BULLETIN OF STOMATOLOGY AND MAXILLOFACIAL SURGERY
Volume 21, Issue 3

DOI: 10.58240/1829006X-2025.3-269

ORIGINAL RESEARCH

EFFECT OF SKELETAL MALOCCLUSIONS ON TMJ HEALTH-A DESCRIPTIVE CROSS-SECTIONAL STUDY

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Received: *Mar 4, 2025;* ***Accepted:*** *Mar.30, 2025;* ***Published:*** *Apr. 8, 2025*

ABSTRACT

Background: Temporomandibular joint disorders (TMD) are musculoskeletal conditions that represent a group of conditions that involve the masticatory muscles, TMJ, and other related tissues. TMD is associated with various factors and skeletal malocclusion is implicated as one of the etiological factors cited inadequately in the literature. To formulate a hypothesis that skeletal malocclusion plays a crucial role in TMJ health.
Aim: To assess the effect of skeletal malocclusions on TMJ health.
Materials and Methods: A Descriptive Cross-Sectional Study was conducted with 180 samples divided into three groups of 60 each with skeletal class I, II, and III malocclusions reported to the Oral and Maxillofacial Surgery Department from June 2022 to December 2023. In each group, data was obtained through clinical examination, radiographs, and a DC/TMD chart. The severity of the functional TMJ is recorded using a modified Helkimo Anamnestic index and the observations were analysed to assess the relation between skeletal malocclusion and TMJ health.
Results: Skeletal malocclusion significantly affected TMJ function and morphology. Disc displacement was more prevalent in Class I ($p < 0.05$), while trauma from occlusion was more frequently observed in Class III ($p < 0.05$). Headache symptoms were high in Class II, showing a significant correlation with TMJ dysfunction ($p < 0.05$). These findings highlight the varying TMJ impacts across different skeletal malocclusion classes.
Conclusion: The present study supports the association of different skeletal malocclusions that contribute uniquely to TMD symptoms, with Class I being most associated with intra-articular TMD and Class III showing more muscle-related pain. Vertical growth patterns and occlusal trauma were also significant factors affecting TMJ health. This study provided a positive relationship between TMD and skeletal malocclusion.

Keywords: Temporomandibular joint disorders, Skeletal malocclusion, Temporomandibular joint, DC/TMD chart, TMJ

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INTRODUCTION

Temporomandibular Joint (TMJ) allows the jaw to move and perform various dynamic activities of the facial skeleton during mastication and speech. It is a ginglymoarthroidal joint that attaches the mandible to the squamous part of the temporal bone by allowing the jaw's orientation and position to be controlled by the neuromuscular frameworks surrounding the joint [1].

TMJ is a modified synovial joint with a biconcave fibrous articular disc separating the lower compartment from the upper compartment of the joint space. The articular disc is held in its functional position within the capsule by ligaments and muscles. The articular disc moves in synchronous with the condyle simultaneously on both sides [2].

Temporomandibular joint disorders (TMD) are clinical conditions involving the masticatory muscles, TMJ, and other related tissues. It has been categorized as a musculoskeletal condition that includes the head, face, and associated structures. Although the etiology of TMD is poorly understood and thought to be multi-factorial, it is frequently argued that malocclusion is one of the etiological factors of the condition [3]. However, the literature's citation of skeletal malocclusion's role in TMD is inadequate.

Skeletal malocclusions are one of the triggering factors in the complex etiology of TMD, resulting in an imbalance of the stomatognathic system. TMD risk is further increased by additional risk factors such as psychological problems, trauma, parafunctional habits, stress, genetics, and hyperlaxity of TMJ [4].

Studies have shown that the altered morphological relationship between the maxilla and mandible leads to changes in muscles of mastication, condyle-fossa, and disc-condyle relationship resulting in disc displacement and temporomandibular joint clicking [5].

Skeletal malocclusion particularly class II malocclusion was more likely to cause muscle strain problems in the joint that result in TMD [6]. Skeletal patterns and condylar asymmetry have a higher risk for TMD [7].

One of the main contributing factors to the etiology of TMD is mandibular retrusion because it causes the condyle to shift posteriorly resulting in excessive pressure on the joint and ultimately leading to joint pain, disc displacement, and degenerative changes [8].

Skeletal alterations cause prolonged strain on the TMJ and can cause degenerative changes including clicking or locking of the jaw, flattening of the condyle, arthritic changes, and asymmetrical growth patterns [9].

The main aim was to assess the effect of skeletal malocclusion on TMJ health and the objective was to evaluate the correlation between skeletal malocclusion and TMJ health.

MATERIALS AND METHODS

A Descriptive Cross-Sectional Study was conducted with 180 samples divided into three groups of 60 each with skeletal class I, II, and III malocclusions with age group 18-35 years reported to the Oral and Maxillofacial Surgery Department from June 2022 to December 2023. All the participants were informed about the study and written consent was acquired from all the participants. The Case history and the data obtained with the examination were recorded and examination results were analyzed by specially prepared forms using a DC/TMD chart which were taken as a reference. The severity of the functional TMJ is recorded using a modified Helkimo Anamnestic index [10] and the observations were used to assess the relation between skeletal malocclusion and TMJ health. The study was performed with the approval of the Institutional Review Board (IRB)/ Institutional Ethics Committee (IEC) 202204005 and the approval date was 22/04/2022.

1. Case history
2. Helkimo Anamnestic Index
3. Class I patient

Figure1.Orthopantomogram

4. Class I patient

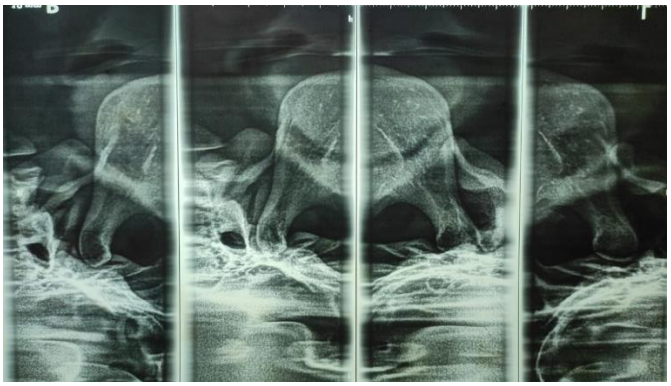

Figure 2.TMJ Open and closed views

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5. **Class I patient**

Figure 3. Lateral Cephalogram

6. DC/TMD chart

	Presence/Absence	**Class I**	**Class II**	**Class III**
Pain related TMD	Presence	4	1	2
	absence	56	59	58
Intra-articular temporo mandibular disorder	Presence	3	0	0
	Absence	57	60	60
Headache	Presence	40	44	21
	Absence	20	16	39
Age	Range	18-35 years	18-35 years	18-35 years

Inclusion criteria: 1. Physical status ASA I and II 2. The age group of 18-35 years with skeletal or dental malocclusion 3. Patients with a full set of dentition. 4. Patient who had given consent.
Exclusion criteria: 1. Patients undergoing orthodontic treatment 2. Patients who underwent orthodontic treatment 3. Patients who underwent orthognathic surgery. 4. Patients having missing teeth. 5. Patients who are using occlusal splints or underwent prosthetic rehabilitation 6. Patients with a history of trauma. 7. Patients having periodontal problems. 8. Patient who underwent any restorative dental treatment. 9. Patients with any systemic disorders /condition affecting TMJ health.
Primary variables were trauma from occlusion, TMJ disorders (pre-existing), Pain, intra-articular disease (IAD), and Headache.
Secondary variables were muscular pain, TMJ signs on palpation, mandibular plane angle, mandibular mobility, and TMJ plane movement.

RESULTS

Statistical methods: Statistical analyses were performed using version 25.0 of the Statistical Package for Social Sciences (IBM Corporation, Armonk, New York, USA). The data was categorical and Pearson's chi-square test was used.

p-value < 0.05 was considered statistically significant. The data was entered in Microsoft Excel 2016 for Windows.

Table 1. Comparison of Primary Variables with Skeletal Malocclusion Class I,II,III:

Primary Variables		Class I	Class II	Class III	chi-square	p-value
Trauma from occlusion	Presence	19(10.6%)	23(12.8%)	39 (21.7%)	15.018	**0.001***
	Absence	41(22.8%)	37(20.6%)	21 (11.7%)		
Pain related TMD	Presence	4 (2.2%)	1 (0.6%)	2 (1.1%)	2.081	0.353
	absence	56 (31.1%)	59 (32.8%)	58 (32.2%)		
Intra-articular temporo mandibular disorder	Presence	3(1.7%)	0 (0.0%)	0 (0.0%)	6.102	0.04*
	Absence	57 (31.7%)	60 (33.3%)	60 (33.3%)		
Headache	Presence	40 (22.2%)	44 (24.4%)	21 (11.7%)	20.70	0.000*
	Absence	20 (11.1%)	16 (8.9%)	39 (21.7%)		

Trauma from occlusion was observed in Class III skeletal malocclusion with a statistically significant p-value of 0.001. Trauma from occlusion was observed in Class III skeletal malocclusion with a statistically significant p-value of 0.001. (Table 1)

Distribution of pain-related TMD with skeletal class I, II, and III malocclusions showed no significant p-value (0.353). Intra-articular TMD was a statistically significant p-value (0.04) in skeletal class I malocclusion. The presence of headache was significant in class II skeletal malocclusion. (Table 1)

Table 2. Comparison of Secondary Variables with Skeletal Malocclusion Class I,II,III:

Secondary Variables		Class I	Class II	Class III	chi-square	p-value
High-angle or low-angle	High	1 (0.6 %)	16 (8.9%)	31 (17.2%)	43.192	0.000*
	low	35 (19.4%)	31 (17.2%)	24 (13.3%)		
	Normal	24 (13.3%)	13 (7.2%)	5 (2.8%)		
Mandibular mobility	Score- 0	31 (17.2%)	49 (27.2%)	45 (25.0%)	15.066	0.005*
	Score -1	28 (15.6%)	11 (6.1%)	15 (8.3%)		
	Score-2	1 (0.6%)	0 (0.0%)	0 (0.0%)		
Temporomandibular plane movement	Score- 0	43 (23.9%)	60 (33.3%)	47 (26.1%)	20.126	0.000*
	Score -1	16 (8.9%)	0 (0.0%)	13(7.2%)		
	Score-2	1 (0.6%)	0 (0.0%)	0 (0.0%)		
Muscular pain	Score- 0	54 (30.0%)	54 (30.0%)	45 (25.0%)	7.059	0.02*
	Score -1	6 (3.3%)	6 (3.3%)	15 (8.3 %)		
	Score-2	0 (0.0%)	0 (0.0%)	0 (0.0%)		
TMJ Tenderness on palpation	Score- 0	36 (20.0%)	52 (28.9%)	45 (25.0%)	18.332	0.001*
	Score -1	20 (11.1%)	2 (1.1%)	12 (6.7 %)		
	Score-2	4 (2.2 %)	6 (3.3%)	3 (1.7%)		

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The mandibular plane angle with skeletal malocclusion shows a significant p-value (0.000) in skeletal class III malocclusion patients. The distribution of mandibular mobility was statistically significant with a p-value (0.005) highest in class 1 skeletal malocclusion with moderate temporomandibular disorder n=28 (15.6%) and severe TMD was observed in one patient. The temporomandibular plane movement was highest in skeletal class 1 malocclusion with a significant value of p = 0.000. (Table 2)

Muscular pain was observed in skeletal class III with n = 15 (8.3%) with p-value (0.02). The association between the malocclusion and pain on TMJ palpation was significant with a p-value of 0.001 and pain was highest in class II skeletal malocclusion. (Table 2)

DISCUSSION

Treatment of TMD at an early stage requires in-depth knowledge and research about the cause-and-effect relationship which was inadequately reported in the current literature. The relationship between functional TMJ disorders and the occlusal factors was neither widely studied nor cited. The alterations in surrounding facial musculature and the occlusal factors were thought to be one of the causative agents and contributing factors for temporomandibular joint dysfunction. Occlusal alterations were described as a co-factor rather than an etiological factor [11].

The research on the association between occlusal features and disorders of TMJ considers nine variables- overjet, overbite, midline deviation, pain-free opening, maximum assisted opening, maximum unassisted opening, lateral excursions, and a protrusion for evaluating any pain-related TMD, Intra-articular disorders, Degenerative disorders, headache attributed to TMD [12].

A Study Evaluating the Multifactorial Pathophysiology of TMD utilized general terms instead of specific terms associated with the problem of the Temporomandibular joint and stated that dental occlusal factors like a posterior crossbite, skeletal malocclusion, and TMD association were not consistent [13].

The current study revealed that trauma from occlusion was associated with Class III skeletal malocclusion than Class II and Class I which indirectly affects the TMJ health.

An analysis of the relationship between skeletal malocclusion and TMD revealed that it was a contributing element, but not the cause. The data supporting these findings was insufficient, and most of the investigations failed to show a significant association between the skeletal pattern and TMD [14].

In a case report authors highlighted those patients with class III skeletal malocclusion had severe facial asymmetry, posterior crossbite on the unilateral side, and TMJ disorder [15]. A comparison of skeletal malocclusion with TMD in the present study shows a significant correlation. TMD was highest in skeletal class I compared to skeletal class II and III. Intra-articular TMD with the highest presence was observed in skeletal class I malocclusion compared to skeletal class II, and III.

Research on the connection between crossbite and masticatory muscle pain is still controversial. Alarcon et al state that samples with posterior cross bite on the left side had a higher activity of the temporalis muscle on the contralateral side and individuals with normal occlusion had the opposite pattern. Long-term effects of skeletal Class III malocclusion on the TMJ, jaw movement, and masticatory system result from an incorrect sagittal relationship between the maxilla and mandible. The condyle-fossa relationship may be compromised because of the TMJ's susceptibility to tension or compression forces from the surrounding tissues [16].

Muscular pain was observed greater in skeletal class III in the current study and deep bite was higher than posterior cross bite in causing muscle pain.

A study on the comparison of skeletal malocclusion and craniofacial structures revealed that before treatment for any craniofacial abnormalities, there is a need to find out the underlying condition related to TMD [17].

The perspective in the Pullinger et al studies states that overjet significantly correlates with pain-related TMD whereas the overbite was associated with internal derangement of TMJ, especially disc displacement with reduction. In opposition, Manifrendi et al manifested that there is no clinical interrelation between overjet, overbite, and midline shift and concluded that TMD is due to family inheritance (genetics) and psychological and psychosocial factors [18]. The present study revealed rather than abnormal overjet, overbite, and deep bite showed a strong association irrespective of the type of skeletal malocclusion.

De Luca et al stated that headache is a predisposing factor or the triggering factor that affects muscles of mastication in and around the joint which results in myofascial pain. Among the different types of headaches, tension-type headache has a higher incidence with TMD [19]. Evaluation of headache clinically also

plays a crucial role in TMD associated with headache. Headache-related TMD was observed in skeletal class I & II malocclusion patients when compared to skeletal class III malocclusion in the present study. Most of the participants did not show any palpable masticatory muscle tenderness.

The present study revealed that low mandibular plane angle and normal angle had an effect on TMJ than high angle patients irrespective of the type of skeletal malocclusion. This shows a significant relation with the existing studies where greater incidence is seen in normal and low-angle cases compared to high-angle classes which are mostly encountered in skeletal class III patients [20].

Clicking sounds of the TMJ are identified as highest in class 1 skeletal malocclusion patients when compared to skeletal class II & III patients in our study. One participant had severe clicking sounds with restricted mouth opening and that is observed in skeletal class I patients.

Skeletal class II growth patterns individuals had higher overjet the reason is due to loss of guidance in the incisal area which resulted in excessive pressure on TMJ and further led to TMD and supporting to this patient with retruded mandible and TMD symptoms had higher facial plane and convex profile revealed an irreversible displacement of the disc with reciprocal click [21].

Vertical growth of skeletal variables had a higher impact when compared to horizontal growth pattern individuals because the variance in height of the mandible results in chances of application of more pressure on condyle and excessive vertical expansion of the mandibular ramus may be the cause of change in condylar width and height and further leading to TMD problem [22].

Final discussion summary:

This study found a strong association between skeletal malocclusion and TMD. Class I malocclusion had the highest intra-articular TMD, while Class III showed more muscle pain. Headache-related TMD was more frequent in Class I & II, with deep bites contributing more to muscle pain than crossbites. Low and normal mandibular plane angles had a greater impact on TMJ dysfunction. TMJ clicking was most common in Class I, while Class II patients exhibited disc displacement. Vertical growth patterns posed a higher TMD risk due to increased condylar stress and mandibular changes.

Scientific novelty:

- Provides detailed evidence between the different skeletal malocclusions with particular types of TMD.
- It highlights that Class 1 malocclusion is more strongly associated with intraarticular TMD, which contrasts with the previous studies.
- Mandibular plane angle has a stronger impact on TMJ dysfunction, which implies a mechanical foundation and understanding of TMJ biomechanics.

- According to the findings, vertical growth patterns represent a greater risk factor for TMD than horizontal patterns, offering fresh insights on joint loading and mandibular adaptation.

Practical Significance:

1. Early diagnosis and intervention
2. Preventive Strategies for TMD
3. Enhanced treatment protocol

CONCLUSION

The occlusal factors were categorically described as predisposing, triggering, or perpetuating factors but were denied to be confirmed as etiological factors for causing TMD owing to the existing evidence. However, the studies published in recent times agree with the reality and the existing evidence is still inadequate between skeletal malocclusion and TMJ. Our study definitively provides proof of skeletal malocclusion and TMJ, but further randomized multicentered trials are needed to strengthen the evidence.

DECLARATIONS

Acknowledgments

Anil Neerukonda Institute of Dental Sciences (ANIDS)

1. Department of Public Health Dentistry, ANIDS, for providing statistical analysis in processing the results.
2. Department of Orthodontics and Dentofacial Orthopedics, ANIDS, for support in data collection.
3. Department of Oral Medicine & Maxillofacial Radiology, ANIDS for contribution to Radiographic data.
4. Sibar Institute of Dental Sciences (SIDS)

Thankful to Dr. Manoj Kumar Musunuri, Associate Professor, Department of OMFS, SIDS for his generous support.

Conflicts of interest: None

Funds: None

Ethical clearance: Ethical approval was taken from the Institutional Ethical Committee with reference number ANIDS /IEC/202204005.

Informed consent: Informed consent was taken from the patient before the study.

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