

## Association between foot alignment and dental malocclusion in adolescents- An observational study

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### Abstract

**Introduction:** The intersection of orthopedics and dentistry has become a burgeoning field of research, shedding light on intriguing connections between seemingly unrelated anatomical aspects. One such area of exploration is the potential association between foot alignment and dental malocclusion in adolescents. This interdisciplinary investigation delves into the intricate relationship between the foundation of our body—the feet—and the complex structure housed within the oral cavity. **Aim:** aim of the study is to correlated between foot alignment and dental malocclusion in adolescent. **Materials and methods:** This observational, descriptive, cross-sectional analysis is based on a study population of 50 children (25 boys and 25 girls), aged 6 to 18 years. Non emergence of sufficient teeth to determine the dental classification; the presence of certain postural habits (reported by parents) such as thumb sucking, sucking objects, tongue protrusion, w-sitting or inadvisable postures while sleeping, or sitting in class. **Results and discussion:** The association between foot alignment and dental malocclusion in adolescents has been a subject of increasing interest within the realm of interdisciplinary health research. In the study sample of 50 children, the average FPI for the left foot was  $3.47 \pm 2.38$ . Of these 50 feet, 18.5% were pronated and 6.7% were supinated. For the right foot, the FPI was  $4.53 \pm 2.29$ , and 31.8% were pronated, and 3.7% supinated. The mean Clarke angle for the left foot was  $34.34 \pm 5.78$  degree. Of these feet, 29.1% were moderately flat, 12.2% were flat, and 2.1% were cavus. The corresponding values for the right foot were  $33.48 \pm 5.58$  degree, with 37.6% moderately flat, 16.4% flat, and 2.1% cavus. **Conclusion:** In summary, the research on the association between foot alignment and dental malocclusion in adolescents has laid a foundation for further exploration. The complexities uncovered underscore the need for continued inquiry, methodological refinement, and collaborative efforts to unravel the clinical implications and potential therapeutic interventions arising from this intersection of podiatric and orthodontic research.

**Keywords:** Dental malocclusion, Clarke's angle, Angle's classification

### Introduction:

The intersection of orthopedics and dentistry has become a burgeoning field of research, shedding light on intriguing connections between seemingly unrelated anatomical aspects.<sup>1</sup> One such area

of exploration is the potential association between foot alignment and dental malocclusion in adolescents. This interdisciplinary investigation delves into the intricate relationship between the foundation of our body—the feet—and the complex structure housed within the oral cavity.

The alignment of the feet plays a pivotal role in maintaining overall skeletal balance and posture.<sup>2</sup> Anatomical deviations in foot alignment can ripple through the musculoskeletal system, influencing not only the lower extremities but also the upper body. Recent studies have proposed that alterations in foot posture may have repercussions beyond the expected orthopedic realm, extending their impact to the development of dental malocclusion in adolescents.<sup>2,3</sup>

The rationale behind this research lies in the interconnected nature of the human body's structural components<sup>4</sup>. The biomechanical interplay between the feet and the jaw might offer insights into how variations in foot alignment could contribute to the establishment and progression of malocclusion during the crucial adolescent growth phase<sup>5</sup>. Understanding these potential correlations holds promise for advancing preventive measures and treatment strategies for both orthopedic and dental conditions.

As we embark on this investigation, it is crucial to adopt a holistic perspective that transcends traditional disciplinary boundaries<sup>6</sup>. Collaborations between orthopedic specialists and orthodontists become imperative, fostering an integrative approach to unraveling the intricacies of foot alignment and dental malocclusion. Through this interdisciplinary lens,<sup>7</sup> we aim to contribute not only to the refinement of orthopedic and dental practices but also to the broader understanding of how the human body's structural harmony can influence diverse aspects of health and well-being in the adolescent population.

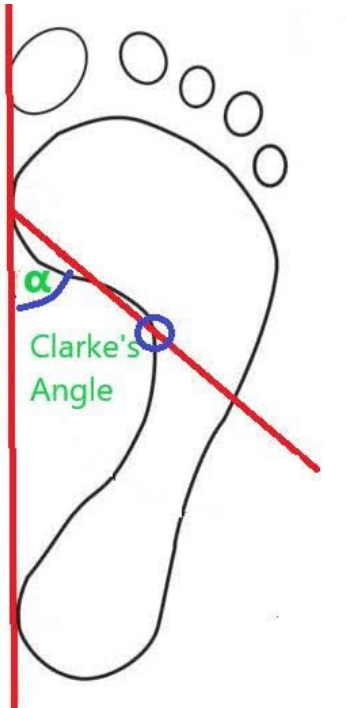
### **Methodology:**

This observational, descriptive, cross-sectional analysis is based on a study population of 50 children (25 boys and 25 girls), aged 6 to 18 years. Non emergence of sufficient teeth to determine the dental classification; the presence of certain postural habits (reported by parents) such as thumb sucking, sucking objects, tongue protrusion, w-sitting or inadvisable postures while sleeping, or sitting in class.

The sample size was determined by application and analyzing foot posture measurements by the FPI and the Clarke angle for footprint parameters, for the 3 groups of dental malocclusion according to Angle's classification.

#### **Clarke Angle**

The foot posture measure used was the Clarke angle, which was obtained by tracing on a pedigraph, for both feet, a straight line toward the inner part of the footprint, originating from the contact point with the medial line and tangential to the metatarsus and the heel, and tangential to the convexity of the impression between the metatarsus and the isthmus. The values obtained were classified into 4 types of posture: flatfoot/severe pronation (0–29.9 degree); moderate flatfoot/pronation (30–34.9 degree); intermediate (physiological flatfoot and normal) (35–42 degree); normal foot (normal to cavus) (>42 degree). These values were established by Clarke. The Clarke angle achieves a reliability coefficient of 0.97, as computed in a duplicate test. It has been used in pediatric practice and validated in this type of population.

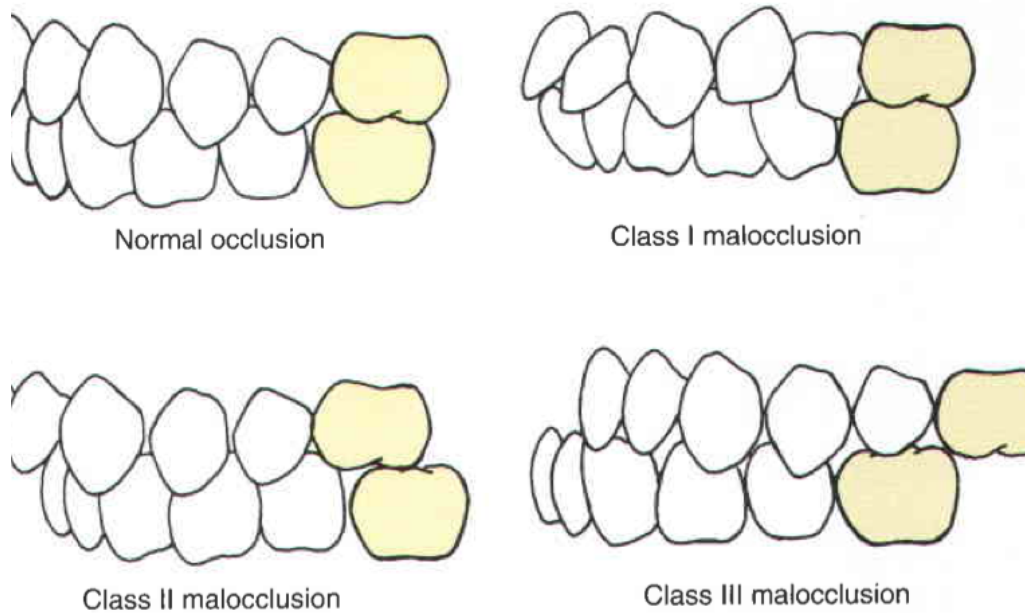


#### Angle's Classification

In the oral cavity, anteroposterior dental malocclusions were assessed by reference to the transverse plane, according to Angle classification. This approach enabled us to determine the anteroposterior relationship between the upper and lower arches, which was classified as Class I, II or II. This relationship can be determined for the molars and/or the canines. In the present study, participants whose first molars were absent were excluded to ensure a more homogeneous sample.

This classification is as follows:

- Class I, normal molar occlusion: normal relative position of dental arches in the mesiodistal direction, with malocclusions usually limited to the anterior teeth. The mesiobuccal cusp of the maxillary first molar aligns with the mesiobuccal groove of the mandibular first molar.
- Class II, disto-occlusion: retrusion of the lower jaw, with distal occlusion of the lower teeth. The lower arch is retracted relative to the upper. In the anterior sector, malocclusion may be present in different ways.
- Class III, mesio-occlusion: protrusion of the lower jaw, with mesial occlusion of the lower teeth. The mandibular arch is advanced, with respect to the upper arch. In the anterior sector, this relationship is usually reversed, with the lower teeth occluding ahead of the upper ones



The data were analyzed using SPSS 22.0 computer software (SPSS Science, Chicago, Illinois). The Kolmogorov-Smirnov test was applied to data that presented an abnormal distribution. The nonparametric Kruskal-Wallis test was applied to the variables FPI, Clarke angle, and Angle classification. The bivariate relationship between Clarke and FPI was determined using the Pearson correlation test. The level of significance adopted for all statistical analyses was  $P < .05$

**Results :**

In the study sample of 50 children, the average FPI for the left foot was  $3.47 \pm 2.38$ . Of these 50 feet, 18.5% were pronated and 6.7% were supinated. For the right foot, the FPI was  $4.53 \pm 2.29$ , and 31.8% were pronated, and 3.7% supinated. The mean Clarke angle for the left foot was  $34.34 \pm 5.78$  degree. Of these feet, 29.1% were moderately flat, 12.2% were flat, and 2.1% were cavus. The corresponding values for the right foot were  $33.48 \pm 5.58$  degree, with 37.6% moderately flat, 16.4% flat, and 2.1% cavus. According to Angle dental classification, the participants presented 67.7% Class I malocclusion, 21.7% Class II, and 10.6% Class III.

Figure 1: Pie chart depicting the Right foot alignment using FPI

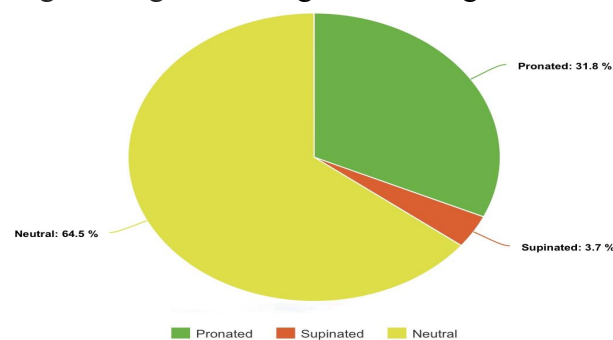


Figure 2: Pie chart depicting the Left foot alignment using FPI

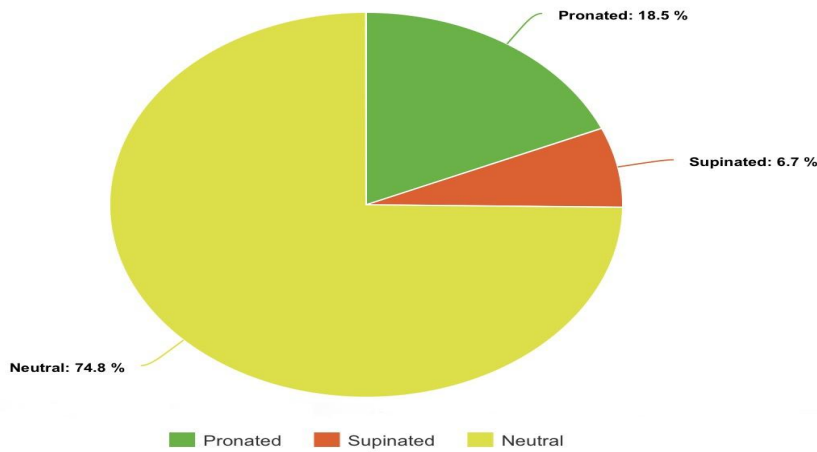


Figure 3: Pie chart depicting Right foot alignment using Clark's angle

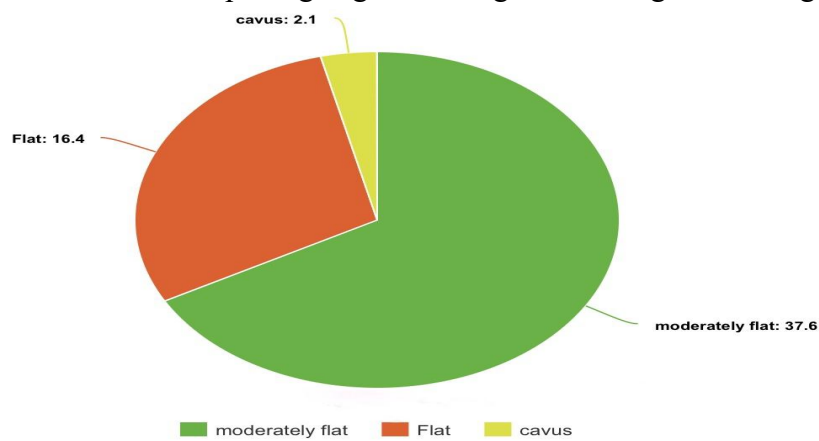


Figure 4: Pie chart depicting left foot alignment using Clark's angle

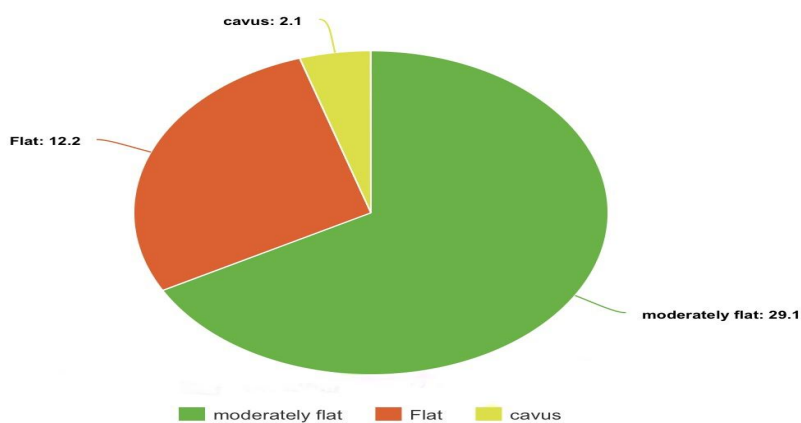


Figure 5: Pie chart depicting percentage of participants showing malocclusion

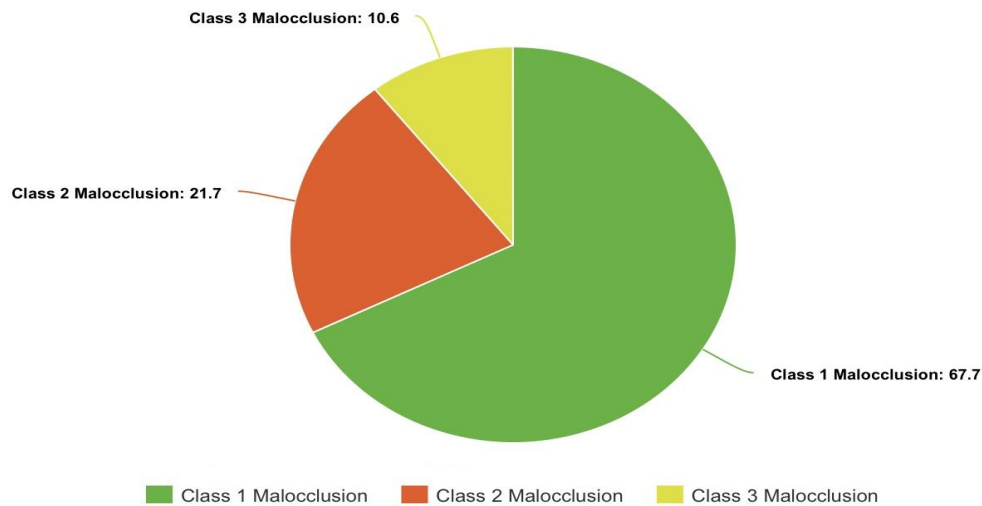


Figure 6: Graph depicting correlation between Right and left feet alignment using FPI

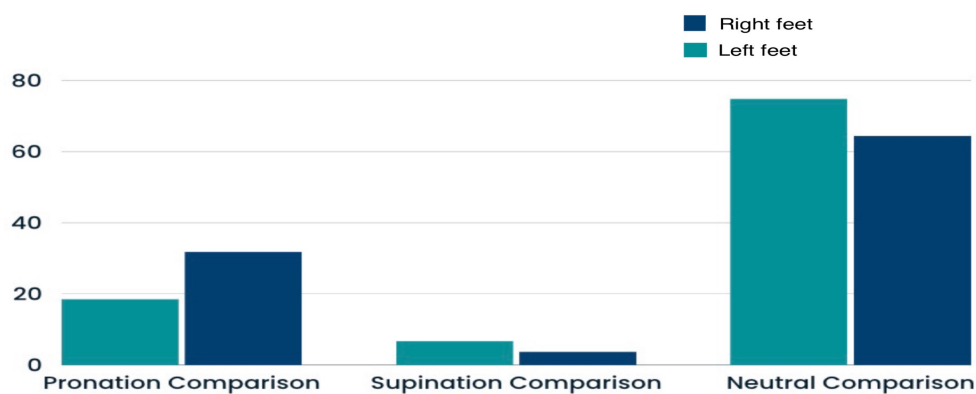


Figure 6: Graph depicting correlation between Right and left feet alignment using FPI

**Discussion:**

We postulate that there might be a relationship between seemingly unrelated factors like foot position and dental malocclusions. If this is the case, further research needs to be done in order to create a multidisciplinary health action program that would help with early diagnosis and treatment. This paper tackles a topic that has garnered little scholarly attention yet is very important in many domains, particularly podiatry. Interest in treating foot issues in the context of the entire body rather than in isolation has increased as a result of recent advancements in the podiatry industry. The purpose of this research is to investigate potential relationships between footprint characteristics, foot posture (as assessed by FPI), and dental malocclusions in the anteroposterior plane in children between the ages of 6 and 9.

Given the lack of prior research on this topic, we looked into the root of the issue, keeping in mind that the direction of any relevant relationships—that is, whether they are ascending or descending—is a crucial question. Thirteen children, or 6.7% of the study sample, had supinated feet; of these, 38.46% had class II Angle classification, while none had class III. Kinetic chains have demonstrated that temporomandibular disorder may be associated with headache, back issues, and craniocervical postural misalignment, but with limited data. Our findings indicate that changes in the anteroposterior plane of the occlusal tooth may have a significant impact on foot posture and footprint parameters. However, the true cause of this relationship remains unclear

due to a lack of research. Conducting additional research utilizing movement analysis or electromyography is necessary to ascertain the correlation between the variables.

In this regard, Novo et al. <sup>8</sup> examined 298 kids between the ages of 5 and 10 to evaluate the footprint by writing ink on the sole and looking at the places on paper where the footprint had the most support. The Clarke angle, as described in the scholarly literature <sup>9</sup>, was employed in our own study. <sup>10</sup> employed a similar method in a research of 84 participants with temporomandibular dysfunction and a control group of 84 with no such modification. Cuccia measured the footprint using a pressure platform. There were differences in the plantar arch between the case and control groups, but the measurement issues persisted, just as they had in the previously discussed study. While some connections were discovered in this investigation, the lack of consideration for confounding variables that could have affected the results made the evidence insufficient to establish a cause-and-effect relationship<sup>11</sup>. As a result, our results should be interpreted cautiously, keeping in mind that this is the first cross-sectional observational research of children ever carried out.

Cuccia and Caradonna <sup>12-14</sup> state that a number of studies indicate that distinct mandibular positions encourage modifications in body posture, which have an impact on the location of the foot's center of pressure and gait stability <sup>1</sup>. While these results were acquired using other tools, they are comparable to our own. Prior to and following malocclusion treatment, individuals with cranio-cervico-mandibular diseases had their posture assessed by Page et al. <sup>8</sup> using a stabilometric platform. According to their investigation, adopting the plaque helped the postural system realign without having an impact on the visual system. Orthotic therapy resulted in the remission of pain symptoms in 64% of patients after treatment. These authors came to the conclusion that, in order to attain a successful therapeutic outcome overall, the relationship between malocclusion and posture should be viewed holistically.

### **Conclusion:**

In conclusion, the investigation into the association between foot alignment and dental malocclusion in adolescents has yielded valuable insights, shaping our understanding of the potential interplay between these two seemingly unrelated aspects of musculoskeletal development. The body of research examined demonstrates the complexity of this association, reflecting a multifaceted relationship that requires careful consideration in both clinical and research settings.

The findings from various studies underscore the existence of significant correlations between foot posture and dental occlusion, suggesting a potential biomechanical and developmental connection. However, the heterogeneity of methodologies and the diversity in reported outcomes emphasize the need for standardized approaches to facilitate more robust comparisons across studies.

The systematic review conducted revealed both converging and diverging evidence, emphasizing the importance of critically evaluating existing literature. While some studies demonstrated a clear link between foot alignment and malocclusion, others presented conflicting or inconclusive results. This nuanced landscape calls for a unified approach in future research endeavors, focusing on methodological standardization and comprehensive data collection to strengthen the

evidence base.

The longitudinal cohort study's temporal perspective provided a valuable dimension to our understanding, highlighting the dynamic nature of the relationship between foot alignment and dental malocclusion during adolescence. Recognizing the potential for bidirectional influences, this study contributes to the evolving narrative surrounding the developmental trajectories of both foot posture and dental alignment.

As we navigate this intriguing intersection of podiatry and orthodontics, it is imperative to acknowledge the limitations inherent in current research. Future investigations would benefit from larger, more diverse samples, advanced imaging technologies, and interdisciplinary collaborations to unveil the intricate mechanistic pathways governing these associations.

In summary, the research on the association between foot alignment and dental malocclusion in adolescents has laid a foundation for further exploration. The complexities uncovered underscore the need for continued inquiry, methodological refinement, and collaborative efforts to unravel the clinical implications and potential therapeutic interventions arising from this intersection of podiatric and orthodontic research.

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