A Comparative Evaluation On Mandibular Movements Before And After Prosthodontic Treatment

Dr.Sanjay Nilawar*, Dr.Amrita Pandita, Dr.Vinod Shewale*****

*Professor and Head of Department, **,***Reader, *,**Department of Prosthodontics and Crown and Bridge, Saraswati Dhanwantari Dental College and Hospital and Post-Graduate Research Institute, Parbhani, Maharashtra, India, ***New Horizon Dental College, Bilaspur, India

Abstract: Background**:** The range of movements of mandible in Indian individuals was not studied to set a norm. The changes happening before and after prosthodontic treatment were also not studied. Material and Methods: The study was conducted on normal individuals and then on prothodontically treated individuals .The sample consisted of 160 normal individuals and 80 treated individuals. The normal individuals were divided into four according to age viz, Group I: 21-30yrs, Group II: 31-40yrs, Group III: 41-50 yrs, Group IV: 51-60 yrs. Similarly the treated individuals were divided into four according to type of treatment viz, Group A- Complete dentures, Group B-Removable partial dentures, Group C-Fixed partial dentures, Group D-single crowns. The morphometric and mandibular movement parameters were first measured in normal individuals and then in prosthodontically treated individuals with digital Vernier caliper directly and using putty index. Result and Conclusion: Conclusions drawn from the study are as follows A norm could be formulated both for morphometrics related to mandible and mandibular arch and for mandibular movements. The values obtained are relevant to individuals belonging to Bangalore and nearby areas. Opening and lateral movements can be measured directly in the incisal region using a pair of Vernier calipers. In order to measure the excursive movements in the posterior region and the protrusion in the anterior region, putty indices can be made which is a simple procedure that can be performed in a dental clinic. Prosthodontic treatment in general has a restrictive effect on mandibular movements. This observation has a limitation that the sample size is only 80. Mandibular movements can be reproduced in a computer using the graphic capabilities of coral draw. More precise data could be obtained if the inclusion of the treated individuals were restricted for the age. [Deshpande S NJIRM 2016; 7(4):125-131]

Key Words: mandibular movements, mouth opening and closing

Author for correspondence: Dr.Sanjay Nilawar, Department of Prosthodontics and Crown and Bridge, Saraswati Dhanwantari Dental College and Hospital and Post-Graduate Research Institute, Parbhani, Maharashtra, India
E- mail: nilawarsanjay@gmail.com

Introduction: Mastication requires a harmonious contact between teeth of the opposing arches both in the static phase and in the dynamic phase. Occlusal contact during the dynamic phase is dictated by the mandibular movements and controlled by temporomandibular joints.[1] Both teeth and movements have diagnostic potential that would provide an insight into the hidden realms of the joints. Teeth provide information on the status of oral function through the identification of desired and undesired contacts with reference to time and which is dictated by the mandibular movements.[2] Studies on mandibular movements have a profound history but in its early stages it evolved around the axis of movements and the type of movements. Once the movement pattern was understood, the direction and range of movements gained priority. Nearly five decades ago the border positions and envelope of movements of mandible were identified and attempts were made to record the movements graphically. The theoretical discourses on mandibular movements were soon replaced with exacting studies using high tech gadgets such as jaw tracking devices, sonography, occlusal contact recording. These studies were conducted both in normal and diseased individuals with a view to identify the restrictions experienced.[3,4,5] However numerical values of mandibular movements were rarely documented with a view to formulate a norm. There is no comprehensive documentation to provide insight into the effect of different types of prosthodontic treatment on mandibular movements. These circumstances served as the need of the present study which was designed to be conducted on both normal and prosthodontically treated individuals.

Aims and Objectives: 1.To determine the range of mandibular movements viz, protrusion, working side movement measured at mandibular first molar region both on the right and left sides while performing lateral excursions, non-working movement measured at mandibular first molar region both on the right and left sides while performing lateral excursions, right lateral movement measured in the incisor region, left lateral movement measured in the incisor region, passive opening and active opening in normal individuals and prosthodontically treated individuals.

2.To determine the morphometric values such as intercondylar distance, distance between intercondylar axis and axis connecting mesio incisal angles of the mandibular central incisors, distance between inter condylar axis and axis connecting mesiobuccal cusps of the mandibular molars and inter mandibular molar distance related to mandible and mandibular arch of the normal individuals and prothodontically treated individuals.

Material and Methods: The present study on the mandibular movements and morphometric measurements were conducted in two phases. In the first phase the parameter was evaluated in normal individuals. In the second phase a comparative observation on morphometric measurements and mandibular movements was made on subjects who have undergone prosthodontic treatment. Permission to perform the study was provided by the Institutional Ethics Committee. The sample consisted of 160 normal individuals and 80 treated individuals. The normal inividuals were divided into four groups according to the age viz, Group I; 24-30 years, Group II 31-40 years, Group III: 41-50 years, Group IV-51-60 years. Similarly treated individuals were divided into four according to the type of treatment viz, Group A- Complete Denture, Group B-Removable Partial Denture, Group C- Fixed Partial Denture, Group D- Single crowns.

The following parameters were recorded in normal as well as in prosthodontically treated patients.- 1) Mandibular intercondylar distance measured between outer poles 2) Distance between the intercondylar axis and the axis connecting the mesio buccal cusps of the mandibular first molars. 3) Distance between the intercondylar axis connecting the mesial angles of the mandibular central incisor.4) Distance measured between the mesio buccal cusps of the mandibular first molars. The materials and instrument used are shown in (Fig-1).The subjects were seated in the dental chair in an upright position. Face bow fork [SAM II] with putty impression material was placed on mandibular arch and patient was instructed to close the mouth. After the curing of the impression material, the fork was removed and the excess material extending to the undercut areas were cut off. The fork was then reseated into the mouth and SAM II ear piece face bow was positioned. Now the position of the adjustable arms in relation to the fixed arm of the face bow was marked with an indelible pencil. The assembly is then removed and readjusted to the original dimensions. A 2mm thick straight stainless steel wire was positioned between the ear plugs and the midpoint was marked on it. One stainless steel wire of 0.5 mm diameter was placed over the mandibular first molars connecting the mesiobuccal cusp tips. A similar wire was placed over the mandibular incisors connecting, the mesial angles. The entire assembly was then placed over a graph paper coinciding the inter condylar axis with a bold line. From this, ear plug positions and centralization could be verified. The distance from the axis of the wire fixed over the molars was measured at the centre using the digital Vernier caliper. Similarly, the distance from the axis to the incisor was also measured (Fig-2). From the distance calculated, 13mm was reduced because the intercondylar axis is positioned 13mm anterior to the external auditory meatus. The intermolar distance was then measured between the tips of the mesio buccal cusps, using digital Vernier caliper (Fig-3). Intercondylar distance was measured using the same face bow. Hinge axis points were marked on the skin on the both sides of the face. The points were marked 13mm anterior to the posterior most point of the tragus in the cantho-meatal line and verifying it further by palpation. After repositioning the face bow, intercondylar distance was measured between the ear pieces. The next parameter measured were opening, protrusive movement and lateral excursive movement. Opening:- vertical overlap was measured at the central incisor region using the digital Vernier caliper. A mark was made on the mandibular central incisors in the intercuspal position. Then the subject was instructed to open the mouth and the inter incisal distance was measured (Fig-4). The subject was again asked to open further as far as he could and opening was measured (Fig-5). The measurement of the vertical overlap was added to the measurements obtained on opening and the actual opening was calculated. The former measurement was considered as passive opening and the later as active opening.[6]

Fig 1 and 2: Materials and instruments used and Distance measured between intercondylar axis and the axis connecting the mesial angles of mandibular central incisors.

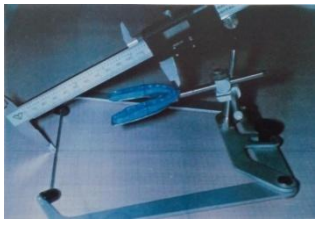


Fig 3: Distance measured between the mesiobuccal cusps of the mandibular first molars.

Fig 4 and 5 : Measuring passive opening and active opening.

Fig 6 and 7 : Extent of protrusion marked on the maxillary tooth with putty index made in incisor region and Distance between the vertical lines being measured

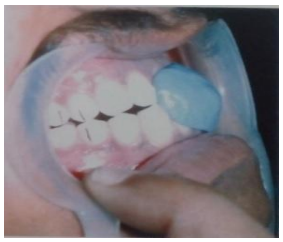
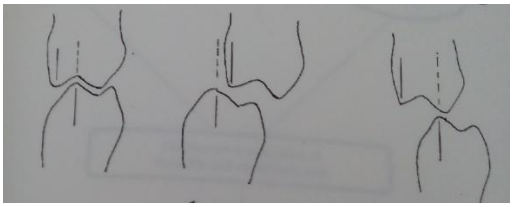


Fig 8: Schematic representation of right side tooth movement during lateral excursions. Intercuspal position. Working side movement. Non-working side movement



Protrusive movement: the subject was instructed to protrude to the maximum and the extent of protrusion was marked on the maxillary tooth against the mark present on the mandibular tooth (Fig-6). After this, silicone putty index was made. A vertical line was then marked with an indelible pencil on the labial surface, 3mm away from the midline. The index was reseated to get the copy of the marking on the inner surface of the index. Along this line index was sectioned vertically. The range of motion was measured between incisal tips. The displacement in the horizontal plane alone was considered for the measurement.

Lateral excursive movement: Subject was instructed to make extreme right and left side movements of the mandible with minimum opening. Vertical lines were marked on maxillary central incisors 3mm away from the midline and this was extended to the mandibular teeth. Then the subject was instructed to make extreme left side movement. Holding on to that position the distance between the vertical lines were measured (Fig- 7). Two measurements were thus obtained and it was averaged to calculate the excursive movement at the incisor region. After this, the lines present on the mandibular incisors were projected to the maxillary teeth in the extreme position. This was used to ascertain the positions during the preparation of the indices. Indices were made on working side and on the non-working side in the first molar region. Silicone putty impression material was placed over the first molar region on both the sides and the subject was instructed to close in maximum intercuspal position. Once the material was cured the indices were removed and the lines were marked on the inner surface to serve as an aid in sectioning indices. Similarly an index was made on the working side when the subject made an extreme movement corresponding to the lines marked previously on the anterior teeth. For the movement an index was made on the non-working side keeping the working side index in position. For these indices also, lines were marked on the maxillary buccal surfaces of molars corresponding to the mesiobuccal cusp tips and were copied on the indices as an aid in sectioning. Similarly indices were made when the subject performed an extreme movement to the other side. The movement of the mandible in horizontal plane was measured between the maxillary and mandibular cusp tips (Fig-8). After this total medio lateral movement of the mandible at lower right and left first molar level was calculated by adding working side movement and non-working side movement. Similarly total mediolateral movement of the mandible at incisor level was also calculated.

Statistical analysis: The values obtained for the different parameters were tabulated for normal as well as prosthodontically treated individuals. Mean and standard deviation values were calculated for different groups and according to the sex distribution. The data were analysed using 'F' test (two way analysis of variance) for comparison between groups and between sexes. For comparing normal and treated individuals student't' test was used.

Results: The values obtained for different parameters were tabulated for normal as well as prosthodontically treated individuals.[7] Table 1 shows the comparison of the morphometric parameters of normal and prosthodontically treated individuals. While considering the intercondylar axis to incisor distance and inter condylar axis to molar distance, the mean values continued to be same among normal and treated individuals.[8,9] However among the treated individuals, the mean intercondylar distance happened to be little higher (118.75mm), than in the normal individuals (116.67mm). Regarding the inter molar distance, there was significant difference, but in this case the mean value of the treated individuals was slightly less(44.62mm) when compared to normal individual group(45.08mm).Table 2 shows the comparison of mean values of mandibular movements obtained from normal and treated individuals. [10,11] In the case of parameters like left non-working side and total mediolateral movement measured at lower left first molar level the mean values showed no significant difference between normal and treated groups.[12] The parameter protrusion showed low mean value of 6.13mm in treated group when compared to 7.6mm in normal group, it was highly statistically significant, (p =< 0.00001).While considering the parameters like right and left working side, right non working side and right and left lateral movement measured in the anterior region showed significantly low mean values in treated group when compared to normal group. Even the mean values obtained for the parameters passive and active opening were slightly low in treated group when compared to the normal group but the difference was significant .[13] The mean values of the parameter total mediolateral movement at lower right first molar region was low 7.69mm in treated group and it was 8.77 mm in normal group and mean values of the parameter total mediolateral movement measured in anterior region was 12.46mm in treated group which was low and it was 14.38mm in normal group. The differences were highly significant. It can be observed that mandibular movements get restricted after prosthodontic treatment.[14]

Table 1: Comparison of the morphometric parameters of normal and prosthodontically treated groups (mm)

Morphometric Parameters	Mean +/-S.D		P value
	Normal (n=160)	Treated (n=80)	
Intercondylar distance	116.67+/-1.22	118.75+/-0.33	P<0.0001
Distance between intercondylar axis and mandibular central incisors	97.10+/-2.19	96.97+/-1.29	P>0.05 (N.S)
Distance between intercondylar axis and the axis connecting mandibular first molars	73.74+/-2.18	73.35+/-1.03	P>0.05 (N.S)
Inter mandibular molar distance	45.08+/-1.18	44.62+/-1.26	P<0.05

Table 2: Comparison of mean values of mandibular movements parameters in normal individual with treated groups (mm)

Mandibular movements measured	Mean+/-S.D		p value
	Normal (n=160)	Treated (n=80)	
Protrusion	7.60+/-0.53	6.13+/-0.31	p<.00001
Working side-Right(1st molar region)	4.38+/-0.61	4.18+/-0.14	p<.00001
Working side-Left(do)	4.34+/-0.13	4.28+/-0.11	p<.05
Non-working side-Right (do)	3.79+/-0.28	3.64+/-0.12	p<.001
Non working side – Left (do)	3.63+/-0.47	3.71+0.08	p>.05 (N.S)
Anterior right lateral movement	7.24+/-0.33	6.18+/-0.21	p<.00001
Anterior left lateral movement	7.18+/-0.50	6.27+/-0.20	p<.0001
Passive opening	38.97+/-0.82	37.98+/-0.74	p<.001
Active opening	51.94+/-0.44	51.26+/-0.73	p<.001
Total medio lateral movement	-	-	-
Lower right first molar region	8.17+/-0.43	7.69+/-0.32	p<.001
Lower left first molar region	7.89+/-0.60	7.79+/-0.16	p>.05 (N.S)
Incisor region	14.38+/-0.78	12.46+/-0.40	p<.00001

Table 3: Normal values obtained from the present study

Intercondylar distance	116.67+/-1.22
Distance between intercondylar axis and mandibular central incisors.	97.10+/-2.19
Distance between intercondylar axis and the axis connecting mandibular first molars	73.74+/-2.18

Intermandibular molar distance	45.08+/-1.18
Protrusion	7.60+/-0.53
Working side movement right(first molar region)	4.38+/-0.61
Working side movement: left (do)	4.34+/-0.13
Non working side movement :right(do)	3.79+/-0.28
Non working side movement: left(do)	3.63+/-0.47
Anterior right lateral movement	7.24+/-0.33
Anterior left lateral movement	7.18+/-0.50
Passive opening	38.97+/-0.82
Active opening	51.94+/-0.44
Total medio lateral movement	-
Lower right first molar region	8.17+/-0.43
Lower left first molar region	7.89+/-0.60
Incisor region	14.38+/-0.78

Morphometric values of the normal individuals and prosthodontically treated individuals were compared. Intercondylar distance and intermolar distance were found to be significantly different in both the groups but numerically the difference is very negligible. The distance measured between the intercondylar axis to the mandibular central incisor and mandibular first molars were not significantly different. The study on movements, it can be observed, was conducted on individuals with similar morphometric parameters.

Discussion: Evaluation of mandibular movements definitely provide an insight into the functioning of TMJ joints, while performing the clinical screening of prosthodontic patients, an operator is very confused to determine the normalcy of function because of the lack of normal values of mandibular movements ascertained for Indian individuals.[15,16,17] Realising the importance and appreciating the reality it was decided to formulate a data pertaining to normal mandibular movements. The present study was designed in this context. The movements were measured in normal individuals as well as in prosthodontically treated patients.160 normal individuals and 80 treated patients formed sample from which the data was generated. The normal individuals were grouped into four according to the age. However an age wise categorization of treated individuals was not made because of limited number of patients who received prosthodontic treatment. The range of movements depended on the size of the jaw as well as the size of the dental arch. Hence a morphometric analysis was also done in the following areas to determine the uniformity of the sample.

1.Intercondylar distance. 2.Distance between intercondylar axis to the axis connecting mesiobuccal cusps of the mandibular first molars. 3.Distance between intercondylar axis to the axis connecting mesioincisal angles of the mandibular central incisors.
4.Inter mandibular-molar distance : The mean value of intercondylar distance measured in normal individuals was 116.67+/- 1.22mm, between the different age groups and between the sexes it was similar and hence this can be considered as a standard value for the individuals who reported to the clinic where the study was conducted. Most of the individuals belonged to Bangalore and hence it can be considered as a norm which can be adopted for the clinical requirements of this city. However in treated individuals it was 118.75+/- 0.33mm, the value is slightly higher but the difference falls within 2mm. The distance between intercondylar axis and mandibular central incisors was 97.1+/-2.19mm in normal individuals and 96.97+/-1.29mm in treated individuals. This distance is similar both in normal and treated individuals. Similarly the distance between intercondylar axis and the axis connecting the mandibular first molars was also similar for normal individuals as well as for the treated individuals.

Intermandibular molar distance was 45.08+/- 1.18mm in normal individuals and 44.62+/- 1.26mm in treated individuals. The difference is less than 1mm. It can be observed that while the intercondylar distance is higher in treated individuals the intermolar distance is higher in normal individuals. In the present study the effect of dimension on the mandibular movements will be marginal and hence it can be considered that the study was conducted on similar individuals. The intercondylar distance measurements obtained in the study are comparable to the values given by Moyers. In that reference the intercondylar distance in males is 120.91+/-6.19 mm and in females it is 117.23+/-5.22mm.The values in males in present study seems to be a little lower. As mentioned earlier mandibular movements were studied under different headings. Both hinge type and translatory movements were included. Direct measurement was done with the Vernier calipers for protrusion and for lateral excursive movements measured at the incisor region. For all other movements indices were made using silicone putty and measurements were done after

appropriately sectioning it. The indices were fairly accurate but it had limitations on the translating side in the molar region because it could not individualise the lateral movement from the forward and downward components. But the possibility of an error creeping into is not significant because this method is designed to be copied in clinical situations, hence the values obtained in this study will have clinical relevance because the values will serve as a norm for comparison. Protrusive movement was measured at the incisor region using two putty indices, one made at intercuspal position and other at maximum protrusive position. In normal individuals males showed higher protrusive value when compared to that of females. No such differences was seen in treated inviduals. While comparing the age groups maximum protrusion was expressed by group III(41-50 yrs) both in males and females. Considering the entire sample protrusion in normal individuals was computed as 7.60+/-0.53mm whereas in treated individuals it was only 6.13+/-0.31 mm. This difference was highly significant when statistical methods were applied. Lateral excursive movements were measured at the first molar region and in the incisor region. In the molar region it was measured on both the left and right side. And in each side it was measured when the molar performed the working function and the non working function.[12] The working side movement in normal individuals was 4.38+/-0.61mm on the right side and 4.34+/-0.13mm on the left side. The non working side movements on the right and left were 3.79+/-0.28mm and 3.63+/-0.47mm respectively. The reduction in values for the non working side is due to the limitations in including the forward and downward components of movements. In treated individuals the working side movement on right and left were 4.18+/- 0.14mm and 4.28+/-0.11mm.The non working side movement on the right and the left were 3.64+/-0.12mm and 3.71+/-0.08mm.

Excepting the non working left side movements all the other values showed a significant reduction in case of treated individuals. Total medio lateral movement was calculated in the first molar region by the addition of working side and non working side movement that have taken place at one site. A reduction in values was seen in treated individuals. The lateral movements measured in the anterior region for the right lateral movements was 7.24+/-0.33mm and for left lateral movement was 7.18+/-0.50mm. In the treated individuals these values have come down to 6.18+/-0.21mm and 6.27+/-0.20mm at a statistically significant level. The total medio lateral movement measured in incisor region was 14.38+/-0.78mm in normal individuals whereas it has significantly reduced in treated individuals expressing the values of 12.46+/-0.40mm. Opening was measured interincisally in order to compute the actual opening. The vertical overlap was first identified and it was added to the opening measured between the maxillary and mandibular incisal tips. Initially the individual was asked to make a passive opening and later to make an active opening within the tolerance limit. The passive opening in normal individuals was 38.97+/-0.82mm and active movement opening was 51.94+/-0.44mm. In prosthodontically treated individuals it was 7.98+/-0.74mm and 51.26+/- 0.73mm respectively. Here also the reduction in opening observed in treated individuals is statistically significant but numerically within 1 mm. Passive opening was marginally more in females but in active opening no such difference was noticed in case of normal individuals. In treated individuals the difference between groups was not significant. Considering the entire study population, opening was slightly less in treated group at a statistically significant level. Numerical values on mandibular movements were provided by Posselt, Roberts and Clark G.T. The values given by Posselt were derived from a graphical representation and hence it was augmented more than the actual values. Clinically we may not be able to make use of those values. The values given by Roberts is based on the data obtained from diseased individuals. Clark has recorded opening of 50.33mm, right lateral excursion of 12.9mm and protrusion of 9.1mm measured in the anterior region. The data was obtained from the subjects belonging to California. As the values were obtained, it was decided to reconstruct mandibular dimensions geometrically and to stimulate the movements using computer graphics making use of coral draw. If the intercondylar distance is measured and the distance from intercondylar axis to mandibular incisors and the intermolar distance are found out, the mandible can be reconstructed and the movements can be simulated as per the norms or as per the measurements obtained from the individuals. In ten percent of the cases the computer graphics was utilized and the translator movements measured in the anterior region and in the posterior region matched with the actual measurements. With this method the mandibular movements can be visualized easily in the clinic with the help of a computer.[18]

Conclusion: From the present study the following conclusions can be drawn .A norm could be formulated both for morphometrics related to mandible and mandibular arch and for mandibular movements. The normal values obtained from the present study are as shown in Table 3. The values obtained are relevant to individuals belonging to Bangalore and nearby areas. Opening and lateral movements can be measured directly in the incisal region using a pair of Vernier calipers. In order to measure the excursive movements in the posterior region and the protrusion in the anterior region, putty indices can be made which is a simple procedure that can be performed in a dental clinic. Prosthodontic treatment in general has a restrictive effect on mandibular movements. This observation has a limitation that the sample size is only 80.Mandibular movements can be reproduced in a computer using the graphic capabilities of coral draw. More precise data could be obtained if the inclusion of the treated individuals were restricted for the age. Exclusion of individuals with first molar restoration would have made the measurements at the posterior regions more precise.

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