

TELE-ROENTGEN ANALYSIS OF CHANGES IN SKELETAL AND SOFT TISSUE IN PATIENTS WITH CLASS II DIVISION 1 MALOCCLUSION AND NORMAL OCCLUSION

ТЕЛЕРЕТГЕН АНАЛИЗА НА ПРОМЕНИ НА СКЕЛТЕТОТ И МЕКИТЕ ТКИВА КАЈ ПАЦИЕНТИ МАЛОКЛУЗИЈА II КЛАСА 1 ОДДЕЛЕНИЕ И НОРМАЛНА ОКЛУЗИЈА

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Abstract

Malocclusions that are usually present in patients often give changes to the skeleton of the face and changes on the soft tissue structures. The **purpose** of this study is to determine the changes that occur in the skeleton and soft facial structures, in tele-roentgen pictures, in patients with Class II Division 1 Malocclusion and subjects with normal occlusion, to determine the bone support (apical and basal) on maxilla and mandible, as a basis for supporting the movement of the teeth and to determine the position of the upper and lower lip in relation to the "Aesthetic" line by Ricketts. For that purpose, 60 patients with Class II Division 1 Malocclusion and 30 patients with normal occlusion were examined. From the **results** obtained, we see that the maxilla is in normal position, and the maxillary incisors are proclined, while the mandible is in a distal position according to the cranial base. The support of the apical bone of the maxilla is thinner in subjects with Class II/1 Malocclusion compared to subjects with normal occlusion. Both lips (upper and lower) touch the "Aesthetic" line in patients with Class II/1. In the same investigated group there is also exposure of the incisions of 1.93 mm, which is not presented in the group with normal occlusion. **Key words:** Class II Division 1 Malocclusion, normal occlusion, protrusion of the incisors

Апстракт

Малоклузиите кои се присутни кај пациентите често даваат промени и на скелетот на лицето и промени на меките структури. **Целта** на ова истражување е да се одредат промените кои што се јавуваат на скелетот и на меките структури на лицето, на Теле ртснимки, кај пациентни со присутна малоклузија II класа 1 одделение и испитаници со нормална оклузија. Да се одреди коскената потпора (апикална и базална) и на максилата и на мандибулата, како основа за поддршка при придвижување на забите. Да се одреди поставеноста на горната и долната усна во однос на "Естетската" линија по Ricketts. За таа цел испитани се 60 пациенти со малоклузија II/1 и 30 пациенти со нормална оклузија. Од добиените **резултати** гледаме дека максилата е во нормопозиција и максиларните инцизиви се проинклинирани, додека мандибулата се наоѓа во дистална позиција. Апикалната коскена основа на максилата е потесна кај испитаници со II/1, во однос на испитаници со нормална оклузија. И двете усни ја добираат "Естетската" линија, кај пациентни со малоклузија II/1. Кај истата испитувана група има и експонираност на инцизивите од 1.93мм, што не е случај кај групата со нормална оклузија. **Клучни зборови:** малоклузија II класа 1 одделение, нормална оклузија, протрузија на инцизиви

Introduction

Normal occlusion and articulation allow for the proper functioning of the entire dento-alveolar complex. Any deviation from the normal occlusion in this region gives its repercussions of inter-cuspidation, which can be manifested not only in the dento-alveolar fetuses but in the soft tissue structures, too. Class II Division 1 malocclusion is manifested by changes in the anteroposterior

direction, with a distal placement of the mandible in relation to the maxilla, perceived through the ratio of the canines and the first permanent molars. In this malocclusion where the protrusion of the maxillary incisors is present is defined as a Class II Division 1 malocclusion.^{1,2}

In the malocclusion of II/1, the maxillary dental arch is marked with a pointed shape and often is in the form of the letter "V". Mandibular incisions most commonly touch palatal mucosa^(1,2)

The position of the maxilla and mandible in relation to the front cranial base may be different, so we can find the cause of this malocclusion right here. There are various combinations of the position of the maxilla and mandible, but as the most difficult degree for this malocclusion is considered when the maxilla is proclined and the mandible is in the retrograde position^{1,2,3}

The extra-oral appearance of patients may suggest a present orthodontic anomaly. Thus, in class II/1 malocclusions due to the protrusion of the maxillary incisors, the upper lip only partially covers them, so here we are talking about incompetent lips. Most often in these patients there is hypotonia of the muscles of the lips. Due to hypotension, we often encounter gum exposure during smile known as the "gingival smile."^{4,5} There are changes in orofacial muscles, such as the persistence of infantile swallowing. The profile in these patients is convex and most often the upper and lower lips touch or pass the aesthetic line⁶.

Orthodontists determine the positioning of the jaws, their interaction and the position of the teeth, using profiled tele-roentgen images and gnathometric analyzes.

Many studies have shown that minor changes in the dento-alveolar complex can lead to significant changes in the ultimate appearance after orthodontic treatment^{7,8,9,10}.

The tele-roentgen analysis provides data on the growth and development of the maxilla, mandible, anterior cranial base and whole facial complex^{11,12}. The growth and development of the facial skeleton and plan for orthodontic therapy for each patient individually can be estimated with measurements of dento-alveolar, skeletal and soft tissue changes. Accordingly, a proper diagnosis is made and appropriate therapy is planned, which will be suitable for the given malocclusion, depending on the growth and development of the jaws^{12,13}.

The size of the alveolar and basal bone has been examined by Bajracharya¹⁴ in patients with Class II/1 malocclusion who came to the conclusion that male and female subjects with a high angle had a smaller maxillary alveolar bone compared to those with a low and average angle. In relation to mandibular alveolar basal bone, it was found to be greater in male examinees with a smaller angle. These trials can determine the borders of the "orthodontic wall" whose frames will enable the movements of the anterior teeth⁴. Normally, if these borders give bigger results with more free teeth movements and increased stability in the retention period. If during tele-roentgen analysis appears that there is insufficient bone in the apical and basal part of the maxilla and mandible, this fact indicates that a successful orthodontic therapy should be done by extraction of the teeth.

The **purpose** of this study is to define and demonstrate the dento-alveolar and skeletal changes that have

repercussion on the extra-oral appearance of patients with Class II Division 1 malocclusion and in patients with normal occlusion.

- To determine the position of the maxillary incisors according to the maxillary plane (Sp) - according to Schwarz
- To determine the placement of mandibular incisors according to the mandible plane (Mp) - according to Tweed
- To determine the size of the apical and basal bone of the maxilla and mandible in patients with Class II /1 and in patients with normal occlusion
- To define the upper and lower lip position relative to the Ricketts aesthetic line

Material and method

Tele-roentgen images of 60 patients with Class II Division 1 malocclusion and 30 subjects with normal occlusion were analyzed. All respondents were from 12 to 18 years of age.

Criteria for selection:

- for class II division 1 malocclusion, the ANB angle is $> 4^\circ$
- for normal occlusion, the ANB angle is between 2° and 4°

Tele-roentgen images were drawn on a pause paper and measurements were made of the following parameters:

- SNA - position of the maxilla in relation to the anterior cranial base
- SNB - mandibular position relative to the anterior cranial base
- ANB - mutual relation of maxilla and mandible
- Sna-Snp - the length of the body of the maxilla
- G0-Gn - length of the mandible body
- 11/Sp - incline of the maxillary incisions by Schwarz
- 31/Mp - incidence of mandibular incisions by Tweed
- Is/Ii - inter-incisors angle by Downs
- MxAD - maxillary alveolar depth (from A to A')
- MxBaD - maxillary basal depth
- MxIAH - maxillary alveolar height, from an incisal edge of maxillary incisor
- MxAH - maxillary alveolar root height
- MdAD - mandibular alveolar depth (from B to B')

- MdBaD - mandibular basal depth
- MdIAH - mandibular alveolar height, of an incisal edge of mandibular incise
- MdAH - mandibular alveolar root height

Tele-roentgen measurement on the soft tissue profile:

- UL-EL - from the most prominent part of the upper lip to EL
- LL-EL - from the most prominent part of the lower lip to the EL
- UI - length of the upper lip (from Sn to Ls)
- UIT- thickness of the upper lip (from maxillary incisor to Ls)
- LI - length of the lower lip (from Li to sulcus mentolabialis)
- LIT - thickness of the lower lip (from mandible incisor to Li)
- Exposure of the maxillary incisors - from stomion to the incisal edge of the maxillary incisors

- Default error
- Minimum
- Maximum
- Students “t” test for the 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

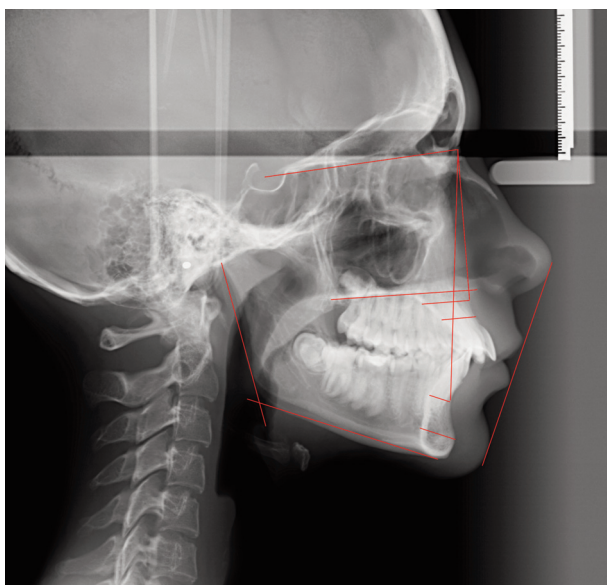
Results

We obtained the results which show the position of the incisors in relation to their reference plains, the size of the alveolar and basal bone of the maxilla and mandible in patients with normal occlusion and in

Table 1. Tele-roentgen values in patients with Class II Division 1 Malocclusion

II/1 n=60	x	SD	SE	Min.	Max.
SNA	82.85	3.60	0.47	75.00	91.00
SNB	76.73	3.48	0.45	70.00	86.00
ANB	6.08	1.17	0.15	5.00	9.00
Sna-Snp	54.37	3.78	0.49	47.00	65.00
Go-Gn	71.75	4.79	0.62	61.00	82.00
11/Sp	117.33	5.52	0.71	102.00	130.00
31/Mp	87.73	14.39	1.86	9.00	119.00
Is/li	122.08	7.01	0.91	108.00	143.00
MxAD	12.13	1.74	0.22	9.00	17.00
MxBaD	15.60	2.24	0.29	10.00	21.00
MxIAH	33.12	3.35	0.43	23.00	40.00
MxAH	21.00	3.19	0.41	10.00	29.00
MdAD	8.72	1.33	0.17	5.00	11.00
MdBaD	15.20	1.80	0.23	9.00	19.00
MdIAH	42.75	4.47	0.58	16.00	50.00
MdAH	34.00	3.06	0.39	26.00	41.00
UL-Rickets	-1.52	2.49	0.32	-8.00	4.00
LL-Rickets	-0.08	3.42	0.44	-8.00	7.00
UL length	20.68	2.53	0.33	15.00	29.00
UI thickness	12.72	2.62	0.34	6.00	19.00
LL length	15.62	3.19	0.41	10.00	29.00
LL thickness	16.72	1.89	0.24	13.00	21.00
Ekspoz 11	1.93	2.43	0.31	0.00	8.00

Statistical processing of results



Picture 1. Tele-roentgen measurements

The obtained results from both examined groups, the normal occlusion group and the group with malocclusion II/1 were computerized with the following statistical parameters:

- Arithmetic environment
- Standard deviation

patients with Class II division 1 malocclusion, the position of the lips in relation to the aesthetic plane and their length and thickness.

From the values in the first table we can see that the ANB angle is increased (6°) which indicates the existence of a skeletal class II, combined with normo-position of the maxilla ($SNA = 82.85^\circ$) and retrusion of the mandible ($SNB = 76.73^\circ$). There is an enlarged length of the body of the maxilla $Sna-Snp = 54.37$ mm, and the normal length of the mandible body $Go-Gn = 71.75$ mm. The mean value of the angle of the maxillary incision (11) with Spina planum is 117.33° , and the normal value of this angle is 104° . Mandibular incisors are placed in mild retraction ($31/Mp = 87.73^\circ$). The inter-incisors angle is reduced ($Is/Ii = 122.08^\circ$). The maxillary alveolar depth (MxAD) is 12.13 mm, and the maxillary basal depth (MxBAD) in patients with II/1 is 15.60 mm. MxIAH - the maxillary alveolar height is 33.12mm, and the alveolar root height (MxAH) is 21 mm. The mandibular alveolar depth is (MdAD) is 8.72 mm, while the mandibular basal depth (MdBaD) is 15.20 mm. The mandibular alveolar height (MdIAH) is 42.75 mm, and the mandibular height of the root is 34.00 mm.

Regarding the Rickett Aesthetic Line, the upper lip is - 1.52 mm backwards, and the lower lip almost touches the line. It is - 0.08 mm behind it. The thickness of the upper lip is 12.72 mm, and its length is 20.68 mm. The lower lip has a thickness of 16.72 mm and a length of 15.62 mm. The upper lip still fails to cover the incisors and they are visible at 1.93mm.

From the values in this table we can see that the ANB angle is 2.73° , indicating the existence of skeletal class I, combined with normo-position of the maxilla ($SNA = 81.27^\circ$) and normo-position of the mandible ($SNB = 78.53^\circ$). There is an increase in the length of the body of the maxilla $Sna-Snp = 54.63$ mm, and an insignificant increase in the length of the mandibular body, $Go-Gn = 74.40$ mm. The mean value of the angle of the maxillary incision (11) with the Spina planum is 105.50° and is in the range of normal values. Mandibular incisors are placed in the normal position ($31/Mp = 92.00^\circ$). The inter-incisors angle is increased ($Is/ Ii = 137.97^\circ$). The maxillary alveolar depth (MxAD) is 12.83 mm, and the maxillary basal depth (MxBAD) in patients with Class II/1 is 16.33 mm. MxIAH - the maxillary alveolar height is 31.83 mm, and the alveolar root height (MxAH) is 21.13 mm. The mandibular alveolar depth is (MdAD) is 8.80 mm, while the mandibular basal depth (MdBaD) is 15.43 mm. The mandibular alveolar height (MdIAH) is 43.53 mm, and the mandibular height of the root is 35.13 mm.

Regarding the Ricketts Aesthetic Line, the upper lip is - 4.60 mm behind the Aesthetic line and the lower lip

Table 2. Tele-roentgen values in patients with normal occlusion

II/1 n=60	x	SD	SE	Min.	Max.
SNA	81.27	2.78	0.51	76.00	89.00
SNB	78.53	2.67	0.49	74.00	85.00
ANB	2.73	1.06	0.19	1.00	4.00
Sna-Snp	54.63	2.82	0.52	47.00	63.00
Go-Gn	74.40	3.76	0.69	68.00	84.00
11/Sp	105.50	6.40	1.17	90.00	114.00
31/Mp	92.00	4.82	0.88	84.00	104.00
Is/Ii	137.97	4.48	0.82	130.00	148.00
MxAD	12.83	1.42	0.26	11.00	15.00
MxBaD	16.33	2.37	0.43	12.00	23.00
MxIAH	31.83	2.44	0.44	26.00	37.00
MxAH	21.13	2.81	0.51	14.00	28.00
MdAD	8.80	1.14	0.21	6.00	12.00
MdBaD	15.43	1.98	0.36	10.00	20.00
MdIAH	43.53	3.26	0.60	36.00	52.00
MdAH	35.13	4.29	0.78	28.00	53.00
UL-Rickets	-4.60	1.87	0.34	-7.00	0.00
LL-Rickets	-2.73	2.11	0.39	-7.00	1.00
UL length	20.20	2.82	0.52	14.00	25.00
UI thickness	14.60	2.46	0.45	10.00	19.00
LL length	16.37	1.94	0.35	13.00	22.00
LL thickness	15.77	2.22	0.40	13.00	20.00
Ekspoz 11	0.87	1.56	0.29	0.00	5.00

is almost in the normal position, i.e. - 2.73 mm behind this line. The thickness of the upper lip is 16.37 mm, and its length is 20.20 mm. The lower lip has a thickness of 15.77 mm and a length of 16.37 mm. The incisors are not exposed during the rest position of the lips, only 0.87 mm.

From the values in this table we can see that the parameters ANB, 11/Sp, Is/Ii, UL-Rickets, LL-Rickets have substantial significance in the level of $p < 0.001$ (***). The significance of $0.05 > p > 0.01$ (*) was for the following parameters: SNA, SNB, Go-Gn, 31/Mp, MxAD, MxIAH, LL thickness and exposure at 11.

For the other parameters, no significant differences were found between the examined groups.

Table 3. Values of t-test in patients with Class II Division 1 Malocclusion compared with subjects with normal occlusion

	II-1		Normal occlusion		t-test	p
	x	SD	x	SD		
SNA	82.85	3.60	81.27	2.78	0.03	0.05 > p > 0.01 (*)
SNB	76.73	3.48	78.53	2.67	0.01	0.05 > p > 0.01 (*)
ANB	6.08	1.17	2.73	1.06	0.00	p < 0.001 (***)
Sna-Snp	54.37	3.78	54.63	2.82	0.71	p > 0.05 (-)
Go-Gn	71.75	4.79	74.40	3.76	0.01	0.05 > p > 0.01 (*)
11/Sp	117.33	5.52	105.50	6.40	0.00	p < 0.001 (***)
31/Mp (IMPA)	87.73	14.39	92.00	4.82	0.04	0.05 > p > 0.01 (*)
Is/li	122.08	7.01	137.97	4.48	0.00	p < 0.001 (***)
MxAD	12.13	1.74	12.83	1.42	0.05	0.05 > p > 0.01 (*)
MxBaD	15.60	2.24	16.33	2.37	0.17	p > 0.05 (-)
MxIAH	33.12	3.35	31.83	2.44	0.04	0.05 > p > 0.01 (*)
MxAH	21.00	3.19	21.13	2.81	0.84	p > 0.05 (-)
MdAD	8.72	1.33	8.80	1.14	0.76	p > 0.05 (-)
MdBaD	15.20	1.80	15.43	1.98	0.59	p > 0.05 (-)
MdIAH	42.75	4.47	43.53	3.26	0.35	p > 0.05 (-)
MdAH	34.00	3.06	35.13	4.29	0.21	p > 0.05 (-)
UL-Rickets	-1.52	2.49	-4.60	1.87	0.00	p < 0.001 (***)
LL-Rickets	-0.08	3.42	-2.73	2.11	0.00	p < 0.001 (***)
UL length	20.68	2.53	20.20	2.82	0.44	p > 0.05 (-)
UI thickness	12.72	2.62	14.60	2.46	0.00	p < 0.001 (***)

Discussion

Orthodontics is a branch of dentistry that aims not only to care for the proper arrangement of teeth in dental arches, which will improve the function of chewing, but to participate in the creation and improvement of facial aesthetics.

For this purpose, the growth and development of each patient should be evaluated to calculate dental, bone and soft tissue parameters and changes that occurred as a result of the presence of an orthodontic anomaly. It will be a guide for establishing a proper diagnosis and conducting appropriate orthodontic therapy.

The assessment of the growth and development of the maxilla and mandible have a major influence on the development of the entire cranial system and the skeletal and soft tissue structures of the face.

Enlow^{15,16} in his study describes the development of the maxilla as a passive displacement upward and downward, as a result of the growth of the cranial base, the

growth of the maxillary structures and the growth of the nose.

The mandible grows so that the beard moves forward and down. The main centers of growth and development of the mandible are the posterior surface of the ramus, the condylar and the coronary process and the partially anterior part of mandible Enlow^{15,16}.

Disharmony between the degree of position of the maxilla and mandible is most often expressed through the ANB angle. In patients with normal occlusion, its value is from 2-4°¹⁶, while in patients with distal position of the mandible it is enlarged. In our examined group with Class II Division 1 malocclusion there is an increase in the ANB angle of 6° indicating that the skeletal Class II is present.

The reason for the present class II malocclusion can be the protrusion of the maxilla in relation to the front cranial base.

But according to the findings of Zuzelova¹⁷, Class II Malocclusion is not exclusively due to the distal position

of the mandible. There are various combinations of components in the oro-facial region that participate in the formation of malocclusions. Our examined values have shown that the present Class II Division 1 Malocclusion is the result of a distal placement of the mandible (SNB =76.83°), and the maxilla is set almost in the normal position relative to the front cranial base.

The placement of the upper and lower incisors among each other and their dependence on the bone tissue of the maxilla and mandible, play an important role when making a tele-roentgen analysis. Achieving good facial harmony and balance of the face profile will depend of their position, which will affect the stability during the period of retention^{14,18,19,20}.

The bone support in the alveolar and basal part of the maxilla and mandible is an important component because the roots of the teeth are located there. The width and height of this section shows how much we are able to retrude or intrude teeth in the frontal region. If in this section we do not have enough bone support then before the start of the therapy we will have to do extraction of teeth in the side region. The values we received for these parameters (MxAD, MxBaD, MdAD, MdBaD) in both examined groups are greater than the values obtained by Bajracharya¹⁴ in his examination.

The maxillary incisors are the front leading slopes for protrusive mandible movements. The placement and axial inclination of the upper and lower incisors (Is/Ii) are also important factors in determining facial aesthetics.^{21,22} In our investigations, the value of this angle has decreased (122.08°) indicating a greater incisors inclination.

The axial incline of the incisors regarding the maxillary plane is determined by the angle Is/Sp and determines the protrusion of the maxillary incisors with the Schwarz analysis, while the placement of the mandibular incisors regarding the mandibular plane gives the IMPA angle (according to the Tweed method). This angle is important to assess whether sufficient space can be provided in the lower dental arch without extraction, or to satisfy the function and the aesthetics there will be a need to extract teeth. Also, this angle points to the stability of the mandible incisions after orthodontic therapy. In his investigation Ceylon²³ finds increased protrusion of mandible incisions, which may result from compensation for reducing o.j. In our study we found that the value of the IMPA angle is 87.73°, indicating a mild retrusion of mandible incisions, in patients with Class II Division 1 Malocclusion, which emphasizes class II.

Janson and Hasund,²⁴ in their study of the placement of lower incisors in orthodontic-treated patients found that lower incisors tend to become unstable and because of their position, they become an important factor in the analysis of the plan for the therapy of malocclusions.

The aesthetic line along the Ricketts is a tangent that connects the tip of the nose (Prn^c) and the tip of the chin, the soft tissue Pg^c (Ozerovic B¹¹). There is normal placement if the upper lip is -3mm and the lower lip is -2mm behind this line. In our examined groups, in the group with Class II Division 1 Malocclusion, the upper lip is -1.52 mm behind the Aesthetic Line, and the lower lip is -0.08 mm behind it. This suggests a protraction of both the upper and lower lip, so the changes in bone tissue are accompanied by changes in soft tissues. These findings coincide with the findings of Gjorgova²⁵, Nanda and all^{26,27} and Forsberg²⁸.

The length of the upper lip is almost the same in subjects with Class II/1 and subjects with normal occlusion, while the thickness of the lower lip differs. Patients with Class II/1 have a thinner lower lip, its value is 12.72 mm, compared to subjects with normal occlusion (14.60 mm) Oliver MB²⁹.

The length and thickness of the lower lip do not differ in subjects with normal occlusion and subjects with Class II Division 1 Malocclusion.

Conclusion

Based on the analysis of the results obtained with the measurements of tele-roentgen images in patients with Class II Division 1 Malocclusion and subjects with normal occlusion, we can conclude that in subjects with Class II/1, except that we have the presence of skeletal class II with more pronounced distal placement of the mandible, there is also inclination of the maxillary incisors with a marked retraction of the mandibular. Therefore, when planning the therapy, a suitable orthodontic device should be planned, which will lead to the set mandible in more mesial position, in order to achieve the correct occlusion.

The width and height of the maxillary and mandibular alveolar and basal bone play a major role as bone support for teeth movements. These parameters will influence the fact whether we will be able to retrude or intrude teeth in the frontal region, or to perform orthodontic therapy without tooth extraction in the side segment. This will be an indicator of a properly implemented orthodontic treatment which will result in bigger stability in the retention period.

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