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Postural changes in orthodontic patients treated with clear aligners: A rasterstereographic study

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ABSTRACT

Background: Correlation between malocclusions and body posture has been discussed in the last decades, but there is still a lack of consensus in existing literature. Rasterstereography allows tridimensional reconstruction of the spine, starting from the back surface analysis. So far studies which tested modifications of rasterstereographic parameters during orthodontic treatment, comparing with those obtained from untreated control group, are not available. Clear aligner treatment produces alteration of vertical height due to the occlusal coverage and, subsequently, a stimulation of periodontal receptors which causes an inhibition of the jaw closing muscles and, hypothetically, changes in mandibular posture.

Objectives: Evaluate possible correlations between orthodontic treatment and posture.

Materials and methods: Rasterstereographic values of 15 untreated patients and of 15 patients treated with clear aligners were compared at baseline, after 1, 3 and 6 months. Rasterstereographic parameters considered were the following: the kyphotic angle, the lordotic angle, the upper thoracic inclination, and the pelvic inclination.

Results: Correlations between Kyphosis Angle, Upper Toracic Inclination and Pelvic Inclination and body posture were found after 6 months of treatment with clear aligners.

Conclusions: Occlusal coverage caused by aligners could influence body posture not only for upper spine sections but also lower spine sections.

1. Introduction

Correlations between dental occlusion and body posture has been discussed and described in the last decades (Festa et al., 2003; Korbmacher et al., 2004; Robin, 1902). According to Kandel et al. (1991), the term “posture” indicates the position of the human body and its orientation in space. Posture involves the activation and the deactivation of muscles, under the control of central nervous system, and with a mechanism of postural adjustments. Through mechanism of feed-back and feed-forward, postural adjustments represent a critical role in postural control. Despite the growing interest in the field there is still a lack of general consensus regarding possible correlation between malocclusions and body, head and/or neck posture (Fromm and Lundberg, 1970; Gresham and Smithells, 1954). As regards the influence of dental occlusion abnormalities on remote musculoskeletal districts, it was hypothesised that jaw posture may influence distal muscles and cause postural adaptations at the spine cord level. Radiologic investigation is still considered the gold standard for analyzing spine modifications: however the biological costs of this kind of analysis is an important limitation in both clinical and research settings. Non-invasive methods for posture analysis have been introduced, such as posturographic platforms (Perinetti and Contardo, 2009) and rasterstereography (Berryman et al., 2008; De Wilde et al., 1992; Walsh and Breen, 1995). Posturographic platforms failed to detect an association between body posture and dental occlusion or, when detected, these were notably small and with poor clinical relevance (Manfredini et al., 2012).

Rasterstereography is an investigation method developed by Drerup and Hierholzer (1987) allowing the tridimensional reconstruction of the thoracic and lumbar spine starting from the back surface analysis.

Several studies concerning the relationship between the characteristics of the body posture determined by rasterstereographic procedures

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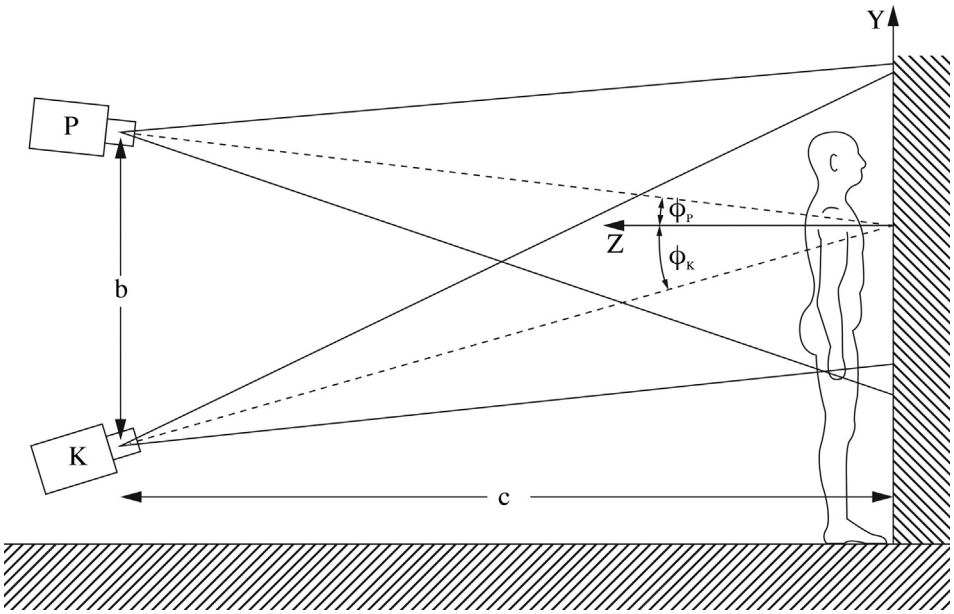

Fig. 1. Schematic illustration of rasterstereography.

and certain cephalometric parameters have been published in recent years. Results showed a strong association between cephalometric vertical parameters and body posture parameters (Lippold et al., 2006a, 2006b, 2007, 2005).

In our knowledge there is a lack of studies conducted to test the effects of orthodontic appliances on the rasterstereographic parameters during treatment. In the last decades an increasing number of patients expressed the desire for an aesthetic and comfortable orthodontic alternatives to fixed appliances. To answer this request clear aligners treatment (CAT) was introduced Rossini et al. (2015a, 2015b). Recent studies demonstrated that CAT is able to achieve predicted tooth positions with high accuracy (Grünheid et al., 2017) and that CAT can obtain clinical results that are comparable to those obtained with fixed appliances (Gu et al., 2017).

On the basis of these premises, the present study was conducted to answer the following clinical/research question:

(1) Does the orthodontic treatment with Invisalign® (Align Technology, San José, CA, USA) aligners produce posture changes during treatment?

The null hypothesis of the study is that no posture changes, evaluated by rasterstereography, in orthodontic patients treated with Invisalign® (Align Technology, San José, CA, USA) could be observed. Considering that aligners produce an alteration of the vertical height due to the occlusal coverage of both dental arches, and that a stimulation of periodontal receptors causes an inhibition of the jaw closing muscles (Erkelens and Bosman, 1985), changes in mandibular posture could be hypothesized during aligners treatments.

2. Materials and methods

The sample consisted of 15 patients (9 females and 6 males) with a mean age of 21.8 years. The patients were recruited at the Orthodontics Department of the Dental School of University of Turin, after a first analysis of all essential diagnostic data (anamnesis, photos, gypsum casts of the dental arches, ortopantomography, skull radiograph, cephalometric analysis). Control Group consisted in 15 patients (8 females and 7 males) with a mean age of 23.67 years.

Inclusion criteria were: patients with class I malocclusions, crowding < 8 mm, with permanent dentition, after the growth spurt, with all the teeth, with the exception of third molars.

Exclusion criteria were motor or neurological problems, internal diseases, orthopedic illness or trauma, orthodontic treatment (ongoing or preceding), extraction cases.

Participants were randomly assigned to one of the two groups:

1. *Study group:* orthodontic treatment was provided with Invisalign aligners (Align Technology, San José, CA, USA). The treatment plan of each patient was designed by the same operator. Treatment was conducted by post-graduate students under the supervision of an expert operator. All patients were provided with a precise sequence of aligners, to be replaced every two weeks, according to the standard treatment protocol (Ravera et al., 2016). Every month each patient was monitored to perform routine controls. Every patient was instructed to wear the aligners for 21 h per day as recommended by the producer.
2. *Control group:* These patients were untreated during the study period and were analyzed at the same timepoints of Study Group. They were enrolled in a control program consisting in monthly appointments to perform routine evaluations. Their orthodontic treatments were planned to start after 6 months from the beginning of the study

2.1. Rasterstereography

To measure spinal shape on the sagittal plane, a non-invasive technique called rasterstereography (Formetric 4D®, Diers International GmbH, Schlangenbad, Germany) was used. The good correlation between this optical analysis and rx findings was demonstrated in the past (Kandel et al., 1991; Korbmacher et al., 2004).

The Formetric 4D® (DIERS, International GmbH, Schlangenbad, Germany) is a largely used rasterstereographic system with excellent reliability (Guidetti et al., 2013; Mohokum et al., 2010). This kind of examination is based on photogrammetry technique, through a single shot of 0.04 s, which can perform accurate and reliable monitoring of body posture without ionizing radiations. It was developed from anatomical and biomechanical models, in order to obtain defined mathematical algorithms and a reconstruction of column curves and anatomical points (Drerup and Hierholzer, 1987; Frobin and Hierholzer, 1981). The machine projected a multiple light sections on patient's back from different directions and thus records the back shape information (Figs. 1 and 2). Rasterstereography showed a very high reliability for both linear and angular data (Drerup, 1982).

This study analyzes the patients (study group and control group) in