MEDICAL SCIENCE MONITOR

CLINICAL RESEARCH

e-ISSN 1643-3750
© Med Sci Monit, 2017; 23: 5589-5598
DOI: 10.12659/MSM.905453

Received: 2017.05.23
Accepted: 2017.06.08
Published: 2017.11.24

# The Influence of Class II Division 2 Malocclusions on the Harmony of the Human Face Profile

Authors' Contribution:
Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

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**Source of support:** Departmental sources

**Background:** Persons with class II division 2 malocclusion are characterized by a very specific dento-skeletal and soft-tissue profile (a profile in which a protruding nose and chin, retruding lips, concave and shortened lower third of the face, and gummy smile are dominant), which is the opposite of the currently modern profiles (convex profile of protruding lips and small chin). The aim of this research was to determine the differences in parameters of harmonies of facial profiles between persons with class II division 2 malocclusions and class I, and to establish the significance of those differences.

**Material/Methods:** For this study, 50 patients with class II division 2 malocclusions and 50 patients with class I were selected; profile photos were recorded and a photometric analysis was done: a type of profile according to Schwarz, the shape of a nose, the prominence of chin, biometrical field, the position of lips in relation to the tangent Sn-Pg, S-line (Steiner), E-line (Riketts) and a facial angle according to Arnett.

**Results:** The significant differences in profiles of persons with class II division 2 compared to class I were: position and prominence of the chin, the position of the lower and upper lip in relation to the S-line, and smaller value of a facial angle in relation to persons with class I.

**Conclusions:** The differences seen in skeletal profiles were not associated with significant differences in the profiled facial contours of the examined groups. The compensatory role of the fullness of soft tissues of the lips is probably the reason why there were not significant deviations in all the examined parameters.

**MeSH Keywords:** **Beauty • Facial Expression • Malocclusion, Angle Class II**

**Full-text PDF:** https://www.medscimonit.com/abstract/index/idArt/905453







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## Background

Facial attractiveness is very important in inter-human communication. Beauty means social power and success and has a positive influence in all areas of civilized society [1]. The correlation between facial aesthetics and sagittal occlusal relationship has been a matter of research since Angle, who noticed that sagittal deviations in occlusion produce different disharmonies of facial contours [2–4]. In 1899, he classified sagittal occlusal relationships into three categories (classes), based mostly on the anteroposterior relationship of the maxillary and mandibular first permanent molars, where class I represents normal (neutral) sagittal occlusal relationship (in which, due to the absence of sagittal disharmony, a pleasant look of the face is expected) class II disto-, and class III mesio-occlusion. He divided class II malocclusions into two divisions: 1) division with the protrusion of upper incisors and 2) division with the retrusion of upper incisors. Many years later, European orthodontists pointed out the pattern of malocclusion which corresponds to class II, division 2. In German-speaking areas, dentists call it "deckbiss", which would mean, cover-bite according to Maihofer (1912) [5]. This malocclusion is of extremely hereditary etiology [5,6] and as such, it requires long-term therapy and even longer retention period. Representation of this class varies with reports of 3.4% [7], and 2.5–14% [5]; in Saudi Arabia it has been reported to be 12% of all the patients that require orthodontic treatment [8], in Brazil it has been reported to be 10% of the entire population [4]. Males are more often affected by this irregularity (14: 9, male: female) [5].

However, class II malocclusions division 2 do not only represent a specific irregularity in bite, which is characterized by a specific ratio of teeth and jaw bases [9], but an adequate appearance of the face, particularly a profile [10–12]. A characteristic skeletal profile of these persons is characterized by a protrusion of nose, subnasal and mental region, as well as following specific dento-skeletal characteristics (Figure 1) [13]: 1) normognathia of the maxilla and mild retrognathia of the mandible; 2) pronounced horizontal pattern of growth with the front rotation of mandibular base; 3) skeletal deep bite; 4) retroclination and supraposition of the upper incisors [9,12,14–16]; and 5) small teeth, pronounced growth of mandibular base and a strong chin [5,16].

Soft-tissue profile in persons with class II division 2 is also specific, and described as a profile of "sharp" facial contours [17]; with concave lower third of the face with a protruding nose and tip of the chin, thin vermillion, and retruded lips (Figure 2) [10,11,18]. The rima oris is placed high, so that when smiling, the upper alveolar arch covered with the gingiva is first displayed (gummy smile) [19–23].

There are contradictory views on the influence of characteristic dento-skeletal pattern on the harmony of a face profile. According to some authors [3,7,14], it does not have a significant influence on the face profile. On the other hand, some researchers indicate dissatisfaction of potential patients with class II division 2, primarily with face appearance and smile (so called gummy smile) [16,19–26]. This is mostly the main reason for seeing an orthodontist [7,11,23,26].

The objective of this study was to compare the characteristics of a profile face harmony in persons with class II division 2 with class I, to establish the existing differences and to determine their significance, by using the analysis of the photos of face profiles.

## Material and Methods

### Material

Fifty persons with class II division 2 malocclusions were chosen for the research, aged 13–30 years, and of both sexes. At the same time, 50 patients with class I occlusion, of both sexes, aged 13–30 years, were chosen for the control group.

Patients of both groups had their impressions taken, on the basis of which cast models and profile roentgen cephalometric shots were made. The criteria for the selection of patients in the group with class II division 2 malocclusion were as follows: 1) distal relationship of the first permanent molars, with retroclined upper incisors (at least two central incisors); 2) angle ANB >4°; 3) absence of congenital anomalies or face asymmetry; and 4) presence of all teeth (except from the 3rd molars). The criteria for the selection of patients in the group with class I occlusion was as follows: 1) occlusion of first permanent molars in class I, with a normal overjet and overbite; 2) angle ANB of 2–4°; 3) regular teeth distribution in the upper and lower dental line (whereby the lack or suficit of space up to 2 mm is tolerated; 4) absence of congenital anomalies or face asymmetry; and 5) presence of all teeth (except from the 3rd molars).

### Methods

All the participants had profile photographs according to the following criteria: profile photographs were taken of each participant using a Coolpix 5700 digital camera (5 MP; Nikon, Tokyo, Japan). The photographs were obtained with the Frankfort plane parallel to the floor and perpendicular to the body axis (natural position) and with the interpupilar parallel to the floor. The participants stood against a white background at a distance of 1.5 m from the camera. Reference lines are plotted on the profile photographs using the program CorelDRAW Graphics Suite X5 (Corel Corporation, Canada).

The photographs of the profiles of participants underwent analyses based on: 1) type of a profile according to Schwarz;





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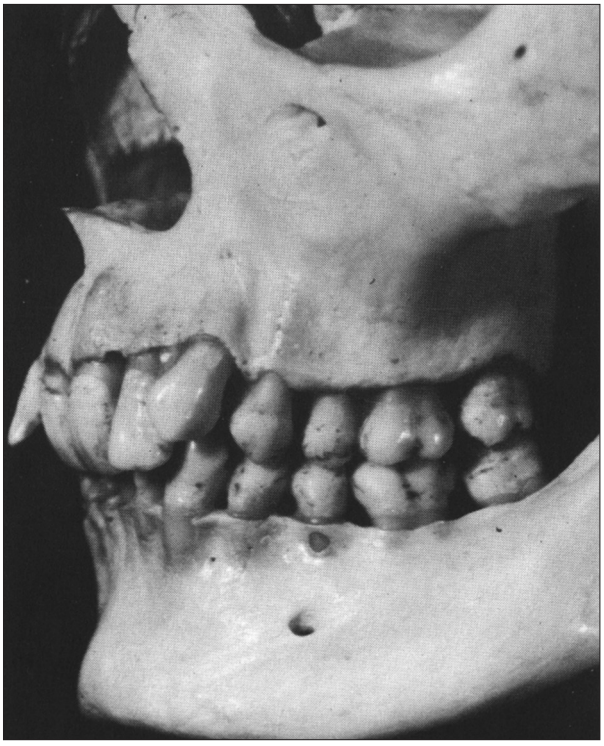

**Figure 1.** Facial skeleton with class II division 2. Dominating spina nasalis anterior, palatal inclination of upper teeth, and overdeveloped apical base of the upper jaw [13].

**Figure 2.** The typical profile of a person with malocclusion class II, division 2: concave lower third of the face with a protruding nose and tip of the chin, thin vermillion, and retruded lips.

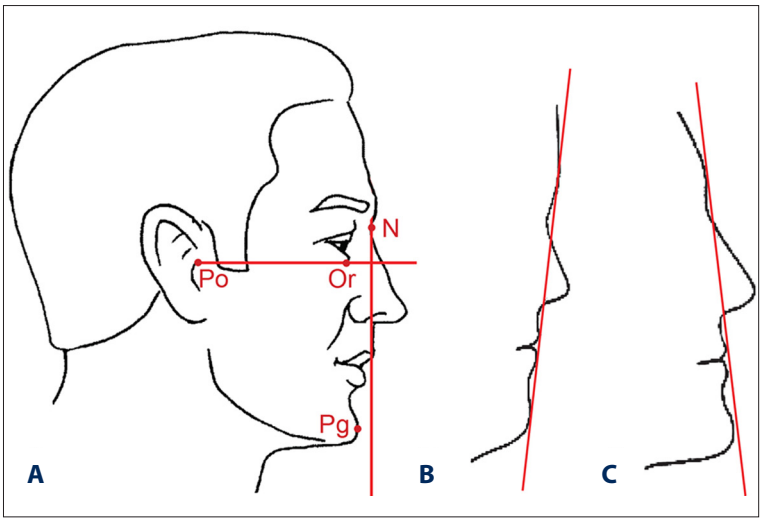


**Figure 3.** The drawings shows orthoprofile (ortotip profile) according to Schwarz (**A**), posteriorly (**B**) and anteriorly inclined (**C**).

2) shape of the nose; 3) prominence of a chin; 4) relationship of the upper lip, lower lip, and the tip of a chin; 5) position of lips in relation to the tangent Sn-Pg; 6) position of lips in comparison to the S-line (Steiner); 7) position of lips in relation to the E-line (Riketts); and 8) facial angle according to Arnett.

The type of a profile was defined according to Schwarz using connecting profile points N-Sn (where N is naison, the uppermost nasal point, at the level of its root that is the projection of the hard-tissues; and Sn is subnasale, the transition point between the nose and the upper lip), into one line, its incline was determined in relation to the Frankfort horizontal line (which connects the points Po and Or (where Po is the porion point, i.e., the uppermost external acoustic meatus; and Or is the lowest point osseous edge of orbit), by which profiles were classified as: straight (profile orthotype) in which N-Sn line is





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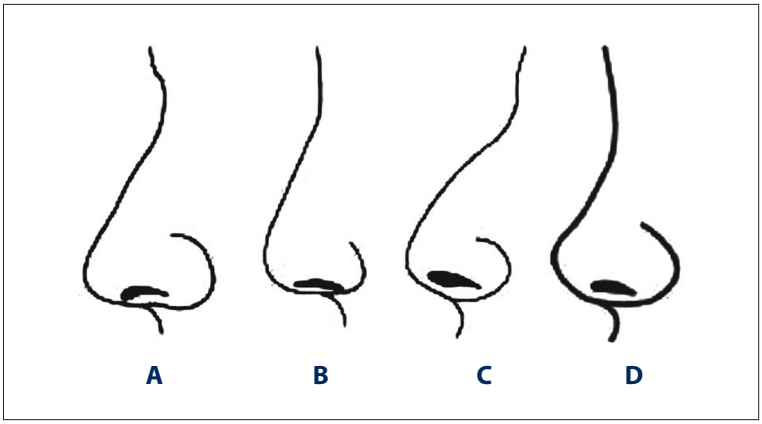


**Figure 4.** Different types of noses: a straight nose long nasal dorsum (**A**), a straight nose short nasal dorsum (**B**), hooked nose (**C**), and short nasal dorsum, upward sloping nasal tip (a snub) (**D**).

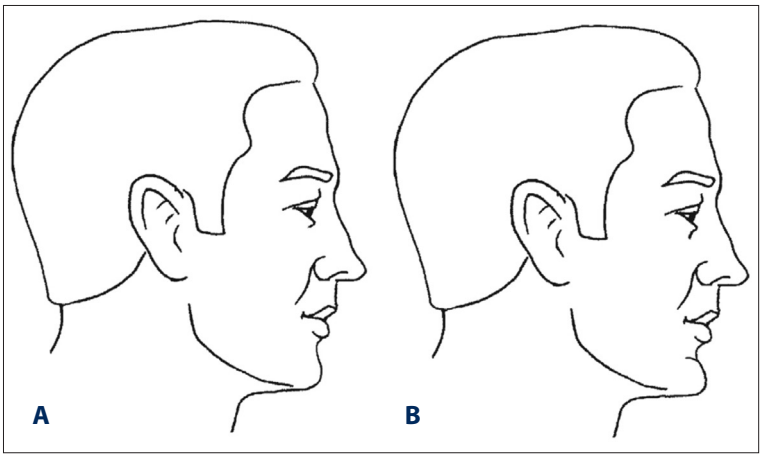


**Figure 5.** Two different types of chin: normally prominent (**A**) or somewhat flatter chin and a type of prominent chin (**B**).

vertical to Frankfort horizontal line (Figure 3A), posteriorly inclined (N-Sn line posteriorly divergent) (Figure 3B), and anteriorly inclined profile (N-Sn line anteriorly divergent) (Figure 3C).

The shape of the nose was defined on the basis of a profile contour of the nose, the shapes were classified as: straight nose long nasal dorsum (Figure 4A), straight nose short nasal dorsum (Figure 4B), hooked nose (Figure 4C), and short nasal dorsum, upward sloping nasal tip (snub nose) (Figure 4D).

The prominence of the chin was defined by two types of chin: normally prominent (Figure 5A) or a somewhat flatter chin, and a type of prominent chin where there is a clearly differentiated mentolabial sulcus and a chin bulge (Figure 5B).

The relationship of the upper lip, lower lip, and the tip of a chin in the biometrical field (the space between the perpendicular from the point N (nasion) and normal from the point Or (orbitale) according to Schwarz (this analysis only referred to profiles, which were straight according to the first examined criterion, the so-called orthoprofile): a normal position of elements in the biometrical field-upper lip touches the vertical from N point, lower lip is on the joint of the front and middle third of the biometrical field, and the tip of the chin on the

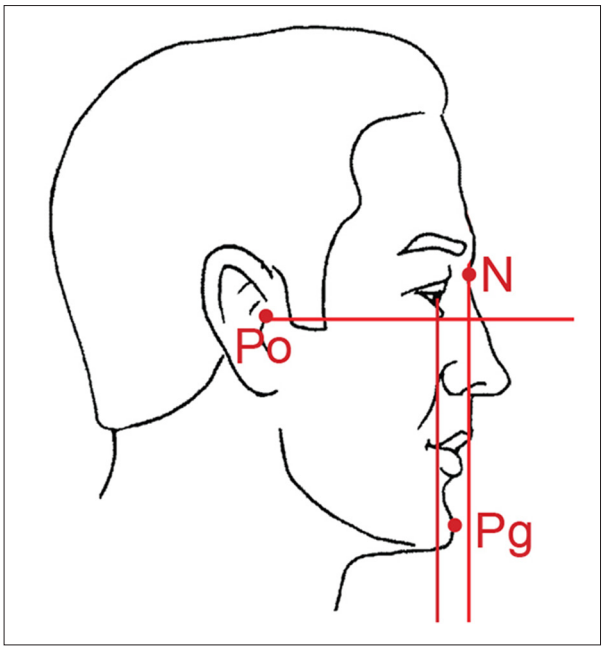


**Figure 6.** The normal position of the upper lip, lower lip and the chin in the biometrical field.





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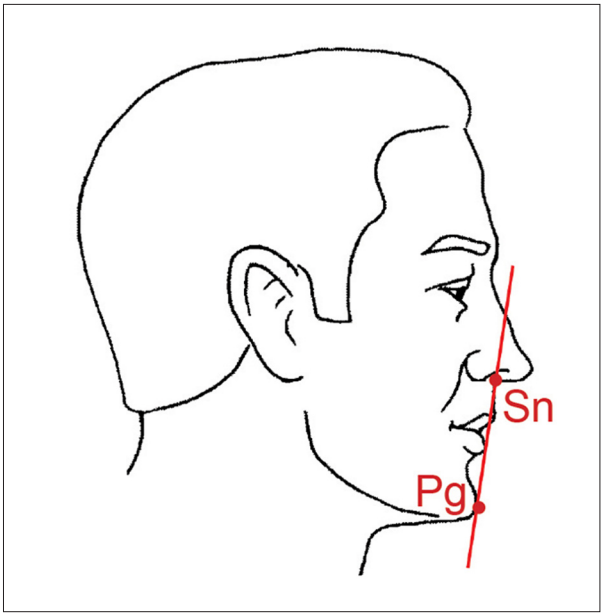


**Figure 7.** The normal position of lips in relation to the tangent Sn-Pg.

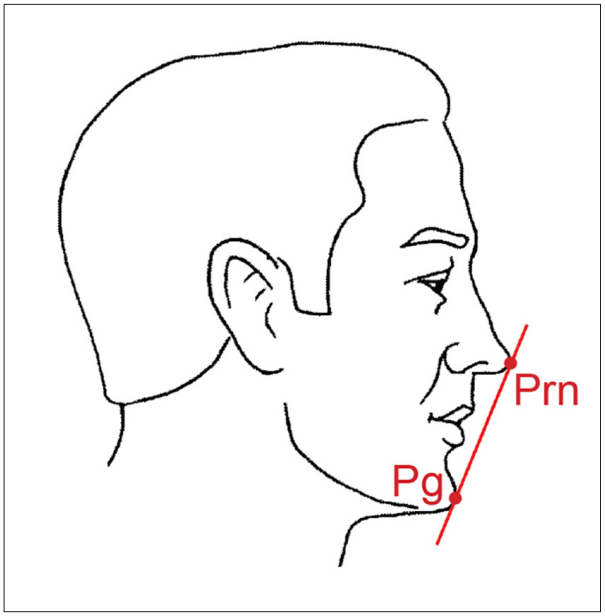


**Figure 9.** The normal position of lips in relation to the E-line (Riketts).

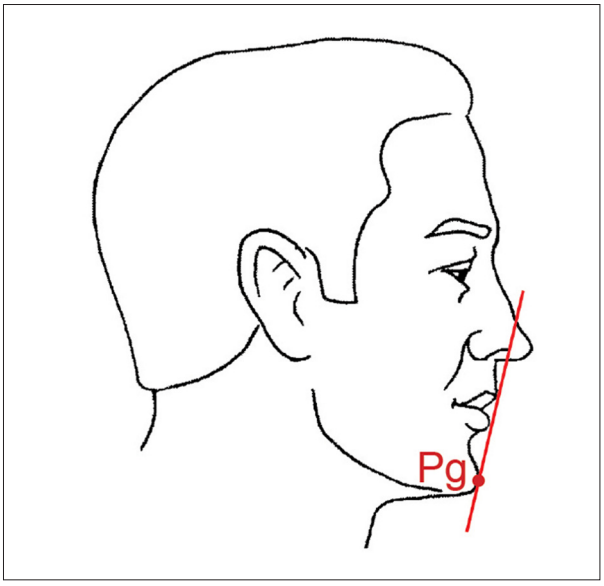


**Figure 8.** The normal position of lips in comparison to the S-line (Steiner).

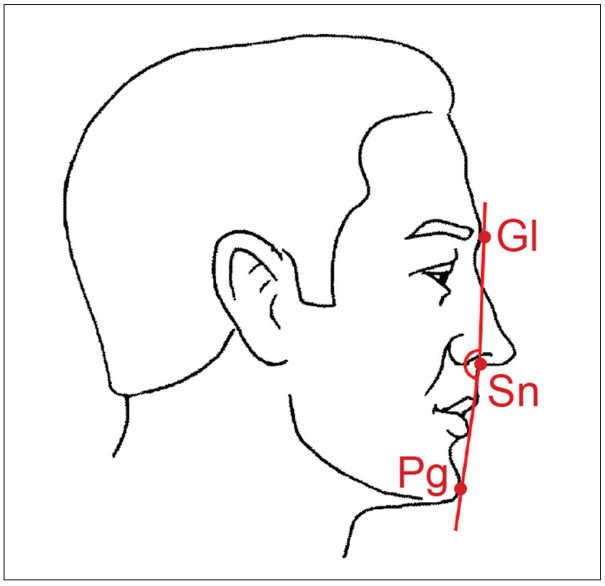


**Figure 10.** Facial angle according to Arnett.

middle of the biometrical field (between the vertical from the N point and the vertical from the center of the pupil) (Figure 6).

The position of lips was defined in relation to the tangent Sn-Pg. Possible findings: lips go through the tangent (normal finding), lips touch the tangent, and lips are inside the tangent (Figure 7).

The position of lips in comparison to the S-line (Steiner) was defined as: the S-line goes from Pg (pogonion, which is the front-most chin point) to the middle of the nose base (the middle of subnasale-pronasale line). In a balanced, harmonious profile, lips should touch this line (Figure 8). However, lips can be placed behind this tangent (so called retrusive lips), as well as in front of it (protruding lips).

The position of lips was defined in relation to the E-line (Riketts) which connects Prn (pronasale-peak of nose) – Pg with the following possibilities. In younger persons, from the early phase of permanent dentition, both lips stand behind the E-line, lower 2 mm and the upper 3 mm (Figure 9). Their position can also





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be more anterior (convex lower third of the face), as well as more posterior (concave lower third of the face).

Facial angle was defined according to Arnett. The angle which connects points Gl (glabella) – Sn (subnasale) – Pg (pogonion). Profiles with normal values of the angle 169±3°, convex profiles <169±3°, concave profiles >169±3° (Figure 10).

**Statistical analyses**

The results are given as absolute numbers and in percentages (%) and for determining statistical significance the data were analyzed using Pearson's chi-squared or Fisher's exact test. The significance levels used were $p<0.001$, $p<0.01$, $p<0.05$; and values of $p>0.05$ were considered not significant (ns).

## Results

The results are presented in Tables 1–10, for every examined parameter.

## Discussion

The notion of harmonious profile is defined and perceived differently. The aesthetic impression of a harmonious profile is the result of many factors: racial affiliation, upbringing, historical period, cultural pattern, the influence of media, demographic factors, age, sex, etc., but it is primarily the result of a subjective view and personal opinion [2,11,27–30]. Because of that, it cannot be analyzed only on the basis of the mean values or numbers, but these values are introduced for the objectivity in the aesthetic evaluation [3].

On the other hand, the aesthetic factor is the strongest motivational factor due to which orthodontic patients need treatment [24,30]. How has class II division 2 malocclusion fit into the objectively measurable aesthetic criteria?

It has already been said, that, in this malocclusion there is a characteristic soft-tissue profile which is a consequence of the existence of a specific skeletal profile, which causes pronounced concavity of a soft-tissue subnasal area with thin, competent lips. The analysis of a type of a profile according to Schwarz (Table 1) established the increased number of posteriorly slanted profiles in participants with class II division 2. As opposed to posteriorly slanted, there are significantly fewer anteriorly slanted profiles in participants with class II division 2, which affects the overall aesthetic impression, given that anteriorly slanted profiles, according to the current aesthetic trends, are considered more attractive, expressive and visually pleasing, especially in females [1,2,31–33]. These differences, however, were not significant.

The shape of the nose, can, to a minor or larger extent, influence the harmony of a profile overall [34,35], especially in persons with class II division 2, where there is already a protrusion of nose and subnasal area. In these persons, a small nose or a nose bent upwards, can camouflage the irregularity and contribute to softening of the "sharpness" of a profile [18,35,36]. By examining representation of different types of noses in both our study groups significant differences were not established (Table 2). These differences were not found in similar research either [35]. However, a hooked nose which emphasizes prominence in class II division 2, in general, creates less pleasant aesthetic impression, it is more represented in percentages in the group with class II, but this difference was not significant either.

Highly significant differences ($p<0.001$) were established in examining representation in percentages of a profile with a prominent chin (Table 3). This characteristic is specific for class II division 2 malocclusions, so the obtained results were expected. However, the issue of aesthetic impression was considered as related to sex. Authors who examined aesthetic value of the prominent chin bulge in men, characterized this phenomenon as an advantage ("it contributes to the impression of manliness"), whereas in females the prominent chin was considered an aesthetic disadvantage [2,3,32,33,37,38]. The same authors related the prominent nose and tip of a chin to lessened aesthetic impression, since, with their emphasis, the concavity of the lower third of a face increases. Even Leonardo da Vinci [36] (Figure 11) talked about the unambiguously great influence of the size and shape of a nose and the prominent chin on the harmony of a profile and the aesthetic impression, but without determining whether the impression was positive or negative. Since aesthetic impression, as already mentioned, is the result of a great number of psychosocial factors, and judging by the entirety of da Vinci's work, he painted attractive and grotesque faces with the same pleasure.

The comparison of findings in a biometrical field, only for the participants with the orthotype profile according to Schwarz, did not give significant results for the positon of the upper (Table 4) and lower lip (Table 5). A significant difference was found only in the position of the chin. This is an expected result, given that the prominence of the chin is an anthropological characteristics of class II division 2 (reduction of the contingency table 2×2, Fisher exact test showed statistically significant greater presence of a chin type beyond the normal position in class I, Table 6). Other authors did not establish these differences either [10,32,33].

There were not significant differences in the position of the upper lip and lower lip in relation to the tangent Sn-Pg (Table 7), given that the protrusion of a nasal area, which is prominent in class II division 2 malocclusions, was completely ruled out with this analysis.





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**Table 1.** Representation of different types of profiles according to Schwarz, in persons with class II and class I.

| Types of profiles | Class II, division 2 (n=50) | | Class I (n=50) | |
|---|---|---|---|---|
| Orthoprofile | 16 | (32.00%) | 18 | (36.00%) |
| Posteriorly inclined profile | 28 | (56.00%) | 22 | (44.00%) |
| Anteriorly inclined profile | 6 | (12.00%) | 10 | (20.00%) |

Non significant.

**Table 2.** Representation of different types of noses (Modified by Uzun A, Ozdemir F – Source 35, in persons with class II and class I).

| Types of noses | Class II, division 2 (n=50) | | Class I (n=50) | |
|---|---|---|---|---|
| Straight nose, long nasal dorsum | 17 | (34.00%) | 22 | (44.00%) |
| Straight nose, short nasal dorsum | 21 | (42.00%) | 18 | (36.00%) |
| Hooked nose | 9 | (18.00%) | 6 | (12.00%) |
| Upward sloping nasal tip | 3 | (6.00%) | 4 | (8.00%) |

Non significant.

**Table 3.** Representation of participants with different prominence of chin in persons with class II and class I

| Prominence of chin | Class II, division 2 (n=50) | | Class I (n=50) | |
|---|---|---|---|---|
| Normally prominent, or somewhat flatter chin | 22 | (44.00%) | 40 | (80.00%) |
| Prominent chin | 28 | (56.00%) | 10 | (20.00%) |

p<0.001.

**Table 4.** Representation of different positions of the upper lip in the biometrical field (only for orthoprofiles according to Schwarz) in persons with class II and class I.

| Positions of the upper lip in the biometrical field | Class II, division 2 (n=16) | | Class I (n=18) | |
|---|---|---|---|---|
| In front of its normal position | 2 | (12.50%) | 2 | (11.11%) |
| The normal position of the upper lip | 10 | (62.50%) | 10 | (55.56%) |
| Beyond the normal position | 4 | (25.00%) | 6 | (33.33%) |

Non significant.

**Table 5.** Representation of different positions of the lower lip in the biometrical field (only for orthoprofiles according to Schwarz) in persons with class II and class I.

| Positions of the lower lip in the biometrical field | Class II, division 2 (n=16) | | Class I (n=18) | |
|---|---|---|---|---|
| In front of its normal position | 1 | (6.25%) | 2 | (11.11%) |
| The normal position of the lower lip | 3 | (18.75%) | 5 | (27.78%) |
| Beyond the normal position | 12 | (75.00%) | 11 | (61.11%) |

Non significant.

The position of the upper lip and lower lip in relation to the S-line showed significant differences (reduction of the contingency table 2×2 determined that lower lip and upper lip in the normal position relative to the S-line statistically were more frequent in class I ($p$<0.05) (Table 8). In a balanced harmonious profile the line that comes from Pg to the middle of the length of Sn-Pn should touch the lips [31,39]. Many participants with class II division had lips that were retruded in comparison to participants with class I. On the other hand, many participants with class I had a normal position of lips in relation to





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**Table 6.** Representation of different chin positions in the biometrical field (only for orthoprofiles according to Schwarz) in persons with class II and class I.

| Chin positions in the biometrical field | Class II, division 2 (n=16) | | Class I (n=18) | |
|---|---|---|---|---|
| In front of its normal position | 2 | (12.50%) | 1 | (5.56%) |
| The normal position of chin | 4 | (25.00%) | 0 | (0.00%) |
| Beyond the normal position | 10 | (62.50%) | 17 | (94.44%) |

p<0.05, (Fisher exact) contingency table 2×2.

**Table 7.** Representation of different lip positions in relation to sn-pg tangent, in persons with class II and class I.

| Lip positions in relation to sn-pg tangent | Class II, division 2 (n=50) | | Class I (n=50) | |
|---|---|---|---|---|
| Lower and upper lip in front of the tangent | 21 | (42.00%) | 24 | (48.00%) |
| The normal position of the lower and upper lip | 23 | (46.00%) | 22 | (44.00%) |
| Lower and upper lip behind the tangent | 6 | (12.00%) | 4 | (8.00%) |

Non significant.

**Table 8.** Representation of different lip positions in relation to the S-line, in persons with class II and class I.

| Lip positions in relation to the S-line | Class II, division 2 (n=50) | | Class I (n=50) | |
|---|---|---|---|---|
| Lower and upper lip in front of the normal position | 13 | (26.00%) | 10 | (20.00%) |
| Lower and upper lip in the normal position relative to the S-line | 12 | (24.00%) | 22 | (44.00%) |
| Lower and upper lip behind the normal position | 25 | (50.00%) | 18 | (36.00%) |

p<0.05, (Fisher exact) contingency table 2×2.

**Table 9.** Representation of different lip positions in relation to the E-line, in persons with class II and class I.

| Lip positions in relation to the E-line | Class II, division 2 (n=50) | | Class I (n=50) | |
|---|---|---|---|---|
| Lower and upper lip in front of its normal position | 1 | (2.00%) | 6 | (12.00%) |
| Lower and upper lip in the normal position with relative to the E-line | 8 | (16.00%) | 6 | (12.00%) |
| Lower and upper lip behind the normal position | 41 | (82.00%) | 38 | (76.00%) |

Non significant.

**Table 10.** Representation of different types of profiles according to Arnett, in persons with class II and class I.

| Types of profiles according to Arnett | Class II, division 2 (n=50) | | Class I (n=50) | |
|---|---|---|---|---|
| The average value of Arnett's corner (169˚±3) | 18 | (36.00%) | 34 | (68.00%) |
| Arnett's angle less than the average value (convex profile) | 27 | (54.00%) | 8 | (16.00%) |
| Arnett's angle greater than the average value (concave profile) | 5 | (10.00%) | 8 | (16.00%) |

p<0.001.

the S-line, which, to a greater extent affected the significance of differences. Protruded lips, as expected, were represented in participants with class I. Jacobson and Jacobson considers this balance of lips according to the S-line to be very important for aesthetic impression. According to their research, the contemporary concept of beauty emphasizes the model of protruded lips [39], which is currently a leading trend in the fashion industry. Retruded lips, which were mostly represented in participants with class II division 2, are considered to be less favorable in the aesthetic sense [1,32,37].

Protrusion of the tip of a chin and nose in relation to lips, has a direct influence on the position of lips in relation to the E-line in persons with class II division 2 compared to persons with





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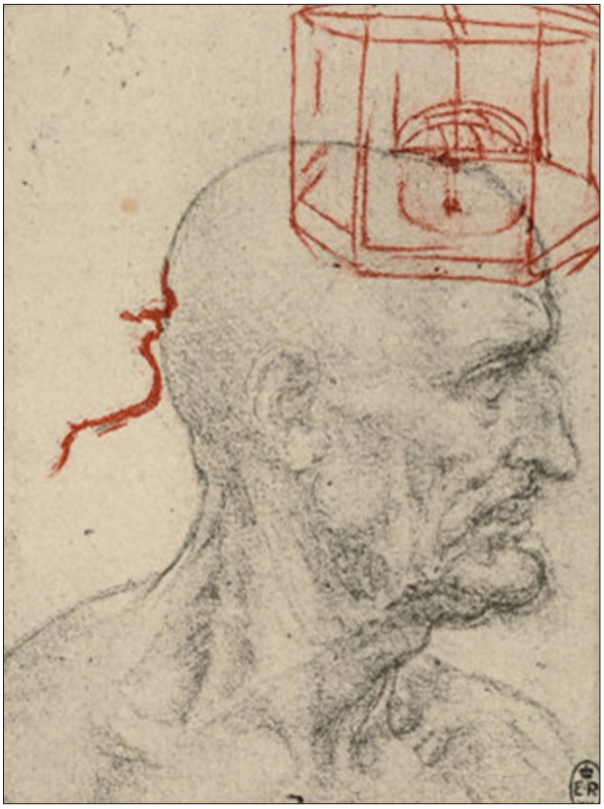

**Figure 11.** Study of a Male Profile by Leonardo da Vinci (Royal Library Windsor). The drawing shows the profile which has all the characteristics of a profile with class II division 2. (Downloaded from *http://www.allposters.com/-sp/Study-of-a-Male-Profile-Black-and-Sanguine-Pencil-Drawing-on-Gray-Paper-Royal-Library-Windsor-Posters_i2547329_.htm*).

class I. The greatest number of participants from both groups in our study had lips behind the normal position in relation to the E-line (the concave lower third of a face) (Table 9), and their number was larger in the group with class II division (but not significant). A greater number of participants with class I had a more anterior position of lips (the convex lower third of the face), also without statistical significance. Dodda et al. determined significant difference only in the distal position of the lower lip towards the E-line in persons with class II [14], whereas Matuola and Panchers consider that greater distance of lips from the E-line is unattractive, especially in women [1,29,32]. Mild convexity of the lower third of the face is considered aesthetically favorable, especially in women [1,4,32]. Every increase in the distance of lips behind the E-line, gives less or more significant difference in relation to the position of lips in persons with orthognathic ratio of jaws, which results in deteriorated aesthetic impression [2,28].

In the end, a highly significant difference was established in examining a profile overall (Arnett angle), even though the profiles of persons with class II division 2, given the dento-skeletal pattern, were overall convex, and concave only in the lower third of the face (Table 10). There was a statistically significant difference ($p<0.001$), which was due to significantly higher representation of the average value of Arnett angle in class I ($p<0.01$), or, according to statistically significantly higher representation of Arnett angle less than the average value (convex profile).

Other authors established similar results (examining Arnett angle in persons with class II) [40,41].

In contemporary society, within the white race and in females, it is considered preferable to have convex profiles with full, protruded lips, slightly prominent chin and somewhat smaller nose, whose dorsum is slightly bent upwards [37]. In men, the contemporary aesthetic ideal represents a straight profile, normally-positioned lips (neither protruded nor retruded), a long, straight nose and prominent chin [3]. These contemporary aesthetic trends are to a greater degree opposite of the profile pattern established in class II, and it is more pronounced in females than in males. Positive circumstance is that, in some analyses, statistical significance was not established, which points to two possible answers: 1) irregularity in certain segments of a dento-skeletal profile is less pronounced [7] and, 2) thickness of soft tissues of lips in class II division 2 is increased so that it camouflages a characteristic dento-skeletal profile form. Almost all the authors who have examined this issue agree with the second statement, since they established that soft tissues of a face, with its fullness, can act in two ways: if the face is thin, it emphasizes the listed marks of the existing malocclusion, or if the face is of a fuller-compensatory appearance, it masks the existing skeletal relationship [7,17,18,40,41].

The results of this study were obtained on the basis of objective aesthetic criteria and indicated that the examined profiles, with their distinctions, leave an unpleasant aesthetic impression. Some authors think that this impression is more conspicuous in class II division 2 malocclusion, than in persons who have overdeveloped lower jaw and more prominent antero-posterior skeletal disbalance [28,29,37], whereas, according to others [3,7,14,23], persons with class II division 2 have quite an acceptable appearance. Judging by the later view, it seems that Plato, by saying "beauty is in the eye of the beholder" had the right idea.

## Conclusions

On the basis of the obtained results, we can say that the significant characteristics of a facial profile of persons with class II division 2, compared to persons with class I, are: position





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and prominence of the chin, the position of the lower lip and upper lip in relation to the S-line, and smaller value of a facial angle. This finding does not fit into a contemporary aesthetic trend of convex face with protruding lips, and in females, a less prominent chin. Taking into consideration that other tests did not show significant differences, it is probable that the fullness of soft tissues of a face manages to "camouflage" the existing disharmony in persons with class II division 2.

### Conflict of interest

None.

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