Section A -Research paper

In Vivo Study on Dimensional Measurements of lip with Changes in Occlusal Vertical Dimension

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Abstract:

Background: In dentistry, the height at which the mandibular and maxillary teeth occlude is referred to as the "occlusal vertical dimension." To address the restorative requirements of prosthodontic patients, increases in the occlusal vertical dimension are frequently required. However, it is usually difficult to tell whether the occlusal vertical dimension has been lost. Therefore, the first concern must be whether any alteration of the occlusal vertical dimension is restoratively acceptable.

Aim: The goal of the current study was to determine how alterations in the occlusal vertical dimension affected the lip position and lower facial height, which are two dimensions of the lip.

Methodology: Thirty study participants in total—15 men and 15 women—were recruited for the in vivo study at this time in accordance with the stated inclusion and exclusion criteria. The statistical analysis was carried out using the Statistical programme for social sciences, and the data was collected using MS Office Excel (v. 2010). (SPSS v 21.0, IBM). After comparing groups within groups using the Greenhouse-Geisser test, pairwise comparisons were done using Bonferroni-corrected paired t tests.

Results: The study's results revealed that, except at 4mm, the ratio of the upper lip to the lower lip increased as the OVD increased (mm). With increasing OVD, increases in both the lower lip to upper incisal edge and the upper lip to upper incisal edge were seen (mm). The Inter commissural width grew as the mm increased at 0 and 2mm, then reduced from 4mm to 8mm.

Conclusion: The current study advanced our knowledge in the numerous aspects of a lip, enabling us to consider all pertinent criteria before initiating any active treatment for prosthodontic patients.

Keywords: Lip Position, Lower Facial Height, Occlusal Vertical Dimension

Introduction

The vertical dimension that is visible when the mandibular and maxillary teeth occlude is known as the occlusal vertical dimension. The ninth edition of the Glossary of Prosthodontic Terms defines the vertical dimension as the distance between two selected anatomical sites. [1] The abbreviation for it is OVD. Prosthodontic patients may commonly require an increase in occlusal vertical dimension as a result of various restorative procedures. This could happen for cosmetic reasons, because opposing teeth are supra erupted into edentulous areas or because of tooth structural loss that reduces the occlusal vertical dimension. [2] However, determining whether a patient's occlusal vertical dimension has been lost can be difficult. [3] It is essential to think carefully about whether altering the occlusal vertical dimension is necessary for restorative purposes.

In addition to the teeth's correct proportions, the teeth's relationship to the lips and gingiva is an important aspect of an appealing lip. The mid-facial gingival borders of the maxillary front teeth should be where the upper lip rests in a typical lip. The maxillary anterior teeth should also follow the upper lip line. [4,5] The incisal margins of the maxillary anterior teeth should curve after the lower lip. [6] As the vertical dimension of occlusion rises, so does the space between the maxilla and the mandible. The upper and lower lip positions during a lip, as well as the distance between the corners of the mouth, are therefore likely to alter.

According to several studies that have observed the dynamic nature of the dentoalveolar complex and masticatory system, the loss of occlusal vertical dimension is thought to be

caused by tooth wear; however, the original occlusal vertical dimension may be preserved by a dentoalveolar compensatory mechanism involving the extrusion of worn teeth. [6,7,8] Some authors have claimed that the occlusal vertical dimension is constant throughout a person's life and that any alteration will affect the patient's ability to adapt and the physiology of the masticatory system. [9,10]

Increasing the occlusal vertical dimension has been observed to facilitate treatment of patients who presented with generalised and complex dental abnormalities, such as generalised tooth wear and severe occlusal irregularities. [11,12] Regarding the kinds of therapies that can be utilised to raise occlusal vertical dimension, there is still a lot of debate in the literature. An increase in occlusal forces, occlusal vertical dimension, bruxism, and temporomandibular dysfunction have all been associated with hyperactivity of the masticatory muscles (TMDs). Other scholars, however, contend that these symptoms are only transient in nature. Although there is currently a dearth of evidence regarding the ramifications of increasing occlusal vertical dimension, the rehabilitative techniques incorporating it are nevertheless addressed cautiously.

Treatment planning for the best aesthetic outcomes has long been the cornerstone of the prosthodontics community. Numerous research has discussed the concepts of treatment planning to maximise occlusion, function, and aesthetics. [5,6,7] Particularly regarding the cosmetic impacts of changing the occlusal vertical dimension, there is currently a dearth of scientific knowledge. The purpose of the current in vivo investigation was to determine how the occlusal vertical dimension affected measurements of lip size.

Materials and Method

Study Design

An in vivo investigation was undertaken to determine the effect of increasing the occlusal vertical dimension on the dimensions of a lip, including lip position and lower facial height. The study's objective was to explore the clinical concerns associated with increasing the occlusal vertical dimension to reconstruct a patient's dentition using the Inter labial gap height, Inter commissural width, Upper Incisal edge to Upper Lip, and Upper Incisal Edge to Lower Lip.

The armamentarium used in the study includes:

1. Metal stock trays (Colour plate -1)
2. Irreversible hydrocolloid impression (Septodont) (Colour plate -1)
3. Type III dental stone (Kalabhaikal stone) (Colour plate -1)
4. Silicon bite registration (Jetbite,Coltene) (Colour plate -1)
5. Semi Adjustable Articulator, HANAU wide vue (Colour plate -2)
6. Arbitary Hinge Facebow (Colour plate -2)

7. Nikon camera (DSLR 5200),Tripod (Colour plate -3)

8. Colour coded box (Colour plate -4)

9. Patient's lip with splint in place. (Colour plate -5)

10. Wall mounted cephalometric head holding device (Colour plate -6)

Inclusion Criteria

1. 20-30 years of age.
2. Voluntary involvement in the study.
3. No missing anterior teeth.
4. At least 3 teeth in occlusion in both posterior segments.

Exclusion Criteria

1. History of surgery in the facial area
2. History of neurologic disorders
3. Centric occlusion- Centric relation discrepancy >1mm.
4. Inability or unwillingness to lip.
5. Persisting ear infections
6. Allergy to silicone, nitrile, oral ginate
7. History of claustrophobia.

The study subjects were encouraged to participate after a brief description of the investigation. None of the individuals had any neurological or surgical issues affecting the face. One examiner performed the clinical evaluation and the required facial measures.

Methodology

The present study was conducted in two sessions:

SESSION 1: Patients who visited the OPD received a quick oral evaluation to determine whether they were eligible for inclusion or not. The chosen study participants were then informed of the study's goal and given the opportunity to provide signed, informed consent. With the help of CO-CR and chin point guiding, it was possible to count the number of teeth that were occluded. Irreversible hydrocolloid impressions were made using metal stock trays. The impressions were cast using stone of Type III dental. The casts were mounted utilising arbitrary hinge facebow transfers and a semi-adjustable articulator (Hanau wide vue).

Silicone bite registration paste was applied at the maximum intercuspation to aid in the precise placing of the maxillary and mandibular casts, even though it wasn't used during the actual articulation surgery. The vertical spacing between the lines was measured with a digital calliper. This location was utilised to open the articulator by +2 mm, +4 mm, +6 mm, and +8 mm to get the necessary posterior openings. At these openings, silicone bite registration material was injected onto the occlusal surfaces of the first premolar to second molar. These bite registrations were used as bite splints to get the necessary apertures in the occlusal vertical dimension. Bite splints were not produced for 0 mm. Following are the trimming

instructions for the biting splints: The top portion was trimmed to a depth of about 1mm at the tips of the maxillary cusps.

1. The buccal surface of the top portion was trimmed to a depth corresponding to the points of the facial cusps. This allowed teeth to be seen fully embedded in the indentations.

2. The bottom portion was cut to the CEJ of the mandibular teeth. This would add stability to the mandibular teeth's biting splints. Splints were kept in plastic color-coded boxes. Blue- 0mm

(i)Red- 2mm

(ii)Purple- 4mm

(iii)Yellow- 6mm

(iv)Green- 8mm

The "blue" plastic boxes were left unfilled because there were no biting splints created for the 0mm group. Color boxes were used to establish the bite splints' insertion order.

SESSION 2: The Nikon D5200 DSLR camera was used to capture three images of each of the various bite splints. In order to achieve a standard head posture for the patient, a wall-mounted cephalometric head holding apparatus was used. The patient was made to stand up straight while having their head held steadily using earpieces on either side and a nasion plane indicator.

A digital single reflex camera (Nikon D5200) equipped with a macro lens measuring 105mm f/2.8VR was used to gather photographic data. The camera was supported by a tripod. The camera was connected to the PC via a laptop running camera control software (Camera Control Pro 2, Nikon). The camera control software made it possible to view the collected images in real time. During this session, the experiment was run by two operators. The first operator placed the bite splints and altered head positions while the other operator took the photographs (straight from the laptop computer) and looked for any discrepancies in the photographs. If there was an obvious discrepancy in any one set of three pictures, new pictures of all three were taken. Some of the noticeable abnormalities included drooling, head movement, and chuckling.

The study subject's head tilt was then adjusted to this vertical level. The head tilt adjustment was done for each collection of images (5 times for each subject). The NASON relator was utilised. The instructions included telling the subjects to unwind, say "M, M, M," gently seal their mouths over their back teeth, and lip. The lip was then staged and photographed.

Before another photograph was taken, the subjects were taught to say "M, M, M," relax, and lip. This method was repeated to take the third photo. The three photos were compared for any evident discrepancies, the bite splint was altered, and file names were modified. The placement of the bite splints was done in a random order, and the colours (blue, red, yellow,

etc.) were employed in place of vertical apertures to distinguish the various groups. To prevent the subjects from seeing the vertical opening, this was done. The 0mm OVD opening did not have a biting splint put, despite the identical instructions being given. Following the import of the images into Adobe Photoshop (Photoshop CS6, Adobe), the measurements are taken:

1. The height of the interlabial gap, which intersects the middle of the incisal embrasure, is measured vertically.

2. Intercommisural width: The distance between the left and right commisures.

3. Incisal edge-upper lip distance: The vertical distance separating the upper lip's midway from the incisal embrasure's midpoint.

4. Upper Incisal Edge - Lower Lip: The vertical distance between the lower lip's midway and the upper incisal edge.

These distances were measured using pixels. The breadth of the upper incisal edge on the stone model was measured with a digital calliper and recorded in millimetres. This distance was measured three times in order to provide an average measurement of the incisal edge. The average incisal edge measurement in pixels (from 15 images) was divided by the average incisal edge measurement in millimetres to find the conversion ratio for each individual subject. The conversion ratio was used to translate the measurements from pixels to millimeters.

Statistical procedures

Groups have been compared between each other using the Greenhouse-Geisser test, and then within each other using paired t tests with Bonferroni correction. With error rates of 5% and 20%, respectively, and a threshold for statistical significance of P 0.05 applied to all tests, the study had an 80% power. The data was collected using MS Office Excel (v. 2010), and statistical analysis was performed using the Statistical programme for social sciences (SPSS v 21.0, IBM).

A statistically significant difference between the various OVD (mm) was found for the variables Upper Lip to Lower Lip, Lower Lip to upper Incisal edge, and Inter commissural Width (p 0.05). However, it was discovered that there was no significant difference ($p>0.05$) between the various OVDs for the distance from the upper lip to the upper incisal edge.

Results

Apart from 4mm, it was seen that as the OVD (mm) increased, the ratio of the upper to lower lip increased as well. With an increase in OVD, both the distance between the upper and lower lips and their incisal edges increased (mm). The Inter commissural Width increased with increasing mm at 0 and 2 mm, then decreased from 4 mm to 8 mm. (Table 1)

Table 1. Inter Group comparison using the Greenhouse - Geisser test for various facial measurements/OVD in mm

Measurement / OVD	mm	N	Mean	Std. Deviation	Std. Error	p (Greenhouse-Geisser)
Upper Lip to Lower Lip	0	30	8.25	1.848	0.337	
	2	30	8.73	2.141	0.391	
	4	30	8.62	2.188	0.400	0.048*
	6	30	8.97	2.086	0.381	
	8	30	9.77	1.573	0.287	
	Total	150	8.87	2.019	0.165	
Lower Lip to Upper Incisal edge	0	30	5.59	1.636	0.299	
	2	30	5.95	1.530	0.279	
	4	30	6.41	1.501	0.274	0.002*
	6	30	6.72	1.432	0.262	
	8	30	7.05	1.371	0.250	
	Total	150	6.35	1.567	0.128	
Inter commissural Width	0	30	55.97	5.561	1.015	
	2	30	55.63	5.672	1.036	
	4	30	53.87	5.877	1.073	0.015*
	6	30	52.90	6.266	1.144	
	8	30	51.13	7.040	1.285	
	Total	150	53.90	6.285	0.513	
Upper lip to upper incisal edge	0	30	5.81	1.265	0.231	
	2	30	5.92	1.234	0.225	
	4	30	6.12	1.176	0.215	0.217
	6	30	6.24	1.095	0.200	
	8	30	6.46	1.057	0.193	

*** Significant ($p \leq 0.05$)**

 # Non - significant (p > 0.05)

The Greenhouse-Geisser test, the Bonferroni-corrected Paired t test, and pairwise comparison was employed to statistically compare two groups. When comparing the various readings for each variable pair by pair, the subsequent pairs revealed statistical differences. There was a statistical difference (p0.05) between top lip to lower lip distances of 0 mm and 8 mm. Between 0 mm and 8 mm, there was a highly significant difference (p 0.01) in the distance between the lower lip and upper incisal edge, whereas between 0 mm and 6 mm and 2 mm and 8 mm, there was a significant difference (p 0.05). The inter commissural width showed a statistically significant difference (p 0.05) between 0 mm and 8 mm and 2 mm and 8 mm. However, for any of the measurements between the upper lip and upper incisal edge, there was no statistically significant difference (p>0.05). (Table 2)

Table 2: Pair wise comparison using Bonferroni corrected paired t tests

Dependent Variable	(I) groups	(J) groups	Statistical analysis		
			Mean Difference (I-J)	Std. Error	p value
ULLL	0 mm	2	-0.483	0.511	0.879
		4	-0.373	0.511	0.949
		6	-0.727	0.511	0.615
		8	-1.520	0.511	0.028*
	2	4	0.110	0.511	1.000
		6	-0.243	0.511	0.989
		8	-1.037	0.511	0.258
	4	6	-0.353	0.511	0.958
		8	-1.147	0.511	0.170
	6	8	-0.794	0.511	0.531
LLUI	0mm	2	-0.357	0.386	0.888
		4	-0.817	0.386	0.220
		6	-1.127	0.386	0.033*
		8	-1.460	0.386	0.002**
	2	4	-0.460	0.386	0.757
		6	-0.770	0.386	0.275
		8	-1.103	0.386	0.039*
	4	6	-0.310	0.386	0.930
		8	-0.643	0.386	0.459
	6	8	-0.333	0.386	0.910

IW	0 mm	2	0.333	1.577	1.000
		4	2.100	1.577	0.672
		6	3.067	1.577	0.299
		8	4.833	1.577	0.022*
	2	4	1.767	1.577	0.796
		6	2.733	1.577	0.417
		8	4.500	1.577	0.039*
	4	6	0.967	1.577	0.973
		8	2.733	1.577	0.417
	6	8	1.767	1.577	0.796
ULUI	0 mm	2	-0.110	0.302	0.968
		4	-0.310	0.302	0.255
		6	-0.430	0.302	0.051
		8	-0.650	0.302	0.325
	2	4	-0.200	0.302	0.633
		6	-0.320	0.302	0.221
		8	-0.540	0.302	0.125
	4	6	-0.120	0.302	0.952
		8	-0.340	0.302	0.055
	6	8	-0.220	0.302	0.245

Discussion

The vertical component of occlusion and its relevance are essential in oral treatment. One of the most sought-after qualities is currently the patient's pleasant facial look. The desire for a beautiful facial look has recently become widespread among all age groups, not just young individuals. In order to meet the patient's cosmetic requirements and preferences, preserving the right occlusal vertical dimension should be of highest importance. The function, comfort, and appearance of a patient can all be significantly impacted by the loss of occlusal vertical dimension. For dentate individuals, the residual dentition predominantly determines the occlusal vertical dimension. There has been various research on lips and attractiveness in the literature, but most of them relied on still photographs or precise measurements.

Research has been done on the effects of ageing on lip length, maxillary incisor exposure, and inter commissural distance. A wide range of lip factors were examined in further research in connection to age. As we age, the lips undergo several predictable changes that affect the appearance of our teeth. For instance, muscular atrophy contributes to lip lengthening,

decreased lip volume, and loss of lip architecture.

Because the digital single reflex camera's image resolution of 4928 by 3264 pixels provided a more detailed image than a 1920 by 1080-pixel video shot by a recent 1080p camera, photography was chosen for this investigation instead of videography. In contrast, McNamara et al research.'s revealed no statistically significant distinction in lip capture between video and photographic methods. The ease of measurements makes photography technology advantageous. [13] There have been some research on lips and attractiveness in the literature, but most of them relied on still photographs or precise measurements. Gross et al. were among the first researchers to examine how lower facial height and occlusal vertical dimension relate to one another as well as how the models perceived the effects of gradually increasing lower facial height. They found an 8mm change in occlusal vertical dimension and a 4mm change in lower facial height. [14] Comparable results were obtained in the tests conducted by Ushijima M et al. with varied levels of lip support and occlusal vertical dimension. [15]

When someone lips normally, the interproximal gingiva and 75% to 100% of the maxillary anterior teeth are visible, according to Tjan et al. [16] Hulsey CM found that the most attractive subjects had top lips that were level with the gingival border of their upper central incisors. [10]

Ackerman refers to the area between the upper and lower lip as the "display zone." The author cited the teeth and gingival scaffold as components of the lip that are situated in this exhibition zone. The display zone area in the current study was determined using the incremental gap between the top and lower lips. The mean display zone area for the 0 mm occlusal vertical dimension groups was 509 ±190 mm; the substantial standard deviation shows that there is a great deal of variation in display.

zone area amongst individual patients. There was a statistically significant rise with increasing occlusal vertical dimension, even though there was no distinction between the +4mm and +6mm occlusal vertical dimension groups. [17]

A statistically insignificant difference between the upper lip and upper incisal edge at lip was found in the current investigation with increasing occlusal vertical dimension. The aesthetics of a lip are impacted by lip width, which also affects buccal corridor width. This analysis found a substantial shift in inter commissural breadth, upper lip to lower lip distance, and lower lip to upper incisal edge distance with increasing occlusal vertical dimension. From a methodological perspective, the current study enhanced facial aesthetics and broadened its applicability to prosthodontic specialties. There were, however, a few limitations, which were as follows:

1. This study needed measuring points to be put on movable tissues for improved occlusal vertical dimension and mandibular splints to be placed on posterior teeth due to the patients' inclination to tensing face muscles.

2. Because the splints were designed to suit the second molar, they had severe occlusal dimension that required continual tweaking and it hinders patients from smiling normally.

3. The measurements derived from the photograph may not be correct because a patient's lip may change with each splint. Even if each participant was given precise instructions, the results could nevertheless differ.

4. The bulkiness of the silicone occlusal registrations may have adversely affected the lip, and tiny angulation variations may have produced a slight error in the estimated vertical distance.

5. The age range of 20 to 30 years may not fully represent the usual prosthodontic patient given that none of the study subjects displayed any loss of occlusal vertical dimension.

Additional research with bigger sample sizes, more diverse people, and more realistic models is required in order to clearly comprehend the long-term therapeutic consequences of the effect of occlusal vertical dimension on lip positions and lower facial height.

Conclusion

The current study extensively studied the OVD-related alterations in lip position and lower face height. The statistical analysis of the measurements taken at the different attributes in the current study revealed a significant difference for the height of the interlabial gap, the distance from the lower lip to the upper incisal edge, and the width between the commissures for an increase in VDO, but no significant difference was found for the measurements from the upper lip to the upper incisal edge. Since all relevant parameters could be considered before any active intervention, the current study helped researchers better comprehend the numerous facets of a lip, enabling them to provide prosthodontic patients with successful and aesthetically acceptable therapies.

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