Forensic Science International 242 (2014) 44–61

Contents lists available at ScienceDirect

Forensic Science International

journal homepage: www.elsevier.com/locate/forsciint

Facial soft tissue thickness database for craniofacial reconstruction in the Turkish adult population

Ozgur Bulut [a,*], Serdar Sipahioglu [b], Baki Hekimoglu [c]

[a] Department of Forensic Anthropology, Turkish Police Forensic Laboratory, Golbasi, Ankara, Turkey
[b] Radiology Department, Polatlı Can Hospital, Polatlı, Ankara, Turkey
[c] Radiology Department, Yildirim Beyazit Traning and Research Hospital, Altindag, Ankara, Turkey

ARTICLE INFO

Article history:
Received 16 September 2013
Received in revised form 6 June 2014
Accepted 15 June 2014
Available online 26 June 2014

Keywords:
Forensic anthropology population data
Facial reconstruction
Facial soft tissue thickness
Computer tomography
Turkish adults

ABSTRACT

320 Turkish adults (160 men, 160 women) who had undergone brain CT in the radiology clinic and showed no sign of maxillofacial pathology were analyzed in order to create a facial soft-tissue thickness database of the Turkish adult population. The soft-tissue thicknesses were measured at 31 landmarks, 10 midline and 21 bilateral anatomical landmarks. Average thickness values for each landmark as well as the standard deviation and range classified according to gender and age are reported.
The differences of these mean values related to age and sexes were calculated. The values were then statistically compared to the findings of the European and Korean adults.
Overall, the soft-tissue thickness measurements obtained in this study can be used as a database for the forensic craniofacial reconstruction of Turkish adult faces.

1. Introduction

Forensic facial reconstruction is the process of rebuilding a face onto a representation of an unknown skull to help with identification in forensic investigations [1–5]. When the skeletal remains cannot be identified by DNA analysis, fingerprint comparison, or radiographic and dental records examination, facial reconstruction may be conducted as a last resort. Therefore, it plays an important role in leading a recognition and positive identification of an individual [6–15].

Two-dimensional (2D) and three-dimensional (3D) techniques are employed to recreate a face from the skull. Besides osteological analyses and skeletal morphology of the skull, facial soft-tissue thickness data are also used in the process of facial reconstruction [4,16–18]. The North American method, from Krogman and Iscan [3] and the Manchester method, from Richard Neave and Caroline Wilkinson [4,7,18,19] use facial tissue depth measurements at a number of bony landmarks on the skull as reference guides.

Facial soft-tissue thickness (FSTT) data can be collected using different methods. The FSTT is measured not only by using cadavers with the puncture method, but is also collected from living individuals by using computed tomography (CT), ultrasonography and magnetic resonance imaging (MRI) [8,20–30]. Recently, these methods have been used by a large number of studies on different populations for assessing the FSTT data [20,21,23,25,27,28,31–37]. The FSTT data acquired using specific anatomical landmarks varies by ethnic group; therefore, the FSTT data of other populations, for example, cannot be applied to the Turkish population.

Only one study, by Sipahioglu et al. [36], on the FSTT of the Turkish adult population has been previously published. However, the study focused on midline facial soft-tissue thickness of 9 points. No other comprehensive Turkish population-specific work has been conducted on facial soft-tissue thickness; this includes bilateral anatomical points for the Turkish population.

In the current study, statistical means and several other parameters describing facial soft-tissue thicknesses were examined for sample head CT scans of 320 Turkish men and women, between 18 and 80 years of age, a population for which there is no previously published data considering the bilateral facial soft tissue thickness.

2. Materials and methods

2.1. Materials

The study consisted of 320 Turkish adults (160 males and 160 females) between the ages of 18 and 80 years. The sample was divided into 5 age groups: 18–29 years, 30–39 years, 40–49 years, 50–59 years and over 60 years (Table 1). Each age group contained the same number of individuals ($n = 32$).

* Corresponding author. Tel. : +90 5055430109.
E-mail address: ozgur.bulut@yahoo.com (O. Bulut).

http://dx.doi.org/10.1016/j.forsciint.2014.06.012
0379-0738/

Table 1
Means and standard deviations of ages by sex and age groups.

Sex	Age groups 18–29	30–39	40–49	50–59	60+
Male	24.7 ± 2.45	35.8 ± 2.60	44.7 ± 2.93	54.2 ± 2.60	67.5 ± 5.70
Female	23.3 ± 3.07	34.5 ± 2.91	45.2 ± 2.73	53.9 ± 2.37	68.6 ± 6.01

CT scans were obtained at the Diskapi Yildirim Beyazit Training and Research Hospital, Ankara, Turkey, for patients referred to the radiology clinic for diagnostic brain CT scans. All the patients underwent CT scans for reasons not related to this study. The subjects with head trauma or any other facial deformities were excluded from the study. Among BMI categories (<20, 20–25, >25) as slender, normal and obese which were used in previous studies [8,21,32], only the subjects who fell into the normal BMI category were included.

A Mx8000 spiral CT scanner (Philips, Amsterdam, Netherland) with a voxel resolution of 0.5 mm, in which the subject is required to be in supine position, was used to obtain CT scans. Three-dimensional craniofacial data were created from the DICOM (Digital Imaging and Communications in Medicine) data acquired from the CT scans. Both soft and hard-tissue images were imported into specific software, Amira 5.2.2 (Visage Imaging, Burlington, USA), to measure the thickness of 31 anatomical landmarks (Fig. 1). This study was approved by the Ethics Committee of Diskapi Yildirim Beyazit Training and Research Hospital, Ankara, Turkey.

2.2. Measurements

Every landmark was localized and measured according to the orthoslice planes (*xy*, *yz*, *xz*) (Fig. 2). The threshold option of the software enabled to view the skull and surface of the face. It was also possible to see hard and soft tissues at the same time by the transparent surface display feature of the software (Fig. 3).

The soft tissue measurements were performed at a total of 31 facial anatomical points which were identified according to De Greef et al. [8]. 10 of these measurement sites were in the midline and 21 were bilateral (Fig. 1). The descriptions of the landmarks are presented in Table 2. In order to eliminate inter-observer error, a single practitioner carried out landmark identifications.

2.3. Statistical analysis

The statistical analysis was carried out using the SPSS software, version 19.0 for Windows (SPSS Inc. Chicago, IL). To assess the intra observer error, CT scans from 30 subjects were selected randomly, and the measurements repeated by a single practitioner at 3-week intervals. Non-parametric Mann–Whitney test and technical error of measurement (TEM) were used to analyze the results.

General descriptive analyses such as mean, SD (standard deviation) and range were determined for each anatomical landmark, and average soft tissue thicknesses were calculated considering the sex and the age groups of the individuals. Skewness and Kurtosis for normality tests was performed to assess the distribution of the data. For normally distributed data, student's *t*-test (independent two-sample) was performed to compare males and females in each age group. Bonferonni correction was applied to the age groups at the default settings "valid options: none". In order to observe significant differences among all age groups, LSD Post Hoc test was applied to the variances and significance level was re-determined by Dunnet C Correction. For non-normally distributed data, Mann–Whitney *U* test was used.

The average soft tissue thicknesses of the Turkish population were then compared to that of Koreans in the study by Hwang et al. [38] and of the White Europeans in the study by De Greef et al. [8] using one-way analysis of variance (ANOVA) test. The significant difference level was set at $p < 0.05$ for all statistical analyses.

3. Results

The results of the non-parametric test indicate that all measurements were reproducible and no significant differences were observed between the first and second round of

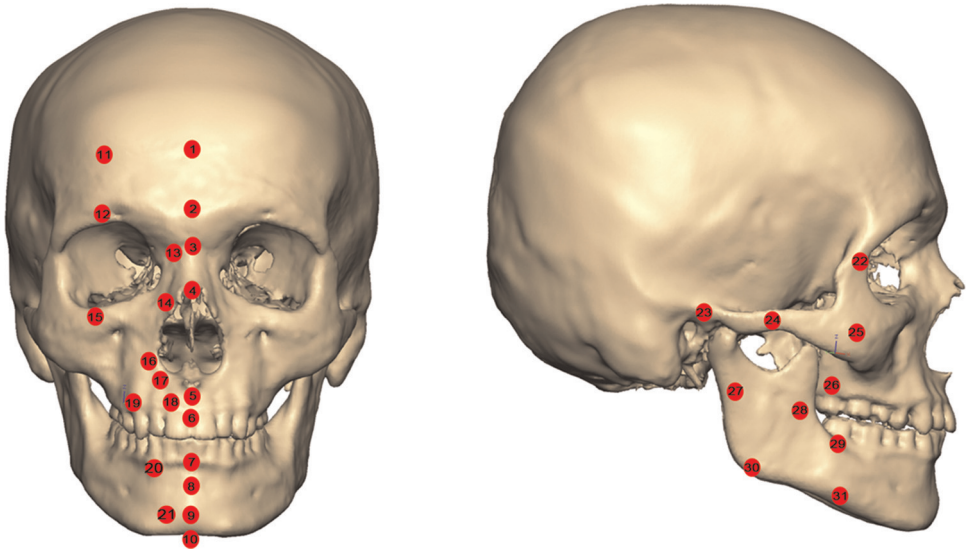

Fig. 1. Anatomical landmarks of the skull.