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Review

Anthropometry of hand in sex determination of dismembered remains - A review of literature

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ABSTRACT

Sex determination is an important and one of the foremost criteria in establishing the identity of an individual. Identification of dismembered/severed human remains that are frequently found in cases of mass disasters and criminal mutilation is a challenging task for the medicolegal experts. The paper presents a review of anthropometric studies conducted on hand with regard to identification of the deceased from dismembered remains. The review further discusses the anthropometric landmarks, techniques, methods, reliability and accuracy and the overall significance of hand anthropometry in personal identification. This review is an attempt to discuss the sexual dimorphism exhibited by the anthropometry of the hand that can assist forensic experts in the identification of amputated/dismembered remains.

1. Introduction

Personal identification refers to the determination of individuality of a person living or dead based on certain characteristics. Identification is required in living individuals, recently dead persons, decomposing and mutilated bodies, and skeletal and fragmentary remains. Amongst the various parameters of identification, determination of sex is an important and one of the foremost criteria in establishing the identity of an individual. Determination of sex is often considered as one of the simplest task in forensic analysis, as the external and internal genitalia can directly suggest the sex of an individual. The issue of sex differentiation however, is complicated in cases of intersex, bodies in advanced state of putrefaction, mutilated, fragmentary and skeletonised remains.

Studies in the past have reported a fair possibility of determining sex from skeletal remains and different body parts. The personal identification from extremities become increasingly important in cases of mass disasters, where there is a likelihood of recovering feet and hands separated from the body.[1] Accurate sexing of the remains primarily narrows down the pool of possible victim matches. Besides, sex determination is vital in further investigation of age and stature of the remains owing to the differences in age of epiphyseal fusion, and formulae for stature estimation in males and females. Accurate sex determination thus, provides some valuable evidences to a forensic scientist with regard to identification of remains.

This review attempts to discuss the sexual dimorphism exhibited by the anthropometry of the hand that can assist forensic experts in identification of amputated/dismembered remains.

2. Anthropology/anthropometry

Methods of biological anthropology are most commonly employed for personal identification despite of the modern techniques being available. Forensic anthropology is a branch of biological/physical anthropology primarily concerned with the postmortem identification of human remains in a medicolegal context. Two most commonly employed methods in forensic anthropology are the metric (Anthropometry) and morphological (Anthroposcopy) assessment of the living and skeletal remains. Anthropometry is the science that deals with the measurements of the size, weight and proportion of the human body and skeleton.[2,3] Anthropometry as a technique to take measurements on the

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human body, cadaver as well as on skeletal remains has been widely utilized in issues relating the identification of an individual.

Subjective and objective criteria have been developed for sex determination. Subjective sex determination is based on morphological features, while objective sex determination is based on metric analysis that includes various measurements and indices. Standards of morphological and morphometric sex differentiation differ with the population involved. The general adult male to female ratio is considered to be about 100 to 92 i.e. the female measurements are 92% of the male measurements.[2]

3. Hand morphology and landmarks[4]

Hands are specialized appendages at the distal end of the upper limbs that act as chief tactile apparatus. They are designed for grasping and precision movements for skilled works. Fingers represent the distal most region of the hand.[5] The fingers are denoted with the standard anthropological formula where 1 is the thumb, 2 the index finger, 3 the middle finger, 4 the ring finger and 5 the small finger, hence the digits are named as 1D, 2D, 3D, 4D and 5D respectively.

Flexures (joint lines) are the major markings found in the vicinity of synovial joints that are produced by adhesions of the skin to sub-adjacent deep fascia. The flexure lines commonly crease the skin across the flexor surfaces of the wrist, palm and digits and are the sites of folding of the skin during movement. These flexures are useful landmarks for measurements from the hand. Landmarks used for estimation of hand length and handbreadth include Interstylion, Dactylion, Metacarpal radiale, and Metacarpal ulnare. Interstylion is the middle point of the line connecting the point stylion radiale (the most distal point on the styloid process of the radius) and stylion ulnare (the most distal point on the styloid process of ulna). Dactylion is the most distal point on the tip of the third finger of the hand. Metacarpal radiale is the point projecting most medially on the head of the 2nd metacarpal when the hand is stretched whereas metacarpal ulnare, is the point projecting most laterally from the head of the 5th metacarpal.[6] Hand length is measured as the distance between the mid-point of inter-styloid line and dactylion, handbreadth as the distance between metacarpal radiale and metacarpal ulnare. Palm length is the distance between the mid-point of distal transverse crease of the wrist and the most proximal flexion crease of the middle finger. Finger lengths are measured as the distance between proximal flexion creases of the finger and the tip of that finger. Various landmarks and measurements on the hand are depicted in Fig. 1.

4. Significance of hand in identification

An individual hand when recovered and brought for examination, can provide valuable information about the age, sex, and stature of the person. Wrist and hand contain forty-five separate distinguishable centres of ossification. The appearance and fusion of these centres provide an excellent assessment of biological development of a growing individual. As per Mckern, complete union of epiphysis for metacarpals and phalanges in males occur between 14 and 19 years and in females between 13 and 17 years.[7] Besides estimation of age based on the ossification of bones of the hand, researchers have attempted to determine sex from the small bones of the hand.[8–13] The width of the phalanx and the total finger width of the index finger demonstrate statistically significant age and sex characteristics. Males have a significantly larger width of the phalanx, total finger width and soft tissue index than females in all age groups.[14] Various measurements of the phalanges have been studied for sex differentiation.[8,9] Musgrave and Harneja provided the first regression formulae to aid in the estimation of the stature

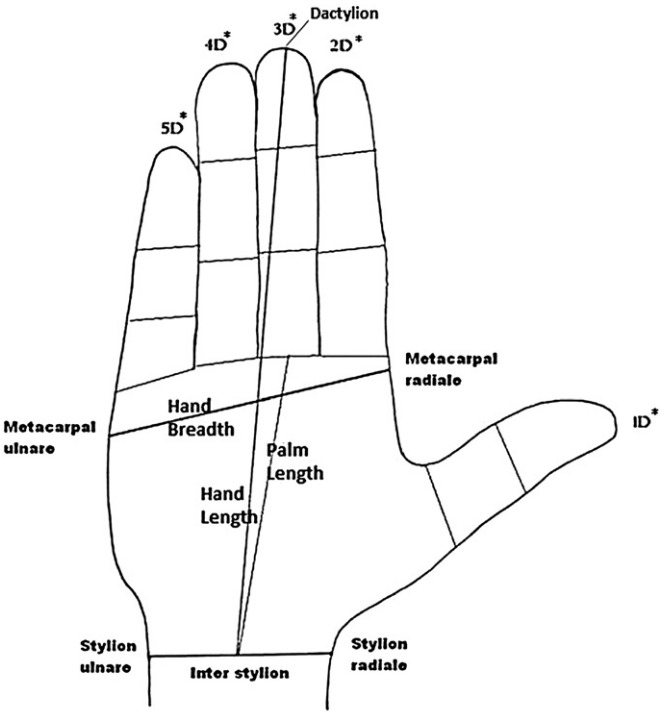

Fig. 1. Landmarks and measurements on the hand.

from the length of metacarpals. Since then a number of studies have estimated stature from the small bones of the hand.[15,16] Besides, hand measurements have shown significant correlation with fetal growth and have been employed in estimation of gestational age of a fetus.[17,18] Anthropometry of the hand is used to estimate the stature of an individual by regression analysis. Different hand measurements have been used to estimate stature in different age groups and populations.[19–23]

5. Sexual dimorphism exhibited by the anthropometry of the hand

The term 'sexual dimorphism' refers to any variations that manifests at the morphologic or nuclear level. Sexual dimorphism is obvious because of the differential development of internal and external genitalia as well as extragenital features such as body size, appendages and specific cellular components.[24] Anthropometry of hand and its different parameters that are valuable in sex determination of dismembered remains is presented in Fig. 2.

5.1. Hand and palm dimensions

Agnihotri et al reported male–female differences in hand dimensions among students in Mauritius.[25] The reliability of sex determination from soft tissue measurements of hand is established recently. Kanchan and Rastogi studied the sexual dimorphism of various hand dimensions and for the hand and palm indices derived from the hand dimensions, among North and South Indian population using statistical considerations.[26] The hand index was derived by using the formula: Hand Index = (Hand breadth/Hand length) × 100, while the palm index was derived using the formula: Palm Index = (Hand breadth/Palm length) × 100. Kanchan and Rastogi examined the utility of palm dimensions and palm