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Analysis of the soft tissue profile in Croatians with normal occlusions and well-balanced faces

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SUMMARY The aim of the study was to test the hypothesis that there is no difference between the soft tissue profile of Croatian and white North American adults. Facial profile photographs were taken of 110 Croatians (52 males and 58 females) with normal occlusions and well-balanced faces (age 22–29 years). The findings were also compared with a white Brazilian group. An independent Student's *t*-test ($P < 0.05$) was used to compare the soft tissue parameters of Croatians with those of North Americans and to assess gender differences.

The soft tissue profile measurements that showed significant gender dimorphism ($P < 0.001$) were the true vertical line [(TVL)-nasal tip (NT)] and TVL-point B, indicating that the males had slightly greater nasal prominence (mean difference: 1.32 mm) and deeper labial sulci (mean difference: 2.04 mm) compared with the females. The upper lip was the same for both genders (1.25 mm), while the lower lip was 0.97 mm more prominent in females than in males. All soft tissue variables, except TVL-NT showed significant differences between Croatian and white American female subjects ($P = 0.096$). For male subjects, nasolabial angle was the only variable that showed no statistically significant difference between the two populations.

A universal standard of facial aesthetic is not applicable to diverse white populations. These differences should be considered in diagnosis and treatment planning for Croatians, together with their individual characteristics.

Introduction

Orthodontic treatment planning often includes soft tissue profile comparison of a patient with the 'norm'. Linear and angular soft tissue facial analysis based on photogrammetry has been extensively described (Stoner, 1955; Farkas, 1981; Powell and Humphreys, 1984; Arnett and Bergman, 1993a,b; Fernández-Riveiro *et al.*, 2002, 2003; Anić-Milošević *et al.*, 2008a,b). The differences regarding various details of soft tissue facial morphology are easily detectable when individuals with different ethnic backgrounds are compared (Cooke and Wei, 1989; Miyajima *et al.*, 1996; Huang *et al.*, 1998; Farkas *et al.*, 2005; Hassan, 2005; Behbehani *et al.*, 2006; Scavone *et al.*, 2006; Wu *et al.*, 2007). On the other hand, differences between white populations of distinct countries or continents also exist and have been previously reported (Trenouth *et al.*, 1985; Argyropoulos and Sassouni, 1989; Bishara *et al.*, 1990; El-Batouti *et al.*, 1995; Hashim and AlBarakati, 2003; Scavone *et al.*, 2008). Currently, there are several numeric analyses employed to analyse the soft tissue profile (Legan and Burstone, 1980; Scheideman *et al.*, 1980; Holdaway, 1983; Arnett *et al.*, 1999). The analysis proposed by Arnett *et al.* (1999), based on a white American sample, has been widely adopted by orthodontists and maxillofacial surgeons in diagnosis and treatment planning.

It seems possible that the soft tissue profile of a Croatian population (Anić-Milošević *et al.*, 2008a,b) may show traits that differentiate it from other populations described in the literature. Nowadays, there are as many Croatians living abroad as there are in Croatia, with increasing expatriate communities in North America and Europe. Based on recent high-resolution phylogenetic studies of uniparental genetic markers, i.e. Y chromosome and mitochondrial DNA, it is clear that Croatians share the major part of their paternal and maternal gene pool with other south Slavic speaking populations (Peričić *et al.*, 2005a,b).

Therefore, on the basis of facial profile photographs taken in the natural head position (NHP), the aims of the present study were to establish reference values for eight antero-posterior soft tissue variables in a sample of Croatian adults with normal occlusions and well-balanced faces, to compare these values with those proposed by Arnett and Bergman, 1993a,b and Arnett *et al.* (1999), and to analyse gender differences. The findings were also compared with a white Brazilian group.

Subjects and methods

The subjects consisted of 110 graduate students between 23 and 29 years of age (52 males and 58 females) from the School of Dentistry, University of Zagreb, Croatia. The mean age for the males was 28.7 and for females 25.7 years. The subjects were prospectively selected and judged by two orthodontists (SA-M and MŠ). The criteria for selection included pleasing and balanced profiles, a dental Class I occlusion with normal overjet–overbite relationships, closed lip posture, facial symmetry, no previous orthodontic treatment, orthognathic or plastic surgery, and no history of trauma.

Standardized right side profile records were taken with the patient in the NHP (Moorrees and Kean, 1958; Viazis, 1991; Lundström and Lundström, 1992). All photographs were taken with an Olympus 3040C (Optical Co., Ltd, Tokyo, Japan) digital camera mounted on a tripod (DT-310; Soligor, Leinfelden-E, Germany).

The method used has been described previously (Anić-Milošević *et al.*, 2008a,b). Briefly, adjustment of the tripod height allowed the optical axis of the lens to be maintained in a horizontal position during the recording; this was adapted to each subject's body height. In a standing position, each subject was asked to relax, with both arms hanging freely beside the trunk. The subject was positioned on a line marked on the floor (1.7 m from the camera) and a vertical measurement scale divided into millimetres allowed measurements at life size was placed behind the subject. A plumb line, suspending a 0.5 kg weight hung from the scale, held by a thick black thread to define the vertical plane, true vertical line (TVL), on the photographs and 120 cm in front of the subject, on the opposite wall was a mirror. In order to obtain a NHP, the subjects looked into their eyes in the mirror with the lips relaxed.

Since the Croatian Ethical Committee does not allow radiographic exposure of patients for the purpose of investigation, standardized facial photographs were used. Subsequently, to compare the values from this study with those proposed by Arnett *et al.* (1999) on lateral cephalograms, the reduction factor of the facial photographs was calculated and the measurements were corrected for their actual values. The method performed in this investigation was reliable since the maximum distortion never exceeded 0.80 per cent.

The photographic records were analysed with the software for Windows (Microsoft® Visio® 2003; Standard Edition, Redmond, Washington, USA). The millimetric paper was superimposed on the computer monitor, which produced a universal background. Each photograph was placed over the calibrating gauge and orientated so that the TVL on the photograph was parallel with the vertical line of the computer monitor. As the TVL was a reference line for all measurements undertaken, it was transferred directly over the digitized image of the soft tissue facial profile, passing through subnasale (Sn). According to Arnett *et al.* (1999), the horizontal distance for each individual landmark, measured perpendicular to the TVL, is termed the landmark's absolute value. Using this method, the photographic records were scaled to life size and eight landmarks were located on the digitized image to obtain all measurements (Figure 1). All procedures were undertaken by a single investigator (SA-M).

Statistical analysis

A Student's *t*-test was used to compare males and females (Table 1). Independent *t*-tests were used to compare the Croatian sample with the values originally proposed by Arnett *et al.* (1999), which are generally used as the standard for American Caucasian samples and often used for comparison with different ethnic groups (Scavone *et al.*, 2006, 2008). The level of statistical significance was set at $P < 0.05$.

In order to assess the method error, 25 photographs were randomly selected and redigitized 3 months after the first evaluation by the same investigator. The reproducibility of

Figure 1 Landmarks used in facial profile evaluation: glabella (G)-the point that borders the upper line of the eyebrow; nasal tip (NT)-the most anterior point of the nose tip; columella (Cm)-the most inferior and anterior point of the nose; point (A)-the deepest point of the superior supralabial concavity; subnasale (Sn)-the point where the upper lip joins the columella; upper lip (UL)-the point that indicates the mucocutaneous limit of the upper lip; lower lip (LL)-the point that indicates the mucocutaneous limit of the lower lip; point B (B)-the deepest point of the inferior sublabial concavity; pogonion (Pg)-the most anterior point of the convexity of the chin. Horizontal linear measurements: (TVL-G-distance from TVL to glabella point; TVL-NT-distance from the most anterior point of the nose tip to TVL; TVL-A-distance from point A to TVL; TVL-UL-distance from the point that indicates the mucocutaneous limit of the upper lip to TVL; TVL-LL-distance from the point that indicates the mucocutaneous limit of the lower lip to TVL; TVL-B distance from inferior sublabial concavity to TVL; TVL-Pg-distance from pogonion to TVL).

the measurements was analysed using the formula of Dahlberg (1940). The error was calculated from the equation: $ME = \sqrt{d^2/2n}$, where d is the difference between duplicated measurements and n is the number of replications. All the respective values for the linear measurements ranged between 0.36 and 0.49 mm (Anić-Milošević *et al.*, 2008a)

Results

The mean and standard deviation for the female and male measurements are presented in Table 1. A negative value was assigned to points to the left side of the TVL and a positive value to those on the right of the TVL.

The soft tissue profile measurements that showed significant gender dimorphism ($P < 0.001$) were TVL-nasal tip (NT) and TVL-point B indicating that male subjects had, on average, slightly greater nasal prominence (mean difference: 1.32 mm) and deeper labial sulci (mean difference: 2.04 mm) compared with the female subjects.

The upper labial segment was, on average, of the same prominence in both genders (1.25 mm). On the contrary, the lower lip was 0.97 mm more prominent in females than in males.

Table 1 Comparison of Croatian facial profile variables between the genders (*t*-test).

Variable	Female ($n = 58$), mean ± SD (mm)	Male ($n = 52$), mean ± SD (mm)	*t*-test, *P*
TVL-G	−6.28 ± 3.88	−5.92 ± 4.75	0.668
TVL-NT	15.58 ± 1.88	16.90 ± 1.75	<0.001
TVL-A	0.59 ± 0.83	−0.80 ± 1.13	0.283
TVL-UL	1.25 ± 1.38	1.25 ± 1.79	0.986
TVL-LL	−1 ± 1.98	−1.97 ± 2.47	0.023
TVL-B	−7.43 ± 2.65	−9.47 ± 3.13	<0.001
TVL-Pg	−5.61 ± 3.37	−6.37 ± 3.88	0.273
NLA	109.39 ± 7.84	105.42 ± 9.52	0.018

All soft tissue variables, except nasal prominence (TVL-NT), showed statistically significant differences between Croatian and white American female subjects (Table 2). On average, the region of glabella was more anteriorly positioned in Croatian females in comparison with North American Caucasians. Croatian females also presented, on average, with less protruded upper and lower lips, deeper lower labial sulci, a chin more posteriorly positioned, and a more obtuse nasolabial angle compared with white American females.

Nasolabial angle was the only soft tissue variable that demonstrated no significant difference between Croatians and white American males (Table 2). Nasolabial angle (NLA) value, including method error (2.5), has been mentioned and discussed previously (Anić-Milošević *et al.*, 2008b).

The findings of the present investigation were also compared with a Brazilian group (Scavone *et al.*, 2008). The results are presented in Figures 2a and 2b and 3.

Discussion

The present study was designed to compare the results with the normative values proposed by Arnett *et al.* (1999) for white Americans. In the present sample, as differences were found regarding the soft tissue profile features between Croatians and white Americans, it may not be advisable to apply a universal standard of facial profile aesthetics to diverse white populations.

Systematic errors of the variables were not statistically significant. For most measurements, random errors were low; however, that for nasolabial angle measurement (mean = 2.5 degrees) was high. The magnitude of the nasolabial angle error may be due to the difficulty in locating this landmark. The proximity between the three points used in the construction of NLA might also have contributed to this error. The random error for point A was 1.3 mm, mainly due to the difficulty in identifying this landmark.

Table 2 Comparisons between Croatians and Americans (*t*-test).

Variables	Females			Males		
	Croatians ($n = 58$), mean ± SD (mm)	Americans (Arnett *et al.*, 1999; $n = 26$), mean ± SD (mm)	*t*-test, *P*	Croatians ($n = 52$), mean ± SD (mm)	Americans (Arnett et al., 1999; $n = 26$), mean ± SD (mm)	*t*-test, *P*
TVL-G	−6.28 ± 3.88	−8.5 ± 2.4	0.000	−5.92 ± 4.75	−8.0 ± 2.5	0.003
TVL-NT	15.58 ± 1.88	16.0 ± 1.4	0.096	16.90 ± 1.75	17.4 ± 1.7	0.046
TVL-A	0.59 ± 0.83	−0.1 ± 1.0	0.000	−0.80 ± 1.13	−0.3 ± 1.0	0.003
TVL-UL	1.25 ± 1.38	3.7 ± 1.2	0.000	1.25 ± 1.79	3.3 ± 1.7	0.000
TVL-LL	−1.00 ± 1.98	1.9 ± 1.4	0.000	−1.97 ± 2.47	1.0 ± 2.2	0.000
TVL-B	−7.43 ± 2.65	−5.3 ± 1.5	0.000	−9.47 ± 3.13	−7.1 ± 1.6	0.000
TVL-Pg	−5.61 ± 3.37	−2.6 ± 1.9	0.000	−6.37 ± 3.88	−3.5 ± 1.8	0.000
NLA	109.39 ± 7.84	103.5 ± 6.8	0.000	105 ± 9.52	106.4 ± 7.7	0.459

Regarding gender differences, it was found that males had more protruded noses (TVL-NT) and less projected lower labial sulci (TVL-B) than females. No gender differences in upper and lower lip protrusion were found (Table 1). In a sample of white patients, Arnett *et al.* (1999), using the TVL as a reference, observed the same results regarding gender differences. Scavone *et al.* (2006) found no gender dimorphism regarding soft tissue profile in Japanese subjects while in Brazilians they found that male subjects had a slightly greater nasal projection and larger upper lip protrusion when compared with females.

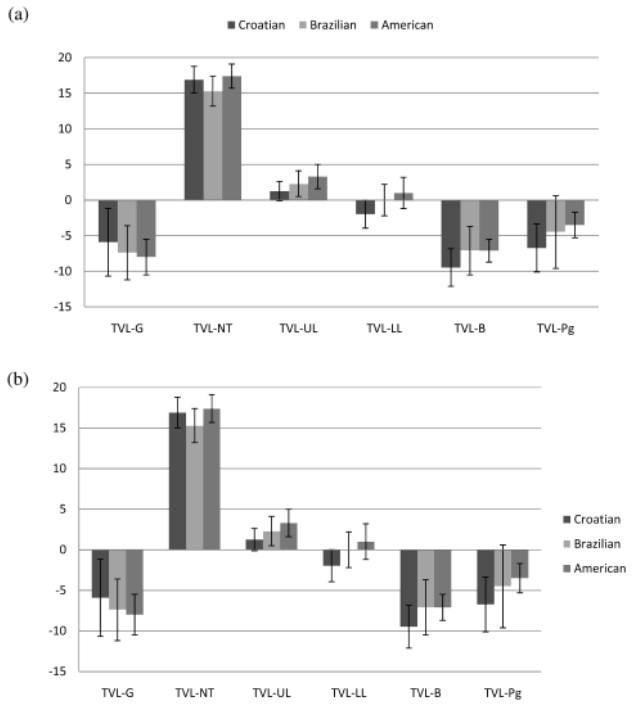

Figure 2 Comparisons of the soft tissue profile variables in females (a) and in males (b) between various Caucasian groups.

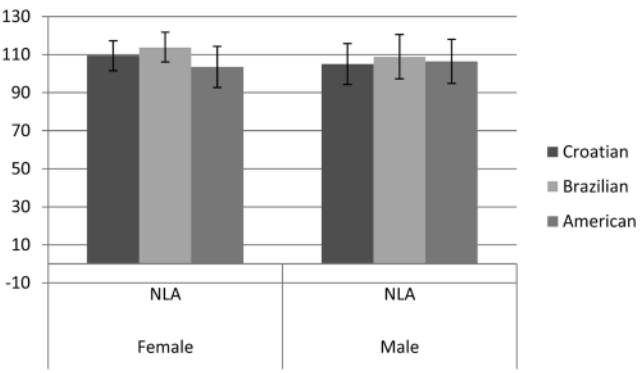

Figure 3 Comparisons of the nasolabial angle between various Caucasian groups.

For the soft tissue profile features, most of the linear variables analysed were smaller in Croatian females, showing that they have a more retruded lower face than white American females (Table 2a). The upper and lower lips of Croatian females were 2.45 and 2.9 mm, respectively, less protruded than those of white American females. In a study of white Brazilians, Scavone *et al.* (2008) observed the same result when comparing white Brazilians with white American females. The nasolabial angle was also more obtuse in the Croatian female, again confirming the retrusive profile pattern, also identified in white Brazilian females (Scavone *et al.*, 2008). The only variable that showed no statistically significant difference between Croatian and American females was TVL-NT (Figure 2b). Croatian females also showed a smaller projection of point B and the chin, with a mean difference of 2.13 and 3.01 mm, respectively, in relation to white American females, indicating a deeper labial sulci and more posteriorly positioned chin.

In agreement with Scavone *et al.* (2008), no differences were found in the soft tissue profile except for the nose area. Nasal prominence was greater in Croatian females while the nasolabial angle was more obtuse in Brazilian females (Figure 2b).

On average, Croatian males showed a tendency towards a less protruded face, at all facial levels analysed, especially in the lip area. All evaluated soft tissue variables showed statistically significant differences between Croatian and white American male subjects. Croatian males presented with glabella more anteriorly positioned, larger nasal projection, less protruded upper and lower lips, and a smaller projection of point B and the chin compared with white American males (Table 2). Comparing Croatian males with the Brazilian sample (Scavone *et al.*, 2008), the greatest difference was seen in the nasal and labial areas (Figure 2a). TVL-NT was significantly greater in Croatian females while nasolabial angle was more obtuse in Brazilian females (Figures 2a and 3); the upper lip was of the same prominence while the lower lip was less prominent in Croatian males. Comparison of white Brazilian and white American males (Scavone *et al.*, 2008) showed that Brazilians had smaller noses and a less protruded upper lips than white American males (Figures 2b and 3).

The results of the present investigation are in agreement with other studies that also showed facial profile differences between different Caucasian groups (Trenouth *et al.*, 1985; Argyropoulos and Sassouni, 1989; Bishara *et al.*, 1990; El-Batouti *et al.*, 1995; Hashim and AlBarakati, 2003; Scavone *et al.*, 2008). A study of Anatolian Turkish adults revealed more retrusive upper and lower lips compared with white American norms (Erbay and Canikliogl u, 2002; Erbay *et al.*, 2002).

Borman *et al.* (1999) found a more convex facial profile and more acute nasolabial angle in Turkish adults than in other population groups. Hashim and AlBarakati (2003)

compared Saudis and white Americans and found significant differences in most of the soft tissue variables evaluated. Argyropoulos and Sassouni (1989) presented the differences in cephalometric norms between white Americans and Greeks. On the contrary, Lundström *et al.* (1992), analysing soft tissue profile variables, did not find differences between Swedish subjects and white Americans. Bishara *et al.* (1990) comparing Egyptian and American adolescents reported no significant differences in their soft tissue parameters.

It must be emphasized that differences in the facial soft tissue profile between the investigated samples could be attributable to ethnic differences, as well as to examiners' individual perceptions of well-balanced faces. Although both samples comprised adults with normal occlusions and well-balanced faces, care should be taken not to develop personal biases as to what is considered a well-balanced face. It is not always related to beauty because its perception is subjective and depends on cultural trends. Peck and Peck (1970) showed that the general public prefers a more protrusive dentofacial pattern in relation to the proposed cephalometric standards. Auger and Turley (1999) and Nguyen and Turley (1998) concluded that there had been a linear trend towards fuller and more anteriorly positioned lips in fashion magazines during the last century. It must be stressed that the general publics' preference regarding facial aesthetics, may not be static but may change with time (Nguyen and Turley, 1998).

Conclusions

There are differences regarding the soft tissue profile features between Croatians and white Americans so a universal standard of facial profile is not applicable to diverse white populations. The results might serve as a useful reference for orthodontists and maxillofacial surgeons and also contribute to more satisfactory diagnosis and treatment planning.

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