Abstract

This doctoral thesis is submitted in the form of scientific publications together with theoretical introduction. The present state of knowledge of facial approximation methods is presented in the introduction. Areas of application, principles of the method and classification of the methods according to medium used are briefly described. Accuracy and limits of the method are further described as they form a base of the research of this thesis.

Simultaneous existence of multiple prediction guidelines, of which the accuracy is not known or published, is typical characteristic of the facial approximation method. The aim of this thesis was to assess the accuracy of the particular prediction rules for estimation of position and size of facial parts (eyes, nose, lips), and based on the results to recommend the most accurate and suitable guidelines for middle European population. An assessment of the strength of the association between craniofacial shape and the shape of soft tissues in the profile using geometric morphometric methods, and determination of the extent to which it might be possible to predict the latter from the former were the purpose of the second part of the research.

Material for this study consisted of 87 lateral head cephalograms of a recent adult Central European population (52 males and 35 females, aged between 19 and 43 years, 30 years – mean age for males and 21 years – mean age for females). The individuals in the sample were without obvious facial disharmony or reverse occlusion as well as never having undergone orthodontic treatment. The contour of the skull as well as the contour of the facial soft tissues were displayed in the radiographs.

Features included for accuracy tested prediction guidelines were: protrusion of the eye globe, vertical position of the eye globe, vertical and horizontal prominence of the external nose (position of *pronasale* point), the mouth fissure position, the upper and the lower vermilion line position, the height of the lips.

The most accurate method (i.e. displaying the least standard error of the estimate, SEE) for eyeball protrusion was the method of Guyomarc'h et al. (2012) displaying SEE = 1,9 mm. Anterior position of the eyeball from the most posterior point of the lateral orbital margin is estimated by proportion of the orbital height (51,3 %) according to this guideline. The vertical position of the eye globe was estimated the most accurately (SEE = 0,3 mm) using the method of "central position" (Gatliff, 1984), i.e. the midpoint of the pupil coincides with the midpoint of the orbit.

The most suitable method of prediction of vertical (ProVert) and anterior (ProAnt) position of the *pronasale* point seemed to be the method of Rynn et al. (2010), which is based on a set of simple regression equations. Its accuracy, expressed as the mean difference between the estimated and the actual position and its standard deviation, reached the lowest values of -1,3 mm (SD = 2,4 mm, ProAnt) and 0,04 mm (SD = 2,2 mm, ProVert). The magnitude of the mean error did not exceed 4,5 % (ProAnt) and 1 % (ProVert), respectively, of the actual dimension.

As for position of the mouth fissure the method of George (1987) performed with the greatest accuracy (error of prediction 1,3 mm), i.e. the position of mouth fissure corresponds to the level of 3/4 mark of the central maxillary incisor height. This rule proposed for males worked accurately in females as well.

The best estimation (expressed as the absolute mean difference) of upper vermilion line position in males was produced using the guideline of Geroge (1987), performing with error of prediction of 1,7 mm, i.e. the upper lip margin was situated at the level of transition between the first and the second quarter of the central maxillary incisors. In females, the margin was positioned a little bit upwards, but mostly (in 80 %) did not exceed the level of the upper margin of the maxillary incisor crown. The lower vermilion line was predicted the most accurately using the method of Veselovskaya (2004, personal communication), Fedosyutkin & Nainys (1993), Lebedinskaya (1998), Gatliff (1984) or Taylor (2001), with error of prediction 2,3 mm, i.e. it corresponded to the level of lower edge of mandibular central incisor crown in the most of cases.

The height of upper and lower lip in females was the most accurately estimated by the method of Wilkinson et al. (2003). The error of prediction was 0,9 mm (13 % of the actual height) for the upper lip, and 1,7 mm (18 %) for the lower lip. The height of upper lip in males was the most accurately estimated by the method of George (1987), displaying difference of 1,1 mm (19 % of the actual height), i.e. the upper lip height is equal to a half of the maxillary central incisor height (a distance between 1/4 and 3/4 transition marks). The lower lip height in males was the most accurately predicted using a regression equation of Wilkinson et al. (2003) showing the error of prediction 1,8 mm (21 % of the actual lip height).

The second part of the research concerned with an assessment of the strength of the association between craniofacial shape and the shape of soft tissues in the profile via geometric morphometrics. The results of this study lead to the realization that soft tissues might not follow the underlying structures as closely as expected. The greatest amount of association between the skeletal contour and overlying soft tissues was exhibited by the region of the nasal root (predictive power: 40.2%, RV = 0.42, r_{PLS1} = 0.72) and the lower lip and chin (predictive power: 37.3%, RV = 0.41, r_{PLS1} = 0.65). The smallest statistically significant covariation was displayed by the upper lip and the maxilla (predictive power: 9.6%, RV = 0.14, r_{PLS1} = 0.43). The shape covariation between the nasal bridge and the tip and lateral border of the nasal aperture was found to be statistically insignificant (predictive power: 5.8%, RV = 0.05, r_{PLS1} = 0.26). These findings are in agreement with the experience that the shape of nose profile and upper lip are very difficult to be reconstructed accurately.

The thesis is closed by two examples of practical application of the method on historical osteological material.