

Temporomandibular Joint Disorders among Implant Patients in Relation to Bite Force

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Abstract

Background: The installation of dental implants may impair the temporomandibular joint's ability to operate by altering bite force. **Aim:** The aim of this study was to compare dental implant patients with partially and fully dentate patients in terms of temporomandibular joint issues related to maximal bite force measurement. **Materials and Methods:** Ninety patients with dental implants aged 50–60 years old were compared to 90 with partial and 90 with complete dentition patients who were age and gender matched. The incidence and severity of temporomandibular joint problems among patients were assessed using Helkimo anamnestic and clinical dysfunction indices. By using a biting force sensor, maximum occlusal bite force was measured in accordance with the manufacturer's instructions as reported at a US-based corporation. Statistical analysis of data was performed using the Statistical Package for the Social Sciences (SPSS) software program, version 22.0 (SPSS, Chicago, Illinois). **Results:** According to the data, patients in the fully dentate group had larger percentages of Helkimo anamnestic symptom-free and clinically no dysfunction than those patients in implant and partially edentulous groups. Patients in the partially edentulous group were more likely to have Helkimo anamnestic mild and severe symptoms, as well as clinical mild, moderate, and severe dysfunction than patients in the other two groups. These data, however, did not show a statistically significant association. Data analysis revealed that maximum bite force measurements were significantly different between groups for all Helkimo anamnestic and clinical indices. **Conclusion:** Following oral implant therapy, the function of the temporomandibular joint was affected. In addition, bite force measures decreased as temporomandibular disorder symptoms became more severe.

Keywords: Bite force, dental implant, temporomandibular joint disorders

INTRODUCTION

The temporomandibular joint (TMJ) is a masticatory system's functional component. It functions as a single entity with the vascular and neural systems of these structures, the periodontium, jaws, masticatory muscles, teeth, and periodontium. TMJ is used by humans more often than other joints in the body, and it is used to govern the simultaneous bilateral movement of the jaw.^[1]

A subtype of craniofacial pain disorders called temporomandibular disorders (TMDs) involve pain and dysfunction of the TMJ, masticatory muscles, and related musculoskeletal structures in the head and neck. In the orofacial region, it is the most frequent nondental pain factor.^[2,3] After chronic low back pain, TMDs are the most frequent musculoskeletal conditions that cause physical discomfort and impairment. The occlusal condition of the

teeth, trauma, emotional stress, parafunctions, hormones, and other elements are some of the contributing variables.^[4] The most common complaint is pain and a reduction in maximum mouth opening (MMO), which is typically above 40 mm on average. The following signs are heard: clicking, crepitation, difficulty opening the mouth, intermittent lock, closed lock, stiffness of joint in the morning, pain at rest, pain during MMO and chewing, and tenderness to palpation of the joint.^[5]

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A feeling known as osseoperception is elicited when dental implants are mechanically loaded, which differs from that of a natural tooth. Natural teeth have periodontal mechanoreceptors that transmit data regarding tooth loads, in contrast to osseointegrated dental implants.^[6,7] There is a growing concern that widespread TMJ issues among the elderly will result from the use of dental implants.^[8]

Losing teeth may have an adverse effect on how well the TMJ function.^[9] In people who had lost more teeth, the likelihood of noises in the TMJ increased dramatically.^[10] However, it had been shown that there are no clinically significant variations in TMD signs and symptoms between people with dental arches that have been shortened by 3–5 occlusal units and those who have entire dental arches.^[11] Loss of posterior teeth, particularly when there are few missing teeth, may cause subsequent alterations in the remaining teeth, such as drifting and tipping. The manifestation of secondary changes in occlusal contact, known as “tightly locked occlusion,” is the outcome of drifting and tipping. When it comes to the indications and symptoms of TMD, tightly locked occlusion was linked to it.^[12] The chance of acquiring a firmly locked occlusion increases with the proportion of posterior teeth missing in a person. This suggests that people who are toothless and have fewer missing posterior teeth may be more likely to develop TMD.^[9]

Bite force, which is a measure of how well the masticatory system is functioning, is caused by the contraction of the jaw elevator muscles, which are altered by the craniomandibular biomechanics.^[13] In addition, it has been suggested that bite force is crucial in the diagnosis of stomatognathic system disorders.^[14] Today, a variety of delicate electronic instruments are used to evaluate bite force. These devices, which include strain gauge transducers, piezoelectric transducers, piezoresistive transducers, and pressure transducers, use pressure sensors to transform force into electrical energy.^[15] A strain gauge transducer is a pressure transducer that converts the measured pressure into a proportional change in resistance value using elastic sensitive components and strain gauges. It is highly sensitive and accurate, has a wide measuring range, is compact and lightweight, and can be used in a variety of settings.^[16] The piezoresistive effect of a single crystal silicon material and integrated circuit technology are used to create piezoresistive transducers. It has been extensively used because of its high sensitivity, quick dynamic response, and excellent measurement accuracy. Strain gauge transducers are no longer an issue thanks to their ability to incorporate resistance, compensation circuits, signal conversion circuits, and even calculation processing circuits and sensors on silicon chips.^[17]

The strongest bite that any given patient can produce varies. Typically, the posterior jaw's occlusal biting load is

around three times that of the anterior jaw. Measurement of the bite force may be a crucial factor in dental implant treatment planning.^[18] Subjects wearing overdentures supported by dental implants applied forces that were noticeably greater than those in the group wearing overdentures with root retention at the maximum bite force (MBF) level. Even so, the implant group's maximal bite forces were still lower than those of the dentate patients. It showed a considerable rise in MBF following dental implant rehabilitation.^[19]

Normal masticatory function can be determined by the ability to bite with enough force.^[20] The ability of the masticatory muscles to contract, the masticatory movements, the potential bite force, and the horizontal mandibular forces may all be impacted in patients with TMD.^[5,21] Maximum biting force values were found to be moderately negatively correlated with the severity of TMD, and masticatory muscle discomfort and/or TMJ inflammation may contribute to this decrease.^[20] Long-term TMJ pain that is seen clinically is linked to severe functional impairment, including a weaker bite. This deficit could be brought on by reflex adaptation and chronic jaw muscle hypoactivity.^[21,22]

The aim of this study was to evaluate TMJ disorders among dental implant patients in addition to the relation with MBF measurement since there has been no previous Iraqi study concerning these relations. Null hypothesis stated that a dental implant would have no impact on the TMJ's ability to function in relation to dental bite force.

MATERIALS AND METHODS

This study was conducted in Iraq Between July 2021 and December 2022, with 50–60 year olds implant patients who were matched for age and gender with patients who were partially edentulous and fully dentate (90 patients in each group). The partially edentulous group's missing teeth ranged in number from 1 to 9 and were located in the posterior region of the jaws (Kennedy classification: class I and class II). In Babylon Governorate, a sample of implant patients was chosen from several private implant clinics.

Inclusion criteria

All volunteers involved in this study could read and write, appeared to be in good health, and who did not take any systemic medications. Participants of either gender were included. Participants signed an informed consent form before taking part in the study.

The frequency and severity of TMJ disorders among patients were determined using the Helkimo anamnestic (Ai) and clinical (Di) indices. A questionnaire-based survey was necessary to record subjective symptoms while applying for the Helkimo Index. Two sections made up the questionnaire: Answers to queries with “yes” or “no”

make up the anamnestic component. Clinical examination methods such as extraoral examination, palpation, and observation of muscle discomfort, TMJ pain, and pain with mandibular movement in all patients were included in the clinical dysfunction section.^[23] According to the intensity of TMD symptoms, patients were split into three groups for the Helkimo anamnestic index: Ai0 (symptom free), AiI (moderate symptoms), and AiII (severe symptoms).^[24] The Arabic version of the Helkimo anamnestic (Ai) index had been used which was implicated by a previous Iraqi study.^[25]

A thorough clinical evaluation of the masticatory system was also carried out in accordance with the Helkimo clinical index (Di). A modified version of Helkimo's dysfunction index (Di) was computed to complete the clinical dysfunction examination. The opening of the mandible, deviation during the opening, TMJ dysfunction, pain in the preauricular region, and palpation of the masticatory muscles including the temporalis, masseter, and lateral pterygoid were all part of the clinical examination.^[26]

The scores given for each of the five symptoms were combined. The total dysfunction score for each person ranged from 0 to 25 points. The more severe/acute the disorder, the higher the score. The patients were categorized as follows based on the results: No dysfunction (Di0), mild dysfunction (DiI) (1–4 points), moderate dysfunction (DiII) (5–7 points), and severe dysfunction (DiIII) (10–25 points). According to the severity of the clinical findings for the Helkimo clinical index, patients were categorized into four groups (Di0 to DiIII).^[27]

In the current investigation, a bite force sensor (Loadstarsensor) was used to detect bite force (bite force sensor, Loadstar Sensors, Fremont, California). It is made up of tiny sub-miniature resistive load cell sensors, which are electromechanical tools that aid in measuring physical parameters by sending a signal that quantitatively measures (level of that physical parameter) and sends a straightforward binary signal that indicates whether an event occurred or not. It may be used to detect compression force since it is stable and accurate. The patients were sitting, facing ahead, and standing when all measures were taken. Using a portable bite force sensor that needs to be straight and parallel to the floor, measurements of each patient's maximal bite force were made during a single session.^[28]

By placing the sensor portion of the device on the molar region and asking the participant to bite as strongly as possible for a few seconds, the MBF was measured for each side. The bite force was then calculated in newton and digitally displayed. The maximum value was recorded for each side, the same for the incisor area, after this bite measurement was done twice for each side in alternating sequence with a 2–3 min gap between records. Every participant sat upright on a standard chair while the bite force was being measured.^[29]

Statistical analysis

The data were statistically analyzed using Statistical Package for the Social Sciences (SPSS) software program, version 22.0 (SPSS, Chicago, Illinois). As statistical tests, chi-square, means, standard error, and analysis of variance (ANOVA) (one-way) were used. Statistical significance was determined as a *P*-value of less than or equal to 0.05.

Ethical approval

The study was carried out in conformity with the ethical standards outlined in the Helsinki Declaration. Before a sample was taken, it was done with the patient's verbal and analytical consent. A local ethics committee evaluated and approved the study protocol as well as the consent form and subject information according to document number 329321 on April 4, 2021 by the College of Dentistry, University of Baghdad to get this approval.

RESULTS

Tables 1 and 2 show the distributions of implant patients by Helkimo anamnestic (Ai) (Ai0, AiI, and AiII) and clinical (Di) (Di0, DiI, DiII, and DiIII) compared with partially edentulous and fully dentate patients. According to data analysis, the fully dentate group had the highest percentage of patients who were Helkimo anamnestic (Ai0) (symptom-free), followed by the implant group and lastly the partially edentulous group. The partially edentulous group had the highest percentages of patients with Helkimo (AiI) (mild symptoms) and (AiII) (severe symptoms), followed by the implant group and then the fully dentate group. These findings, however, did not show a statistically significant association (*P* > 0.05). The same picture was observed concerning percentages of Helkimo clinical (Di0) (no dysfunction), (DiI) (mild dysfunction), (DiII) (moderate

Table 1: Distribution of the implant patients according to Helkimo anamnestic (Ai) compared with partially edentulous and fully dentate patients

Helkimo		Study groups						Statistic
		Implant		Partially edentulous		Fully dentate		
		No.	%	No.	%	No.	%	
Ai	Ai0	34	37.78	20	22.22	36	40.00	8.041
	AiI	36	40.00	44	48.89	35	38.89	
	AiII	20	22.22	26	28.89	19	21.11	

Table 2: Distribution of the implant patients according to Helkimo clinical (Di) compared with partially edentulous and fully dentate patients

Helkimo		Study groups						Statistic
		Implant		Partially edentulous		Fully dentate		
		No.	%	No.	%	No.	%	
Di	Di0	25	27.78	18	20.00	35	38.89	12.119
	DiI	38	42.22	41	45.56	33	36.67	
	DiII	15	16.67	17	18.89	12	13.33	
	DiIII	12	13.33	14	15.55	10	11.11	

Table 3: Maximum bite force measurement (newton) by Helkimo anamnestic (Ai) for the implant group compared with the partially edentulous and fully dentate groups

Bite force	Helkimo Ai	Study groups						Statistic
		Implant		Partially edentulous		Fully dentate		
		Mean	SE	Mean	SE	Mean	SE	
Right	Ai0	243.635	8.457	189.727	12.314	257.444	8.691	12.048*
	AiI	206.634	11.389	187.362	9.112	242.378	11.397	3.669*
	AiII	179.294	11.252	158.107	13.829	219.244	14.300	10.240*
F test		11.014*		2.247		3.525*		
Left	Ai0	237.071	9.065	183.248	12.299	255.098	8.582	12.704*
	AiI	199.162	11.486	180.683	9.214	243.358	1.452	4.214*
	AiII	173.528	11.982	152.097	14.018	216.014	3.173	11.788*
F test		10.119*		2.220		3.863*		
Anterior	Ai0	153.845	3.278	126.388	4.179	169.292	3.249	31.825*
	AiI	136.640	4.041	121.112	3.291	163.275	4.562	23.371*
	AiII	131.282	4.204	116.944	4.804	160.028	4.599	30.746*
F test		10.365*		1.258		1.531		

*Significant at $P \leq 0.05$

dysfunction), and (DiIII) (severe dysfunction) with statistically no significant association ($P > 0.05$).

Regarding bite force measurement, data analysis showed that the MBF measurements were significantly higher among the fully dentate group followed by the implant and finally the partially edentulous groups for all Helkimo anamnestic index (Ai) and Helkimo clinical index (Di) ($P \leq 0.05$) as illustrated in Tables 3 and 4. Inside each group, results showed that the MBF measurement decreased with increasing the severity of TMD symptoms with statistically significant differences ($P \leq 0.05$) among the implant group for all measurements (right, left, and anterior) and among the fully dentate group for right and left sides. The same figure was observed regarding Helkimo clinical (Di) dysfunction with statistically significant differences ($P \leq 0.05$) among the partially edentulous group for all measurements.

DISCUSSION

TMDs are pathological illnesses that cause discomfort and dysfunction in the musculoskeletal system of the temporomandibular region.^[30] Helkimo presented an epidemiologic index that scored what was then referred

to as “functional disruption of the masticatory system” based on five often reported physical indications and symptoms. It was created primarily as an epidemiologic survey test to look at the prevalence of “global” TMDs and the necessity for treatment.^[27]

This study was conducted among implant patients with different types, numbers, diameters, and positions of dental implants. Data analysis reveals that the percentages of patients with Helkimo anamnestic and clinical (symptom and dysfunction-free) were higher among the fully dentate group than the implant and the partially edentulous groups while percentages of patients with Helkimo anamnestic (mild and severe symptom) and clinical (mild, moderate, and severe dysfunction) were higher among the partially edentulous group followed by the implant and finally the fully dentate groups. This might be as a result of the sensation known as osseoperception being elicited when dental implants are mechanically loaded. When a natural tooth is loaded, sensory signals are produced that are qualitatively distinct from those underlying this occurrence. Natural teeth have periodontal mechanoreceptors that transmit information about tooth loads, in contrast to osseointegrated dental implants that lack periodontal ligaments.^[6] This crucial cushioning permits the tooth to

Table 4: Maximum bite force measurement (newton) by Helkimo clinical (Di) for the implant group compared with the partially edentulous and fully dentate groups

Bite force	Helkimo Di	Study groups						Statistic
		Implant		Partially edentulous		Fully dentate		
		Mean	SE	Mean	SE	Mean	SE	
Right	Di0	227.814	14.872	207.811	11.786	259.067	13.405	3.721*
	DiI	222.047	9.257	196.454	10.299	241.547	7.952	6.601*
	DiII	211.641	15.592	167.078	12.183	225.357	26.354	8.523*
	DiIII	179.480	18.560	112.673	8.248	192.887	22.765	20.250*
F test		1.779		9.147*		2.786		
Left	Di0	223.255	15.870	202.009	11.989	256.754	13.564	4.085*
	DiI	218.354	9.503	190.739	10.388	238.862	7.927	7.569*
	DiII	204.480	15.596	160.901	12.331	218.241	25.809	16.797*
	DiIII	173.836	18.600	106.137	8.172	193.752	18.481	25.231*
F test		1.670		9.136*		2.464		
Anterior	Di0	147.801	5.617	131.372	4.626	168.742	5.100	13.087*
	DiI	142.070	3.388	126.433	3.637	161.707	3.047	34.338*
	DiII	138.300	5.119	117.318	4.087	156.507	10.474	9.528*
	DiIII	130.943	7.757	100.938	2.803	149.660	5.924	31.338*
F test		1.667		7.858*		1.085		

*Significant at $P \leq 0.05$

bend when being bit down, lowering the possibility of the tooth breaking and absorbing some of the stress that would otherwise be transferred to the jaw joints. There is increasing alarm that the use of dental implants will cause older people to experience severe TMJ problems. The concern is that since dental implants lack the cushioning that natural teeth do, chewing will be more stressful, resulting in dysfunctional wear and injury to the TMJs.^[8] Within the first few weeks after implant installation, TMD symptoms such as muscle aches, TMJ pain, and swallowing discomfort may appear, but they are thought to be self-limited.^[31,32] As a result, lengthy clinical procedures involving dental implant therapy, such as placing several immediate loading implants at once, would no longer be advised as the first course of treatment for individuals who have TMD or even just a history of it.^[33] The hinge axis of the TMJ, which is an imaginary line around which the working condyle rotates during lateral mandibular movement with the sagittal and vertical axes working simultaneously, can provide noticeably larger reaction forces at the intercuspal position of dental implants. In addition, dental implant treatment may affect the condylar position behind the centric occlusion which can negatively impact the masticatory system.^[34,35]

It had been reported that individuals who lose their teeth, especially posterior teeth have a higher prevalence of TMD.^[9] This may be due to the fact that losing some posterior teeth without restoration often causes the original occluding tooth/teeth to supra-erupt from the original upright position and causes the neighboring tooth/teeth to shift in angle. Once the tooth/teeth begin to shift in angle, the vector of force tends to increase tooth/teeth tilting, thus imposing a different biomechanical effect on the mandible.^[36] However, the present results

concur with previous reports that tight locking of the occlusion, a secondary change associated with supra-eruption, tipping or drift, and tilting of the posterior tooth/teeth, is associated with TMD.^[12]

Concerning bite force measurement, data analysis revealed that the mean value of MBF measurement for the right side, left side and anterior teeth were higher among the fully dentate group followed by the implant and finally the partially edentulous groups with statically significant differences among the three groups. In addition, results showed that the MBF measurement were decreased with increasing the severity of TMD symptoms with statically significant differences among the implant group for all measurements and among the fully dentate group for the right and left sides. The same figure was observed regarding Helkimo clinical dysfunction with statically significant differences among the partially edentulous group for all measurements. This result was in the line of many previous studies.^[5,22] This outcome may be as a result of the fact that each person's system has a different capacity for the stomatognathic system to respond physiologically to the altered bite force. It has been proposed that bite force measures may be impacted by TMD signs and symptoms. When compared to people without such pain, it has been found that discomfort in the masticatory muscles and TMJ can result in considerable alterations in the maximal biting force.^[21,37] In healthy patients, the maximum biting force was greater than in subjects with TMJ problems.^[38] However, tooth loss frequently results in significant masticatory system modifications that affect the muscles, oral mucosa, and bone structures.^[20] Numerous researchers have shown that patients with TMD have lower MBF values than healthy persons^[5,19,39]

CONCLUSION

According to the findings of this study, having dental implants increased the risk of TMJ diseases depending on the number of implants. In addition, bite force measures decreased as TMD symptoms became more severe. To analyze the risks and benefits of treating TMD in the context of implant rehabilitation, more clinical studies are required.

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Conflicts of interest

There are no conflicts of interest.

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