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"Evaluation Of Bite Force And Its Corelation With Skeletal Malocclusions – An In Vivo Study"

Dr. Madhvi Bhardwaj[1*], Dr. Ashish Chauhan[2], Dr. Sweety Gupta[3], Aisshanya Pandey[4], Kanchan Sahu[5], Dr. Manish Dagdiya[6]

[1]Department of Orthodontics and Dentofacial Orthopedics
Email ID : drmadhvi80@gmail.com
[2]Depatment of Orthodontics and Dentofacial Orthopedics
Email Id : chauhanashish1101@gmail.com
[3]Department of Orthodontics and Dentofacial Orthopedics
Email Id : guptasweety679@gmail.com
[4]Department of Orthodontic and Dentofacial Orthopedics
Email ID : aisshanyapandey.7680@gmail.com
[5]Department of Orthodontics and Dentofacial Orthopedics
Email ID : sahukanchan.08@gmail.com
[6]Email ID : dagdiyamanish@gmail.com
***Corresponding author:**
Dr. Madhvi Bhardwaj
Department of Orthodontics and Dentofacial Orthopedics
Email ID : drmadhvi80@gmail.com

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ABSTRACT

Introduction: Maximum bite force (MBF) refers to the greatest force generated by the masticatory system during functional contact. It serves as a key indicator of the functional capacity of the stomatognathic system and reflects the efficiency of the masticatory apparatus.

Aim : The present study aimed to compare maximum bite force among individuals with different sagittal malocclusions.

Methodology : Patients reporting to the Department of Orthodontics and Dentofacial orthopaedics' at Saraswati Dental College were recruited for the study. Participants were classified into three groups based on skeletal (Class I, Class II and Class III) malocclusion. Maximum bite force was measured using a digital bite force transducer, expressed in Newton's, and the data were subjected to statistical analysis.

Result : A decreasing trend in maximum bite force was observed across the groups, with the highest values recorded in Class I malocclusion and the lowest in Class III malocclusion.

Conclusion : Within the limitations of this study, it can be concluded that subjects with Class I malocclusion exhibit greater maximum bite force, suggesting a more efficient masticatory system and improved chewing efficiency compared to those with Class II and Class III malocclusions..

1. INTRODUCTION

The masticatory system is a complex functional unit composed of the maxilla, mandible, temporomandibular joint (TMJ), teeth, tongue, masticatory muscles and their associated blood vessels and nerves. These components work in coordination to facilitate essential functions such as mastication, speech and swallowing. Among these, mastication involves the generation of force through mandibular movements, which enables the breakdown of food for digestion. The force generated primarily by the elevator muscles (masseter, temporalis and medial pterygoid) between the maxilla and mandible is referred to as bite force [1]. According to an article bite force is a direct measure of masticatory performance and is influenced by multiple factors such as age, sex, height and facial morphology [2]. Bite force is not only a marker of masticatory efficiency but also a significant indicator of the functional status of the stomatognathic system [3]. Moreover, maximum bite force has also been

positively correlated to cognitive function and mastication has been associated with an increase and improvement in cognitive performance [4][5][6]. Additionally, the habitual intake of hard food, which naturally requires greater bite force, has been linked to improved cognitive and brain function [7][8]. According to an article, bite force and the number of occluding teeth is critical determinant of masticatory performance [9]. A reduction in bite force can compromise chewing efficiency which may in turn affect nutritional intake and overall health status[10]. Therefore, assessing bite force can provide valuable insights into a patient's functional capacity, particularly in the context of malocclusion. Previous research has examined bite force in patients with crossbites, different facial types, normal occlusion and various Angle's malocclusions, considering parameters such as body mass index, occlusal contacts, overjet, overbite, mandibular movements and dental restorations. Despite these efforts, the findings remain variable and there is still limited clarity on the relationship between skeletal malocclusion patterns and maximum force [11]. Malocclusion is defined as a deviation from the normal alignment of the teeth and jaws and can be broadly classified into skeletal Class I, Class II and Class III based on the anteroposterior relationship between the maxilla and mandible. Skeletal malocclusions are often associated with discrepancies in jaw size and position, which can influence occlusion, muscle activity and ultimately bite force. For example, Class II malocclusions often involve mandibular retrusion, while Class III cases typically present with mandibular prognathism. These anatomical differences can alter the biomechanics of the masticatory system. Given these variations, it is important to understand how skeletal malocclusion affects bite force and chewing efficiency. Therefore, the aim of this study is to evaluate and compare maximum bite force among individuals with different skeletal malocclusion patterns. By highlighting the functional differences between these groups, this research seeks to underscore the clinical relevance of bite force assessment in Orthodontic diagnosis, treatment planning and prognosis.

2. MATERIAL AND METHODOLOGY-

The Aim of the study is to compare maximum bite force in different skeletal malocclusion. The objective are to measure maximum bite in skeletal class I, to measure maximum bite force in skeletal class II, to measure maximum bite force in skeletal class III and to compare maximum bite force in between class I, class II and class III.

This study was conducted in the Department of Orthodontics & Dentofacial Orthopaedics in Saraswati Dental College, Lucknow. The present study involved the selection of cases which fulfils the selection criteria.

The inclusion criteria involved, non-growing patients between age 18-40 years. Cases selected were having skeletal Class I, Class II & Class III malocclusion.

The exclusion criteria included, Any craniofacial disorders including Cleft lip & cleft palate. Local/systemic issues or trauma which effects the growth & development of facial skeleton. Growing patients, periodontally compromised cases, medically compromised cases.

Armamentarium used in this study-Standardised digital printed lateral cephalometric radiograph, data reading sheet, geometry box, lead acetate matte tracing sheet, x- ray view box, masking tape, pen & pencil. Dental examination tools (mouth mirror, probe & explorer) personal protective equipment (gloves, mask & head cap).

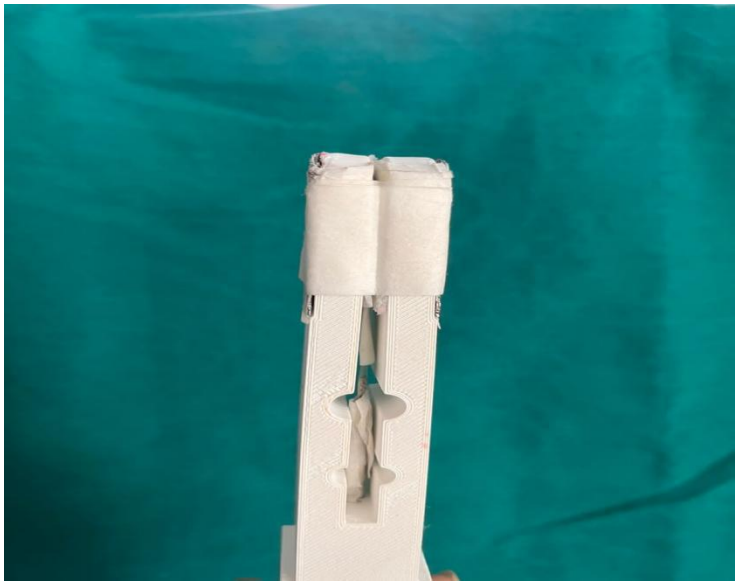


Fig 1:

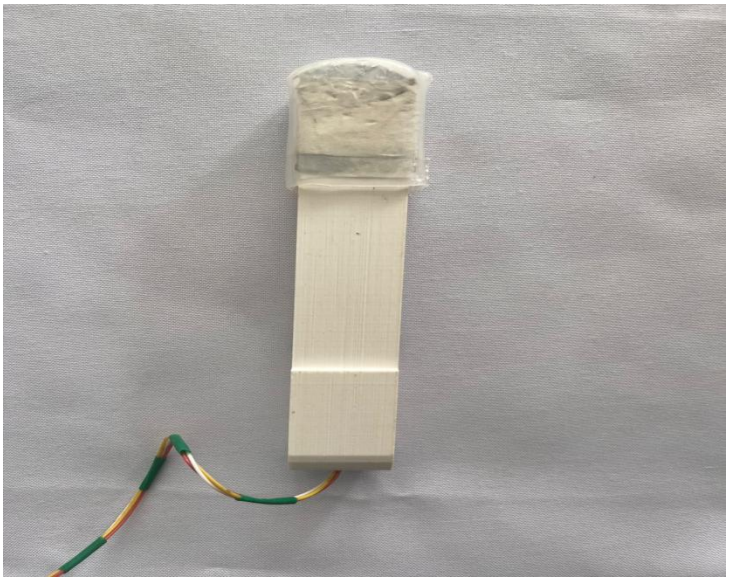


Fig2:

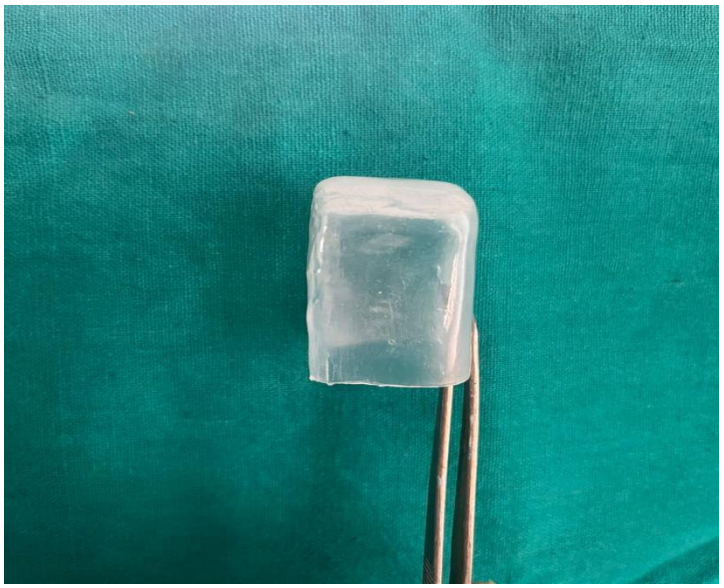
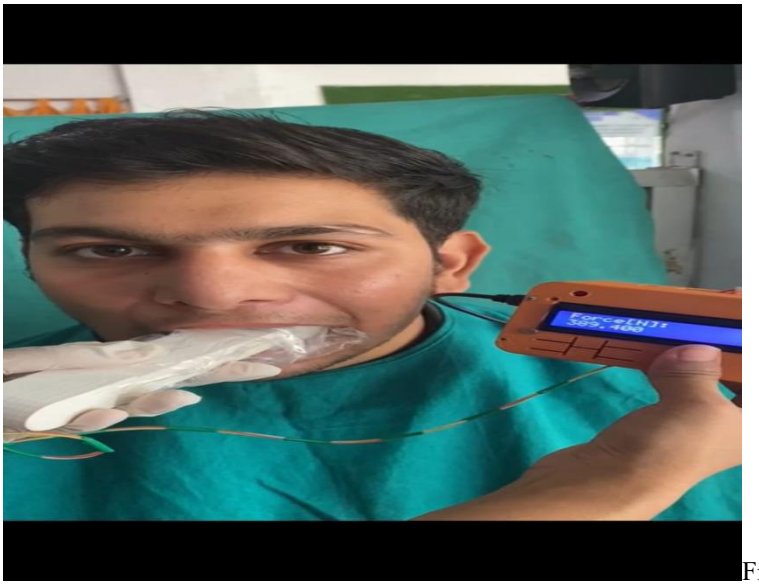


Fig 3: A metallic biting fork covered with acrylic resin



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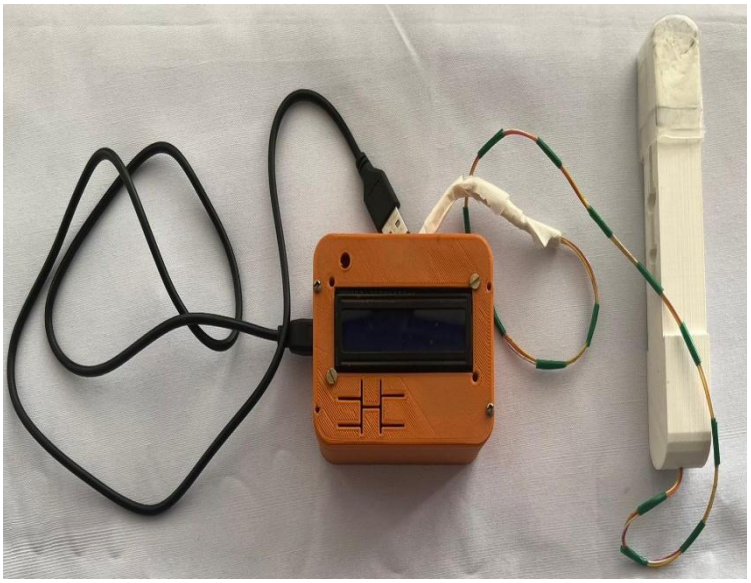


Fig 5: Strain gauge bite force transducer

Patients reporting to the department were considered for inclusion in the study if they fulfilled the specified criteria and provided written informed consent. Each subject underwent a thorough clinical examination using sterilized diagnostic instruments and their demographic details were documented. Based on skeletal classification determined by the ANB angle, the participants were divided into three groups: Group A (Class I), Group B (Class II) and Group C (Class III). Subjects with an ANB angle between 0° and 4° were assigned to Group A, those with an ANB angle greater than 4° were assigned to Group B and those with an ANB angle less than 0° were assigned to Group C[12]. A total of 90 subjects were included, with 30 participants in each group [Table 1]. Maximum bite force was recorded using a digital bite force transducer. The device was first positioned in the right molar region, followed by the left molar region and subjects were instructed to bite firmly in centric occlusion. Three consecutive recordings were obtained from each side and the mean value was calculated for analysis.

GROUP (overall)	NUMBER OF PARTICIPANTS	BITE FORCE	
		MEAN	SD

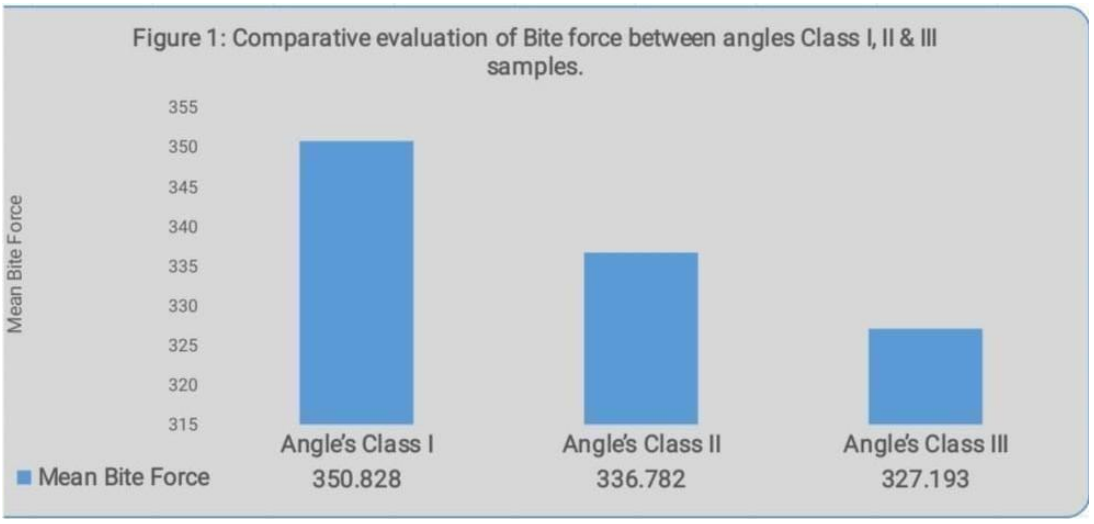
Skeletal Class I	90	350.828	51.7861
Skeletal class II	90	336.782	43.1103
Skeletal Class III	90	327.193	56.1731
Total	270	338.268	51.3879
ANOVA 'F' value	4. 958		
Significance 'p' value	0.0 08(S)		

Table 1: Comparative evaluation of bite force between skeletal class I, II, III samples.

Ethical approval for the study was obtained from the College Ethical Committee the portfolio number of which is #FM10R07062025R ,and written informed consent was secured from all the participants.

3. RESULT-

A total of 270 participants within the age range of 18–40 years were enrolled in the study. According to skeletal malocclusion classification based on the ANB angle, the subjects were equally divided into three groups: Class I (n = 90), Class II (n = 90) and Class III (n = 90). The mean bite force values (measured in Newtons) were compared across these groups. The highest mean bite force was observed in Class I subjects (350.82 N), followed by Class II subjects (336.78 N), whereas the lowest mean bite force was recorded in Class III subjects (327.19 N). The comparative distribution of mean bite force across the three skeletal malocclusion groups is illustrated in below mentioned graph [Figure 1].



4. DISCUSSION-

This study was conducted to compare the maximum bite force among individuals with different skeletal malocclusions, classified according to skeletal classification. The results demonstrated that patients with Class I skeletal relationships exhibited the highest bite force, followed by those with Class II, while Class III malocclusion patients showed the lowest bite force values. Our findings align with those of Alam M K et al. [13] who investigated the influence of nine confounding variables on maximum voluntary molar bite force. One of the significant outcomes of their study confirmed that individuals

with Class I skeletal malocclusion had the greatest bite force, supporting our observation. Similarly, Ciavarella D et al. [14] assessed bite force in patients with Class II subdivision malocclusions. Their results indicated that subjects with Class I occlusion exhibited higher bite forces compared to their Class II counterparts. However, it is important to note that Class III subjects were not included in their analysis, limiting the scope of their comparisons. Interestingly, a contrasting observation was reported by Turkistani K A et al. [15] who found that Class III individuals demonstrated higher posterior bite forces compared to those with Class I and II malocclusions. This discrepancy may be attributed to differences in sample characteristics, such as muscle activity, jaw morphology, or dental compensation, which are often more pronounced in Class III cases. Our findings align with those conducted by Araújo S C et al.[16] where the mean bite force of normal occlusion was found to be greater when compared to class II and Class III malocclusion. This can be explained by a study conducted by Bakke M [17] where it was concluded that the relation between maximum bite force and amount of occlusal contact becomes more relevant in posterior region of jaw and that bite force increases with number of present teeth. Furthermore, in a study by Trawitzki LVV et al.[18] which involved 125 subjects with Class II and Class III malocclusions undergoing orthodontic treatment, there was no statistically significant difference in bite force between the two groups. However, both groups exhibited significantly lower bite force values when compared to a control group with normal occlusion, indicating that malocclusion in general may negatively impact bite force efficiency. According to a study conducted by Alshammari A et al.[19] the bite force in permanent/mixed dentition period was found to be lower in children with malocclusion compared to the control Group. In children with primary dentition maximum bite force was found to be similar in both children with malocclusion and normal occlusion. During the primary dentition period, younger children regardless of the presence of malocclusion exhibit similar bite forces due to underdeveloped jaw muscles. This results in lower and more variable bite forces compared to adults, which can be attributed to the immaturity of orofacial structures that continue to develop as the child grows into adulthood. Another study conducted by Tsai H[20] concluded that children with normal occlusion had statistically significantly larger maximum bite force than children with malocclusion this can again be attributed to orofacial structures that are yet to develop which might be the cause of lower bite force in children with malocclusion. Another study by Willemijn F C de Sonnaville et al [21] was conducted in children with juvenile idiopathic arthritis (JIA)with or without involvement of temporomandibular joint (TMJ), the AMVBF was found to be lower in children with JIA when compared with healthy children. The reduction of AMVBF in children with JIA without TMJ involvement can be attributed to the fact that a thorough investigation related to TMJ arthritis was not conducted hence the result. Another reason can be that since bite force measurements of children with JIA was conducted in hospital so there might be some behavioural changes which are reflected in result. On the other hand, the measurements of healthy children were conducted in their own school so any behavioural changes didn't affect the result. However, in literature, bite force reduction in children with JIA can be attributed to masticatory muscle weakness which can be reflected in problem with chewing, biting. In another study conducted by Singh S et al.[22] it was found that maximum bite force at intercuspal (molar) and anterior bite position (incisal) were not significantly different between normal, Class I, Class II div1 and Class III malocclusion groups. The inconsistency in results can be attributed to either variations in bite recorder (lack of accuracy and flexibility of recorder) or different variables within the subjects (like variations in jaw morphology, masticatory muscles, different masticatory habits, overall health and mental being of patient at the time of bite force measurement). In one of the studies conducted by Sonnesen L et al. [23] Among children between 7-13 years, it was concluded that the bite force did not vary significantly between different malocclusion groups. In a study conducted by Bonjardim L R et al. [24] it was found that bite force in patients with temporomandibular dysfunction was lower when compared to the control group. In a study conducted by Subramaniam P et al.[25] to assess the effect of dental treatment on bite force it was found that there was significant increase in bite force this might be because of elimination of pain, discomfort and increased surface area following restoration of a decayed tooth. These varying results in the literature suggest that maximum bite force is influenced by multiple factors, including skeletal and dental morphology, muscle strength, occlusal contact patterns and whether the subject is undergoing or has completed orthodontic treatment. Differences in sample size, age, gender distribution and measurement protocols may also contribute to the inconsistencies observed across studies. Limitations of this study include the exclusion of patients with craniofacial anomalies such as cleft lip and cleft palate, which may influence bite force characteristics and skeletal relationships. Additionally, the study did not account for subdivisions within different molar relation classes, potentially overlooking nuanced variations within each malocclusion category. Furthermore, several confounding variables such as the presence of open bite, deep bite or preferred chewing side were not evaluated, any of which could have impacted the bite force measurements and influenced the overall results. Future studies incorporating these factors may provide a more comprehensive understanding of the relationship between skeletal malocclusion and bite force. Understanding the maximum bite force in different skeletal malocclusions is essential for evaluating the functional efficiency of the masticatory system. This information is valuable for diagnosis and plays a critical role in treatment planning, particularly in orthodontics, prosthodontics and oral surgery. It helps in selecting appropriate appliances, predicting treatment outcomes and assessing muscular adaptation before and after intervention.

5. CONCLUSION-

This study utilized a straightforward chairside method to record the bite force of 270 patients. The results demonstrated a significant variation in bite force across different skeletal malocclusion types. Notably, patients with Class I malocclusion exhibited the highest bite force values, while those with Class II and Class III showed comparatively lower forces. These

findings highlight the influence of skeletal structure on masticatory function and underscore the importance of considering malocclusion type in clinical assessments and treatment planning. .

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