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Evaluate the Freeway Space and Velocity of Closure of Mandible in FMR Patients Pre and Post Temporisation

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ABSTRACT

Objective: This clinical study aimed to evaluate changes in freeway space and mandibular closure velocity in patients undergoing full mouth rehabilitation (FMR), before and after the placement of temporisation crowns.

Methods: A total of 25 systematically healthy patients requiring tooth-supported FMR were enrolled. Using a mechanical jaw tracker and computerized mandibular scanner, vertical dimension at rest (VDR), vertical dimension at occlusion (VDO), and mandibular movement velocities were recorded pre- and post-temporisation. Temporisation was performed using Poly Methyl Methacrylate crowns. Freeway space was calculated as the difference between VDR and VDO. Paired t-tests were used to analyze pre- and post-treatment differences.

Results: Post-temporisation, a significant increase in VDO was observed ($p = 0.003$), while VDR showed a non-significant increase ($p = 0.07$). Consequently, freeway space significantly decreased ($p = 0.005$), indicating improved occlusal balance. No significant change was noted in mandibular opening velocity ($p = 0.058$), but closure velocity significantly increased after temporisation ($p = 0.031$), suggesting enhanced neuromuscular coordination during occlusion.

Conclusion: Temporisation in FMR patients leads to significant improvement in occlusal vertical dimension and closure velocity, with a notable reduction in freeway space. These findings underscore the clinical value of temporisation in reestablishing occlusal harmony and optimizing mandibular function during the rehabilitative phase of treatment.

Keywords: *Freeway space, Vertical dimension, Temporisation, Full mouth rehabilitation, Mandibular velocity*

INTRODUCTION

The vertical dimension (VD) is commonly described as the separation between two reference locations used to calculate the rest vertical dimension (RVD) and the VD at occlusion (VDO). Freeway space is the measurement formula used to compare VDO with RVD (FWS) [1]. Silverman has also discovered another way to calculate VDO: the nearest speaking gap, which is approximately 1mm when the patient pronounces the letter S. The majority of clinicians employ FWS, a technique first introduced by Niswonger (1934) [2].

A decrease in VD can be caused by a variety of factors, most frequently physiological or mechanical tooth wear, which can raise FWS and worsen VDO loss-related pain in the TMJ in addition to having an aesthetic effect. Turner (1984) used the available FWS and the quantity of VD loss to quantify the severity of dental wear [3,4]. His three-category classification, which is extensively used to identify and treat inadequate VD, is as follows: Extreme tooth loss with OVD loss falls into Category 1, extreme tooth loss without VDO loss and space availability falls into Category 2, and extreme tooth loss without VD and no space is available falls into Category 3[5].

The main cosmetic factor contributing to the rise in VDO is patient pressure to visit a dentist in order to create a healthy connection between opposing teeth and provide room for the restoration to be seated. Although the exact effect of increasing vertical dimension is yet unknown, numerous research suggest that it may be the cause of TMD [6]. Increased vertical dimension has been linked to severe TMJ pain, according to some recommendations; others describe temporary impacts that should subside in a week or two; still others find no effect from their research. After all this research, the VDO has been raised, but it still depends on the patient's subjective reaction and the various millimeter ranges [7,8].

There are numerous techniques for raising VD. Dahl developed the first technique, which uses Co-Cr appliances that sit on the maxillary arch's palatal surface. This appliance's idea is to extrude posterior teeth and invade anterior teeth in order to increase interocclusal space and provide room for restorations [9]. The successful range of increased vertical dimension between 1.8 and 4.7mm was proposed by Dahl et al. in 1975. For example, Dahl's new idea is to repair the VD by swapping out the detachable equipment for fixed appliances or restoration [10,11].

While several research have been done using other measurements to increase vertical dimension, the majority of them have produced results of ≤ 5mm. According to Remiszewski et al. (2017), there was a negligible rise in facial height when the VDO increased by 3mm [12]. Gough and Setchell planned to use temporary appliances to generate interocclusal space. On the maxillary and mandibular teeth, cemented chrome-cobalt appliances that extend Antero posteriorly were used to treat the majority of their cases [13,14].

Subsequently, Hemmings's case series supported several forms of definitive restorations, or direct composite restorations, to address anterior tooth surface loss. Subsequently, Gow and Hemmings included restorations and indirect definitive appliances [15]. Later on, direct and indirect anterior restorations were used by Redman et al. (2003). Strategies for enhancing VD for various oral and dental part statuses were demonstrated in a retrospective study. Updated studies employ various materials to increase the VD, such as mockups and temporary restorations for varying amounts, to let the patient to adjust with VD [16].

Based on the patient's response to varying increases in millimeters, we have determined that the safest range for adaptation to the altered vertical dimension is up to 6 mm, with an adaptation period of 1-2 weeks. An implant-supported prosthesis may require an additional two to three months for adaption. TMJ pain may manifest during this period, along with additional complications [17]. By using a metal occlusal splint instead of an acrylic one, which encourages less complaints, it is possible to reduce these concerns. Carlsson discovered that, as opposed to elevated VDO, complaints are caused by occlusal splint wear [18,19]. The present aimed to assess the freeway space and velocity of closure of mandible in FMR patients pre and post temporisation.

MATERIALS AND METHODS

This clinical trial was done in the Department of Prosthodontics and Implantlogy in the month of January to June 2023 for patients who visited the outpatient department of a private dental college. The ethical approval from the study was obtained from the Institutional ethical committee. The sample size was calculated from study done by Bedrossian et al [20] with power 95 and alpha error of 5. The sample size was calculated to 25.

The participants criteria included patients who require tooth supported full mouth rehabilitation who were systematically healthy and who have lost their vertical dimension at rest and occlusion has been included in the study. Also the patients with no gross facial asymmetry, with no history of jaw or TMJ surgeries were included. The patients who were partially or completely edentulous, patients with dentures or defnite malocclusion or who were systemically ill were excluded from the study.

The patients were documented before the tooth preparation and subsequently the teeth thats going to be used as abutment for FMR were prepared for all the patients. A jaw tracker device (Bio JT-3D™- Wisconsin, USA) was used to check the vertical dimension at rest (VDR) and vertical dimension at occlusion (VDO) after the tooth preparation. Freeway space was calculated by subtracting VDO from VDR.

A computerized mandibular scanner (K7 Evaluation Software) was used to record 72 diagrams of patients' voluntary mandibular velocity movements (12 for opening and 12 for closing). A number of measures were examined, with a particular emphasis on the maximum velocity records curve. The loop of temporary velocities was found for each movement. After the diagram was loaded into the AutoCAD calculating program, movement analysis was carried out. Movement accelerations (a) and the actual maximum velocity values on opening (Vmax), closing (V0), and average velocity values (Vav) were noted. For each velocity phase, the correlation coefficient values and velocity means were computed.

After the baseline measurements, tooth supported temporary crowns made of Poly Methyl Methacrylate were fit in the tooth abutments with temporary luting cement (Prime Dental Temp-Lute Temporary Crown & Bridge, India). After cementing the temp, again the velocity of mandibular movements, vertical dimension at rest and occlusion were recorded.

The data was recorded and tabulated in Microsoft Excel and analysed in SPSS Software version 24.0. The dimensions were expressed in mean and standard deviation. Paired t test was done to assess the differences the parameters before and after the temp crown restoration with p value less than 0.05.

RESULTS

The present study contains 25 participants who underwent full mouth rehabilitation. The mean age of the participants was depicted as 48.34±18.63. There were 14(56%) males and 11 (44%) females participated in the study (Figure 1).

Results revealed that before placing temporary crown, Vertical Dimension at Rest (VDR) and Vertical Dimension at Occlusion (VDO) both were lower than that of the after placing temporary crown (Figure 2). Paired t test revealed that, in VDO, the post dimension increased significantly increased after the temporisation. In VDR, even though the dimension increased , there was no significant increased and it remained the same post temp crown. Freeway space being the difference between VDO and VDR (Freeway space = VDR - VDO), the leeway space decreased significantly after placing the temporary crown (Table 1).

Paired t test revealed that velocity of mandible during closing and opening before and after placing the crowns. In the opening velocity, before and after velocity did not have a significant difference and it remained the same. Whereas in the closing velocity, the velocity significantly increased after placing the temporary crown (Table 2).

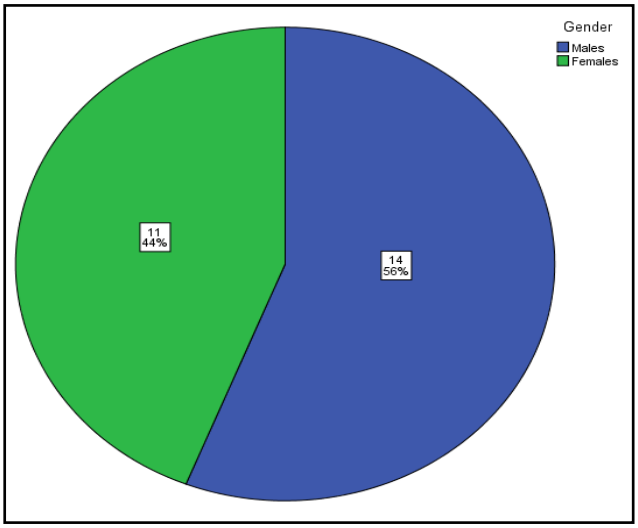

Figure 1 : Gender distribution among the study participants

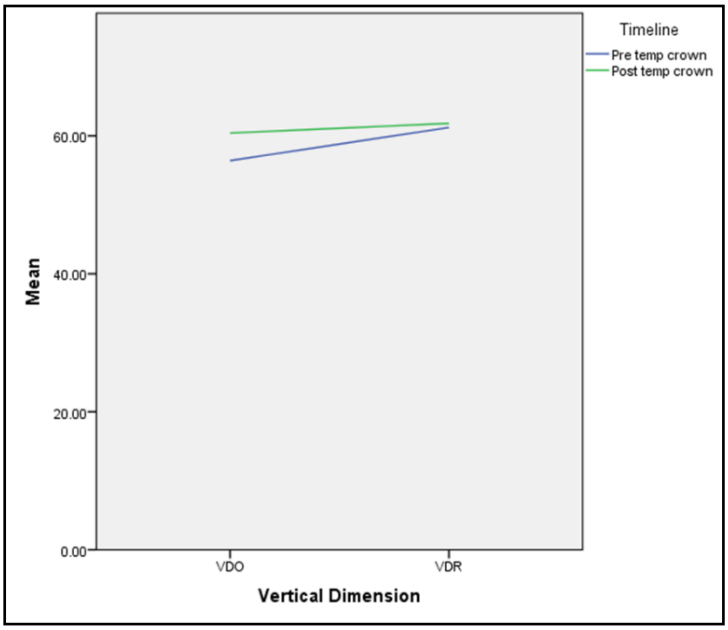

Figure 2 : Vertical Dimension at occlusion and rest pre and post temporisation

Table 1 : Paired t test showing the significant differences vertical dimension and leeway space before and after temporisation

	Mean ± SD	t value	p value
VDO -pre temp	56.4±5.69	-6.325	0.003*
VDO -post temp	60.4±6.84		
VDR -pre temp	61.2±6.87	-2.249	0.07
VDR-post temp	61.8±6.97		
Leeway space pre	4.82±1.34	5.667	0.005*
Leeway space post	1.41±0.54		

Table 2 : Paired t test showing the significant differences in velocity of mandible movements before and after temporisation

Velocity	Mean ± SD	t value	p value
Pre temp - Opening	384.25 ±43.79	-3	0.058
Post temp - Opening	386.5±45.15		
Pre temp - Closing	444.25±40.53	-3.851	0.031*
Post temp - Closing	456.86±38.97		

DISCUSSION

The value of the RVD is subtracted from the value of the OVD to determine the freeway space. Since it is widely acknowledged that some oral and facial anatomical sites are largely fixed throughout life [21], OVD and RVD are determined using landmarks such as mouth width, inter-alar width, bi-zygomatic width, and inter-pupillary distance. However, in order to minimize errors resulting from racial and gender disparities, these landmarks should be utilized in combination with other approaches rather than being employed separately [9]. The average highway space in this investigation was 3.11 mm. It was discovered that this and some other research [1,22,23].

Before and after temporization, VDO underwent considerable alterations in the current study. The results of this study support previous research showing that the masticatory muscles and stomatognathic system operate differently with age [24–26]. This may be related to the lower VDO reestablishment that elderly individuals were able to achieve [27].

In the present study, mechanical jaw tracker was used to measure the freeway space. This has been widely used among studies and it goes back from 1950s. Stuart invented a pantograph-based device in 1957 for the aim of tracking mandible movements. The device consisted of a parallelogram-shaped arrangement of rods [28]. Six recording styli and recording plates arranged around the head at right angles to one another made up the apparatus.It was the only study conducted in 1986 to compare the motions of the jaws as captured by two distinct pantographs. According to Donaldson et al., these pantographs recorded mandibular movements with a mean difference of less than 0.1 mm [29].

The length of a masticatory cycle and mandibular motions have been observed in numerous studies. The velocity of mandibular movement that were recorded for different age groups were different. Usually the people with younger age wont have much differences in the velocity. But the elderly might have differences due to ageing [30]. In the present study, in the opening velocity there was no significant difference whereas in the closing velocity, the post temporisation velocity significantly increased.

The mandibular movement velocity has an effect on the function of the masticatory system. Studies on mastication and aging indicate that changes in the number of teeth and the function of the jaw muscles with aging diminish sensory input to the central nervous system [31]. Since most of these jaw movement characteristics are related to one another (e.g., amplitude and height of mastication; cycle duration and lateral guidance angle; occlusal glide length and amplitude), it's possible that the apparent differences between studies are the result of population differences rather than distinct associations [32].

With statistical analysis, the occlusal contact area was substantially correlated with masticatory performance; however, this correlation vanished when bite force and jaw movement parameters were taken into account [33]. Thus, in a population with a full or nearly full complement of natural teeth, bite force and mandibular movement appear to be more closely connected to masticatory performance than the occlusal contact area is. The occlusal scheme should consider these findings when a fixed prosthodontic restoration is needed to replace lost occlusal surfaces or missing teeth [34].

This study has a few limitations. First one is that the present study only involved middle aged patients and not young adults. So, there is no comparison between the age groups. Another drawback of the study is that the patients with definite malocclusion were not included, and therefore the ways to increase freeway space in them is not assessed. Also, only a mechanical jaw tracker machine was used to measure the dimensions. Although there are photographic, Roentgenographic, electronic and many more methods to assess the VD, it was not included and compared. There are also many methods to increased the vertical dimension as discussed. Only the temporisation was assessed in the study. Instead if other methods have also been compared, it would be easy to assess the effectiveness of different methods.

CONCLUSION

The findings of this comprehensive study shed light on the dynamic changes in vertical dimensions and mandibular movements before and after temporisation in patients undergoing full mouth rehabilitation. The investigation focused on Vertical Dimension at Rest (VDR), Vertical Dimension at Occlusion (VDO), freeway space, and the velocity of mandibular movements.

Before the placement of temporary crowns, both VDR and VDO were observed to be lower compared to the measurements taken after the temporisation process. This notable difference suggests that the temporary crowns had a significant impact on the restoration of vertical dimensions in these patients. Specifically, in VDO, there was a substantial increase in post-dimension after temporisation, indicating a positive response to the treatment among individuals requiring full mouth rehabilitation.

While VDR also exhibited an increase after the placement of temporary crowns, the change was not statistically significant. However, the fact that there was an observable upward trend suggests a potential influence of temporisation on restoring the vertical dimension at rest, even though it did not reach statistical significance.
The analysis of freeway space, defined as the difference between VDR and VDO, revealed a significant decrease after the placement of temporary crowns. This reduction in freeway space underscores the efficacy of temporisation in achieving a harmonious relationship between the rest and occlusion vertical dimensions. The narrowing of freeway space is indicative of a more stable and balanced dental occlusion, which is crucial for the success of full mouth rehabilitation.

Furthermore, the study investigated the velocity of mandibular movements, specifically focusing on opening and closing velocities. Interestingly, no significant differences were observed in opening velocity before and after temporisation. However, the closing velocity showed a significant increase post-temporisation. This finding suggests that the temporisation process had a pronounced effect on the closing phase of mandibular movements, potentially indicating improved efficiency or coordination in this aspect of occlusal function.

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