The relationship of postural body stability and severity of malocclusion

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Abstract

Objective: To evaluate the relationship between postural body stability (static and dynamic) and malocclusions of varying severity and to find whether different skeletal patterns showed variation in postural body stability. **Materials and Methods:** Seventy-five subjects were divided into three groups based on case complexity using ABO discrepancy index. Group A consisted of 25 subjects restricted to Class I skeletal base and an ABO score ≤ 10; Group B consisted of 25 subjects with either Class II or III skeletal base and an ABO score of 11–25; Group C consisted of 25 subjects with either Class II or III skeletal base and an ABO score >25. Postural body stability in both static and dynamic equilibrium was recorded using a computerized dynamic posturography. The average values were obtained for the scores obtained in each group and the data obtained wes subjected to statistical analysis using one-way analysis of variance and *post hoc* Tukey's test. A $P \leq 0.05$ was considered significant. **Results:** In both static and dynamic conditions, postural body stability was inversely proportional to the severity of malocclusion. The assessment of the overall body score showed that subjects in Group A and Group B had acceptable postural stability and only subjects with Group C showed statistically significant lack of postural stability. **Conclusions:** Our study showed that patients with malocclusion showed decreased stability and increased sway with increasing severity of malocclusion.

Key words: Computerized dynamic posturography, Malocclusion, postural body stability

INTRODUCTION

The orientation of the human body in space is referred to as posture. Postural body stability is the sustaining of the body in equilibrium by maintaining the projected center of mass within the limits of the base of support.[1,2] It is a complex mechanism influenced by multisensory inputs (visual, vestibular, and somatosensory) integrated in the central nervous system.[3] Research has shown that several factors such as head and neck position, oral functions, stomatognathic system, oculomotor, and visual systems affect postural stability.[4]

The stomatognathic system is considered to play an important role in postural stability. Malocclusion caused by deviation or deformities in any component of the stomatognathic system can also affect the masticatory muscles.[5] Researchers have suggested that masticatory muscle imbalance might affect not only the postural muscles of head and neck but also the cervical spine and pelvis resulting in a compensatory role in postural control.[6]

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The muscular and ligamentary connections to the cervical region through the temporomandibular joint (TMJ) makes a functional unit called the “cranio-cervico-mandibular system.” Studies have indicated a role for trigeminal afferents on body posture. Numerous anatomic connections have been described between trigeminal systems and the mesencephalic nucleus of the trigeminus (MNT). Connections have also been suggested between the MNT and vestibular systems, cerebellum, and portions of the midbrain which are involved with motor and gait control as well as gaze movements.[7]

Thus, the relationship between stomatognathic system and body posture is an area of interest. The effect of malocclusion on posture has been explored in the past, and it has been established that subjects with Class III malocclusion display a posteriorly displaced posture, and the opposite is true for Class II.[8] Studies have shown that subjects with TMJ dysfunction show alterations in head and body posture as compared to normal subjects.[9] Few studies have evaluated the effect of specific malocclusions on gait and body posture.[10] However, very few studies have evaluated the effect of malocclusion on postural body stability.

Thus, this study was conceived to evaluate the effect of malocclusion on postural body stability. Postural stability involves two main components, “static posturography which is a characterization of postural sway during quiet standing”[11] and dynamic posturography which is the “postural response to an external or volitional perturbation of the postural control system.”[12] It is logical to assume that if malocclusion affects postural body stability, patients with more severe malocclusions will show less postural stability.

Laboratory techniques commonly used to evaluate stability are posturometry, neuro equitest, stabilometry, arteriography, and electromyography. A recent advancement is the computerized dynamic posturography (CDP) which has been effectively used to assess balance in both static and dynamic modes.[13]

Thus, the aim of this study was to (1) evaluate the relationship between postural body stability (static and dynamic) and malocclusions of varying severity. (2) To evaluate whether different skeletal patterns showed variation in postural body stability.

MATERIALS AND METHODS

A total of 75 subjects seeking orthodontic treatment were screened for the study. A detailed case history and routine investigations for orthodontic treatment planning such as clinical photographs, study models, OPG, and lateral cephalogram were taken. The ABO discrepancy index was used to categorize the subjects into three groups based on case complexity[14] (Group A consisted of 25 subjects restricted to Class I skeletal base and an ABO score ≤10; Group B consisted of 25 subjects with either Class II or III skeletal base and an ABO score of 11–25; Group C consisted of 25 subjects with either Class II or III skeletal base and an ABO score >25).

Postural body stability in both static and dynamic equilibrium was recorded using a CDP. The CDP used was SportKAT 2000 which is commercially available for testing and/or balance training and consists of a circular platform with a movable floor. The platform is equipped with a two-axis electrolytic tilt sensor, fixed at the anterior edge of the circular platform and also quantifies position of the transverse plane[13] [Figures 1 and 2]. This device is widely used in clinics, hospitals, and community programs as a balance-testing and training device. Using the kinaesthetic ability trainer (SportKAT) 2000 we intended to provide performance analysis of balance with a clinically based tool more applicable to today’s clinical setting. SportKAT 2000 includes “virtual reality” software displayed on a 17” video screen for balance training and assessment.

The testing protocol requires the individual to stand barefoot on both feet on the platform with the knees slightly flexed without holding onto the handrail [Figure 3]. All tests were performed with the subject focusing on a designated marker on the computer screen. Instructions were given to the subject to attempt to maintain his/her stability. Recordings were performed for both static and dynamic equilibrium with the mandible in the postural rest position and habitual occlusion. Postural rest position was attributed using phonetic methods.

The subjects were given three familiarization exercises on the testing device, one static and two dynamic. All test studies were carried out at a hydraulic pressure (PSI) based

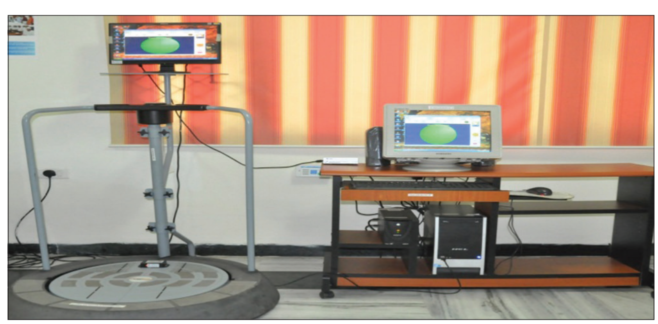

Figure 1: Kinaesthetic ability trainer – SportKAT 2000

on the subject's body weight (1PSI = 0.07 kg-force/cm^2) [Figure 4]. The objective of the static balance test was to maintain the platform at the initial level relative to the X and Y axes [Figure 5]. The objective of the dynamic balance test was to follow a round target in a clockwise and counter-clockwise moving circle for 30 seconds [Figure 6]. A numerical score was obtained, based on the actual time spent in the exercise and the distance from the center of the platform, measured every second. The score was calculated by measuring the distance from the tilted position to the reference position and adding up the absolute numbers over the duration of the test. The lower the score, the better the postural body stability.[15]

The average values were obtained for the scores obtained in each group and were subjected to statistical analysis using Statistical Package for Social Sciences (SPSS Inc., Chicago, Ill, USA) 15.0 software for windows. Inter- and intra-group comparisons were done using one-way analysis of variance and *post hoc* Tukey's test. A $P \leq 0.05$ was considered significant.

RESULTS

Intra-group comparison of mean static and dynamic balance scores with the mandible in rest and occlusion using *post hoc* Tukey test are documented in Table 1. In

Figure 2: Circular balance platform with two-axis electrolytic tilt sensor

Figure 3: Postural balance test

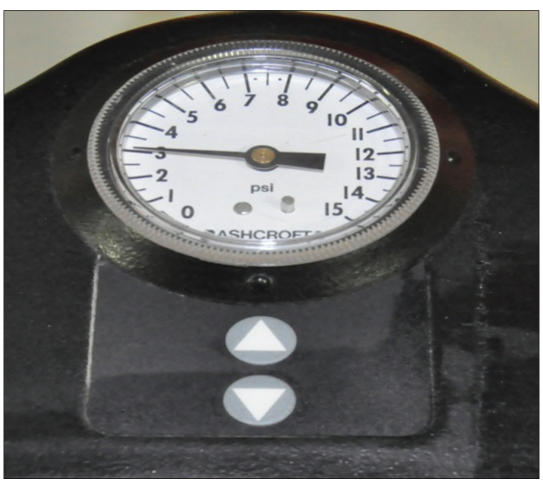

Figure 4: Hydraulic pressure scale

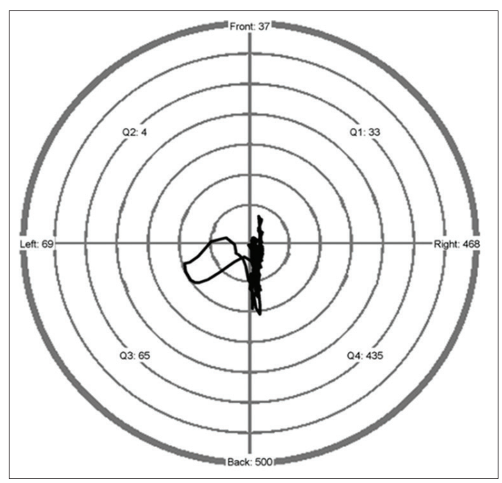

Figure 5: Numerical scoring for static balance test

Table 1: Intra-group comparison of mean (standard deviation) static and dynamic balance scores in rest and occlusion conditions of mandible

Groups	Rest (static)	Occlusion (static)	*P* (static)	Rest (dynamic)	Occlusion (dynamic)	*P* (dynamic)
A	249±34	235±42	0.862	1710±228	1635±432	0.352
B	338±69	308±57	0.714	3242±269	3242±317	0.635
C	694±439	457±204	0.006*	4088±383	3945±308	0.100

Group A and Group B, the comparison of mean static and dynamic balance scores between rest and occlusion did not show any significance. Group C ($P = 0.006$) showed statistically significant differences between rest and occlusion during static conditions. Intergroup comparisons of mean static and dynamic balance scores in rest and occlusion using *post hoc* tukey test are documented [Tables 2 and 3]. In rest and occlusion condition, Group A versus Group B scores was not statistically significant in static condition. On the contrary, Group A versus C and Group B versus C were statistically significant in both rest and occlusion positions. The results showed that for both static and dynamic conditions, postural body stability was inversely proportional to the severity of malocclusion. The assessment of the overall body score showed that subjects in Group A and Group B had acceptable postural stability and only subjects with Group C showed statistically significant lack of postural stability. The sway showed an increase with severity of malocclusion with the mild malocclusions showing the least postural sway [Table 4].

The results for both static and dynamic conditions for different sagittal jaw positions of mandible showed Class I displaying best postural stability and Class III displaying the least in both rest and occlusion conditions of mandible [Table 5]. Overall balance scores for static conditions were not very different between Class II and Class III, but Class I was significantly different, but significant differences were found in dynamic conditions [Tables 6 and 7]. Class II subjects tended to lean in the anterior direction and had less stability in that direction and the same applied to Class III patients in the posterior direction [Table 8].

Table 2: Intergroup comparison of mean (standard deviation) static balance scores in rest and occlusion conditions of mandible

Groups	Group A	Group B	Group C
A		0.275	<0.001**
B	0.374		<0.001**
C	0.008*	0.040*	

Table 3: Intergroup comparison of mean (standard deviation) dynamic balance scores in rest and occlusion conditions of mandible

Groups	Group A	Group B	Group C
A		<0.001**	<0.001**
B	<0.001**		<0.001**
C	<0.001**	<0.001**	

DISCUSSION

Orthodontics has stood out as an important field of dentistry which recognizes that the craniofacial complex is interlinked with body physiology and is significant in diagnosis and treatment planning. The stomatognathic system is a complex functional unit characterized by various structures involved in numerous functions. It has been established that the stomatognathic system by way of muscle, ligaments, and nerves forms numerous connections with the cervical region and higher centers of the brain which also control postural stability.[3-5,7,9,16]

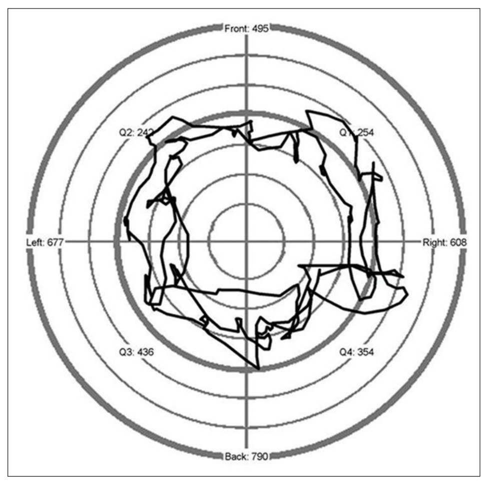

Figure 6: Numerical scoring for dynamic balance test

Table 4: Mean static and dynamic scores of postural body sway

Groups	Rest (static)		Occlusion (static)		Rest (dynamic)		Occlusion (dynamic)	
	Right	Left	Right	Left	Right	Left	Right	Left
A	239±39	9±20	230±45	4±14	923±212	787±182	795±197	840±259
B	298±94	40±51	286±73	21±37	1544±320	1697±342	1545±295	1715±266
C	500±193	190±382	386±136	70±156	2053±372	2021±342	1888±351	2056±303

Table 5: Mean static and dynamic balance scores of different sagittal jaw positions

Sagittal jaw positions (°)	Rest (static)	Occlusion (static)	Rest (dynamic)	Occlusion (dynamic)
Skeletal Class I ANB=2-4	249±34	235±42	1710±228	1635±432
Skeletal Class II ANB >4	453±199	358±122	3505±575	3473±469
Skeletal Class III ANB <0	566±458	401±197	3793±528	3278±413

The correction of malocclusion affords the patient several benefits such as improvement in esthetics, function, and oral health, substantiated several studies that show disorders of the craniofacial complex causing a change in the posture.[17-19] Research has unraveled evidence that suggests that untreated diseases of the stomatognathic system might affect body posture, stability, and gait.[3-5,7,9,16] However, to establish better the cause - effect relationship of malocclusion on postural body stability, this study was designed to evaluate and compare malocclusions of varying severity and their effect, on postural body stability.[9,16] In this study, we used the ABO discrepancy index to classify malocclusions.[14] Although the ABO discrepancy index is primarily used to assess the case complexity for Phase III clinical exams, it is an objective evaluation of case complexity based on traditional orthodontic records.

The kinesthetic ability trainer (SportKAT 2000) used in our study is economical, easy to apply and has proved to be reliable in evaluating both static and dynamic balance.[20] With advancements and refinement in technology, equipment available in clinical settings have made it easier and more practical to evaluate postural body stability.[13,15,20]

In our study, the assessment of the overall body score showed that subjects in Group A and Group B had acceptable postural stability and only subjects with Group C showed clinically significant lack of postural stability. This is in accordance with the parameters suggested by Johnston *et al.*, which stated that a static balance score above 500 was considered as poor postural body stability.[21]

Some of the additional findings in this study are the sway which showed an increase with severity of malocclusion with the mild malocclusions showing the least postural sway. The postural sway reflects the right to left load difference from the overall scores.

Although this was not the primary objective of the study, it was found that patients with displayed best postural stability and Class III display the least. Overall balance scores for static conditions were not very different between Class II and Class III, but Class I was significantly different. We also found that Class II subjects tended to lean in the anterior direction and had less stability in that direction and the same applied to Class III patients in the posterior direction.

Since no previous study has evaluated postural stability on the basis of severity of malocclusion, we have not been able to draw direct comparisons to previous studies. However, previous evidence which linked TMJ disorders and craniomandibular disorders to postural body stability substantiate our findings that the more complex the malocclusion, the more compromised the postural body stability.[17,22,23]

Table 6: Intergroup comparison of static balance scores of different sagittal jaw positions in rest and occlusion conditions of mandible

Sagittal jaw positions	Class I	Class II	Class III
Class I		0.014*	<0.001**
Class II	0.136		0.183
Class III	0.045*	0.618	

P<0.05-statistically significant. *Significant, **highly significant

Table 7: Intergroup comparison of dynamic balance scores of different sagittal jaw positions in rest and occlusion conditions of mandible

Sagittal jaw positions	Class I	Class II	Class III
Class I		<0.001**	<0.001**
Class II	<0.001**		<0.001**
Class III	<0.001**	0.003*	

P<0.05-statistically significant. *Significant, **highly significant

CONCLUSIONS

Our study showed that patients with malocclusion showed decreased stability and increased sway with increasing severity of malocclusion. Further long-term studies are required to conclude that correction of malocclusion would improve postural body stability, but the results of this study does indicate that malocclusion might have far-reaching effects on the overall health and well-being of the individual, and orthodontists need to recognize this and employ a multidisciplinary approach.

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Nil.

Conflicts of interest

There are no conflicts of interest.

Table 8: Mean anteroposterior scores for different sagittal jaw positions

Sagittal jaw positions (°)	Rest (static)		Occlusion (static)		Rest (dynamic)		Occlusion (dynamic)	
	Front	Back	Front	Back	Front	Back	Front	Back
Skeletal Class I ANB=2-4	39±49	209±61	42±57	192±77	808±233	903±136	820±252	815±261
Skeletal Class II ANB >4	349±205	104±153	271±162	87±79	1854±315	1650±298	1929±348	1566±279
Skeletal Class III ANB <0	119±137	443±362	78±117	322±128	1610±324	2183±408	1669±315	2059±271

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