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INFLUENCE OF VERTICAL IRREGULARITIES ON THE SIZE OF SOFT TISSUE CONVEXITY, NASOLABIAL AND LABIOMENTAL ANGLE

ВЛИЈАНИЕ НА ВЕРТИКАЛНИ НЕРЕГУЛАРНОСТИ ВРЗ ГОЛЕМИНАТА НА КОНВЕКСНОСТА НА МЕКОТО ТКИВО, НАСОЛАБИЈАЛНИОТ И ЛАБИОМЕНТАЛНИОТ АГОЛ

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Abstract

Introduction: Modern orthodontics is a creation for the best possible balance between occlusal relations, dental and facial esthetics, result stability, and their maintenance as well as teeth restoration. The configuration and expression of the face primarily depend on the skeletal build, the position and fit of facial bones, soft tissues covering, as well as the size of the nose, lips and chin. The soft tissues of the face are determined by three interactive factors: - Skeletal base which, in the middle and the lower third of the face, is represented by the jaws, - Dental support structures, represented by the teeth, - Soft-tissue mask, which is determined both by the underlying hard tissues and by the soft tissues themselves (nose, chin, lip thickness and their respective tonus). **Aim.** The aim of our study is to determine the size of the vertical skeletal dimensions of the face, N'Prn'Pg', NLA and LiB'Pg' angle in three experimental groups and determine the statistically significant differences between those groups. **Material and methods:** Depending on the vertical incisal rate characteristics - overbite, the respondents were divided into three groups: the first group consisted of respondents with open bite, meaning the overbite is smaller or equal to -1mm, the second group consisted of respondents with deep bite, meaning the overbite is over +4mm, and the third group consisted of respondents with normal overlap, meaning the overbite is more than +1mm, but lower or equal to +4mm. **Results:** The results show that the vertical incisal step has an effect on the convexity of the soft tissues, as well as the nasolabial and labiomental angle. **Conclusion:** The soft tissue convexity N'PrnPg' is bigger in the deep bite group (both male and female), while the labiomental angle LiB'Pg' is increased in the open bite group and decreased in the deep bite group. **Key words:** overbite, soft tissue convexity, nasolabial angle, labiomental angle, cephalometry.

Апстракт

Вовед: Современата ортодонција е креација за најдобра можна рамнотежа помеѓу окулзални односи, дентална и фацијална естетика, стабилност на резултатите и нивното одржување, како и реставрација на забите. Конфигурацијата и изразот на лицето претежно зависат од скелетната градба, позицијата и вградбата на фацијалните коски, меките ткива кои го покриваат, како и големината на носот, усните и брадата. Меките ткива на лицето се одредени од три интерактивни фактори: • Скелетна база која, во средниот и долниот дел на лицето, е претставена со вилиците, • Дентални поддржни структури, претставени со забите, • Мекоткивна маска, која е одредена и од основните тврди ткива и од самите меки ткива (нос, брада, дебелина на усните и нивниот респективен тонус). **Целта** на нашето истражување е да се определи големината на вертикалните скелетни димензии на лицето, N'Prn'Pg', NLA и LiB'Pg' агол во три експериментални групи и да определи статистички значајни разлики помеѓу тие групи. **Материјал и методи:** Во зависност од вертикалните инцизални карактеристики - преклоп, испитаниците беа поделени во три групи: првата група која се состои од испитаници со отворен преклоп, што значи дека преклопот е помал или еднаков на -1mm, втората група која се состои од испитаници со длабок преклоп, што значи дека преклопот е повеќе од +4mm, и третата група која се состои од испитаници со нормален преклоп, што значи дека преклопот е повеќе од +1mm, но помал или еднаков на +4mm. **Резултати:** Резултатите покажуваат дека вертикалниот инцизален чекор има ефект врз конвексноста на меките ткива, како и врз насолабијалниот и лабиоменталниот агол. **Заклучок:** Конвексноста на меките ткива N'PrnPg' е поголема во групата со длабок преклоп (кај мажите и жените), додека лабиоменталниот агол LiB'Pg' е зголемен во групата со отворен преклоп и намален во групата со длабок преклоп. **Клучни зборови:** преклоп, конвексност на меките ткива, насолабијален агол, лабиоментален агол, цефалометрија.

Introduction

Examining the factors that influence facial harmony and disharmony, it is proven that facial components are inherited regardless of one another, and not as a complex that leads to different facial configuration creations. The facial configuration and facial expression depend primarily on the constitutional build of the skeleton, facial

bones position and alignment, the upper and lower jaw position, bite type, soft-tissue components covering the facial base, as well as nose, lip, and chin size.

Modern orthodontics' goal represents the best possible balance between occlusal relations, dental and facial esthetics, result stability and their maintenance as well as teeth restoration[1]. The regular or irregular vertical development of the facial skeleton is connected to multiple skeletal groups: nasomaxillary complex, alveolar processes and mandible. There is a connection between the structure of the front part of the maxilla and mandible, and the lower part of the face, so in the case of an open or deep bite, the dentoalveolar development can be insufficient to compensate for the oversized or undersized detachment of the jaw system[2].

Zuzhelova[3] proves that the nasolabial structures, by virtue of their morphology and position, are directly involved in the formation of the external appearance of the face as a whole. Nasal structures, lips and chin are potential factors in the formation of facial appearance[4].

Angle points to the importance of facial harmony by emphasizing the role of soft tissues in shaping the facial region. She considers that the lips are an important factor in determining and evaluating the criteria for facial aesthetics[2].

Zuzhelova[5] examined the linear and angular dimensions of the nasolabial structures in individuals with normal occlusion, class II/1 and class III. According to her findings, the growth of the nose and the upper lip takes place simultaneously, they accompany each other and participate in the formation of a soft profile. The shape of the nasal structures is closely correlated with the general convexity of the face.

Lo and Hunter[6] found a high correlation between NLA and retroclination of the upper incisors. Each retraction of the upper incisors leads to an increase in NLA by 1.63º.

Coonor and Moshiri's[7] findings on the size of the NLA between black and white populations indicated marked significance. Perceptible differences appeared between the sexes in the white race. The NLA in female subjects was 107.34º, and 101.34º in males, which indicates that there is a more blunt relationship between the nose and the upper lip.

De Freitas et al.[8] analyzed the NLA in subjects at rest and when smiling. The difference between one angle and the other was statistically significant with a difference of 5.74º. Variations of NLA at rest and while smiling were significant in normal samples and are used as a diagnostic tool in treatment planning for sagittal and vertical dentofacial skeletal deformities.

Orthodontic treatment is directly influenced by the soft tissues, namely the pressure of the lips, cheeks and tongue on the teeth, the periodontal support system, the muscles and the connective tissue components of the TMJ, and the contours of the soft tissues of the face.

The aim of our study is to determine the size of the vertical skeletal dimensions of the face, N'Prn'Pg', NLA and LiB'Pg' angle in three experimental groups, and to determine statistically significant differences between those groups.

Material and method

For the realization of the set goal, examinations were conducted on 90 individuals from both sexes, aged 13-15, randomly chosen from the Clinic of Orthodontics at PHO – Dental Clinical Centre "St. Pantelejmon" in Skopje.

The selection of the respondents taking part in realizing the set goal was based on the following criteria: individuals that had not previously undergone orthodontic treatment, with no great craniofacial disorders, and with complete dentition.

In relation to the characteristics of the vertical incisal rate, the respondents were divided into three groups, and were classified as follows:

- The first group consisted of respondents with open bite, where the vertical incisal rate is lower or equal to -1mm.
- The second group consisted of respondents with deep bite, where the vertical incisal rate is over +4mm, and
- The third group consisted of respondents with normal incisal overlap, where the vertical incisal rate is more than +1mm, but lower or equal to +4mm. This group was also the control group.

Every group consisted of 30 respondents, 15 female and 15 male that came in the period from 2016 to 2022.

In the respondents from the research groups, standardized clinical and diagnostic procedures were conducted with X-ray cranial imaging in a standardized way in norma lateralis.

The soft tissue roentgen cephalometric points used in this investigation are:

- N' – the deepest part of the soft tissue outline in front of Nasion,
- Prn (Pronasale) – tip of the nose,
- C or Cm (Columella) – the most anterior point on the tip of the nose,
- Sn (Subnasale) – the junction of the nasal septum and the upper lip in the mid-sagittal plane,
- Ls (Labrale superius) – the most anterior point on outline of the upper lip (vermillion border),

- Li (Labrale inferius) – the most anterior point on outline of the lower lip (vermillion border),
- Sm (Supramentale) B' – the deepest midline point on outline of the inferior labial sulcus (soft tissue B-point),
- Pg' (Pogonion) – the most anterior point on outline of the soft tissue chin,
- Gn' (Gnation) – the lowest point on outline of the soft tissue chin.

We measured the following soft tissue angular variables: (Figure1)

Soft tissue convexity – angle **N'Prn'Pg'**,

Nasolabial angle – **NLA** or C Sn Ls,

Labiomental angle or contour of the mandibular sulcus – **Li B' Pg'** or Md S C or Li Sm Pg'.

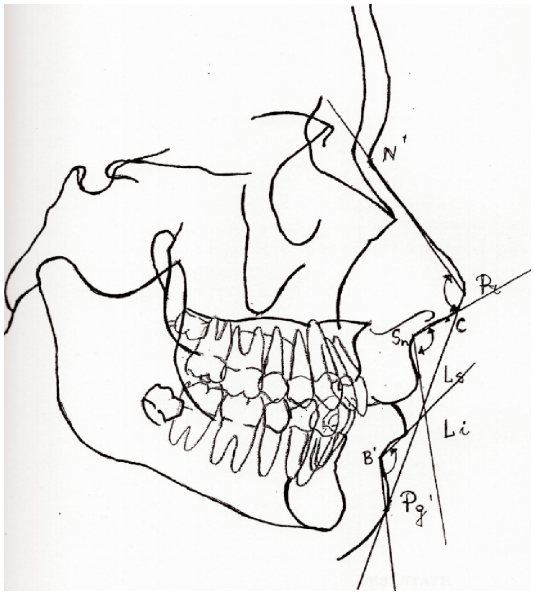


Figure 1. *Soft tissue angular variables*

The statistical data analysis was conducted in the SPSS 17,0 program for Windows.

- ✓ Shapiro – Wilk's W test was used for data testing,
- ✓ Descriptive statistics was used for data depiction,
- ✓ One Way Anova was used for comparing the analyzed parameters between the three analyzed groups, and Tukey – test was used for inter-group differences,
- ✓ The Student "t" test was used for comparison of the analyzed parameters in relation to gender,
- ✓ The levels of probability for achieving a null hypothesis, concordant with international standards for bio-medical sciences were 0.05 and 0.01.

Results

The average size of the soft tissue angle convexity (N'PrnPg') significantly differs between the three analyzed groups (F=18.7 p<0.001). This statistical significance is due to a significantly smaller average N'PrnPg' angle in the group of subjects with a deep bite compared to the other two groups, open bite (123.1±4.7º vs 127.43±3.8º), and normal bite (123.1±4.7º vs 129.9±4.4º). (Table 1, Graphic 1)

The results of the research show that the size of the soft tissue convexity angle does not significantly depend on the gender of the respondents for any of the analyzed groups: for open bite (t=1.09 p=0.28), for deep bite (t=0.341 p= 0.74), and for normal bite (t=0.28 p=0.78).

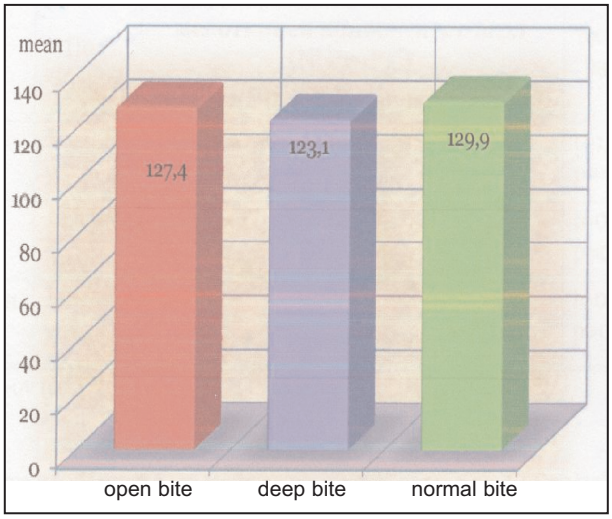
In the open deep bite groups, male subjects had a non-significantly smaller mean N'PrnPg' angle compared to female subjects (126.67±2.8º vs 128.2±4.6º, and 122.8±4.9º vs 123.4 ±4.8°), while in the control group, the average size of this angle is insignificantly higher in

Table 1. Soft tissue angle convexity (N'PrnPg') between groups with open, deep, and normal bite

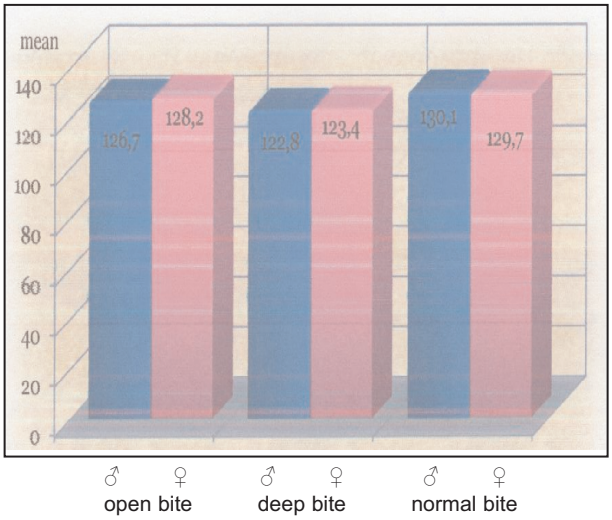
Group	Soft tissue angle convexity (N'PrnPg')		
	mean ±SD	min - max	median
OPEN BITE	127.43±3.8	121-137	127.5
DEEP BITE	123.1±4.7	110-132	123
NORMAL BITE	129.9±4.4	124-140	129.5
F – analysis of Variance	F=18.7 p<0,001 post hoc open bite vs deep bite p<0,01 open bite vs normal bite p<0,01 deep bite vs normal bite p<0,01		

Table 2. Differences between male and female subjects for soft tissue angle convexity (N'PrnPg') in groups with open, deep and normal bite

Group	Gender	Soft tissue angle convexity (N'PrnPg')			Student's t-test
		mean ±SD	min - max	median	
OPEN BITE	male	126.67±2.8	121-131	127	t=1.09
	female	128.2±4.6	121-137	129	p=0.28 ns
DEEP BITE	male	122.8±4.9	110-129	123	t=0.341
	female	123.4±4.8	112-132	123	p=0.74 ns
NORMAL BITE	male	130.13±4.7	124-137	130	t=0.28
	female	129.67±4.3	124-140	129	p=0.78 ns



Graphic 1. *Graphic image of mean values for N'PrnPg' angle in three groups*



Graphic 2. *Graphic image differences between male and female subjects for N'PrnPg' angle in three groups*

the group with male respondents (130.13±4.7º vs 129.67±4.3º). (Table 2, Graphic 2)

The average size of the nasolabial angle (NLA) in the group with an open bite is measured at 103.4±10.4º, at 108.03±10.8º in the group with a deep bite, while in the group with a normal bite the average size of the NLA is measured at 102.57±8.9º.

The average size of the nasolabial angle (NLA) in the group with an open bite is measured at 103.4±10.4º, at 108.03±10.8º in the group with a deep bite, while in the group with a normal bite the average size of the NLA is measured as 102.57±8.9º. The deep bite is characterized by a slightly higher average nasolabial angle compared to the open and normal bite. (Table 3, Graphic 3)

The average size of the nasolabial angle in the group of male subjects with an open bite is measured at 109.93±6.2º, while in the group of female subjects with an open bite is measured at 96.87±9.6º.

The difference of 13.06º was statistically confirmed as significant (t=4.42 p=0.00013). We can conclude that the size of the NLA in the open bite condition significantly depends on gender.

In the group with deep and normal bite, the male subjects presented a non-significantly lower average NLA than the female subjects (106.2±11.4º vs 109.87±10.1º, and 100.53±10.3º vs 104.6±7.1º), consequently. (Table 4, Graphic 4)

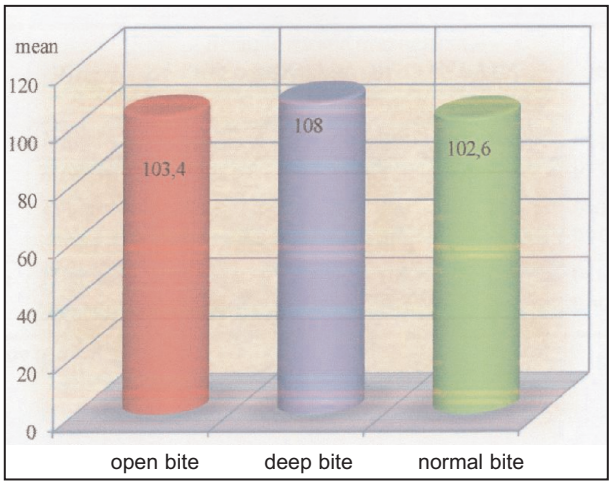
Subjects with open, deep and normal bites have significantly different average sizes of the labiomental angle LiB'Pg' (F=94.07 p<0.001). Post hoc analysis showed that the differences in all paired comparisons were statistically significant, that is, LiB'Pg' had a sig-

Table 3. Nasolabial angle (NLA) between groups with open, deep and normal bite

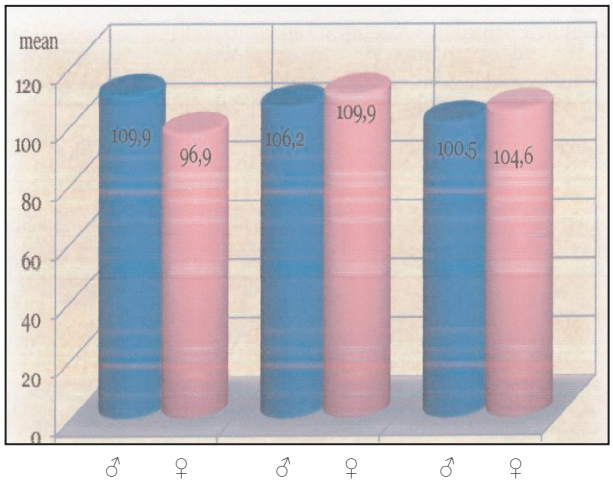
Group	Nasolabial angle (NLA)		
	mean ±SD	min - max	median
OPEN BITE	103.4±10.4	85-120	106
DEEP BITE	108.03±10.8	89-133	108
NORMAL BITE	102.57±8.9	77-119	102.5
F – analysis of Variance	F=2.58 p<0,08 ns		

Table 4. Differences between male and female subjects for nasolabial angle (NLA) in groups with open, deep, and normal bite

Group	Gender	Nasolabial angle (NLA)			Student's t-test (**p,0,01)
		mean ±SD	min - max	median	
OPEN BITE	male	109.93±6.2	100-120	108	t=4.42
	female	96.87±9.6	85-111	91	p=0,00013
DEEP BITE	male	106.2±11.4	89-125	106	t=0.93
	female	109.87±10.1	91-133	109	p=0,36 ns
NORMAL BITE	male	100.53±10.3	77-118	102	t=1.26
	female	104.6±7.1	95-119	104	p=0,22 ns



Graphic 3. *Graphic image of mean values for NLA angle in three groups*



Graphic 4. *Graphic image differences between male and female subjects for NLA angle in three groups*

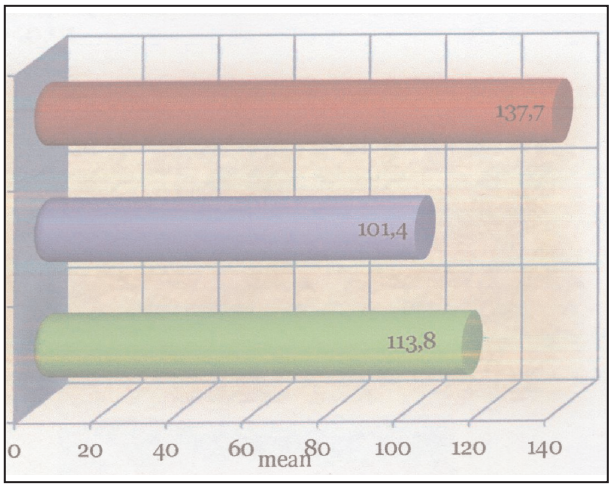
nificantly smaller average size in the group with deep bite versus open bite (101.37±11.2º vs 137.7±7.8º), and versus the normal bite (101.37±11.2º vs 113.83±11.8º), as well as significantly smaller average size in the group with normal bite versus open bite (113.83±11.8º vs 137.7±7.8º). (Table 5, Graphic 5)

Table 5. Labiomental angle (LiB'Pg') between groups with open, deep and normal bite

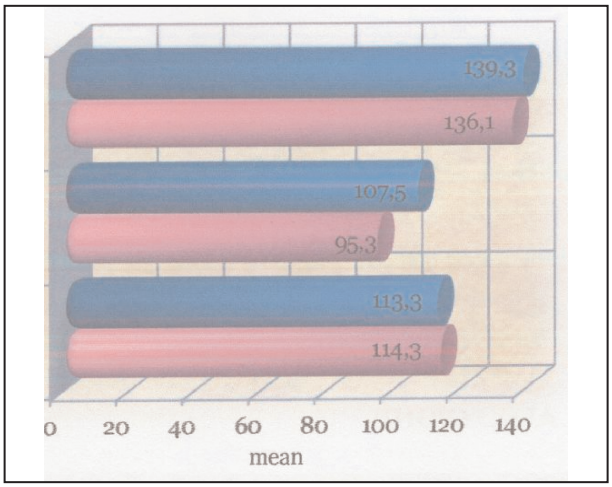
Group	Labiomental angle (LiB'Pg')		
	mean ±SD	min - max	median
OPEN BITE	137.7±7.8	125-154	136.5
DEEP BITE	101.37±11.2	72-119	102
NORMAL BITE	113.83±11.8	98-140	115.5
F – analysis of Variance	F=94.07 p<0,001 post hoc open bite vs deep bite p=0,0001** open bite vs normal bite p=0,0001** deep bite vs normal bite p=0,0001**		

Table 6. Differences between male and female subjects for labiomental angle (LiB'Pg') in groups with open, deep, and normal bite

Group	Gender	Labiomental angle (LiB'Pg')			Student's t-test
		mean ±SD	min - max	median	
OPEN BITE	male	139.27±8.1	128-154	137	t=1.104
	female	136.13±7.5	125-149	136	p=0,28 ns
DEEP BITE	male	107.47±8.7	91-119	109	t=3.5
	female	95.27±10.3	72-112	92	p=0,0016**
NORMAL BITE	male	113.33±12.7	98-140	111	t=0.23
	female	114.33±11.1	99-132	113	p=0,82 ns



Bar Graphic 5. *Graphic image of mean values for LiB'Pg' angle in three groups*



Bar Graphic 6. *Graphic image of differences between male and female subjects for LiB'Pg' angle in three groups*

The influence of gender on the size of the labiomental angle was confirmed as significant only in the deep bite group (t=3,5 p=0,0016). In this group, male subjects present a significantly higher average LiB'Pg' angle compared to female subjects (139.27±8.1º vs 136.13±7.5º).

In the open and normal bite group, the differences in the average size of the labiomental angle between male

and female subjects are insufficient to be confirmed as significant (p>0.05). (Table 6, Graphic 6)

Discussion

The soft tissue convexity is the angle formed by the points N'Prn'Pg'. This angle presents the convexity of the face. The average size of the soft tissue angle convexity significantly differs between the three analyzed groups (F=18.7 p<0.001). This statistical significance is due to a significantly smaller average N'Prn'Pg' angle in the group of subjects with deep bite compared to the other two groups, open bite (123.1±4.7º vs 127.43±3.8º), and normal bite (123.1±4.7º vs 129.9±4.4º).

The obtained values indicate that the subjects with irregularity II/2 have a convex face, but the convexity is more pronounced in subjects with irregularity II/1. Our findings coincide with the findings of Nanda et al.[10], and they do not coincide with the findings of Zuzhelova[3] in which the respondents from the open bite group, aged 10-16 years, had a mean value of 136,75±4,70º for the soft tissue convexity. This angle increases during growth, although insignificantly, which coincides with the findings of Posen, who points out that this angle increases by 8.65º from 2 to 18 years of life. Subtenly and Chaconas[9] indicate that the soft tissue convexity angle decreases during growth. The results of the research showed that the size of the angle of soft tissue convexity does not significantly depend on the gender of the respondents for any of the analyzed groups. In the open and deep bite groups, male subjects had a non-significantly smaller mean N'Prn'Pg' angle compared to female subjects (126,67±2,8º vs 128,2±4,6º, and 122,8±4,9º vs 123,4±4,8º), while in the control group, the average size of this angle is insignificantly higher in the male respondents group (130,13±4,7º vs 129,67±4,3º).

The average size of the nasolabial angle NLA in the group with an open bite is 103.4±10.4º, 108.03±10.8º in the group with a deep bite, while in the group with a normal bite, the average size of the NLA was measured as 102.57±8.9º. The average size of the nasolabial angle (NLA) in the group with an open bite was 103.4±10.4º, 108.03±10.8º in the group with a deep bite, while in the group with a normal bite the average size of the NLA was measured as 102.57±8.9º. The deep bite is characterized by a slightly higher average nasolabial angle compared to the open and normal bite. Compared with Zuzhelova's[5] results, Lo and Hunter6 found lower values of this angle. In subjects at the age of 13, its value was 106.80º, and in subjects at the age of 16, the NLA value was 105.76º. The differences in the value of this angle that we found among individual authors in individuals with a normal bite are the result of the subjects belonging to individual races, which is especially noticeable in the studies of Coonor and Mochiri[7]. De Freitas[8] has also performed tests on 40 white Brazilians with normal occlusion and facial harmony. NLA was analyzed in subjects at rest and while smiling. NLA at rest was 104.93º and 110.67º when smiling. The difference between one NLA and the other was statistically significant with a difference of 5.74º. Variations of NLA at rest and while smiling were significant in normal samples and were used as a diagnostic tool in treatment planning for sagittal dentofacial skeletal deformities.

The size of the nasolabial angle in the open bite condition significantly depends on the gender. In the group with deep and normal bite, the male subjects presented a non-significantly lower average NLA than the female subjects (106.2±11.4º vs 109.87±10.1º, and 100.53±10.3º vs 104.6±7.1º, consequently). Our studies are in agreement with the studies of Zuzhelova[3], Lo and Hunter[6], De Freitas[8], Coonor and Mochiri[7], Nandini et al.[11], however, only for the white population where the average value of NLA in female subjects is 107.34º, and 101.2º in male respondents, which indicates the fact that there is a more blunt relationship between the nose and the upper lip.

Subjects with open, deep and normal bites have significantly different average sizes of the labiomental angle LiB'Pg' (F=94.07 p<0.001). Post hoc analysis showed that differences in all pairwise comparisons were statistically significant. The influence of gender on the size of the labiomental angle was confirmed as significant only in the deep bite group (t=3,5 p=0,0016). In this group, male subjects present a significantly higher average LiB'Pg' angle compared to female subjects (139.27±8.1º vs 136.13±7.5º).

Liu Y[12], Jacobson et al.[13] examined the changes of hard and soft tissues in subjects with class III, and open bite after orthodontic-surgical treatment. After bilateral osteotomy of the ramus of the mandible in the 20 studied patients, there was a decrease in the SNB and LiB'Pg' angles (p<0.01), and an increase in the convexity of the face as well as the ANB angle.

Conclusions

The soft tissue convexity of the face or the **N'PrnPg'** angle is most pronounced in subjects with a deep bite compared to the other two studied groups.

The size of the N'PrnPg' angle does not significantly depend on the gender of the subjects for any of the analyzed groups.

The nasolabial angle NLA is characterized by a non-significantly higher value in the deep bite group.

The size of the **NLA** in the open bite condition is significantly gender dependent. Male subjects from the deep and normal bite group present a significantly lower NLA than female subjects.

The labiomental angle LiB'Pg' in the deep bite group has the smallest average size and the influence of gender on the size of this angle was confirmed as significant in the same group.

Reference

1. Proffit W.R. Contemporary orthodontics. Mosby year book, 2nd ed.1992.
2. Arnett G.W, Bergman T.R. Soft tissue cephalometric analysis: Diagnosis and treatment planning of dentofacial deformity. Am J Orthod Dentofacial Orthop 1999;116;239-53.
3. Zuzhelova M. Angularni dimenzii na nazolabijalnite strukturi klasa I,II/1 i III klasa po Angle. Maked Stomatol Preg 1985; 3-4:103-7.
4. Gjorgova J. Polozbata na incizivite i nivnoto vlijanie na dentoskletalnite i mekotkivni strukturi i promeni na profilot na liceto. (Master's Thesis), Skopje, 1981.
5. Zuzhelova M. Rentgenska kefalometriska proučavanja linearnih I angularnih dimenzija nazolabijalnih struktura kod osoba sa normalnom okluzijom i malokluzijom II/1 i III klase. (PhD dissertation). Univerzitet u Beogradu, Stomatološki fakultet,1989.
6. Lo F.D., Hunter W.S. Changes in nasolabial angle related to maxillary incisor retraction. Am J Orthod 82:384-391,1982.
7. Coonor A.M., Moshiri F. Orthodontic surgery norms for American black patients. Am. J Orthod 87:1 1985.
8. De Freitas DS, De Freitas MR, Janson G, De Freitas KM, Cardoso CL. Nasolabial angle at rest and upon smiling. J Maxillofac Surg 2014 Dec; 72(12):2567.
9. Subtenly J.D. A longitudinal study of the soft tissue facial structures and their profile characteristics, defined in relation to underlying skeletal structures. Am J Orthod 1959:45:481-507.
10. Nanda SK. Patterns of vertical growth in the face. Am J Orthod Dentofac Orthop 1988; 93:103-16.
11. Nandini S, Prashanth CS, Somiah SK, Reddy SR. An evaluation of nasolabial angle and the relative inclinations of the nose and upper lip. J Contemp Dent Pract.2011 May 1;12(3):152-7.
12. Liu Y, Bi WW, Chen Y. Soft and hard tissue changes after orthodontic and orthognatic treatment in patients with skeletal Class III malformation. Shangai Kou Qiang Yi Xue:2012 Apr;21(2):166-9.
13. Jakobsone G, Stenvik A, EspelandL, Importance of the vertical incisor relationship in the prediction of the soft tissue profile after Class III bimaxillary surgery. Angle Orthod 2012 May; 82(3):441-7.
14. Milosevic-Antic S, Varga Lapter M, Slaj M. Mogucnosti analize mekih tkiva u ortodontskoj praksi. Acta Stomatol Croat.2007; 41(3):251-259.