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Balance and thickness of soft tissue of the lower third of the face in different vertical patterns of growth

Баланс и дебљина меких ткива доње трећине лице код различитих вертикалних образаца раста

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SUMMARY

Introduction/Objective Variations in thickness of soft tissues can influence the position of facial structures as well as facial aesthetics.
The objective of the study was to determine whether the frequency of soft tissues imbalance depends on the vertical growth pattern of the face.

Methods The present study consisted of 90 pretreatment lateral cephalograms of adult Serbian Caucasian orthodontic patients (30 male and 60 female), between 18 – 27 years of age, average 23.6 years. Only the patients with the skeletal class I, based on the values of ANB angle and Wits appraisal, were chosen for the study. All patients were divided into three groups of 30 patients, those with hyperdivergent, hypodivergent and normal vertical growth patterns based on the values of Frankfort mandibular plane angle (FMA). Soft tissue of each patient was evaluated following the method given by Merrifield.

Results The obtained results showed that soft tissues of the chin and upper lip were thickest in hypodivergent and thinnest in patients with hyperdivergent growth type. The largest number of patients with soft tissue imbalance was observed in the normal and hyperdivergent vertical growth pattern groups, eight out of 30 patients. The number of patients with imbalance greater than 3mm was largest in the group with hyperdivergent growth pattern.

Conclusion The pathological skeletal pattern of growth combined with the common occurrence of soft tissue imbalance makes orthodontic treatment in hyperdivergent group of patients more difficult in comparison to patients with normal or hypodivergent growth pattern.

Keywords: soft tissue; face; imbalance

САЖЕТАК

Увод/циљ Варијације у дебљини меких ткива утичу на положај структура лица као и на естетику лица.
Циљ спроведеног истраживања је био да се утврди разлика у учесталост појаве дисбаланса меких ткива лица у зависности од вертикалног обрасца раста лица

Методе Спроведеним истраживањем је обухваћено 90 профилних снимака главе одрађених пре почетка ортодонске терапије код одраслих пацијената беле расе, Српске националности (30 мушког и 60 женског пола), узраста 18–27 година старости, просечно 23,6. Основни критеријум за укључвање у студију је било постојање I скелетне класе на основу вредности АНБ угла и на основу процене. Сви пацијенти су подељени у три групе од по 30 пацијената, оне са хипердивергентним, хиподивергентним и нормалним вертикалним обрасцем раста на основу вредности угла који заклапају франфуртска хоризонтала и мандибуларна раван Анализа меких ткива је спроведена на основу мерифилдове анализе.

Резултати Добијени резултати су показали да су мека ткива браде и горње усне најдебља код пацијената са хиподивергентним, а најтања код пацијената са хипердивергентним обрасцем раста лица. Највећи број пацијената са дисбалансом меких ткива присутан је у групи са нормалним и хипердивергентним обрасцем раста, 8 од 30. Број пацијената са дисбалансом меких ткива већим од 3 мм је највећи у групи са хипердивергентним обрасцем раста лица.

Закључак Патолошки образац раста комбинован са честом појавом дисбаланса меких ткива лица чини ортодонтску терапију пацијената са хипердивергентним обрасцем раста захтевнијом у односу на пацијенте са нормалним и хиподивергентним обрасцем раста.

Кључне речи: мека ткива; лице; дисбаланс

INTRODUCTION

Orthodontic therapy can affect the facial profile of a patient in both positive and negative ways. It is therefore important to devote special attention to the facial appearance of a patient

within a diagnostic procedure and planning of orthodontic treatment. It is necessary to define what affects the profile. The pattern of facial skeletal growth, the position of the incisors but also soft tissues significantly contribute to the appearance of a patient profile. Variations in thickness of soft tissues can influence the position of facial structures as well as facial aesthetics [1].

Facial disharmonies that are not the results of skeletal or dental distortions are generally the result of poor soft tissue distribution [2].

Before starting to move teeth, an orthodontist needs to understand the consequences of these movements on profile aesthetics [3].

Charles Tweed was one of the first people to show interest in the facial proportion and harmony of a patient within the orthodontic treatment [3]. There are a lot of methods of profile aesthetics assessment in orthodontics, and some of them are based on Ricketts' E lines, Merrifield's Z lines or Steiner's S lines [4, 5, 6].

It seems that modern orthodontic literature does not pay enough attention to the importance of soft tissue analysis when it comes to establishing the diagnosis and making the therapy plan. The largest number of studies are concerned with tracking the changes in thickness of soft tissues which occur during the treatment [7, 8]. There are also studies which deal with the analysis of soft tissues in horizontal type of malocclusion [9, 10]. Krooks et al. [11] claim that sagittal dimensions of the face influence facial esthetics more than the vertical dimensions.

Just a small number of studies investigate the thickness of facial soft tissues in relation to the vertical facial growth pattern [12].

The knowledge of soft tissue characteristics of the lower part of the face in correlation to the vertical facial growth pattern would certainly contribute to a better understanding of the vertical types of malocclusion and help us to make easier decisions and treatment plans in these

patients.

The aims of the conducted research were to establish the difference in thickness of the soft tissues of the lower third of the face in patients with the first skeletal class and different vertical growth patterns and to determine whether the frequency of soft tissues imbalance (STI) depends on the vertical growth pattern.

METHODS

This cross-sectional retrospective clinical research was conducted on 90 lateral cephalograms of adult Caucasian orthodontic patients of the Clinic of Dentistry in Niš, Serbia (30 male and 60 female), between 18 – 27 years of age, average 23.6 years, obtained as part of a diagnostic procedure before the beginning of the orthodontic treatment.

All lateral cephalograms were taken by orthophos SL 3D (Densply Sirona, Norway) under standardized conditions with the mandible in centric occlusion and without contraction of the facial soft tissues. All cephalograms were traced manually by the same investigator on acetate paper. The linear measurements were made with the help of a millimeter ruler. Corrected values of linear measurements were recorded to eliminate magnification error of 10%.

Signed information documents and the consent of patients to participate in the study were obtained. The study was approved by the Ethics Committee of the Clinic of Dentistry in Niš, No 14/8-2019-2 EO.

The criteria for the participation in the study were the following: patients should not have a history of orthodontic or prosthetic treatment; they should not be undergoing an orthodontic treatment; they should not have dentofacial deformity or a forced bite.

Only the patients with the skeletal class I, based on the values of Steiner ANB angle ($1^{o} \leq ANB \leq 3^{o}$) and Wits appraisal ($\pm 1$) were chosen for the study [13].

The radiographs without matching between ANB angle and Wits appraisal values were excluded from the study.

The patients who participated in the study were divided into three groups of 30 patients, 10 male and 20 female: those with hyperdivergent, hypodivergent and normal growth patterns based on the values of Frankfort mandibular plane angle (FMA) from Tweed-Merrifield analysis [6]. This angle is formed by the Frankfort plane (orbitale-porion) and the mandibular plane, constructed by the points of menton and gonion.

Patients with FMA angle 21º or less were considered to have hypodivergent growth patterns [3].

The ones with FMA angle values between 22-28º were considered to have normal growth patterns, while the patients with the angle wider than 28º were considered to have hyperdivergent growth patterns [3].

The analysis of sex differences was not conducted due to the uneven distribution between the sexes.

Each patient was evaluated following the method given by Merrifield [6] (Figure 1). The thickness of the upper lip was measured as the distance from the greatest curvature of the labial surface of the maxillary central incisors to the vermilion border of the upper lip. The chin thickness was measured as the distance between the skin pogonion and perpendicular projection of this point on the NB (Nasion-pt B) line.

All the measurements of the profile image were performed by the same examiner (orthodontist), The analysis of 20 profile images was repeated after two weeks in order to insure reliability. Intra-class correlation coefficients were performed to assess the reliability for the measurements. The values of coefficients of reliability were found to be greater than 0.90 for all the variables.

It was considered that the patients with the same thickness of the chin and upper lip or

patients whose chin thickness exceeded the thickness of the lips had a balanced soft tissue ratio.

On the other hand, the patients with the thickness of the upper lip greater than the chin thickness had soft tissue imbalance.

All patients with diagnosed STI were divided into those whose upper lip thickness exceeded chin soft tissue thickness by 3 mm or less and those whose imbalance was bigger than 3 mm. We considered that a soft tissue imbalance greater than 3 mm can lead to noticeable profile disorders even in those patients with a good skeletal growth pattern and a position of the frontal teeth.

Statistical data analysis was performed by the SPSS program. Continuous variables are given as means, SD (standard deviations) and (medians). Categorical variables are given as absolute numbers (N) and in percentages (%). Normality of the distribution of continuous variables was established by the Shapiro-Wilk test. The comparison of the examined parameters between the groups was performed by the Student's t-test of independent samples. Intra-class correlation coefficients were used to assess the reliability of the measurements.

RESULTS

Soft tissues of the chin and upper lip are thickest in hypodivergent growth pattern patients, thinner in normal vertical growth pattern, and certainly thinnest in patients with hyperdivergent growth type (Table 1).

Thickness of the chin soft tissue is statistically significantly higher in hypodivergent growth pattern group compared to the normal and hyperdivergent growth pattern group ($p < 0.001$).

The values of the upper lip thickness in hypodivergent group are statistically significantly higher compared to the normal growth pattern group ($p<0.05$) and hyperdivergent growth pattern group ($p<0.001$) (Table 1).

The largest number of patients with STI was observed in the normal and hyperdivergent vertical growth pattern groups, 8 out of 30 patients, (26.7%), while the smallest number was observed in the hypodivergent growth pattern group, 4 out of 30, (13.3 %) (Figure 2).

In the normal vertical growth pattern group, only 2 patients (6.7%) had soft tissue imbalance greater than 3 mm; in the hyperdivergent growth pattern group there were 5 patients (16.7%), while in hypodivergent growth pattern group there was only 1 patient (3.3%) (Figure 3).

Intra-class correlation coefficients were performed to assess the reliability for the measurements in the study. The values of coefficients of reliability were found to be greater than 0.90 for all the variables.

DISCUSSION

The analysis of soft tissues plays a significant role in orthodontic diagnosis and in achievement of good facial aesthetics [14]. Even though soft tissue is often overlooked in modern orthodontic practice, Holdaway [15] claims that the results of an orthodontic therapy are significantly better if soft tissue is taken into consideration during the process of establishing a diagnosis.

Considering that there are differences in the thickness of the facial soft tissues in patients with different sagittal malocclusions [10], the conducted research included just patients in skeletal class I based on the values of ANB angle. Wits analysis was used in order to overcome the limitations of ANB angle like recording a wrong value with altered antero-posterior or vertical position of nasion or in case of increased or decreased vertical height of the face [16].

Our research has shown that soft tissues of the chin are thickest in hypodivergent patients, slightly thinner in patients with the normal vertical growth pattern, and definitely thinnest in patients with hyperdivergent growth type. Such a result is expected having in mind that soft

tissues are stretched due to the rotation of the mandible in clockwise direction in patients with hyperdivergent growth type.

Changes in the facial soft tissue thickness also occur with aging. The thickness of the soft tissues of the chin, increases for example [17]. Ferrario et al. [17] noted that the signs of facial aging appear even after the age of 30. It should be emphasized that the patients in our examined group were significantly younger than the mentioned age.

Our results coincide with the results of Ashraf et al. [14], Pertović et al [18], Somaiah et al. [1], Al-Mashhadany at al. [19] as well as Celikoglu et al. [20]. In fact, Celikoglu et al. [20] claim that statistically significant difference in chin soft tissue thickness of patients with different vertical growth patterns exists only in females, not males. Female patients prevail in our study, which explains the coincidence of our and their results.

Our results do not coincide with those of Nanda et al. [21] who came to the conclusion, while investigating southern Europeans, that the greatest thickness of soft tissues of the chin in the area of pogonion is present in people with hyperdivergent growth patterns. Vertical pattern implies that the chin is distally positioned. Nanda explains the results by the tendency of soft tissues to preserve normal profile by their thickness.

The conducted research has shown that the upper lip thickness correlates with the vertical growth pattern, too. Here, as a rule, its thickness is greatest in hypo, then normal and lowest in patients with the hyperdivergent growth pattern. These results also coincide with those of Ashraf et al. [14].

A balanced relationship of the upper lips and soft tissues of the chin has a direct impact on the beauty and harmony of the face [21]. Upper lip thickness should be equal or somewhat lower than the soft tissue thickness of the chin. If there is the opposite situation, there is an imbalance of soft tissues which means that the upper incisors have to be moved distally in order to improve the profile aesthetics [22].

Our research has shown that the number of people with STI was largest in the groups with the normal and hyperdivergent vertical growth pattern. Still, the number of patients with STI greater than 3mm was largest in the group with hyperdivergent growth pattern.

Pathological skeletal pattern of growth combined with severe soft tissue imbalance makes orthodontic treatment in hyperdivergent group of patients more difficult in comparison to the other vertical types of growth. Retraction of the upper incisors in these group of patients is often needed in order to obtain a more balanced facial profile because lip retraction follows tooth retraction.

There is no similar data with which we could compare ours in the reference literature. New research on this topic should be conducted on a larger sample in order to get more relevant data and compare it to the obtained results.

CONCLUSION

Soft tissues of the chin and the upper lip are thickest in patients with hypodivergent, and thinnest in patients with hyperdivergent growth pattern. The largest number of people with severe soft tissue imbalance is present in the hyperdivergent growth pattern group, which implies that special attention is required in treatment of these patients. Pathological skeletal pattern of growth combined with soft tissue imbalance means that it takes more efforts in order to achieve good facial aesthetics at the end of treatment.

Conflict of interest: None declared.

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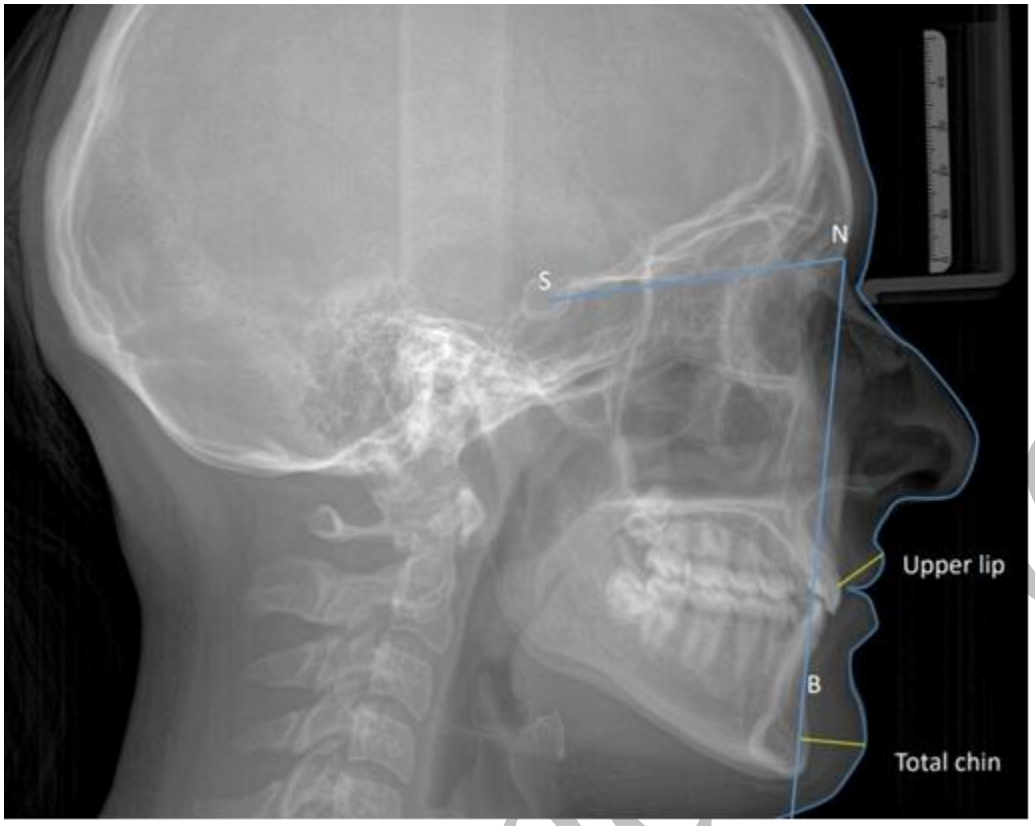

Figure 1. Facial soft tissue analysis given by Merrifield

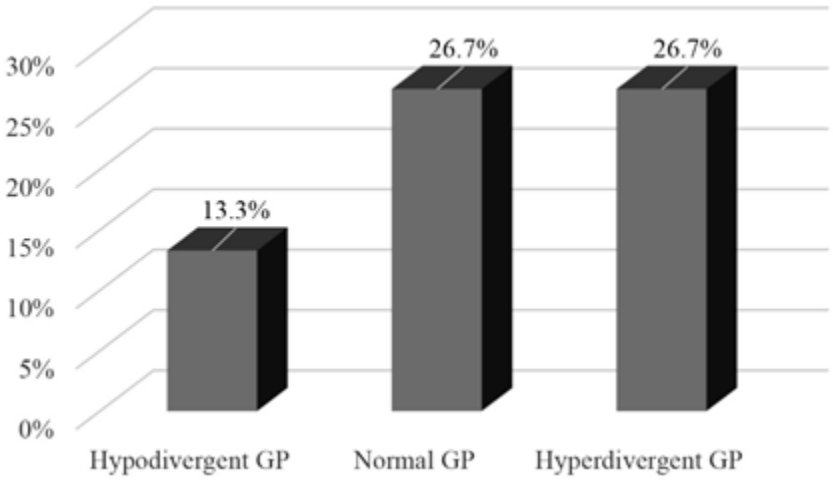

Figure 2. Percentage of patients with soft tissue imbalance in different vertical growth pattern groups

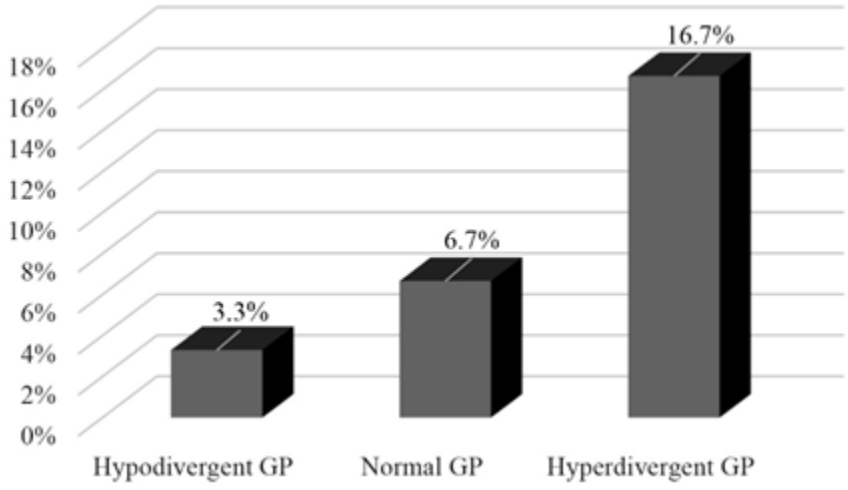

Figure 3. Percentage of patients with soft tissue imbalance bigger than 3 mm in different vertical growth pattern groups

Table 1. Values of total chin and upper lip thickness in regard to vertical pattern of facial growth

Parameters	Hypodivergent GP	Normal GP	Hyperdivergent GP
Chin	$13.6 \pm 2.0^{ab***}$ (13.5)	11.6 ± 2.0 (11.5)	10.7 ± 1.6 (11.0)
Upper lip	$13.4 \pm 2.4^{a*b***}$ (13.0)	12.0 ± 2.5 (12.2)	11.1 ± 1.7 (11.0)

Continues variables are given as means ± SD (medians); SD – standard deviation; GP – growth pattern
* – $p < 0.05$
*** – $p < 0.001$ (Independent samples t test)
a – *vs* normal
b – *vs* high

