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Relationship between foot posture and dental malocclusions in children aged 6 to 9 years

A cross-sectional study

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Abstract

The aim of this study was to determine the association, if any, between foot posture and dental malocclusions in the anteroposterior plane, in children.

The study population consisted of 189 children (95 boys and 94 girls) aged 6 to 9 years. In every case, previous informed consent was requested and obtained from the parent/guardian and the study was approved by the Ethics Committee of the University of Málaga (CEUMA 26/2015H).

This observational, descriptive, cross-sectional analysis is based on a study population (STROBE). Qualified personnel conducted a podiatric and dental examination of each child, recording the Clarke angle and the foot posture index (FPI) as an outcomes measure in the feet, and also dental malocclusions, according to Angle classification.

A significant correlation was observed for the FPI scores (for right foot) as well as the Clarke angle (for right foot), in relation to dental malocclusions as determined by Angle classification ($P < .001$). Of all the supinated feet analyzed, 38.46% were Class II according to Angle classification, and none were Class III. Of the pronated feet, 48.57% were Class III, 42.85% were Class I, and 8.57% were Class II.

The Clarke angle decreases with the progression from Class I to III, whereas the FPI increases with that from Class I to III. These findings suggest there is a relation between the Clarke angle and FPI, on the one hand, and dental malocclusion on the other.

Abbreviations: CEUMA = Ethics Committee of the University of Málaga, FPI = Foot Posture Index, ICC = intraclass correlation coefficient, STROBE = Strengthening The Reporting of Observational studies in Epidemiology, WHO = World Health Organization.

Keywords: children, dental malocclusions, foot posture, temporomandibular disorders

1. Introduction

There is growing research interest in determining possible correlations between the stomatognathic system and body posture.[1,2] However, there is considerable controversy as to whether any correlations observed in experimental studies are actually of clinical relevance.

According to this hypothesis, functional disturbances (e.g., in chewing and swallowing) of the masticatory muscles may be transmitted to distal musculature along "muscle chains." Masticatory disorders, therefore, may provoke postural asymmetries and/or pain conditions, affecting in particular the musculature of the head and neck, shoulder, lower back and leg. Valentino et al (1991) used electromyography to reveal a functional relationship between mastication muscles and leg muscles, after artificially creating interdental occlusal dysfunction.[3]

It has also been suggested that this etiological chain of events may be reversed,[4] via the concept of the kinetic chain, that is, that coordinated motion derives energy from the lower extremity through the trunk up to the upper extremity,[5] through the coordinated sequencing of the segments. Thus, sequential activation of the lower extremities, pelvis, and trunk muscles is required to facilitate the transfer of appropriate forces from these body segments to the upper extremities.[6] Several studies have reported that biomechanical dysfunction of the trunk or lower extremities, involving core stability, hip range of motion, and foot posture, are related to elbow and shoulder injuries.[7,8] Body posture can be defined as the alignment of the torso and head with respect to gravity, the point of support, the field of vision, and internal references. Therefore, body posture is a static moment with very limited periods of oscillation, whereas body balance is a dynamic moment that can be maintained even if a major or minor oscillation of the body occurs.[9] Postural attitude is defined as the general posture of the joints in the body at a given time, whereas static postural alignment is the relative positioning

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AM-R and AL-S contributed equally to this work.

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards (CEUMA 26/2015H).

Informed consent: Informed consent was obtained from all individual participants (parents) included in the study.

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of several body segments and joints. Postural alterations may affect various body systems, including the stomatognathic system,[10] and posture-related pathologies are known to affect different parts of the body. Thus, the dental system might be influenced by disorders of the cervical spine,[11] pelvic, lordotic or thoracic inclination,[12] pelvic rotation,[13] and/or alterations in the body-muscle balance that could influence the mandibular position and facial morphology.[14]

The foot is subject to many possible alterations affecting plantar support. Foot disorders may affect the transversal, the frontal, or the sagittal plane. Transversal plane alterations include abductus and adductus foot. With respect to alterations to the frontal plane, the foot may be varus or valgus. On the sagittal plane, alterations can produce talus or equinus of the foot.[15] However, dental occlusion refers to the alignment of the teeth and to the intercuspal position. Malocclusion can affect various functions, including facial aesthetics and the status of the stomatognathic system. It is defined as a deviation from proper dental organisation, and can occur during craniofacial development. A classification of malocclusions was first proposed by Angle,[16] based on the anteroposterior position of the first molar, the malocclusion of which can affect skeletal relations. Alterations may occur in the vertical, sagittal, or transverse plane. The etiology of malocclusion is multifactorial, and subject to the influence of environmental and genetic factors. The prevalence of occlusal alterations in the anteroposterior position has been determined in various adolescent populations, with reported values of 70% in the United States, 77% in Venezuela, and 88% in Colombia. In Europe, the most prevalent malocclusion is Class I (normal molar occlusion) (79% of cases), followed by Class II (disto-occlusion) (18%) and class III (mesio-occlusion) (3%).[17–19]

According to the World Health Organization (WHO), malocclusions are the third most prevalent oral alteration among adults, after caries and periodontal disease. However, for the pediatric population worldwide, it ranks second in prevalence, preceded only by caries.[20] Among children, the prevalence among different age groups ranges from 20% to 93%.[21] A reliable diagnosis of the anteroposterior relationship between the dental arches may be made when complete primary dentition is achieved.[22] The range of postural alterations that can be readily compensated is greater in healthy individuals than in patients with occlusal problems.[14] Currently, most published data in this field refer to the effects of dental occlusion on head and body posture,[23–25] and very little information is available on the inverse effects of posture on malocclusion.[3,26]

Several risk factors are related to dental malocclusions.[27–29] Among these are structural disorders for temporal occlusion (the absence of diastemas in the upper and/or lower arch, upper and/ or lower dental crowding, non-coincident mid-lines, and so on). Other risk factors are postnatal, such as the premature loss of temporary molars or other temporary teeth, trauma with the loss of anterior teeth or proximal caries. Problems may also be related to demographic characteristics, such as inadequate oral hygiene, irregular or non-existent dental examination, or an inappropriate diet.[30,31] In addition, ethnicity has been associated with dental disorders. Thus, Traldi et al (2015) observed a relationship between ethnicity and facial morphology. On the contrary, these authors observed no association between ethnicity and dental arches.[22] However, another study reported that 60% of whites presented Class I malocclusion.[32]

Various alterations have been associated with dental malocclusions in children, including alterations in dentofacial aesthetics, chewing, breathing, speech, and physical and psychological balance.[33–36] The main clinical manifestations of mouth breathing appear in the craniofacial structures. Mouth breathers frequently suffer from dental malocclusions and craniofacial bone abnormalities. Chronic muscle tension around the oral cavity can widen the craniovertebral angle, affecting the posterior position of the mandible and narrowing the maxillary arch. The most common dental alterations are Class II malocclusions (total or partial) with the protrusion of the anterior teeth, cross bite (unilateral or bilateral), anterior open bite, and primary crowded teeth.[35]

Recent developments in the field of podiatry have spurred interest in treating foot complaints in the context of the whole body, and not in isolation. Therefore, it would be interesting to consider whether there exists an element of interrelation by which a craniomandibular dysfunction could be transmitted, via the muscular system, to the lower limbs, and vice versa, and if so, what form this interrelation might take.[37] Studies have been conducted to correlate body posture and pathologies of the temporomandibular system, but the findings reported are inconclusive and the question remains controversial.[38–40] In the present study, the age range was selected taking into account that malocclusions often start at an early age, being present in about 50% of primary teeth, a value that in some cases can rise to 70%.[41] The early recognition (at 6–9 years of age) of incipient malocclusions and, if appropriate, the provision of simple orthodontic attention could minimize or eliminate the need for costly treatment in the future.[42]

In addition, it may be possible to establish the anteroposterior relationship between the dental arches as soon as the primary dentition is complete,[22] and thus take initial steps toward establishing a protocol for early, multidisciplinary intervention in children, and optimizing the treatment provided. Accordingly, the aim of this article is to determine whether there is any correlation between foot posture, footprint parameters, and anteroposterior malocclusions.

2. Material and method

2.1. Design and sample

This observational, descriptive, cross-sectional analysis is based on a study population of 189 children (95 boys and 94 girls), aged 6 to 9 years, who were recruited during 2016, from a randomly selected public sector school in the province of Malaga, Spain by a sequence generator (http://www.random.org). Participants were selected for this study consecutively from those who satisfied the inclusion criteria (see below), following the STROBE (Strengthening the reporting of observational studies in epidemiology) checklist. The following inclusion criteria were applied: aged 6 to 9 years and informed consent provided by parent or guardian. Parents/guardians were previously informed about the study and completed a questionnaire with the data required on the participants. Exclusion criteria were: previous surgery of the lower limbs or the upper body; previous severe trauma that altered the child's initial posture; previous orthodontic and/or orthosis treatment; nonemergence 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.

This study was carried out in full accordance with the Declaration of Helsinki on ethical principles for medical research involving human subjects, and was approved by the Ethics Committee of the University of Málaga (CEUMA 26/2015H) (Spain).

The sample size was determined by application of the EPIDAT program, using a post hoc pilot sample to evaluate the statistical power, 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. The study was designed to detect changes exceeding 0.8 (high effect size) for a variation of the sample according to the above classification, with a type I error of 0.05 and a type II error of 0.2. This calculation produced a necessary sample size of 148 subjects, although in fact 189 were included, thus comprising the post hoc sample used for the calculation.

2.2. Procedure

Participants were selected by addressing a questionnaire to the parents/guardians of children within the stipulated age range, at the school chosen for this purpose. The questionnaire asked about the children's postural habits, concerning both the mouth and the lower extremities, including aspects such as thumb sucking, mouth breathing, snoring, previous traumas, previous orthodontic treatment, w-sitting, certain sleeping positions, and the use of plantar supports. All of these factors are incorporated into the inclusion/exclusion criteria applied in this study.

Following examination by the orthodontist and the podiatrist, any children found to be lacking the dental structures necessary for evaluation was excluded from the study.

For greater precision, 2 foot-related variables were measured: foot posture, to detect alterations in the 3 planes; and the footprint, to focus on the support provided and to determine whether any of these parameters was particularly influential.

2.3. Foot Posture Index

The first variable studied concerned the foot. Thus, the foot posture index (FPI) was obtained by an expert podiatrist, who was blinded to the results obtained by the orthodontist. The intraclass correlation coefficient (ICC) for intraobserver agreement was 0.95 to 0.98, a good result that is in line with the value of 0.893 to 0.958 reported previously.[43] The FPI is a 6-point tool for clinical assessment[44] that achieves acceptable levels of validity.[45] This index evaluates the multisegmental nature of foot posture in all 3 planes, and does not require the use of specialized equipment. Each index point is scored between −2 and +2, and so the possible total ranges from −12 (highly supinated) to +12 (highly pronated). The FPI measurements were collected at baseline to classify the results into supinated (−12 to −1), neutral (0 to +5), pronated (+6 to +8), and overpronated (+9 to +12),[46] and the following points were considered: talar head palpation, supra and infralateral malleolar curvature, calcaneal inversion/eversion, talo-navicular prominence, congruence of the internal longitudinal arch and abduction/adduction of the forefoot with respect to the rear foot (Fig. 1). The participants were evaluated in a relaxed position, standing on a bench at a height of 50 cm to facilitate measurement.

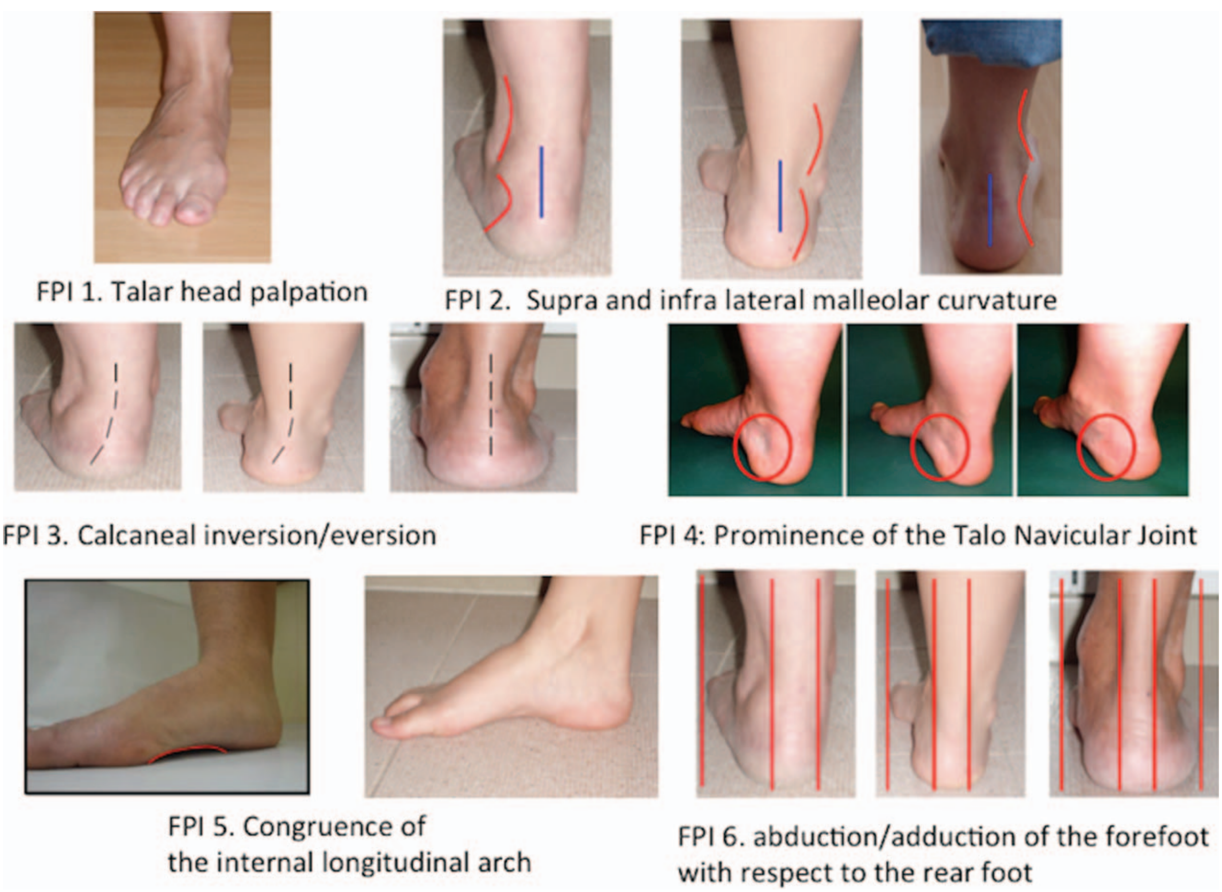

Figure 1. Different measures of the Foot Posture Index.

Figure 2. Measure of the Clarke angle.

2.4. The clarke angle

The second 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 (Fig. 2). 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.[47] The Clarke angle achieves a reliability coefficient of 0.97, as computed in a duplicate test.[48] It has been used in pediatric practice[49,50] and validated in this type of population.[51,52]

2.5. Angle dental 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.[16,53,54] 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[16] (Fig. 3).

The study data were collected by direct observation of the oral cavity, by an experienced orthodontist with more than 20 years of experience in the fiel private clinic, who was blinded to the podiatric results. Each participant was classified according to the dental occlusion observed. To avoid interoperator bias, all dental examinations were performed by a single orthodontic specialist. The reliability of the examiner was confirmed by intraexaminer repeat examinations for 30 subjects. The intra-rater ICC was 0.94 to 0.97.

The dental examinations were performed under natural light, in accordance with WHO recommendations. All the photographs obtained were taken by the examiner at the school, using, among other instruments, a flat dental mirror and a probe. Molar Classes I, II, and III were recorded, using the first permanent molars as reference teeth. Cases of half-cusp displacement less than normal were considered class I.[54]

Figure 3. Angle's dental classification.

Table 1

Anthropometric data and foot measurements.

	Mean	SD	95% CI	
Age, y	7.76	1.05	7.61	7.91
BMI kg/m^2	17.50	3.36	17.02	17.98
Clarke angle right, degrees	33.48	5.59	32.68	34.28
Clarke angle left, degrees	34.35	5.79	33.52	35.18
FPI Right	4.54	2.29	4.22	4.87
FPI left	3.47	2.38	3.13	3.81

CI = confidence interval, FPI = Foot Posture Index, SD = standard deviation.

2.6. Statistical analysis

To preserve the independence of data,[55] and based on the strong correlation between FPI scores for left and right feet achieved in previous studies,[44] although both were measured, for further statistical analysis only 1 foot (the right, chosen at random) was included in the statistical analyses.

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 $P < .05$.

3. Results

In the study sample of 189 children, the average FPI for the left foot was 3.47±2.38. Of these 189 feet, 18.5% were pronated and 6.7% were supinated. For the right foot, the FPI was 4.53±2.29, and 31.8% were pronated, and 3.7% supinated. The mean Clarke angle for the left foot was 34.34±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±5.58 degree, with 37.6% moderately flat, 16.4% flat, and 2.1% cavus (Table 1).

Table 2

Relation between foot measurements and dental malocclusions.

	N	Mean	SD	95% CI		*P*
Clarke angle						
Angle I	128	33.69	5.07	32.80	34.58	
Angle II	41	35.46	4.37	34.09	36.84	<.001
Angle III	20	28.10	7.59	24.55	31.65	
FPI						
Angle I	127	4.49	1.93	4.15	4.83	
Angle II	41	3.63	2.67	2.79	4.48	<.001
Angle III	20	6.70	2.32	5.62	7.79	

CI = confidence interval, FPI = Foot Posture Index, SD = standard deviation.

According to Angle dental classification, the participants presented 67.7% Class I malocclusion, 21.7% Class II, and 10.6% Class III.

The mean values for the foot measurements were well correlated, with $P < .01$ and a correlation of −0.610 among measures of the right foot.

In our analysis of the variables for the foot compared to the dental classification, there was found to be a relation between FPI and the Clarke angle and the dental classification, at $P < .001$. The Clarke angle tends to decrease as Angle classification increases from Class I to III, whereas the FPI is greater as Angle classification increases from Class I to III (Table 2).

Of the 13 supinated feet (6.7% of the total), 8 were Class I and 5 were Class II in Angle classification. Of the supinated feet, 38.46% were Class II, whereas none were Class III (Fig. 4).

Of the 35 pronated feet, 17 were Class III, 15 were Class I, and 3 were Class II. Of the 35 pronated feet, 48.57% were Class III, 42.85% were Class I, and 8.57% were Class II (Figure 4).

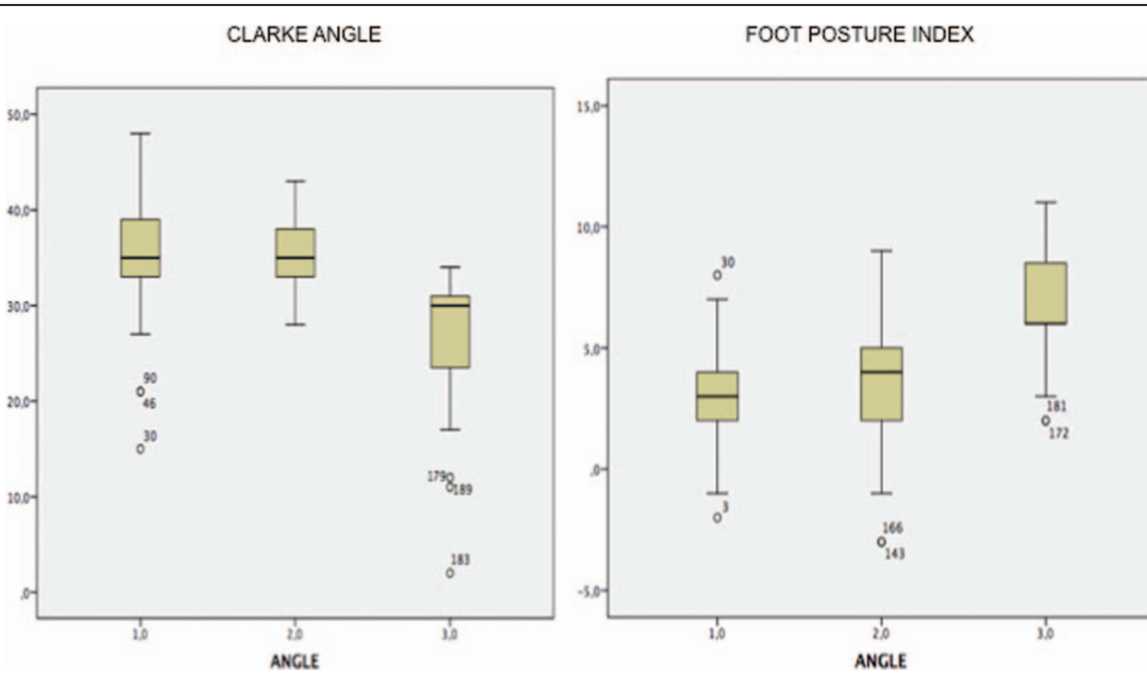

Figure 4. Box-and-Whisker plot of changes between Foot Posture Index, the Clarke angle, and Angle classification.

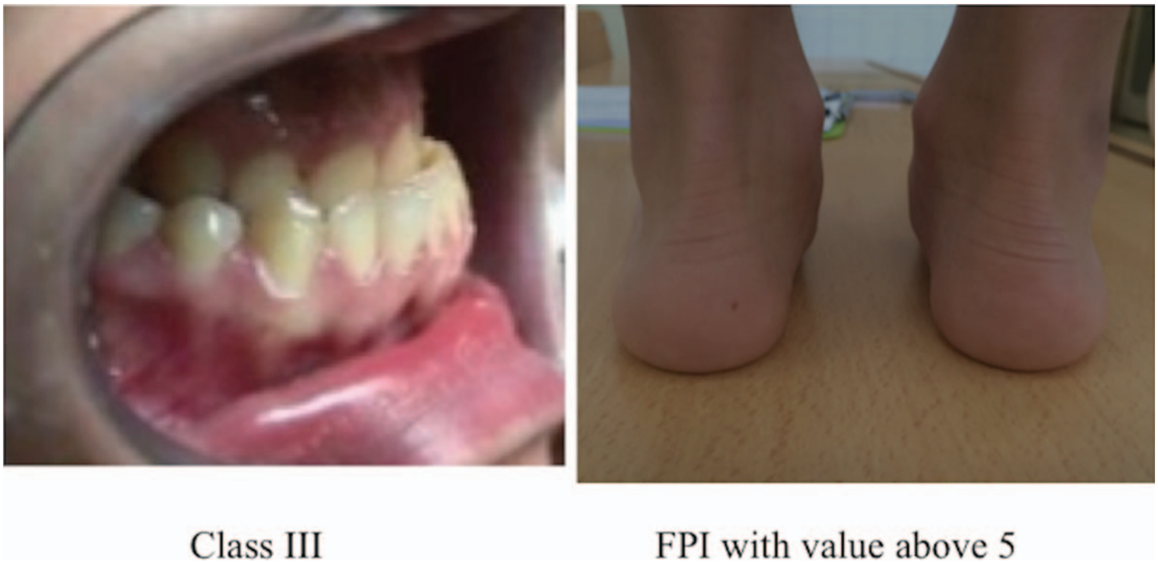

Figure 5. A participant who presented Class III in Anglé classification and a foot posture index >5.

Of the 20 participants who presented Class III in Angle's classification (10.6% of the study population), 85% presented a FPI with values >5, that is, with right pronated foot (Fig. 5).

4. Discussion

Our hypothesis is that there may be a relation between variables as apparently unconnected as dental malocclusions and foot posture. If this were so, further study should be undertaken to design a multidisciplinary health action protocol and thus facilitate early diagnosis and treatment. This study addresses an issue that is of great interest in a wide range of fields, especially in podiatry, but which has only recently attracted research attention.

Recent developments in the field of podiatry have spurred interest in treating foot complaints in the context of the whole body, and not in isolation. The aim of this study is to examine whether there is any correlation between foot posture (determined by FPI), footprint parameters and dental malocclusions in the anteroposterior plane in children aged 6 to 9 years.

Taking into account that no previous studies have been undertaken to analyze this issue, we sought to investigate the source of the problem, taking into account that an important question is that of the direction of the relation (if any), that is, ascending or descending. Supinated feet comprised 6.7% of the study sample (13 children), and of these 38.46% presented class II Angle classification, whereas none presented class III. In terms of kinetic chains, it has been shown (although on the basis of little evidence) that temporomandibular dysfunction may be related to back problems, headache, and craniocervical postural misalignment.[56]

Of the 35 pronated feet in our study sample, 48.57% presented Class III Angle classification and 8.57% were Class II. In 2013, Novo et al[57] reported that when Class II or Class III was present, children adopted positions that allowed them to compensate for their mandibular retraction or protrusion, respectively, by seeking a postural balance. Many studies have examined the relationship between the stomatognathic apparatus and body posture,[9] but few have been conducted to consider possible relations with more distant segments, taking into account variables providing suitable validity and reliability for both segments; among these, Rothbart[58] examined the relation between pronated feet, the innominate bones and vertical facial dimensions, and observed a positive relation between relatively pronated feet, anterior rotation of the hip, and a shortening of the vertical facial dimension. Valentino,[26] in a study based on electromyography, detected a correlation between the interdental occlusal plane and the muscles of the plantar arches.

Our results suggest there may be a strong relationship between foot posture and footprint parameters, on the one hand, and alterations in the anteroposterior plane of the occlusal tooth, although because of the dearth of research on this question we can only speculate on the real cause of this relation. Further study is required, using electromyography or movement analysis, to determine the relationship of the variables. In this respect, Novo et al[57] analyzed 298 children aged 5 to 10 years and assessed the footprint by marking the sole with ink and examining the areas of maximum support on paper. Our own study used the Clarke angle, as defined in the scientific literature.[48] A similar approach was taken by Cuccia,[59] who assessed the footprint using a pressure platform, in a study of 84 subjects with temporomandibular dysfunction and a control group of 84 with no such alteration. Differences in the plantar arch were observed between the case and control groups, but the same problems of measurement arose as in the previous study discussed.

Other studies made have been based on a single case report, such as Baldini[60] and Rivero et al.[61] The first of these analyzed a clinical case of dysfunction of the oral cavity and its relation with postural balance, measured on a force platform after the application of an intraoral splint. The second article analyzed the greater support on the right side of the rearfoot observed in a patient with Class III malocclusion.

According to Cuccia and Caradonna,[2] various studies suggest that different mandibular positions favor changes in body posture, affecting the position of the centre of pressure of the foot and gait stability.[62] These findings are similar to our own, but were obtained using different instruments. Chessa et al[63] used a stabilometric platform to evaluate posture changes in patients with cranio-cervico-mandibular disorders before and after treatment for malocclusion. Their analysis showed that adoption of the plaque facilitated a rebalance of the postural system, without affecting the visual system. After treatment, 64% of patients experienced remission of pain symptoms with orthotic therapy. These authors concluded that the relationship between malocclusion and posture should be viewed from a holistic standpoint in order to achieve an overall therapeutic outcome.

In the present study, although some associations were found, the evidence was insufficient to demonstrate a cause-effect relation, because of the nonconsideration of confounding variables that might have influenced the results obtained. Accordingly, our findings should be considered with caution, and taking into account that this is the first such cross-sectional observational study of children to be conducted.

A major limitation to our analysis could be a failure to consider the effects of natural change in growing children. However, in the understanding that it is from the age of 6 to 9 years that dental and podiatric treatment is usually started, expanding the sample and attempting to treat all the children who require it at an appropriate age would have greatly complicated the study design and implementation. Moreover, it was taken into account that the anteroposterior relationship between the dental arches can be established when primary dentition is completed, without the need to wait for mixed dentition to be present.[22] Another possible limitation to our study is the absence of a cephalometric analysis. Such a study, obviously, would provide information impossible to obtain by other means, but the aim of this study was to observe dental and non-skeletal malocclusion, clearly differentiating these concepts. Therefore, we decided not to perform radiographic studies of this population, as information on dental malocclusion can be obtained observationally.

Neither the vertical facial dimension nor the participants' body weight nor the type of body morphology was included as study variables. However, it might be useful to introduce these variables in future research, to determine whether they are relevant to the results obtained.

If a direct relationship was obtained between the study variables, this would represent an initial step toward providing a balanced, multidisciplinary approach to ensure the success of this treatment, with the publication of a protocol for early intervention. Clearly, clinical action addressing functional disorders of the mouth and teeth during periods of peak growth is important to prevent these alterations from becoming consolidated.

Experience has shown that the treatment of malocclusions at an early age is efficient and produces more stable results than at older ages.[64] Furthermore, it is important to note that the anteroposterior relationship established between the dental arches can be determined when the primary dentition is complete, without needing to wait for the mixed dentition to arrive.[22] At the podiatry level, it is from the age of 6 years when the physiological values are lost and more reliable measurements can be obtained.

Given the scant literature available on this research subject, and the controversy it nevertheless generates, a systematic review should be performed to evaluate the current knowledge available of the questions we consider. Such a review could lay solid foundations for a more extensive investigation.

In addition, a longer-term study is needed to take into account the effects of natural growth; alternatively, a study population with a wider age range, and with medium-term monitoring, should be considered so that the evolution of the participants can be properly determined. Other relevant variables that could be considered in future research include body mass index, sex, ethnicity, and the level of physical activity. As knowledge of this topic is currently so limited, this expanded approach would add great value to the results we present.

This initial study is intended to indicate useful directions for future broader-based research, enabling it to overcome the limitations of our work and advance it so that definitive conclusions may be reached concerning the presence or absence of correlations among the study variables.

5. Conclusions

We suggest there may be a relation between the Clarke angle, on the one hand, and the FPI, on the other, with dental malocclusion, such that the Clarke angle tends to decrease as Angle classification increases from Class I to III, whereras the FPI is greater as Angle classification increases from Class I to III. None of our study population had a supinated foot in association with Angle Class III, while approximately 50% of the pronated feet were associated with Angle Class III.

Author contributions

Conceptualization: Ana Marchena-Rodriguez, Noelia Moreno-Morales, Alejandro Luque-Suarez, Gabriel Gijon-Nogueron.
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Validation: Gabriel Gijon-Nogueron.
Writing – original draft: Ana Marchena-Rodriguez, Alejandro Luque-Suarez, Gabriel Gijon-Nogueron.
Writing – review & editing: Ana Marchena-Rodriguez, Edith Ramirez-Parga, Noelia Moreno-Morales, Maria Teresa Labajos-Manzanares, Alejandro Luque-Suarez, Gabriel Gijon-Nogueron.

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