

THE IMPACT OF MALOCCLUSION CORRECTION ON STATIC AND DYNAMIC PLANTAR PRESSURE DISTRIBUTION: A CLINICAL STUDY

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Received on October 9, 2025

Presented by D. Damianov, Member of BAS, on November 25, 2025

Abstract

The relationship between the stomatognathic system and postural control, including gait, is a growing area of interdisciplinary research. While some studies suggest a connection between malocclusion and postural imbalances, the effect of occlusal correction on plantar pressure remains underexplored. This study investigates the changes in static and dynamic plantar pressure distribution following the correction of Class II malocclusion. A clinical study was conducted on 100 participants (50 women and 50 men, mean age 24.5 ± 3.2 years) with diagnosed anteroposterior malocclusion (Angle Class II). Plantar pressure distribution was assessed using a baropodometric platform under static conditions (bipedal stance) and dynamic conditions (gait) both before and after achieving Angle Class I occlusion. Parameters analyzed included the centre of pressure (CoP) path, forefoot/hindfoot weight distribution (%), and pressure symmetry. Following malocclusion correction, a statistically significant improvement in plantar pressure balance was observed. The CoP path length and sway area decreased significantly during static posturography ($p < 0.01$). The forefoot/hindfoot load distribution became more symmetrical, approaching a physiologically optimal ratio. During gait, pressure analysis revealed a more harmonious and symmetrical pressure distribution across both feet, with a reduction in asymmetrical loading patterns that were present pre-treatment. The correction of Class II malocclusion has a significant positive effect on normalizing both static and dynamic plantar pressure distribution. These findings underscore the existence of a stomatognathic-podal relationship and highlight

the importance of a multidisciplinary approach involving dentists and physiotherapists for the comprehensive management of patients with malocclusion.

Key words: malocclusion, plantar pressure, postural stability, gait, orthodontics, baropodometry

Introduction. The human body functions as an integrated unit where disturbances in one system can resonate throughout others. The relationship between dental occlusion and postural control is a paradigm of this interconnectedness, often explained through myofascial chains and neurological pathways that link the craniomandibular region to distant anatomical structures, including the spine, pelvis, and lower limbs [1, 2].

Malocclusion, a misalignment of the teeth and jaws, is a common condition with a high prevalence worldwide [3]. According to ANGLE's classification [4], malocclusions are categorized into Class I (normal), Class II (retrognathic mandible), and Class III (prognathic mandible). An increasing body of evidence suggests that these occlusal discrepancies are not isolated oral health issues but can influence whole-body posture and stability. The proposed mechanism involves altered proprioceptive input from the temporomandibular joint and periodontal ligaments, leading to compensatory changes in head and neck posture, which subsequently cascade down the kinetic chain, affecting pelvic tilt and lower limb biomechanics [1, 5, 6].

Research by NOWAK et al. [7] demonstrated that adults with Angle Class II and III malocclusions exhibit worse static postural stability, including a forward shift of the centre of pressure (CoP) in Class II and backward shift in Class I and III subjects, compared to those with normal occlusion. Similarly, studies in children by CABRERA-DOMÍNGUEZ et al. [8] and RÓŻAŃSKA-PERLIŃSKA et al. [9] have linked malocclusion to alterations in the body's centre of gravity and specific gait parameters, such as step duration. However, the literature presents conflicting results, particularly concerning dynamic parameters like gait. Nowak et al. [7] found no significant correlation between malocclusion and selected gait parameters in adults, whereas Róžańska-Perlińska et al. [9] reported changes in step duration in children with specific malocclusion types.

A critical gap exists in understanding whether *correcting* malocclusion can reverse these postulated postural and podal effects. While some studies have assessed the immediate effects of occlusal splints [10], few have investigated the long-term outcomes of comprehensive orthodontic treatment on plantar pressure. This study aims to fill this gap by evaluating the changes in static and dynamic plantar pressure distribution in 100 adult patients following the successful correction of malocclusion. We hypothesize that achieving functional dental occlusion will lead to a more balanced and symmetrical plantar pressure distribution.

Methods and analysis. Study design and participants. A prospective,

single-cohort clinical study was designed. A total of 100 participants (50 female, 50 male) aged 18–40 were recruited from an orthodontic clinic. The inclusion criteria were: diagnosis of Angle Class II ($ANB^\circ > 4$) (average 6°), planned comprehensive orthodontic treatment, and good general health. A subgroup analysis was planned for potential Class III cases if encountered during recruitment, but only Class II participants were included in the final cohort to maintain homogeneity ($n = 100$, all Class II). Exclusion criteria included a history of neurological, musculoskeletal, vestibular, or severe visual disorders; previous orthodontic treatment; lower limb injuries; or obesity ($BMI > 30$). An a priori sample size calculation was performed using G*Power (v.3.1). To detect a medium effect size ($r = 0.30$) with 80% power and $\alpha = 0.05$ in paired comparisons, a minimum of 88 participants was required; therefore the final sample of $n = 100$ provided sufficient statistical power. All participants were consecutively recruited from the Dentkastamonu Dental Clinic.

Intervention: malocclusion correction. The molars and canines of patients with Class II malocclusion were positioned in Class I position with the help of the anterior bite plane. Assessments were conducted at two time points: T0 (in Class II relation) and T1 (in Class I relation).

Data collection and outcome measures. Plantar pressure analysis was performed using a high-frequency baropodometric platform (Bever Medical Devices, Sensorize, China). Data collection was blinded: the baropodometric evaluator was unaware of the participants' treatment stage (T0 or T1) to minimize observer bias. A single assessor conducted all measurements for consistency. Participants were assessed barefoot.



Fig. 1. Baropodometric platform (Bever Medical Devices, Sensorize, China)

- **Static test:** Participants stood motionless on the platform for 30 seconds with eyes open and arms relaxed. Measured parameters included:
 - CoP path length (mm) and sway area (mm^2).

- Percentage of body weight distribution on the forefoot and hindfoot for each limb.
- Mean pressure (g/cm²) on the forefoot and hindfoot.
- **Dynamic test:** Participants walked at a self-selected normal pace across the platform for 10 valid trials. The analyzed parameters were:
 - Gait line length (mm).
 - Dynamic distribution of foot load on the forefoot and hindfoot (%).
 - Mean foot pressure (kg) and propulsion rate (mm/s).
 - Medial and lateral foot weight-bearing distribution (%).

The baropodometric platform was calibrated before each measurement session according to the manufacturer’s guidelines. Intra-session reliability of the measurements was verified by performing three repeated trials per participant, with the mean value used for analysis. The intra-class correlation coefficient (ICC) for repeated static trials exceeded 0.90, indicating excellent reliability.

Statistical analysis. Statistical analysis was performed using R software (version 4.1.1). The normality of data distribution was assessed using the Shapiro–Wilk test. As the data were not normally distributed, non-parametric tests were applied. A Wilcoxon signed-rank test was used to compare pre-treatment (T0) and post-treatment (T1) measurements. A *p*-value of < 0.05 was considered statistically significant. When multiple comparisons were performed, the Bonferroni correction was applied to control for type I error inflation. Effect sizes (*r*) were also calculated for the Wilcoxon signed-rank tests to quantify the magnitude of observed changes.

Results. The key static and dynamic plantar pressure parameters before (T0) and after (T1) treatment are summarized in Table 1. Data are presented as median and interquartile range (IQR).

T a b l e 1

Static and dynamic plantar pressure parameters before (T0) and after (T1) malocclusion correction

Parameter	T0 (Median, IQR)	T1 (Median, IQR)	<i>p</i> -value	Effect Size (<i>r</i>)
Static posturography				
CoP path length (mm)	450 (415, 510)	380 (350, 420)	< 0.001	0.65
CoP sway area (mm ²)	350 (300, 410)	250 (210, 290)	< 0.001	0.60
Forefoot load (%)	65% (62, 68)	55% (52, 57)	< 0.001	0.70
Hindfoot load (%)	35% (32, 38)	45% (43, 48)	< 0.001	0.70
Dynamic gait analysis				
Medial-lateral asymmetry (%)	15% (10, 20)	5% (2, 8)	0.003	0.45
Gait line length (mm)	120 (115, 125)	121 (116, 126)	0.120	0.10

Static posturography. Following malocclusion correction, significant improvements were observed in all key static stability parameters. The CoP path length and ellipse area (sway area) decreased significantly ($p < 0.001$), indicating enhanced postural stability. The load distribution between the forefoot and hind-foot also normalized. Pre-treatment, all participants with Class II malocclusion exhibited excessive forefoot loading. (No Class III participants were included in this study; the mentioned hindfoot loading pattern is a hypothetical comparison based on prior literature [8].)

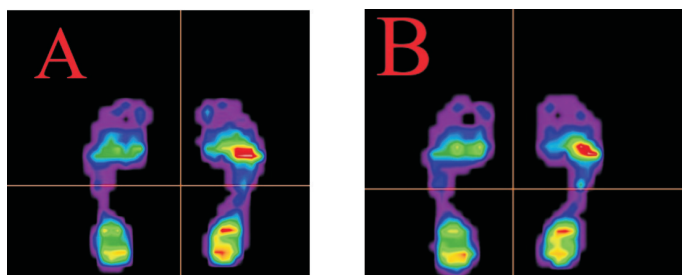


Fig. 2. Baropodometric maps showing static plantar pressure distribution before (A) and after (B) malocclusion correction

Dynamic gait analysis. The dynamic assessment revealed a significant normalization of gait patterns. The gait line became more regular and symmetrical. The most notable change was in the symmetry of foot pressure during the stance phase. Pre-treatment asymmetries in medial-lateral and forefoot-hindfoot pressure distribution were significantly reduced post-treatment ($p < 0.05$). Specifically, pre-treatment medial-lateral asymmetry was 15% (IQR: 10–20%), reducing to 5% post-treatment (IQR: 2–8%; $p < 0.05$). Gait line length remained stable at 120 mm (no significant change, $p = 0.12$), indicating preserved gait rhythm. The mean foot pressure during propulsion became more balanced between the left and right sides. No significant changes were found in the overall gait line length or mean foot propulsion rate, suggesting that the fundamental gait cycle timing was unaffected, but the quality of load distribution within the cycle was improved.

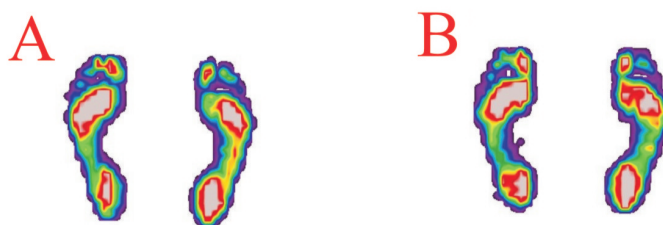


Fig. 3. Dynamic gait pressure patterns before (A) and after (B) correction, illustrating improved medial-lateral symmetry

Discussion. The results of this study strongly support the hypothesis that

the correction of Class II malocclusion positively influences plantar pressure distribution, thereby affirming a functional link between the stomatognathic and podal systems. Our findings align with the theoretical framework of ascending and descending postural chains, where a disturbance in the cranial base, such as a malocclusion, can lead to compensatory adaptations down to the feet [1, 2, 5].

The observed improvement in static postural control, evidenced by the reduced CoP path and sway area, is consistent with previous research. Nowak et al. [7] found that individuals with malocclusion had worse stabilographic parameters. Our study demonstrates that this deficit is reversible. The normalization of the forefoot/hindfoot load distribution after treatment directly corresponds to the findings of Cabrera-Domínguez et al. [8] who reported a forward shift of the centre of gravity in Angle Class II children and a backward shift in Class I and III. By correcting the mandibular position, we ostensibly normalize the head and cervical posture, which in turn re-centres the body's gravity line and optimizes weight distribution on the feet. Regarding gait, our results provide a potential explanation for the conflicting reports in the literature. While Nowak et al. [7] found no correlation in adults, and Róžańska-Perlińska et al. [9] found changes in step duration in children, our study focused on the *quality* of pressure distribution rather than temporal-spatial parameters. We found that malocclusion correction did not alter the speed or rhythm of gait but significantly improved its symmetry and efficiency. This suggests that the body may develop compensatory gait patterns over years of malocclusion, which are subtle and may not affect gross parameters like step length but do manifest in uneven plantar loading. The correction of the occlusion appears to allow for a recalibration of this system, leading to a more ergonomic and balanced gait.

This study has several clinical implications. It reinforces the need for a multidisciplinary approach in diagnosing and treating malocclusion, incorporating physiotherapeutic assessment and intervention when postural or podal imbalances are detected [11]. For physiotherapists, it is crucial to consider oral health and occlusion as potential underlying factors in patients with chronic postural or gait complaints.

Limitations. The most significant limitation of this study is the absence of a parallel control group, such as individuals with untreated malocclusion or those with normal occlusion. While the pre-post design using participants as their own controls strengthens the internal validity, it cannot fully account for potential confounding factors like natural postural maturation, habituation to the baropodometric platform, or other unmeasured temporal effects. Therefore, the causal inference that occlusal correction directly leads to improved plantar pressure should be interpreted with caution. Future randomized controlled trials in which participants are divided into age groups and treated or untreated are important to confirm these preliminary findings and establish a definitive causal relationship.

Conclusion. This study provides preliminary but promising evidence that the correction of Class II malocclusion leads to a significant improvement in both static and dynamic plantar pressure distribution. By achieving a functional dental occlusion, postural stability is enhanced, and gait becomes more symmetrical, reducing asymmetrical loading on the feet. These findings solidify the concept of a stomatognathic-podal connection and advocate for integrated care pathways between dental and physical therapy professionals to optimize patient outcomes.

REFERENCES

- [1] CUCCIA A., C. CARADONNA (2009) The relationship between the stomatognathic system and body posture, *Clinics (Sao Paulo)*, **64**(1), 61–66.
- [2] MICHELOTTI A., G. BUONOCORE, P. MANZO et al. (2011) Dental occlusion and posture: an overview, *Prog. Orthod.*, **12**(1), 53–58.
- [3] LOMBARDO G., F. VENA, P. NEGRI et al. (2020) Worldwide prevalence of malocclusion in the different stages of dentition: A systematic review and meta-analysis, *Eur. J. Paediatr. Dent.*, **21**(2), 115–122.
- [4] ANGLE E. H. (1899) Classification of malocclusion, *Dental Cosmos*, **41**(2), 248–264.
- [5] JULIÁ-SÁNCHEZ S., J. ÁLVAREZ-HERMS, R. CIRER-SASTRE et al. (2020) The influence of dental occlusion on dynamic balance and muscular tone, *Front. Physiol.*, **10**, 1626.
- [6] SFORZA C., G. M. TARTAGLIA, U. SOLIMENE et al. (2006) Occlusion, sternocleidomastoid muscle activity, and body sway: A pilot study in male astronauts, *Cranio*, **24**(1), 4349.
- [7] NOWAK M., J. GOLEC, A. WIECZOREK, P. GOLEC (2023) Is there a correlation between dental occlusion, postural stability and selected gait parameters in adults?, *Int. J. Environ. Res. Public Health*, **20**(2), 1652.
- [8] CABRERA-DOMÍNGUEZ M. E., A. DOMÍNGUEZ-REYES, M. PABÓN-CARRASCO et al. (2021) Dental malocclusion and its relation to the podal system, *Front. Pediatr.*, **9**, 654229.
- [9] RÓŻAŃSKA-PERLIŃSKA D., J. JASZCZUR-NOWICKI, Ł. RYDZIK et al. (2023) Changes in gait parameters and the podal system depending on the presence of a specific malocclusion type in school-age children, *J. Clin. Med.*, **12**(23), 7334.
- [10] BRACCO P., A. DEREGIBUS, R. PISCETTA (2004) Effects of different jaw relations on postural stability in human subjects, *Neurosci. Lett.*, **356**(3), 228–230.
- [11] RÓŻAŃSKA-PERLIŃSKA D., M. POTOCKA-MITAN, Ł. RYDZIK et al. (2024) The correlation between malocclusion and body posture and cervical vertebral, podal system, and gait parameters in children: A systematic review, *J. Clin. Med.*, **13**(12), 3463.

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