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Original Article

Dentistry Section

Absence of Anterior Guidance and its Effects on Early Discal Changes in Temporomandibular Joint: A Cross-sectional Study

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ABSTRACT

Introduction: Anterior guidance plays a crucial role in occlusal harmony and Temporomandibular Joint (TMJ) function. Its absence may contribute to early joint changes, potentially leading to dysfunction. Joint Vibration Analysis (JVA) provides a non invasive method to assess TMJ status and detect subclinical discal changes.

Aim: To evaluate the effect of the absence of anterior guidance on TMJ function using JVA and to assess early discal changes.

Materials and Methods: This cross-sectional study was conducted at the Department of Prosthodontics, Saveetha Dental College, Chennai, Tamil Nadu, India, over the period of March 2024 to August 2024 total of 30 participants were categorised into three groups based on anterior guidance: Group 1 served as the control group and consisted of participants with intact anterior guidance. Group 2 included participants without anterior guidance who had previously undergone orthodontic or prosthodontic therapy. Group 3 comprised participants without anterior guidance and without any prior history of orthodontic or prosthodontic treatment. JVA parameters, including total integral, integral values greater than 300 Hz and integral values less than 300 Hz, were analysed. Statistical analysis was performed using Statistical Package for Social Sciences (SSPSS) version 23.0, employing One-way Analysis of Variance (ANOVA) and Tukey's post hoc test for group comparisons.

Results: Participants without anterior guidance exhibited significantly higher total integral values (p-value <0.05), indicating subclinical discal changes in the TMJ. A significant difference (p-value=0.02) was observed in maximum mouth opening among the groups. The higher integral values greater than 300 Hz and less than 300 Hz in the groups without anterior guidance further supported the presence of early joint dysfunction.

Conclusion: Early subclinical discal changes in the TMJ were noted in patients with an absence of anterior guidance. JVA can serve as an effective diagnostic tool for the early detection of TMJ dysfunction.

Keywords: Disc displacement, Mandibular kinetics, Masticatory function, Occlusal relationship, Temporomandibular joint disorders

INTRODUCTION

Anterior guidance, or incisal guidance, pertains to the functional influence exerted on mandibular movements by the occlusal contact relationships of the maxillary and mandibular anterior teeth. The steepness of this guidance is contingent upon the horizontal and vertical overlap of these anterior teeth. In ideal occlusion, the lingual inclines of the six upper anterior teeth are considered to be the determining factor for incisal guidance. Considerable emphasis has been placed on the significance of condylar guidance in dental literature. Conversely, insufficient focus has been directed towards incisal guidance, which holds equal or greater importance than the Temporomandibular Joints (TMJs) in shaping the functional occlusion of teeth. Recognising its paramount role, incisal guidance should be prioritised in the planning of all dental restorations, whether as simple as a single inlay or as comprehensive as full occlusal rehabilitation [1]. Improper incisal guidance can lead to abnormal functional movements of the condyles, potentially causing abnormal stresses and movements that may result in pathological conditions [2].

The TMJ is capable of both hinge and gliding movements, making it a ginglymo-arthroidal joint [3]. In a healthy joint, synovial fluid facilitates smooth gliding motion, free from vibrations. Early discal changes in the TMJ can manifest as alterations in the position, structure, or function of the articular disc, which serves to cushion and stabilise the joint during movement. These changes can include disc displacement, degeneration, or inflammatory processes and are often associated with symptoms such as pain, clicking, or limited jaw movement [4]. In recent years, numerous methods, both objective and subjective, have been developed to record and analyse TMJ sounds. These range from basic techniques like palpation and auscultation to more advanced methods such as Electromyography (EMG), jaw tracking, Joint Vibrational Analysis (JVA), thermography, sonography, Doppler ultrasound, Magnetic Resonance Imaging (MRI), Computerised Tomography (CT) scans, arthrography and arthroscopy [5]. While these tools aid in diagnosing Temporomandibular Disorders (TMD), the underlying occlusal determinants-particularly anterior guidance-play a fundamental role in the functional biomechanics of the joint. Accurate selection and positioning of maxillary anterior teeth are critical in establishing effective anterior guidance, thereby promoting occlusal harmony and TMJ stability [5,6]. JVA objectively records the vibrations of the joints and aids in diagnosing joint pathology.

Despite the importance of incisal guidance in occlusion and TMJ function, there may be a gap in the literature regarding its specific role in early discal changes. Thus, the aim of the present study was to identify whether there are any discal changes in patients without incisal guidance. Conducting the present study can help fill this gap, advancing knowledge in the field and providing a foundation for future research endeavours. The null hypothesis has been formulated as: "There is no significant association between the absence of incisal guidance and the occurrence of early discal changes in the TMJ."

MATERIALS AND METHODS

The present cross-sectional study was conducted at the Department of Prosthodontics, Saveetha Dental College, Chennai, Tamil Nadu, India, over the period of March 24 to August 24, to assess the association between the absence of incisal guidance and early discal changes using JVA. Ethical approval was obtained from the Institutional Ethics Committee (IEC) of Saveetha Dental College, Chennai (IHEC/SDC/PROSTHO-2206/24/255). The study followed the Strengthening the Training and Reporting of Observational studies in Epidemiology (STROBE) guidelines, ensuring methodological rigour.

Inclusion and Exclusion criteria: The study included participants aged between 18 and 45 years, comprising both male and female individuals with complete dentition, except for third molars. Only individuals free from systemic conditions that could potentially influence the TMJ and occlusion were considered. Participants with a history of TMJ disorders, acute pain conditions, or other oral pathologies were excluded. Additionally, individuals with missing teeth, apart from third molars, or those requiring extensive dental rehabilitation were not included in the study. A history of maxillofacial trauma or surgical intervention affecting the TMJ also served as exclusion criteria to maintain a homogeneous sample.

Sample size calculation: The required sample size was determined using G*Power software (version 3.0.10) based on a pilot study. A pilot study was conducted with 12 samples, comprising 4 samples in each group, to evaluate the feasibility of the study design and standardise the methodology. The pilot study helped refine the data collection and analysis process. These samples were not included in the final study to ensure unbiased results. A significance level of α=0.05 and a statistical power of 1-β=0.8 were employed, yielding a final sample size of 30 participants. The participants were divided into three groups, with 10 individuals in each group. Group 1 served as the control group and consisted of participants with intact anterior guidance. Group 2 included participants without anterior guidance who had previously undergone orthodontic or prosthodontic therapy. Group 3 comprised participants without anterior guidance and no prior history of orthodontic or prosthodontic treatment.

Study Procedure

In the present study, the Bio-Joint Vibration Analysis (JVA) system was used to measure the vibrations produced during the opening and closing of the mouth to assess TMJ function. The methodology was standardised to ensure consistency in data collection. The patient was seated on a chair with their thighs parallel to the floor and their feet flat on the ground, ensuring that the body was stable and properly aligned for accurate measurement. This posture was crucial in preventing any movement artefacts during the data collection process. Two accelerometers were positioned on either side of the head, directly over the TMJ region, one on the left and one on the right. These accelerometers were responsible for detecting the vibrations produced by the TMJ during mouth movements. The accelerometers were securely attached to ensure proper contact with the skin without shifting during the testing process. An amplifier was attached to the patient's neck to further enhance the signal quality from the accelerometers. This set-up ensured that even small vibrations produced by the TMJ were clearly recorded and amplified for analysis. The Bio-JVA system was connected to a compatible computer system, which was equipped with Bio-JVA software. This software allowed for real-time visualisation and recording of the vibrations produced during mouth opening and closing. The synchronisation of the patient's mouth movements with the software was essential to ensure accurate capture of the joint sounds. Patients were asked to open and close their mouths in a controlled, synchronous manner [7]. The Bio-JVA software was programmed to ensure that these movements were synchronised with the system's recording mechanism. This was important to capture the exact joint sounds generated during these movements [8]. During the opening and closing cycle, the software recorded the joint vibrations and the six highest-frequency vibrations were selected for analysis. These vibrations were identified based on the amplitude and frequency of the signal produced by the TMJ. The software then marked these six highest-frequency vibrations and calculated the average values for both the left and right TMJs [Table/Fig-1a,b].

[Table/Fig-1]: a) Joint Vibration Analysis (JVA) of patient with anterior guidance; b) Joint Vibration Analysis (JVA) of patient without anterior guidance.

Variables measured: The following variables were measured and compared:

- **Total integral:** This represented the overall energy of the joint vibrations recorded during the cycle of mouth opening and closing.
- **Maximum mouth opening:** This value was recorded to correlate the degree of mouth opening with the vibrations detected by the Bio-JVA system.
- **Integral >300 Hz:** The energy of the vibrations with frequencies above 300 Hz was isolated and analysed.
- **Integral <300 Hz:** The energy of the vibrations with frequencies below 300 Hz was also isolated for analysis [1].

The use of these specific parameters allowed for a detailed comparison between the TMJ vibrations, identifying possible dysfunctions or irregularities [9]. The variables measured in this study were chosen based on their established clinical relevance and sensitivity in diagnosing TMJ dysfunction, as supported by previous literature [9]. While additional parameters, such as peak amplitude and peak frequency, can be assessed, they are typically used to study the severity of the condition and did not provide the additional diagnostic value necessary for this analysis.

STATISTICAL ANALYSIS

The statistical analysis was performed using One-way Analysis of Variance (ANOVA) to compare differences in TMJ function across three groups based on the presence or absence of anterior guidance. ANOVA was utilised to assess whether there were significant differences in TMJ function, as measured by JVA, between these three groups. A p-value of less than 0.05 (p-value <0.05) was considered statistically significant. To identify specific differences between the groups, Tukey's post hoc test was conducted. This post hoc analysis allowed for pairwise comparisons between each group to determine which specific groups differed significantly in TMJ function.

RESULTS

The study included 30 participants aged between 18 and 45 years, with a mean age of 32.4±6.8 years. The gender distribution was 16 males (53.3%) and 14 females (46.7%), ensuring a balanced representation across all groups.

The mean Total Integral values and corresponding Standard Deviations (SD) for each group, along with the 95% Confidence Intervals (CI) for the upper and lower bounds, are presented below. A p-value of less than 0.001 (p-value <0.001) indicates that the differences in Total Integral between the three groups were statistically significant. Similarly, significant differences were observed in high-frequency (Integral >300 Hz) and low-frequency (Integral <300 Hz) vibrations among the groups (p-value <0.05). A significant difference was also found in maximum mouth opening (p-value=0.02) [Table/Fig-2].

Parameters	Group	Mean±SD	95% CI upper	95% CI lower	F-value	p-value
Total integral	1	17.7±2.54	19.51	15.88	23.20	<0.001
	2	27.4±3.74	30.08	24.71		
	3	28.5±5.01	32.26	24.93		
Maximum mouth opening (mm)	1	48.2±2.5	50.1	46.3	2.14	0.02
	2	46.8±3.1	49.4	44.2		
	3	45.9±3.7	48.7	43.1		
Integral >300 Hz	1	6.2±1.5	7.1	5.3	19.87	<0.001
	2	11.4±2.1	12.9	9.9		
	3	13.1±2.4	14.8	11.4		
Integral <300 Hz	1	9.3±2.0	10.5	8.1	12.43	<0.001
	2	15.1±2.7	17.0	13.2		
	3	16.8±3.0	18.9	14.7		

[Table/Fig-2]: One-way ANOVA for total integral, maximum mouth opening, integral >300 Hz and integral <300 Hz.

Following the significant results of the ANOVA, Tukey's post hoc test was conducted to determine which specific groups differed from each other. The post hoc analysis revealed significantly higher Total Integral, high-frequency (Integral >300 Hz) and low-frequency (Integral <300 Hz) values in Groups 2 and 3 compared to Group 1 (p-value <0.001) [Table/Fig-3].

Parameters	Comparison	Mean difference	95% CI lower	95% CI upper	p-value
Total integral	2 vs 1	9.70	5.37	14.02	<0.001
	3 vs 1	10.80	6.47	15.12	<0.001
	3 vs 2	1.10	-3.22	5.42	0.80
Maximum mouth opening	2 vs 1	-1.40	-3.70	0.90	0.15
	3 vs 1	-2.30	-4.90	0.30	<0.001
	3 vs 2	-0.90	-3.10	1.30	0.31
Integral >300 Hz	2 vs 1	5.20	3.40	7.00	<0.001
	3 vs 1	6.90	5.10	8.70	<0.001
	3 vs 2	1.70	0.20	3.20	0.01
Integral <300 Hz	2 vs 1	5.80	4.00	7.60	<0.001
	3 vs 1	7.50	5.70	9.30	<0.001
	3 vs 2	1.70	-0.30	3.70	0.10

[Table/Fig-3]: Post hoc Comparisons for total integral, maximum mouth opening, integral >300 Hz and Integral <300 Hz.

DISCUSSION

The study's findings underscore the importance of understanding the role of anterior guidance in TMJ health, particularly in asymptomatic individuals. Specifically, the absence of anterior guidance was found to be associated with noticeable discal changes, even in the absence of symptoms; hence, the null hypothesis was rejected. Participants in Group 1 exhibited the lowest total integral values. The reduced JVA parameters suggest that the occlusal dynamics in this group allowed for efficient mandibular function with minimal strain [10]. A well-established anterior guidance facilitates smooth disocclusion during functional movements, minimising posterior interferences and ensuring efficient mandibular dynamics.

Groups 2 and 3 demonstrated increased total integral values and higher JVA parameters compared to Group 1. Additionally, both high-frequency and low-frequency vibrations were more pronounced in these groups. A less efficient anterior guidance may lead to prolonged posterior tooth contact during functional movements, increasing the vibrational response within the system. These findings suggest that individuals in these groups experienced the most inefficient anterior guidance patterns.

The results indicate that an optimal anterior guidance mechanism, as seen in Group 1, contributes to efficient disocclusion and minimal total integral values. In contrast, Groups 2 and 3, with altered anterior guidance patterns, demonstrated increased total integral values and higher JVA parameters. These findings align with the established understanding that anterior guidance plays a crucial role in reducing occlusal interferences and ensuring smooth functional movements.

The elevated parameters in JVA, including total integral in individuals without anterior guidance, point to subclinical changes that are indicative of underlying joint pathology [11]. These findings challenge the conventional notion that only symptomatic patients are at risk for TMJ disorders and highlight the potential of JVA to detect early joint dysfunction that may otherwise remain undiagnosed. Conversely, individuals with anterior guidance in this study exhibited lower JVA parameters, which are generally considered indicative of normal joint function. This stark contrast between the two groups suggests that JVA can be an effective Non invasive diagnostic tool for detecting joint abnormalities early, even in asymptomatic patients [12].

By identifying changes in joint vibrations, clinicians can potentially intervene before the development of clinical symptoms, which could prevent the progression of TMJ disorders and reduce the need for more invasive treatments in the future. Moreover, for individuals already diagnosed with TMJ disorders, regular monitoring using JVA can help track the progression of their condition. By measuring changes in vibration parameters, such as total integral, peak frequency and peak amplitude, over time, clinicians can gauge the effectiveness of ongoing treatments and adjust management plans accordingly. This provides valuable insight into the dynamics of the joint and the impact of treatment, offering a more objective and quantifiable method for assessing treatment success [13].

The ability of JVA to detect subclinical joint changes in asymptomatic individuals could be transformative for preventive care. By identifying potential issues before they become symptomatic, clinicians can implement early interventions, such as occlusal adjustments, splint therapy, or other therapeutic measures, to preserve joint function and prevent the onset of TMJ disorders [14,15]. These preventative measures can help maintain joint health and reduce the long-term burden of TMJ-related symptoms, potentially improving the patient's overall quality of life. These findings align with existing literature that shows a correlation between skeletal malocclusions and TMJ issues.

To the authors knowledge, there is currently no existing evidence regarding the discal changes of the TMJ with and without anterior guidance. Soft-tissue changes in the TMJ, such as disc displacement and alterations in ligamentous integrity, can progressively lead to structural modifications in the condyle. Over time, persistent mechanical stress and altered joint loading may contribute to condylar remodelling, surface flattening, or even osteoarthritic changes. These degenerative processes can exacerbate joint dysfunction, leading to progressive deterioration of TMJ function and symptoms such as pain, restricted movement and joint noises. Early detection of soft-tissue changes through JVA and other diagnostic tools may help prevent these long-term condylar alterations. However, this

hypothesis requires further verification through long-term studies to establish a definitive relationship between early soft-tissue changes and subsequent condylar modifications.

These findings emphasise the need for early detection and treatment, particularly for patients with skeletal malocclusions. Orthodontic treatment, occlusal therapy and other targeted interventions may be necessary to address the biomechanical stresses placed on the TMJ and prevent the onset of TMJ disorders. Additionally, regular monitoring of joint function using non invasive techniques like JVA can provide valuable insights into joint health, allowing for proactive management to maintain optimal joint function and prevent long-term damage.

Limitation(s)

One of the key limitations of the present study is the lack of longitudinal data, as it provides only a cross-sectional analysis of TMJ function. A long-term follow-up study would help in understanding the progression of TMD over time and assessing how changes in joint vibrations correlate with clinical outcomes. Additionally, while JVA is a valuable diagnostic tool, it does not provide direct visualisation of soft tissue structures, disc position, or joint morphology. MRI, which is considered the gold standard for TMJ evaluation, could offer a more comprehensive assessment of internal joint derangements and help validate the findings of JVA. Future studies integrating MRI with JVA and clinical symptom correlation could enhance diagnostic accuracy and provide deeper insights into TMJ dysfunction.

CONCLUSION(S)

The absence of anterior guidance was linked to early subclinical discal changes in the TMJ, as indicated by increased joint vibrations. Despite there being no significant difference in maximum mouth opening, higher integral values suggest compromised joint function. Early detection through JVA can aid in preventive interventions. Future studies are needed to validate these findings. Anterior guidance plays a crucial role in maintaining TMJ health.

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