trace	1617.67	269.612	6	.047*	0.999
	Roy's Largest Root	1617.67	269.612	6	.047*	0.999

that mandibular flexure during wide opening ranged from 0.04-0.34mm and condylar convergence during wide opening ranged from 0.18-1.48mm. And mandibular flexure during protrusion ranged from 0.05-0.44mm and condylar convergence during protrusion ranged from 0.2-1.6mm. Various other studies had similar results [25]. A study done by Shinkai et al., [26] showed that MMF while opening ranged between -0.21mm to 0.44mm and MMF during protrusion ranges from 0mm to 0.36mm. The results were almost similar to our study but had some higher range of values. These results were contradictory to results seen by Goodkind et al.[10] According to his study the mean value of deviation ranges from 0.0531 to 0.1092 mm in the molar region, and from 0.0114 to 0.0610 mm. in the area of the first bicuspid region. Similar results were obtained by Omar et al, [2] which showed the mean deviation of 0.093 + 0.044 mm, with a range of 0.012-0.164 mm, was obtained. Osborne and Tomlin research observed that the decrease in the arch at the molar level during the protrusion movement was 0.09 mm [25]. Some studies have shown lateral mandibular flexure instead of medial mandibular flexure [4, 27].

According to Misch, [28] mandibular flexure may be more than 10 to 20 times the movement of a healthy tooth; therefore, it is important in the patient evaluation as much as tooth-implant connections. The amount of mandibular flexure occurring and its impact on the clinical outcome of implant supported complete arch rigid prosthesis is unknown. If the amount of MMF is known then it helps to reduce the mandibular flexure related problems by changing treatment plan, prosthesis design, materials with a high modulus of elasticity as frameworks for complete arch splinted prosthesis [17].

Limitation of our study is that it has been done in limited sample size, study is done in a particular demographic population in a private setting and the procedure used for measurement can be advanced. Hence, further studies can be done in which relation of medial mandibular flexure and implant prosthesis is evaluated by changing treatment plan, prosthesis design, materials with a high modulus of elasticity as frameworks for complete arch splinted prosthesis.

Conclusion

This study concluded that there is change in the arch width at relative rest, maximum jaw opening and on protrusion. This showed that the median mandibular flexure occurs in significant amounts and can affect the prosthesis fabricated in the mandible, especially complete arch implant supported fixed prosthesis. But the actual effect on the implant supported prosthesis is not known. The effect of medial mandibular flexure can be reduced by changing treatment plan, prosthesis design, materials with a high modulus of elasticity as frameworks for complete arch splinted prosthesis. All these changes can increase the survival rate of the prosthesis.

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