



Cephalometric study of the relationship between facial morphology and ethnicity: Review article

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ABSTRACT

Morphology of the face depends on many factors such as sex, ethnicity, race, climate, nutrition, genetic constitution and socio-economic status. The goal of cephalometrics, at its most fundamental level, is to compare the patient or victim with a normal reference group, so that differences between the person's actual facial morphology and those expected for his or her racial or ethnic group are revealed. This study therefore, was designed to examine the review on a preliminary cephalometric study of the relationship between facial morphology and ethnicity. Here, we review contemporary advancement in the importance of cephalometry, cephalometric analysis, cephalometric methods and cephalometric indices in relation to facial morphology and ethnicity. The present study gives an account of full knowledge of the use of the outstanding knowledge of preliminary cephalometric study of the relationship between facial morphology and ethnicity in anatomy, forensic study and related.

1. Introduction

Anthropometry is an essential tool of biological anthropology which involves a series of standardized measuring techniques that express quantitatively the dimensions of human body. Cephalometry is one of the disciplines of anthropometry which deals with the measurement of the head and face of living human beings and cadavers. Direct facial anthropometry is considered a gold standard method in assessing facial dimensions [17] (see Tables 1 and 2).

Cephalometry has been widely used by many researchers for sex estimation. Determination of sex is of fundamental importance both for personal identification in forensic science as well as population data studies [56]. Sex is generally inferred from facial morphology which is highly reliable. The ultimate aim of determining sex in forensic science is to help law enforcement agencies in achieving personal identity in medico-legal cases like mutilated and decomposed body parts. In many cases cephalofacial dimensions are the only means of evidence for forensic examination. Such studies are also useful in forensic and clinical medicine, plastic and oral surgery, facial reconstruction and research.

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compare the patient or victim with a normal reference group, so that differences between the patient's or victim actual facial morphology and those expected for his or her racial or ethnic group are revealed. This type of cephalometric analysis was first popularized after World War II in the form of the Downs analysis, developed at the University of Illinois and based on skeletal and facial proportions of a reference group of twenty-five untreated white adolescents selected [36]. Cephalometric measurements enjoy several unique characteristics that will simplify the work necessary to add them to an existing terminology standard. The set of cephalometric index study is relatively small. Comprehensive atlases [10,46] [50]; list fewer than 200 cephalometric study; current research papers commonly list twenty to thirty separate studies on cephalometry.

Over the last decade, there has been a rise in the occurrence of disasters such as floods, earthquakes, typhoons, fire, road traffic accidents etc. In such situations, it becomes difficult to determine the sex of the dead victims especially bodies that have decomposed. In most countries, facial recognition systems based on cephalometry are used in combination with dental records to identify such victims. Therefore, the present study was designed to examine the review on a preliminary cephalometric study of the relationship between facial morphology and

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Table 1
Comparison of selected Cephalometric analysis tools.

Cephalometric Analysis Tool	Comparison
1. Steiner's analysis	1 Gives an interrelationship of measurement from lateral radiography into patterns. 2 This provided better comparison among Bangladesh and Caucasians subjects
2. Downs analysis	1 Provides comparison between an ideal profile, skeletal relationship and occlusion of patient based on specific linear and angular measurement.
3. McNamara analysis	1 This is mainly use to determine jaw and tooth 2 It does not provide an accurate analysis for craniofacial relationships
4. Ricketts analysis	1 It determines the proper spatial relationship of the jaw and the tooth.

Table 2
Summary of the Cephalometric indices in relation to Ethnicity and Sex.

Cephalometrics Indices in Relation to Sex	Cephalometrics Indices in Relation to Ethnicity
1. Filipino males have longer anterior cranial base, total facial height, longer lower anterior facial height, longer ramus height, longer lower posterior dentoalveolar height and total mandibular length than the females	2. Chinese subjects when compared with European-Americans had less convex faces, retrognathic chin, acute nasolabial angle and more protrusive lips than the European-American subjects
3. Nigerian males have protrusive upper and lower lips than the females	2. Bangladeshi adults had smaller mandibular plane angle and larger facial axis angle compared with the Japanese group
4. Upper and lower lips were more protrusive in the Chinese males and a more convex facial profile was seen compared with the Caucasian males	3. There is also a significant facial soft tissue profile difference between adolescents from Nigeria, Ghana and Senegal compared to Caucasian adolescents

ethnicity. In this review, we mainly concentrated on the most contemporary advances on the preliminary cephalometric study of the relationship between facial morphology and ethnicity. We happen to present the novel ideal on cephalometric analysis, and cephalometric methods approaches for forensic, anthropology and related studies and then emphasized the enlightened concepts on extending the importance of cephalometry. Next, the general review on cephalometric indices in relation to facial morphology and ethnicity were summarized. Also, the research challenges on cephalometric indices in relation to facial morphology and ethnicity and the perspectives in future researches were also advocated.

2. Review

2.1. Cephalometry

Cephalometry is the scientific measurement of the dimensions of the head, taken either directly or by radiography with relation to specific reference points and sufficient standardization to assess facial growth and development [49]. Cephalometry is a reliable and reproducible diagnostic technique mostly used in clinical orthodontics research. Beside its use in orthodontic treatment and orthognathic surgery, analysis of cephalometry is also used in the evaluation of ethnic groups in forensic science [35].

A reliable and reproducible cephalometric measurement and analysis depends on the position of the head [48]. Standardized and reproducible natural head position in an upright posture with the eyes focused on a point in a distance at eye level is taken into consideration. This implies that the cephalometric measurement is more effective when visual axis is horizontal [41]. Natural head position provides the key for meaningful cephalometric analysis. This is because an extra cranial reference line is used instead of intracranial reference line, which is known to be subjective to considerable biological variations in its inclination. Although the principle of natural head position is being recognized in orthodontic literature, its registration may contain an element of unavoidable errors that require corrections. These errors are as a result of variations in the position of the head during cephalometric measurements. To maximize the contribution of natural head position in cephalometry, clinicians and researchers try to eliminate or reduce to the bearest minimum these errors such that the measurements taken are almost closer to the true values [38].

2.2. Importance of cephalometry

The face is used as the first step in the evaluation of patients who present for facial cosmetics or reconstructive surgery [64]. It is an important aspect of the initial encounter, as it helps to formulate the goal and desired outcome of the proposed surgical procedure. This is because the facial beauty arises from the symmetric balance and the harmonious proportion of the skeletal, dental and the soft tissue [32]. Cephalometric evaluation of the soft tissue facial profile is used to determine which surgical modalities will lead to a favorable function and aesthetic outcome, especially in more complex cases involving orthognathic surgery [39]. In recent years, it is getting very important to establish identity to an individual. Biometric is superior to any other authentication system. But such systems are weak and disposed to a number of attacks like storage template attack which is the most common [30]. There has been a lot of improvement to develop the systems, but some issues related to its use by a disabled person also exist. In disabled persons who cannot be identified biometrically, facial recognition using cephalometry can be used to identify them. A new strong and reliable cephalometric system for facial recognition has been proposed. The system takes human skull x-ray as input, extract it features and then compares it with the real time x-ray image [58].

The most reliable method used in identifying dead persons is DNA analysis. This method however is time consuming as well as expensive, and may not be possible if the remains are extremely degraded or expose to extreme environmental conditions. In such cases radiographic cephalometric evaluation of the frontal sinuses becomes valuable especially where only the skull of the remains can be used for identification [45]. The frontal sinuses are absent at birth, but are generally fairly well developed between the seventh and eight years, only reaching their full size after puberty [24].

Skeletal components play a significant role in sex determination in forensic investigation. The skull is considered the best, after the pelvis in determination of sex. Methods based on morphological characteristics and morphometrics are already in used with reasonable accuracy. But standardized radiographic techniques like cephalometry have advantages of being more precise and objective when compared with morphometric methods. For this reason, cranio-mandibular parameters of lateral cephalometric radiograph can be used to determine sex in forensic investigations [12].

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