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Systematic Review on Forensic Craniofacial Reconstruction. I. Facial Soft-Tissue Thickness

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Systematic Review on Forensic Craniofacial Reconstruction. I. Facial Soft-Tissue Thickness[a]

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ABSTRACT: Forensic anthropologists are traditionally interested in facial approximations and reconstruction of physiognomies of individuals from past populations and creation of lifelike features onto unknown skulls retrieved from forensic or bioarchaeological contexts. Present review article examines the significance of facial soft-tissue thickness (FSTT) in craniofacial reconstruction by revisiting the studies published in the recent past decade (2010–21). The searches for published articles mentioning the FSTT and related topics over these years were performed using the following search engines: PubMed, ScienceDirect, Web of Science, and Scopus. A total of 325 research articles were identified using different keywords, out of which 84 studies were found relevant for systematic review presented in this article. The selected studies were further analyzed based on the adopted study design, radiographic modality used for estimating FSTT, and generated databases and their advantages and limitations. Out of 84 relevant articles, 30 articles presented databases for sex, age, and ethnicity-dependent variations in soft tissue thickness measurements. Finally, 17 studies reporting sexual dimorphic variations in FSTT values estimated in supine or upright postured individuals (aged 18–90 years and above) were considered for meta-analysis. This article gives a decisive outlook on research trends in FSTT estimations, its contributions in refining craniofacial reconstruction technology, and identifying where we lack and where we can improve.

KEYWORDS: Craniofacial reconstruction, face analytics, facial soft tissue thicknesses, FSTT, forensic anthropology, radiographic modalities.

INTRODUCTION

Face Prediction, Facial Approximation, Facial Recognition, and Facial Identification

Face prediction from an unknown skull is a widely accepted forensic investigation tool in situations where identification of skeletonized human remains from other means becomes very difficult (if not impossible) and craniofacial reconstruction is the only option left to the investigators. Unknown skulls recovered by investigating agencies, police informants, or trained archaeologists might be the victims of violent crimes, mass genocides, or mass disasters. Identification of such remains (skulls) becomes important from ethical, moral, legal, and sometimes political perspectives. Morphological appearance of an individual can also be approximated even from the cranial remains while using varied forensic facial reconstruction approaches like facial tissue thickness estimation, craniometrics, and face analytics [27,28]. The facial bones grow more slowly and end up growing later than the cranial elements which make them more responsible for changing the facial profile of an individual [22,27].

Facial approximation is a method to recreate the likeness of an individual face based on application/knowledge of tissue thicknesses, cranial dimensions, musculature design, and the overlying skin layers. These inputs by forensic anthropologists have helped in devising automatic *face recognition* systems for security and surveillance purposes.

Automatic facial recognition solutions have become an essential part of our daily life for personal surveillance (e.g., access to ATM machines, mobile devices, bank lockers, high security zones), national security arrangements (e.g., entry to airports, nuclear reactors, music concerts, business malls), and many other purposes. Automatic facial recognition systems have been developed by experts based on different parameters like artificial intelligence and computer-generated analogs and algorithms. Automated facial recognition systems can play a very crucial role in criminal identifications and verifications by facilitating easy recording, retrieval, analysis, and sharing of information between different organizations.

Identification through recognition is frequently needed to identify suspected perpetrators by gathering and comparing images retrieved from closed-circuit television (CCTV) footage, newspapers, magazines, raids, drone captures, albums, sketches, etc. Recognition is also needed for verifications of beneficiaries of certain citizen civil services, identifying illegal migrants or asylum seekers, locating endangered elderly, children or differently abled individuals, and verifying human trafficking and other crimes by searching across all the images and videos in the database. The soft-tissue thickness and craniometrics

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Jagmahender Singh Sehrawat was educated at Panjab University, Chandigarh (UT, India) to obtain his M.Sc. (Hons.) and doctorate (Ph.D.) degrees in anthropology with specialization in physical anthropology. He further pursued his postgraduate diploma in forensic science and criminology from Punjabi University, Patiala (Punjab, India). Dr. Sehrawat joined Panjab University, Chandigarh in May 2013 as a regular faculty of Anthropology in the Department of Anthropology, Panjab University, Chandigarh.

Dr. Sehrawat is a principal research scientist in a Core Research Project (animal sciences) funded by the Science and Engineering Research Board, Department of Science and Technology (DST), Govt. of India. The project entitled "Forensic Anthropological Provenancing of Human Skeletal Remains Excavated from a Well at Ajnala (Amritsar, India): Bones, Teeth and Personal Artefacts as Identity Signatures" aims to identify thousands of unknown human bones, teeth, and numerous items of personal identity recovered from an abandoned well at Ajnala. These remains are being examined from their forensic anthropological, radiographic, chemical, and molecular contexts by the scientific team under his guidance and supervision. He also served as Forensic Anthropologist in the Department

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Dr. Sehrawat 's major areas of research specializations include forensic anthropology, odontology and osteology, forensic biology, investigation of crimes against humanity, and ancient DNA and stable isotope analysis studies. Dr. Sehrawat has more than 18 years' professional experience in biological profiling of unknown human remains. He was Principal Consultant in four Social Impact Assessment studies executed and completed under his guidance and funded by Chandigarh Administration and GLADA, Ludhiana (Punjab, India).

Dr. Sehrawat has published a total of 86 research papers in reputed journals (international: 69; national: 17) and has presented his research papers in more than 50 national and international conferences/seminars/scientific meetings in India and internationally in countries like England, Portugal, Spain, USA, and Canada. He has delivered 42 keynote guest lectures at various scientific platforms like DST-INSPIRE programs. He is a member of international scientific societies such as the American Academy of Forensic Sciences, IUAES, the Canadian Society of Forensic Sciences, the Spanish Association of Forensic Osteology and Odontology, the Association of Forensic Odontologists for Human Rights, and the International Association of Paleodontology. He has supervised/supervising many students for their PhD thesis in forensic anthropology and odontology, and M.Sc./MPH dissertations in the subjects of anthropology, forensic science, and public health at various departments of Panjab University, Chandigarh. Recently, he has been awarded the "Young Progressing Career Achievement Award — 2018" by the University of Delhi (Delhi, India), in recognition to his contributions to the discipline of anthropology in India.

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