3D Facial Reconstruction From A Skull Of A Female Who Buried and Bound Using Hog-Tie; Found In Excavations At Aktopraklik, Bursa-Turkey Is 8500 Years Old

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Abstract

There are many excavation centres in Anatolia, most combining international and national teams. Facial reconstruction has been done for many purposes, from forensic medicine to surgical requirement. Recently, it has become favourable in historical findings. Although there are a few techniques for face construction, ethnicity, geography, and age of the skeleton should be taken into account. The aim of this study is to make a facial reconstruction using a different approach, using soft tissue thickness that specifically belongs to the Anatolian people. In the present study, a face is defined using four steps to reach a more accurate construction for Anatolians. First, a skeleton was examined, then soft tissue thickness determined by predefined-MRI pool data, followed by x-ray computed tomography of the skull, and finally, computer aided correction. At the end of this protocol, the face was reconstructed in the best way. Also, for the first time, it was printed using a 3D printer for further analysis and display. The skeleton was found in Topraklık-Bursa (West Anatolia) excavation. The skull was aged about 8500 years old, gender determined as female from examination of the whole skeleton. All measurements of the whole skeleton and facial reconstruction showed high similarities to the people who lived in this region in history.

Key Words: forensic science, anthropology, facial reconstruction, 3D printer, aktopraklık, anatolia

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Introduction:

Many different historic findings, mostly coins, jewellery, implements, and inscriptions, as well as sculptures, are displayed to people in museums. However, skeletal findings, especially human, are generally stocked in rear rows, without interest. Facial reconstruction is gaining popularity and recently historical skull work has become favourable. Facial reconstruction is important for many areas, especially forensic medicine (Wozniak, Moskala, Pohl, Latacz, Dybala, 2012).

Previously, many studies have made possible identifications of face (Miyasaka,1999). There are three methods for face construction: American (by tissue thickness), Russian (by muscles), and Manchester (combination of tissue and anatomical) (Sever, 2007). The mostly used Manchester and Gerosimov techniques use clay that is harmful to skull and bone structures (Çağdır, 1997 & Clement, Marks, 2005 & Wilkinson, 2004 & Boz, Özdemir, Özer, Boz, 2012). A recent advancement in face construction is the computerized 3D face construction technique (Claes, Vandermeulen, Greef, Willems, Suetens, 2006). Ethnicities, geography, biological and historical age of the sample are very important parameters for determining the protocol and accurate reconstruction of a face. Routine and general techniques could be done, but special attention should be given to historical skeletons.

Archaeological findings can help in understanding historical homicide, execution, and religious rituals. Hence, among the many skeletal findings, this hog-tied case was preferred as it had already been aged and anthropometrical measurements were done.

The aim of this study is to make a facial reconstruction using the measurements of the Anatolian peoples and 3D scanning and printing technique coded by special software.

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Material and Methods:

Excavation Area

Aktopraklık mound is located west and at 25 km distance from Bursa and the east side of Ulubat Lake. The mound has been excavated by a team led by Necmi Karul since 2004 (Karul, Özeren, 2007). The mound has three settlement areas (A, B, and C) and has very important traces of Neolithic and Chalcolithic periods. The settlement, which was unearthed in the oldest ruins, dates back to the year 6400 BC (Alpaslan-Rodenberg, 2011).

Skeleton and facial construction

Many skeletons have been found in the ruins of settlements. Some have been buried in interesting positions. One skeleton has forensic interest because it is buried and bound using hog-tie (Photo 1) at area C. Anthropometric measurement of the skeleton was made by Roodenberg.

In the first step, the head of the skeleton was examined by a forensic medicine specialist; naked eyes and pieces missing from the incomplete cranium were reconstructed by hand (Iscan, Helmer, 1993). In the second step, the skull was scanned transversally by computer tomography (Philips Brilliance CT 16 V2.00) and dicom files transferred to computer (Photo 2, CT). In the third step, soft tissue thickness data obtained from the local population were applied virtually on pc, with ten different points defined on the cranium (Table 1) (Photo 3) (Teke, 2010). In the fourth step, fine corrections were carried by manually using Blender version V2.74 (Photo 3). Finally, virtual data were embodied by 3D printer (Zortrax M200) using Acrylonitrile butadiene styrene (ABS)) plastic (Photo 4).

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Results:

The skeleton was aged and gender detected as female by standard anthropometric measurement by Roodenberg.

Face construction was completed (Fig 3) and 3D printing applied to both Forensic medicine and archaeology. A 3D printed sample of the skull was given to the excavation team to display in Bursa Archaeopark.

Discussion

For reconstructions of faces upon skulls, reconstructions are usually based on a meticulous anthropological and anatomical analysis of the particular skeletal remains (Setefan, Henneberg, 2001& Prag, Neave, 1997 & Mays, 1998). From these observations the importance of fine tuning average anthropological values of soft-tissue thickness appropriate for that region of the face and for that particular set of remains can be assessed (Vincent, 2001). Facial tissue thickness is affected by age, gender, and factors related with environmental, ethnic, and genetic differences (Midori, Ricanek, 2008). Therefore, it is important to have a large series of data from each community, measuring facial soft tissue thickness with scientific methods. Facial thickness data from the Ankara Sample were used (Teke, 2010). These data were more reasonable for the Bursa region. The study provided the opportunity to try many types of skin, eyes, hair and other aspects on the 3D reconstructed face. 3D printing is very useful without disturbing the original findings and can be used widely in forensic, orthopaedic, educational and historical examinations as well as art exhibitions.

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Photo 1 legend:

The photograph represents a section of the burial excavation. Four skeletons have been found by Karum et al.in the burial: an adult woman, man and two child skeletons. Two adults have been positioned back to back hands tied at back suggesting a possible sacrifice cult. Each child's skeleton has been positioned between the adults' legs, buried separately. Because the four skeletons were unearthed at different depth levels and for other reasons, a photograph of all four skeletons together could not be obtained.

Table 1: Soft tissue thickness data obtained from central

AGE	*	POINT	FEMALE Mean (mm)	MALE
30-40	1	Right porion	7,65	8,70
	2	Right medial canthus	3,03	5,30
	3	Superior labial margin	13,09	10,80
	4	Inferior labial margin	13,22	14,10
	5	Midphiltrum	15,32	15,80
	6	Left medial canthus	2,92	4,70
	7	Left porion	7,98	8,90
	8	Beneath chin	9,47	9,60
	9	Chin-lip fold	1026	12,00
	10	Inion	12,48	14,40

Anatolian people were used on cranium at ten different points (9).
*The numbers represented on figure 3.

Figure 1 The skeletons in burial.

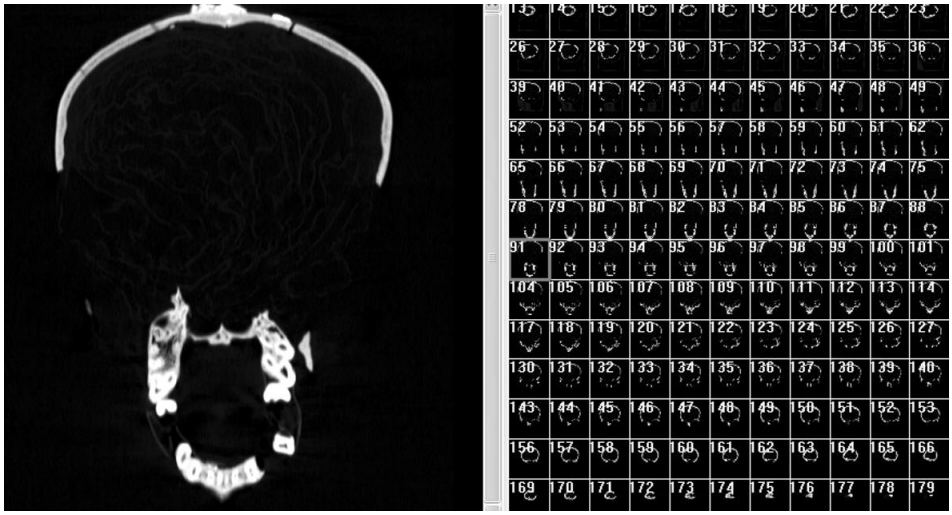

Figure 2 Scanned image of the skull.

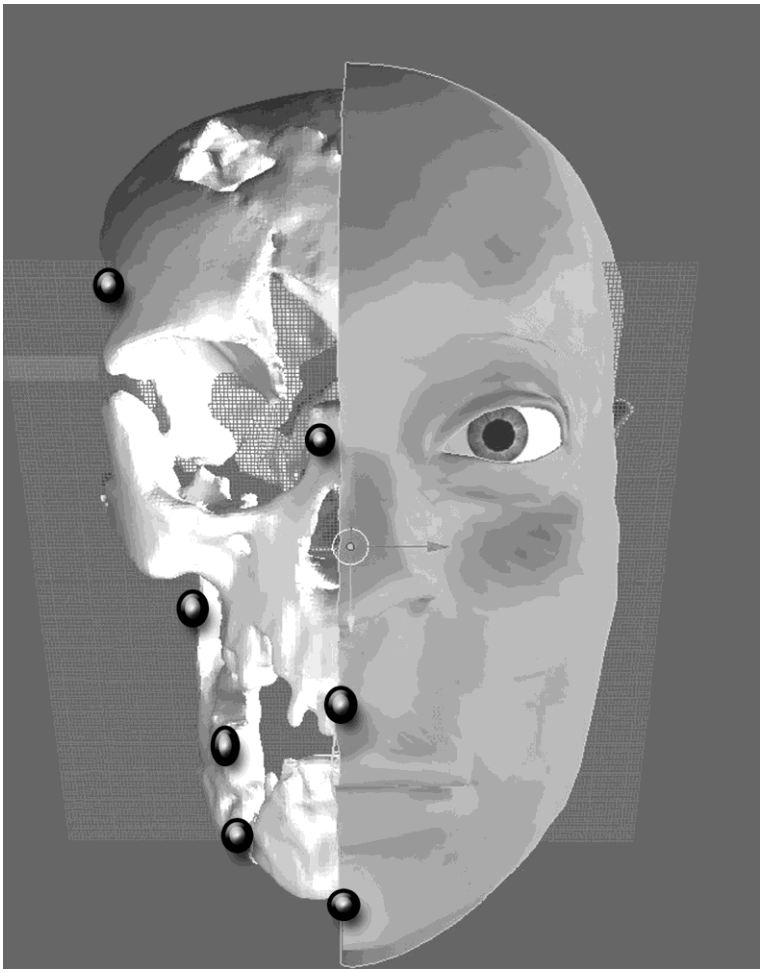

Figure 3 Used points showed in skull and digitally completed face construction

Figure 4. Half of the re contracted face printed as 3D.