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AESTHETIC CHANGES IN PATIENTS WITH CLASS II DEVISION 1 MALOCCLUSION

ПРОМЕНИ ВО ЛИЦЕВАТА ЕСТЕТИКА КАЈ ПАЦИЕНТИ СО МАЛОКЛУЗИЈА II КЛАСА 1-ВО ОДДЕЛЕНИЕ

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Abstract

Malocclusions are manifested with changes in the teeth position, different position of the bones of maxilla and mandible are often accompanied by soft tissue changes. Orthodontic treatment also affects the changes of soft tissue structures, and improves the facial aesthetics of the patients. In order to see the benefits of orthodontic therapy in Class II/1 malocclusion, an analysis of the changes that occur in the soft tissues and lips in patients before and after, was performed. For this purpose, 7 soft tissue parameters of the lips were analyzed in 30 patients with Class II Division 1 malocclusion, before and after orthodontic treatment, and in 30 patients with normal occlusion. The results indicate that after orthodontic treatment in patients with Class II/1 malocclusion, there are significant changes in the upper smile line, the height of the upper lip at rest position and during the smile and for the intercommissural length. From the analysis it can be concluded that the soft tissues follow the changes that occur with orthodontic treatment, which positively affects the aesthetics of the lips and the smile. **Key words:** Class II Division 1 malocclusion, aesthetics, smile aesthetics, lip position.

Апстракт

Малоклузиите се манифестираат со промени на поставеноста на забите, дентоалвеоларните и коскените структури, а често се пропратени и со промени на меките ткива. Ортодонтскиот третман влијае и на промените на меките структури и на подобрување на лицевата естетика на пациентите. Со цел да се согледаат придобивките од ортодонтската терапија кај малоклузија од II/1, направена е анализа на промените кои настануваат на меките ткива, на усните кај пациенти пред и после ортодонтската терапија. За таа цел анализирани се 7 параметри на усните кај 30 пациенти со малоклузија II класа 1-во одделение, пред и после ортодонтската терапија, и кај 30 пациенти со нормална оклузија. Резултатите укажуваат дека после ортодонтскта терапија кај пациенти со малоклузија II/1, има сигнификанти промени во горната линија на насмевка, во висината на горната усна при мирување и при насмевка и во интеркомисуралната должина. Од направената анализа може да се заклучи дека меките ткива ги следат промените кои настануваат со ортодонтскиот третман, кои позитивно влијаат на естетиката на усните и насмевката. **Клучни зборови:** малоклузија II класа 1-во одделение, естетика, естетика на насмевка, поставеност на усните.

Introduction

Malocclusions, in addition to altering the position of the teeth and occlusion, also affect the extraoral appearance of patients.

Class II / 1 malocclusion is characterized by protrusion of the maxillary incisors, the same can be manifested on face appearance also, therefore the upper lip only partially covers the incisors and these patients have incompetent lips. Hypotonia of the lip muscles is often present. Due to hypotonia, very often it is possible for gingiva to be exposed above the maxillary incisors during smiling, known as "gingival smile"[1]. These patients have a convex profile and the upper and lower lip touch or cross the aesthetic line.

Sometimes even modest inconsistencies in the face configuration cause a feeling of dissatisfaction and concern in the individual[2, 3]. The configuration and expression of the face, depend of the structure and position of the bones of the face, the position of the upper and lower jaw in relation to the cranial base and their mutual relation, the ratio of hard and soft tissues that cover the whole facial skeleton, forehead, nose, chin and lips[4, 5].

Arnett, Bergman, Proffit[6] emphasized the importance of perceiving aesthetics from a frontal point of view. The dynamic of the lip muscles during conversation and smiling in patients should also be analyzed.

Dejanovski[7] examining the length of the upper lip and the visibility of the incisions concludes that the visibility of the teeth is inversely proportional to the length of the upper

lip and in terms of gender, females have a shorter lip and greater visibility of the incisions.

Mackley[8] says that it is very important for orthodontists to make an effort to create a harmonious balance, which will produce an attractive smile in every orthodontically treated individual.

Utley[8, 9] indicates that facial aesthetics are not static. The orthodontist must know the proper vertical ratios of the dentition and the soft tissue.

Rafiqul et al.[10] examined lip changes in patients with class II/1 malocclusion, and in patients with normal occlusion at rest position and when smiling. Twenty patients were examined, 17 of them were treated without extraction, while 3 were treated with extraction. They found that in patients with class II/1 malocclusion, before treatment, both lips were placed facing down, when smiling. There is an improvement in the smile after the orthodontic treatment, but it takes time for the soft tissues to adapt to a new position.

Utley[8,9] examined patients before and after fixed orthodontic treatment and concluded that, in all treated patients, the torque of the maxillary incision had not been improved. There is a correction of the protrusion of the maxillary incisors and improvement of the smile before and after the orthodontic treatment.

Ackerman et al.[11] examined the size of the interlabial gap, the intercommissural length, and the length of the incisions in posted smile and speech. Patients were suggested to say "cheese," and videos were made, which were later used for analysis. The obtained results indicate that in posted smile there is greater display of incisions and a greater width of the smile. While in relation to the interlabial gap, no significant changes were found in a posted smile and during speaking. When planning the vertical placement of the maxillary incisions with orthodontic treatment, the orthodontist should account for the visibility of the incisions in rest position, when talking and when smiling.

An aesthetically pleasing smile usually shows symmetry between teeth, gingiva and lips. In some people, a smile shows the gingiva above the maxillary front teeth. This anatomical feature is defined as gingival line of a smile[12].

Ackerman et al.[11] took digital photographs of 50 patients (27 male and 23 female) who said "cheese" while smiling. From the photographs, the following were measured: the intercommissural length in mm, the interlabial space in mm, the visibility of the incisors below the commissure line, and the maximum visibility of the incisors in mm. The obtained results indicate that the visibility of the incisors is different when talking and smiling. Therefore, during orthodontic treatment, it is important to plan the vertical placement of the incisors.

Aim of the study

Purpose of these study is to see the benefits of orthodontic therapy in patients with Class II/1 malocclusion thought the analysis of the changes that occur in the soft tissues and lips in patients before and after orthodontic therapy. Because very often soft tissue changes occur during orthodontic treatment and have their impact in approving esthetic appearance of the face of the patients.

Material and methods

The aesthetic components of extraoral changes in patients with Class II/1 malocclusion were examined in this research. 30 subjects had Class II/1 malocclusion, before and after orthodontic treatment, and 30 subjects had normal occlusion.

The following extraoral parameters measured on the teeth and lips were used for analysis, measured extraorally (Figure 1):

1. Length of permanent left maxillary incisior (21) - from the incisal edge of the maxillary incisior to the highest point of the marginal edge of the crown,
2. Top smile line during maximum smile - the horizontal line that passes through the cervical edge of the maxillary central incisors is the zero point. It imagines a normal, passing through the middle of the face, graduated in mm. Measure the distance from the zero axis to the lower edge of the upper lip during maximum smile. This distance is "+" when the lip is above the zero axis and "-" when the lip is below it,
3. Upper lip at rest position - when the mandible is at physiological rest position and the distance from Sn to the lower edge of the upper lip (mm) is measured,
4. Upper lip height during maximum smile,

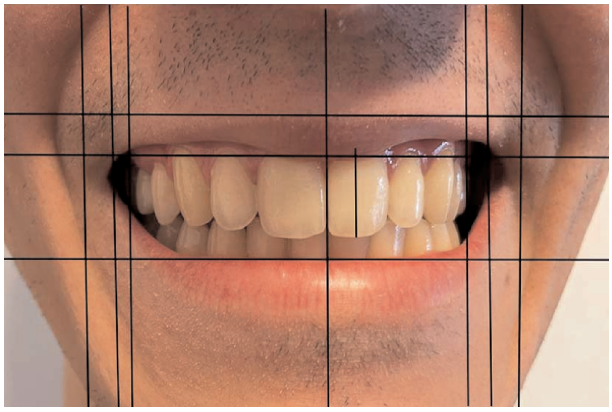

Figure 1. *Teeth and lip position during smile*

5. Distance between the lower edge of the upper lip and the incisal edge of the upper maxillary incisor during smile,
6. Intercommissural length - distance between the commissures of the lips during maximum smile,
7. Interlabial space (gap) - distance between the lower edge of the upper lip and the upper edge of the lower lip during maximum smile.

All examined patients were from 12 to 18 years of age.

Statistical processing of results

During the analysis of the obtained results from the examined groups, the following statistical parameters were applied and processed:

- Arithmetic mean
- Standard deviation
- Standard error
- Minimum
- Maximum
- Student "t" test for significance of differences

p> 0.05 (-) has no significance
0.05> p> 0.01 (*) has significance
0.01> p> 0.001 (**) high significance
p <0.001 (***) expressed significance

Purpose of the study

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Results

Table no. 1 shows the values for t - test between patients with normal occlusion and patients with Class II/1 malocclusion before orthodontic treatment. Significant changes were found for the height of the upper lip at rest position and during smiling. We found significant changes for intercommissural length, interlabial gap and upper smile line.

In table no. 2 are given the values for t - test between patients with normal occlusion and patients with Class II/1 malocclusion after orthodontic treatment. The obtained values indicate significantly significant changes for the intercommissural length. Highly significant changes were found in both values, the value for the

Table 1. Differences (t-test) of extraoral parameters in patients with normal occlusion and Class II/1 malocclusion before treatment

	Normal occlusion		**Class II/1 before treatment**			
	X	SD	X	SD	t-test	P
Length of 21	9.73	1.24	9.63	0.95	0.73088	p > 0.05
Top smile line	-0.30	2.08	0.43	1.65	0.01425	0.05 > p > 0.01*
Upper lip height at rest position	21.83	2.21	17.17	2.16	0.00000	p < 0.001***
Upper lip height at max smile	17.93	2.37	13.67	2.45	0.00000	p < 0.001***
The lower edge of the upper lip and the incisal edge of 21 during a smile	8.00	2.32	9.10	2.49	0.08761	p > 0.05
Intercommissural length	66.00	4.51	58.53	4.45	0.00000	p < 0.001***
Interlabial space (gap)	8.97	2.65	12.83	3.51	0.00001	p < 0.001***

Table 2. Differences (t-test) of extraoral parameters in patients with normal occlusion and Class II/1 malocclusion class after orthodontic treatment

	Normal occlusion		Class II/1 before treatment			
	X	SD	X	SD	t-test	P
Length of 21	9.73	1.24	9.70	0.90	0.90697	p> 0.05
Top smile line	-0.30	2.08	0.13	1.06	0.03220	0.05 > p > 0.01*
Upper lip height at rest position	21.83	2.21	20.30	1.99	0.00730	0.01>p>0.001 **
Upper lip height at max smile	17.93	2.37	16.50	1.84	0.01257	0.05 > p>0.01*
The lower edge of the upper lip and the incisal edge of 21 during a smile	8.00	2.32	9.30	1.35	0.01159	0.05 > p>0.01*
Intercommissural length	66.00	4.51	61.10	4.17	0.00007	p<0.001***
Interlabial space (gap)	8.97	2.65	11.60	3.50	0.00204	0.01>p>0.001 **

Table 3. Differences (t-test) of extraoral parameters of patients with Class II/1 malocclusion before and after treatment

	Normal occlusion		Class II/1 before treatment			
	X	SD	X	SD	t-test	P
Length of 21	9.63	0.95	9.70	0.90	0.78458	p> 0.05
Top smile line	-0.43	1.65	0.13	1.06	0.041233	0.05 > p > 0.01*
Upper lip height at rest position	17.17	2.16	20.30	1.99	0.00000	p<0.001***
Upper lip height at max smile	13.67	2.45	16.50	1.84	0.00001	p<0.001***
The lower edge of the upper lip and the incisal edge of 21 during a smile	9.10	2.49	9.30	1.35	0.70534	p>0.05
Intercommissural length	58.53	4.45	61.10	4.17	0.02720	0.05 >p>0.01*
Interlabial space (gap)	12.83	3.51	11.60	3.50	0.18558	p>0.05

size of the interlabial space and the height of the upper lip at rest position. Significant changes were found for the values of the upper lip height at maximum smile, for the value from the lower edge of the upper lip to the incisal edge of the maxillary left central incisor (21), and for the top smile line.

In table no. 3, we can see that there is a significant difference in the height of the upper lip at rest position and in a maximum smile, in the examined group with Class II/1 malocclusion, before and after treatment. There is a significant change for the intercommissural length, and for the value of the top smile line.

Discussion

In order to achieve the maximum benefits from the orthodontic treatment of malocclusions, it should have a positive impact on the aesthetic characteristics of the face. This can be achieved if the therapy plan is aimed at improving the relationship between the maxillary incisors and the smile line.

A study by Terpsithe et al.[13] who searched 5 electronic databases and selected 814 papers, based on how orthodontic treatment affects smile aesthetics in relation to the three dimensions, found that tooth extraction did not affect smile width and the width of the buccal corridor, but orthodontic treatment improves these smile components.

In our examination we found that the height of the upper lip in patients with normal occlusion, at rest position is 21.83 mm, while during a smile there is a significant shortening of the upper lip and its values is 17.93 mm, which matches the data obtained by Desai[14], with a value of 21.58 mm for the same parameter. During a smiling, the length of the upper lip is shortened, and its value is 17.93 mm, while Desai[14] gets a slightly lower value than ours, 16.84 mm. Examinations show significant changes in the upper lip in patients with Class II/1 malocclusion before and after treatment, at rest position and during a smile. An increase in the height of the upper lip at rest from 17.17 mm to 20.30 mm after treatment, indicates a significant elongation of the upper lip, which results of the retraction of the maxillary incisors and lowering of the upper lip, as a result of which the lip muscles are not pressured from the maxillary incisions proclination.

There are also changes for value of the height of the upper lip during a smile from 13.67 mm before treatment to 16.50 mm after treatment, which favors less exposure of the gingiva above the maxillary incisors, during a smile.

The results show that patients with class II/1 malocclusion have a shorter upper lip. This shorter upper lip may be the result of hypotension of the lip muscles. This results in greater exposure of the incisors, not only during a smile but also at rest position. After treatment in patients with Class II/1 malocclusion there is an increase in the height of the upper lip length.

Bisson et al.[15] in the analysis of individuals who are photo models and those who are not, found that full lips are aesthetically more beautiful and more desired by patients.

The upper line of the smile at maximum smile, depends on the height of the upper lip relative to the maxillary incisor.

Gerona[1] did a photo examination to determine the aesthetics of the smile when talking and smiling and to define whether the display of gingival tissue is more or less aesthetic. She defined that the most attractive is the smile where the upper lip is in the zero position, up to 2 mm to cover the crowns of the maxillary central incisors. The smile is considered unattractive when the crowns of the mandibular central incisors are fully exposed. Unattractive are those smiles where a smile shows more than 1.5 mm of the gingiva. A study by Van der Gelda et al.[16] found that smiles were less aesthetically pleasing when the upper smile line covered the maxillary incisors similar as smiles where gingival tissue was overexposed during a smiling.

Peck et al.[17] found that the lower smile line is characteristic for males, while the upper smile line predominates in females. They found that maxillary anterior teeth are more exposed in females, while males are more likely to show mandibular incisors. The findings show that if the gingiva is seen more than 1 mm when smiling, the smile is considered unaesthetic. While the exposure of the mandibular incisors and their gingiva are signs of the aging process.

Our findings coincide with the findings of Gerona[1] and indicate that in patients with Class II/1 malocclusion before treatment, the upper smile line is 43.4 mm, and after treatment is 0.13 mm, while in patients with normal occlusion the value is - 0.30 mm. Our values are slightly lower than the values defined by McLeoda et al.[18] in their study of the Canadian population. The ideal value of gingival exposure is considered to be 2.7 mm, the minimum tolerable value is 2.7 mm and maximum is -2.52 mm. For the American population they found that an ideal value is 2.1 mm, a minimum tolerance value is 4mm, and a maximum tolerance value is -3.6 mm. Kokich et al.[19] suggest that an acceptable tolerance threshold is ± 4 mm.

We can notice that the upper line of the smile in patients with Class II/1 malocclusion is above the zero position, i.e. it is above the cervical edge of the maxillary incisors. It occurs as a result of protrusion of the

maxillary incisors. When the position of the upper lip in patients with class II/1 malocclusion is below zero, it is as a result of greater mobility of the lip muscles and soft tissue compensation to mask the orthodontic anomaly. It can be seen that after the therapy, the upper line of the smile passes below the zero position, which is a positive and desired effect of the treatment. By retrusion of the maxillary incisors, the lips follow the movements of the hard tissues, descending; the gingival exposure, which was present before therapy, is lost. With this we can say that the orthodontic treatment is satisfied with the aesthetic component of the smile.

Rafiqul et al.[10] evaluated the morphological changes of the lips in patients with class II/1 malocclusion, before and after orthodontic treatment, compared with patients with normal occlusion, and determined the degree of improvement of the smile after orthodontic treatment. They concluded that after the treatment, when smiling, the corners of the lips are wider and closer to the control group. The lips of the treated group are not under tension during a smile. This is probably due to the fact that the lips cannot immediately adapt to the new position and it takes more time for that. Perhaps the orthodontic treatment of wearing braces for a period of 2 years interferes with the normal movement of the lips.

The size of the clinical crown of the maxillary incisors, their color and placement play an important role in creating a smile. In our study, the value for this parameter in patients with normal occlusion is 9.73 mm. Our findings are consistent with the findings of Peck et al.[17] which indicate a value of 9.8 mm for the crown of the maxillary incisor (21). No difference was found in the size of the maxillary incisions before and after orthodontic treatment. This indicates that the changes that occur during treatment do not refer to excessive extrusion or intrusion of the maxillary incisors, but rather to the teeth movement; there are more changes in the tooth torque and their labio-palatal displacement.

The value of the lower edge of the upper lip and the incisal edge of the maxillary incisors (21) when smiling i.e. the maximum exposure of incisions during a smile, in the examined patients with normal occlusion, is 8.00mm. Our obtained values do not match (are higher) the values obtained by Ackerman et al.[20] who obtained a value of 6.47 mm, while they match the values obtained by Desai[21, 22] with a value of 8.76 mm. Our data do not match the data obtained from Peck et al.[17] who has obtained larger values of 10.2 mm for the same parameter for the examined patients.

The value obtained for the interlabial space is 8.96 mm in patients with normal occlusion and match the values of Ackerman et al.[11,19] who obtained a value of 8.41 mm, and do not match with the findings by Desai[21,22] with a value of 12.00 mm. For the same examined parameter, we found an increased value (12.83 mm) in patients with Class II/1 malocclusion before treatment. After treatment the value is 11.60 mm. Our findings are consistent with those of Maganzini (Anthony et al.)[23].

The enlarged interlabial gap is due to protrusion of the maxillary incisors in patients with class II / 1 malocclusion, weaker perioral muscles, and a shorter, hypotonic upper lip.

The intecommissural length actually shows the length of the smile itself. The value we obtained for this parameter is 66.00 mm in individuals with normal occlusion. Ackerman et al.[11,19] got a lower value than ours, 49.39 mm. Our values match the values obtained by these authors.

In our study we found that the examined group with normal occlusion (66.00 mm) has a longer smile length compared to the patients with Class II/1 malocclusion before treatment, where it is 58.53 mm. After the treatment, the width of the smile increases, which is due to the expansion of the maxilla, the correction of the protrusion and we can say that the lips muscles are strengthened. The value of this parameter in patients with Class II/1 malocclusion after orthodontic treatment is 61.10 mm. Soft tissues also have a positive effect on therapy and follow the changes in dentoalveolar structures. Our values do not match the values obtained by Ackerman et al.[11,19] but match the values of Jannathul et al.[24] who found that after orthodontic treatment there are large changes in the lips during a smile which affects the aesthetic and emotional changes in patients.

Conclusion

The values obtained from the examined soft tissue parameters lead to the following conclusions: the length of the left maxillary incisor (21) remains unchanged before and after orthodontic treatment. The size of the maxillary incision (21) is the same in both patients with normal occlusion and patients with class II/1 malocclusion before and after treatment. The value obtained for the top smile line in patients with Class II/1 malocclusion is 0.43 mm, before therapy, indicates full exposure of the maxillary incisors when smiling, but that value is not so high and does not indicate the appearance of a gingival smile. After the treatment, there is a slight lowering of the upper line of the smile, which indicates that after orthodontic treatment and retraction of the maxillary incisions, the slight lowering of the upper line of the smile meets the required aesthetic criteria. The height of the upper lip at rest position is longer in individuals with normal occlusion than in patients with Class II/1 malocclusion before treatment. There are significant changes

in the height of the upper lip at rest position and when smiling in patients with Class II/1 malocclusion, before and after therapy. This indicates that with orthodontic treatment we do not only act on the dentoalveolar structures, but there are also changes in the soft tissues. No significant changes were found in relation to the lower edge of the upper lip and the incisal edge of the maxillary incisor (21) during a smile, in none of the examined groups. Changes in intercommissural length are significant in patients before and after orthodontic treatment. After orthodontic treatment there is an increase of the intercommissural length. There is a significant change in the size of the interlabial space. The group with normal occlusion (8.97 mm) has a lower value compared to the value found in patients with Class II/1 malocclusion before (12.83 mm) and after orthodontic therapy (11.60 mm).

Facial and dental harmony depend on the mutual position of the maxilla and the mandible, their placement relative to the anterior cranial base, and the placement of the incisions relative to their reference planes and their mutual position. Correction of malocclusions is followed by soft tissue changes, and meeting functional and aesthetic criteria.

Properly planned and implemented orthodontic treatment will enable achievement of the desired results, i.e. correction of malocclusion that is present in patients, and meeting all criteria from a functional and aesthetic point of view.

Reference

1. Gerona, S., Wasserstein, A. Influence of Sex on the Perception of Oral and Smile Esthetics with Different Gingival Display and Incisal Plane Inclination. Angle Orthodontist. 2005; 75(5):778-84.
2. Chaconas, J. S., Jack, D. B. Prediction of Normal Soft Tissue Facial Changes. The Angle Orthodontist. 1975;45 (1):12-25.
3. Aboucaya, W. A. Le sourire: classification et criteres, applications en esthetique faciale. Nouv Presse Med. 1973;39: 26611-2616.
4. Janson, I., Hasund, A. Cephalometric guidance for the positioning of the lower incisors. European Journal of Orthodontics. 1981;3(4):237-240.
5. Kasai, K. Soft tissue adaptability to hard tissues in facial profile. Am I Orthod Dentofacial Orthop. 1998;113(6): 674-80
6. II–Hyung, Y., Dong-Seog, N., Seung- Hak, B. Which Hard and Soft Tissue Factors Relate with the Amount of Buccal Corridor Space during Smiling?. Angle Orthodontist. 2008; 78 (1):5-11.
7. Dejanovski, K. Somatometriski aspekt na odnosot na dolzinata na gornata usna i vidlivosta na centralnite maksilarni incizivi Maked Stomatol Pregl. 1988; XII (1-2):47-50.
8. Mackley, R. J. "Animated" Orthodontic treatment planning. JCO. 1993; 27: 361-364.
9. Mackley, R.J. An evaluation of smiles before and after orthodontic treatment. The Angle Orthodontists. 1993; 63 (3):183-9.
10. Rafiqul, I., Toru, K., Lutfun, N., Atsushi, H., Akihiko, N. Lip Morphological Changes in Orthodontic Treatment. Class II Division 1 Malocclusion and Normal Occlusion at Rest and On Smiling. Angle Orthodontist. 2009; 79 (2):256-64.
11. Ackerman, B., M., Colleen, B., J, Richard, L. An Evaluation of Dynamic Lip-Tooth Characteristics During Speech and Smile in Adolescents. Angle Orthodontist.2004; 74(1):43-50.
12. Isaacson, J., R. Smile, Face and Straith Teeth. Angle Orthodontist. 2002; 72 (4):282.
13. Terpsithea, C., Anna, B., Najd, A., Dorithy, O., Chung, H., K. Clinical effectiveness of orthodontic treatment on smile esthetic: systematic review. Clin Cosmet Investing Dent. 2019; 2(11):89-101.
14. Desai, S., G. Dynamic Smile Analysis: Changes with Age. University of Connecticut. Healt Center. Master Thesis. 2008.
15. Bisson, M., Adriaan, O., G. The Esthetic Properties of Lips: A Comparation of Models and Nonmodels. Angle Orthodontist. 2004; 74(2):162-6.
16. Piter Van del Geld, Paul, O., Guus Van Hek, Anne Marie, K-J. Smile attractiveness. Self-perception and influence on Personality. Angle Ortodontist. 2007; 77 (5): 759-65
17. Peck, S., Peck, L., Kataja M. The gingival smile line. Angle Orthodontist. 1993; 62 (2): 91-100.
18. Mc Leod C., Fields, H., V. Esthetics and smile characteristics evaluated by laypersons: A comparation of Canadian and US data. Angle Orthodontist. 2011; 81 (2):198-205.
19. Vincent, O Kokich., Vincent, G Kokich., Asuman, K., H. Perception of dental professionals and laypersons to altered dental esthetic: asymmetric and symmetric situations. Am I Orthod Dentofacial Orthop. 2006; 130(2):141-51.
20. Ackerman, B, M., Ackerman, J., L. Smile Analysis and Design in the Digital Era. I Clinic Orthodontist.2002; 36(4): 221-36.
21. Desai, S., Madhur, U., Nanda, R. Dynamic smile analysis: Changes with age. Am I Orthod Dentifacial Orthoped. 2009; 136 (3):310-1.
22. Desai, S., G. Dynamic Smile Analysis: Changes with Age. University of Connecticut. Healt Center. Master Thesis. 2008.
23. Maganzini, A., L., Schroetter, S., B., Freeman, K. Improvement in smile esthetics following orthodontic treatment: A retrospective study utilizing standardized smile analysis. Angle Orthodontist. 2014; 84(3):492-9.
24. Jannathul, F., K., Rengalakshimi, S. Analysing the smile arc in Class 2 patients before and after orthodontic treatment. International Journal of Scientific Development and Research. 2020; 5 (1):70-4.