EVALUATION OF THE SKELETAL DIVERGENCE ANGLE ON ORTHOPANTOMOGRAMS

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ABSTRACT

Facial divergency patterns are important factors for orthodontists. Various growth patterns were associated with dental anomalies, including tooth agenesis. An early identification of these patterns might be critical in preventing severe complications. Orthopantomograms are more often available for dentists than lateral cephalograms. Skeletal divergence angle, which can be used to determine facial divergency patterns, might be measured on orthopantomograms in the lack of cephalograms. Our goal was to find a method to measure skeletal divergence angle on orthopantomograms. A total number of 80 orthopantomogram and cephalogram pairs were used for this study. There were certain differences between the angle values obtained from the cephalograms and the orthopantomograms, but these were not statistically significant. The method described might be helpful for a preliminary determination of the skeletal divergence angle on orthopantomograms in order to decide the next steps and refer the patient to a specialist.

Keywords: skeletal divergence angle, orthopantomogram, comparison of radiographs

INTRODUCTION

The concept of facial divergency and its two extreme patterns, hypo- and hyperdivergency were introduced by Schudy. These dysplasias are due to discordant vertical osteogenesis. Vertical variations and vertical dimension itself are very important factors for orthodontists [1]. Both craniofacial and dental development might be influenced by the same gene disorders. Some growth patterns were associated with dental anomalies like tooth agenesis. Early identification of these problems could be helpful in preventing severe complications

[2].

The various skeletal discrepancies in the vertical plane might be studied with by measuring the skeletal divergence angle. This angle is given by the intersection of the maxillary and the mandibular planes. Maxillary plane is defined by the Spina Nasalis Anterior and Spina Nasalis Posterior landmarks (SpNA- SpNP), mandibular plane being given by the Menton and Gonion landmarks (Me-Go). Based on the variation of the angle three patterns could be identified: hyipodivergent, (<23 grades), normodivergent (23-32 grades) and hyperdivergent (>32 grades) [3].

Skeletal divergency is important from the point of view of the rotation of the mandible, which has the main role in the facial position, growth direction of the condyles and the form of the mandible [4].

Our goal was to find a method to measure skeletal divergence angle on orthopantomograms (OPG), in order to make possible the early detection of skeletal discrepancies in the vertical plane, in cases when patients refer to average dental offices and no lateral cephalograms (LC) are available. Our second goal was to evaluate the variation of the skeletal divergence angle in the local population.

MATERIAL AND METHOD

A total number of 80 orthopantomograms were included in the present study from a local orthodontic patient population. The radiographs were randomly selected. Inclusion criteria: no orthodontic treatment in the anamnesis and presence of lateral cephalograms for comparison.

All radiographs were digitally evaluated and measurements were made with the Image Pro Insight 9.3 software. Cephalograms were analysed in the classical way: based on the cephalometric landmarks the maxillary plane (SnA and SnP) and the mandibular plane (Me and Go) were defined (Table I). At the intersection of the two planes the skeletal divergence angle was defined (Fig. 1).

Table I – Cephalometric landmarks used in the study

Landmark	Definition
Spina nasalis anterior (SnA)	The most anterior point of the anterior nasal spine
Spina nasalis posterior (SnP)	The point of intersection of palatum posterior durum, palatum molle and fossa pterygopalatina
Menton (Me)	The most inferior part of mandibular symphesis
Gonion (Go)	The most posterior inferior part of angle of mandible
Orbitale (Or)	The most inferior anterior point on margin of orbit
Condylion (Co)	The highest point on the head of the condylar process

In order to obtain the same angle on OPGs other cephalometric landmarks were taken. The maxillary plane was replaced with a modified Frankfurt plane which passes through the Orbitale (Or) and Condylion (Co) landmarks (Table I). In order to

obtain the mandibular plane a landmark was matched for the Me point, marked with Me' and for the Go point, marked with Go'. A line from the middle of the distance between the root of the lower canine and second incisor on the same side was projected perpendicular on the base of the mandible in order to define the Me' landmark (Fig. 2). The Go' point was defined by the most inferior part of the angle of mandible (Fig. 2).

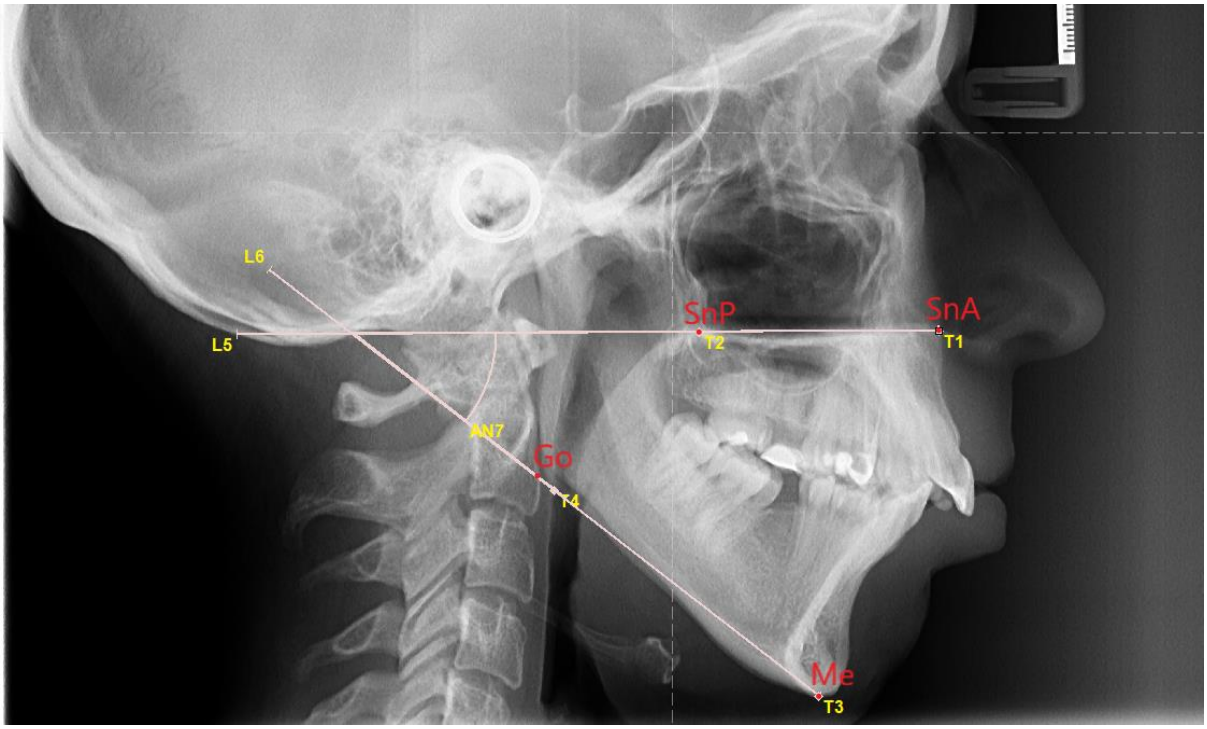

Figure 1 – Skeletal divergency angle measurement on lateral teleradiogram

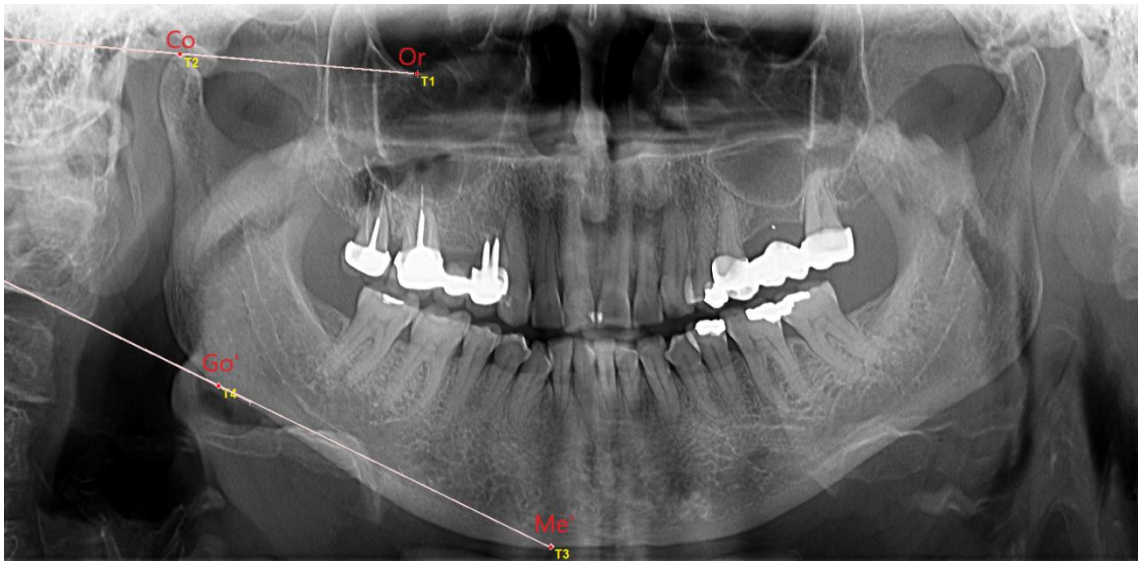

Figure 2 – Modified planes in order to measure the skeletal divergency angle on orthopantomogram

The skeletal divergence angles on the OPGs were measured on both sides. Measurements were done by the same operator to exclude interoperator biases. Ten pairs of radiographs were chosen for testing intraoperator reliability. These radiographs were remeasured after two weeks.

Statistical analysis was performed using GraphPadInStat software. As normal distribution of data was observed, t tests and chi square tests were used for finding the differences, the significance level was set at α=0.05.

RESULTS

From the evaluated radiograph pairs 40 were from men and 40 from women.

The results from the ten chosen radiograph pairs for testing intraoperator reliability showed no significant differences between the measurements of the same operator (*p>0.05*).

The differences between the angle values obtained from the LCs and the OPGs were not statistically significant (*p=0.08*). The largest difference between the angles measured on the radiograph pairs was 6.23 grades, an outlier value, occuring only once. In all the other cases the difference was lower than 3.21 grades, both values fitting in the same pattern.

In case of OPGs no statistical differences were detected between the skeletal divergency angle measured on the right side and the left side (*p=0.51* in men, *p=0.96* in women). Regarding differences between genders, no statistically significant differences were detected between male and female cases (*p=0.21*).

The average value of skeletal divergency angle in the studied population was 26±5.63: 25.07±5.38 in women, 26.92±5.78 in men. The majority of the studied population for both genders were normodivergent. In the case of hypodivergency differences were detected between genders: more women were hypodivergent than men, but the difference was not statistically significant (*p=0.15*) (Fig. 3).

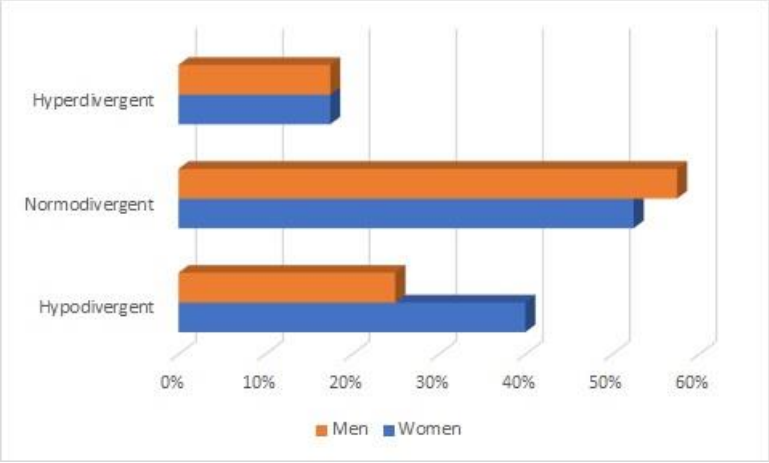

Figure 3 – Distribution of facial divergency patterns in the studied population

DISCUSSION

The methodology described in this paper might be useful in determining the skeletal divergence angle on orthopantomograms. An OPG is always more accessible than a LC. By this measurement the dental or skeletal origin of a malocclusion might be determined. This measurement can be done easily by every dentist when needed in order to refer the patient to a specialist. Further, the method might be helpful in explaining the treatment need and options to the patient, as this is an important factor for the patient to accept the proper treatment plan [5].

Several papers from the scientific literature studied the associations between different dental anomalies, growth and skeletal malocclusion patterns. Fernandez et al. (2018) found tooth agenesis to be associated with the hypodivergent growth pattern. This might be explained by a possible disturbance in the proliferation and development during odontogenesis or due to genetic influences [2].

Other studies refer to the associations between the severity of hypodontia and different skeletal patterns. Taju et al. (2018) found increased severity of hypodontia to be related to a retrusive maxilla with reduced mandibular plane angle and anterior lower facial height [6]. In these cases might be important to determine the facial divergency pattern of the patient. For this reason, skeletal divergence angle could be measured even on OPGs, as these are more often available than LCs.

Nohadani et al. (2008) compared orthopantomograms and cephalograms, assessing the vertical facial and alveolar changes. They consider that a lot of differences might result when comparing measurements on OPGs to the same measurements on LCs [7]. The main challenge in the present study was to determine the maxillary plane on OPGs despite the distortions. A modified Frankfurt plane was used, parallel with the maxillary plane. Measuring the skeletal divergency angles using the alternative planes lead to satisfactory results.

Kumar et al. (2017) compared themself the two radiograph types for measurement accuracy. They stated that OPGs might not have the same accuracy, but they give a higher diagnostic yield than LCs. Cephalograms are more exact in determining different parameters, but it is more difficult to make bilateral interpretations because of supraimposed structures. In addition, OPGs give an increased coverage of the dental arches, but the radiation exposure is reduced [8]. Our study is in accordance with these findings. OPGs make easier to measure parameters bilaterally without overprojection, although these radiographs have disadvantages, like distorsions, which could lead to errors [7,8]. In case of borderline values additional examinations are needed in order to determine the origin of the disorder. Additionally, the overbite, the cervico-incisal diameter of the teeth and the vertical dimension of occlusion might negatively influence the results of OPG measurements.

Armonic distribution of different facial divergency patterns in the studied population are in accordance with the results of other studies [1]. In the studied population the hypodivergent pattern was more often present in women than in men.

CONCLUSIONS

The method described in the present study, with certain limitations, is helpful for an easy, preliminary determination of the skeletal divergence angle on orthopantomograms in order to decide the next steps and refer the patient to an orthodont.

AKNOWLEDGEMENT

This paper was published under the frame of Internal Competition of Research Grants of University of Medicine, Pharmacy, Science and Technology „G.E. Palade", Targu Mures, Romania, Grant no. 15609/14/29.12.2017.

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