HUMAN HAIR AS AN IMPORTANT TOOL IN FORENSIC INVESTIGATIONS OF SEXUAL OFFENCES

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Background: Human hair has been the subject of only a few studies. The study of the macroscopic and microscopic appearance of human hair is of a greatest importance to the medical jurists. Such materials are usually recovered from scenes, victims, and assailants of various types of crimes specially sexual crimes. Objective: The aim of this study is to find a reliable method to identify the body region (scalp or pubic), to which the hair found in the scene of the crime belongs to. Material and methods: A total of 90 samples of human hair from volunteers of both sexes were collected from the scalp and the pubic regions of each volunteer. These samples were subjected for some medico-legal investigations by using light and scanning electron microscope (SEM). Each sample investigated by the light microscope was examined in both the longitudinal plane and after making a cross-section of the hair by using either paraffin technique or freezing technique. Results: It was found that the best method used for investigation of the hair in forensic science purposes was by light microscopic examination of the cross-section of the hair using the freezing technique. Cross-section of the hair in the scalp region has a definite characteristic shape, circular in soft hair, triangular in the silky type and oval in the spiral (curly) type with regular contour of the section. This findings were the same in both sexes. While, the cross-section of the hair in the pubic region has no characteristic shape ranged from the triangular to the elongated shape with characteristic irregular contour of the section. Also, this findings were the same in both sexes. Conclusions: Examination by making cross-section of the hair using the freezing technique is of a great importance to differentiate between hair of the pubic and scalp regions. So it could be used as a reliable method in forensic investigations specially of sexual crimes. But it is not conclusive method for identification regarding sex.

INTRODUCTION:

* The freezing technique in this article was done by the first author.
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Human hair has been the subject of only a few studies. Hair and fibers are among the most frequently encountered contact trace evidence in forensic science. The study of the macroscopic and microscopic appearance of human hair is of a great importance to the medical jurist (*Janet and Dudley, 1980*).

**Objective:**

The choice of the subject of hair in this study was based on the fact that the presence of hair on the body of the victim or the accused or in the scene of the crime is an important finding in various types of crimes specially sexual crimes.

The aim of this study is to find a reliable method to identify the body region (Scalp or pubic), to which the hair found in the scene of the crime belongs to.

**Materials and Methods:**

a) **Subjects:**

A total of 90 samples of hair of different forms and colour were obtained from 45 Egyptian volunteers aged from 25 to 35 years old, 25 non pregnant females and 20 males. All subjects that selected for sampling were apparently healthy and free from localized or generalized diseases.

Two samples were taken from each volunteer (one from the scalp region and other from the pubic region).
Each sample was put in an envelope with the name and region of the body taken from ready for examination.

**b) Methods**

Three methods were performed for the examination of hair samples.

1. The first method: Studying the longitudinal plane of the hair.

2. The second method: To make a cross-section of the hair by using either:
   a. Paraffin technique.
   b. Freezing technique.

3. The third method: Examination of the hair by the scanning electron microscope (SEM) (*Abou-Salem, 1999*).

In examination of the longitudinal section of hair samples and their cross-section using paraffin technique and steps used by *Drury and Wallington, 1976* and *El-Mansory, 1981* were followed.

For making cross-section of the hair by using the freezing technique the following steps were tried by the first author and used for examination of all hair samples.

*Steps of the freezing technique:*
1. Temperature of the freezing microtome champer was adjusted at -20°C.

2. Distilled water was dropped on a holder till it formed an ice cone.

3. A bundle of hair was then inserted perpendicular to the base of the holder in a hole made at the centre of the cone apex. The bundle was held in its place by some drops of distilled water which solidified instantly.

4. Frozen sections were cut at 12μ thick.

5. Sections were dried in air and a drop of canda balsam was applied and covered by a cover slip.

6. Sections were then examined by the light microscope then photographed.

**Results:**

From the obtained microscopical findings the results were as follow:
1. Examination of the longitudinal plane of the hair:

Light microscopic examinations of all samples in a longitudinal plane revealed the following features as shown in fig. (1).

a) Cuticle: The cuticle appeared very thin and narrow in all the samples.

b) Cortex: The cortex occupying most of the width of the shaft which was greater than the medulla. The density of pigmentation is more to the cuticle. It was noticed that the density of pigmentation is less in blond hair than in dark either black or brown hair.

c) Medulla: The medulla usually seen in the central part of the hair. It is less than one-third of the shaft, mostly not continuous when present.

There is no difference in shape of the longitudinal plane of the hair between males and females in all examined samples.

2. Examination of the cross-section of the hair:

The obtained results after using the freezing technique were as follows:
a) Scalp hair:

- Shape of the cross-section was greatly affected by the form of the hair seen by the naked eye as shown in (fig. 2). That is to say, the shape of the silky hair in most examined cases (11 out 12 (91.66%) was triangular in shape and one case was oval in shape. The cross-section of the soft hair (15 case) in all (100%) was circular in shape. The cross-section of the spiral (curly) hair in all the examined cases [(18 cases (100%)] was oval in shape.

- The contour of the cross-section of all these forms were regular.

b) Pubic hair:

The shape of the cross-section of the hair from the pubic region in all the examined samples (45 samples) is irregular in shape ranged from the irregular triangular to the irregular elongated shapes. There is no circular shape of the cross-section in all the examined samples. The characteristic findings in all the examined samples from the pubic region is the irregular contour of the cross-section in comparison to the regular contour belongs to the scalp region (fig. 3).
It is noticed that the size of the cross-section of the hair is different from one sample to the other in both regions. Also, there is no difference in the shape of the cross-section between both sexes for the hair of the pubic or scalp regions.

3. Examination of the hair by the scanning electron microscope (SEM):

SEM did not add additional details for investigation of sex and region of the body hair, but in contrary it damage hair fiber in some examined samples by its electronic beam.

Discussion:

Hairs are a very common, if not the most common trace material encountered in forensic work. Unlike some other types of biological evidence, hair is remarkable stable to most environmental conditions, and will not easily break down. Also, since it is relatively unnoticeable to the untrained eye, a criminal is not likely to make a special effort to destroy hair evidence. The greatest danger is to have hair examined by generalists without proper training and competencies (Robertson, 1999).

From the obtained results of this study, light microscopic examination of the longitudinal planes of hairs. It gives a knowledge about basic structure and morphology of human hair. This is of importance to differentiate it from hair of non human origin. It was mentioned by Robertson,
that the first question which must be considered in any hair examination is whether the hair is of human or non-human origin (Fig. 4). Microscopic examination of the longitudinal planes of hairs in this study gave no information about the region of the body to which the examined hair belongs to.

Also, in this study the results obtained from cross-section of the hair using Drury and Wallington, 1996 technique were not completely satisfactory because the contour of the cross-sections were usually interrupted. In 1931, Glaister reported that if a hair is embedded in a paraffin wax and cut with the microtome, the actual sections of the hair embedded there in will leave the wax when the film is floated upon water preparatory to being passed on the microtome slide.

Using El-Mansoury technique (1981) it was found that the hair dissolved and left the paraffin wax, when sections were cut by the microtome, the place of the hair was occupied by a dark jelly-like substance. It is also a time consuming method.

The freezing technique used in this study was found to be the most suitable for making cross-section in a hair. This is in accordance with what was recorded by Joshua and Cyril, (1980), that hair is much harder than many of the
embedding materials used for sectioning, subsequently good section are rarely obtained from paraffin-type preparation. They added that a method that generally produces good hair sections involves frozen sectioning. But they did not explain how to do this technique. The used technique in the methodology of this study was done by first author.

From the present data, in addition to the advantage of freezing technique in keeping the natural hair colour with preserving the melanin distribution and the shape of cross-section as a whole. Also, it could be observed that the greatest importance of cross-section of the hair is to differentiate whether the obtained sample of hair is from the scalp or the pubic region. The most important point of differentiation is the contour of the cross-section. It is regular and has characteristic shape of the hair in the scalp (i.e., it is circular in soft type, triangular in silky type and oval in the spiral (curly) type.

Our results were in agreement with those recorded by Glaister, (1931); Soliman and Emara, (1961); and Mohamed et al., (1994).

While in the pubic region the cross-section has irregular contour with no definite shape. The irregularity in contour is varying from an irregular triangular to an irregular elongated shape.
The present results are in agreement with that recorded by *Glaister, (1931)* who mentioned that section of the pubic hair are irregular in contour and may show great variations. The absence of the circular shape of the cross-section in pubic hair which is characteristic to the soft-type of hair in the scalp region could be explained by what was mentioned by *Gliaister, (1931)* that the hair covering the pubic in both male and female usually possesses a curly character. *Douglas, (2000)* also mentioned that pubic hair are generally coarse and wiry in appearance.

Cross-section of the curly pubic hair has an irregular contour in comparison to the regular contour of the curly scalp hair in cross-section.

There is no relation between the shape of the cross-section in both regions and the sex. This finding is in agreement with *Glaister, (1931)* who stated that to which sex the hair belongs is not reliable and therefore valueless. He also added that after the careful examination of many thousands of hairs, an accurate determination of the sex of the subject form which the hair has been derived can not be deduced in all cases from the microscopic appearance of hair alone. *Duglas, (2000)* mentioned that the sex of an individual is difficult to determine from microscopic
examination. But nuclear DNA and mitochondrial DNA (mtDNA) tests will provide more specific information.

Also, from the present study it was noticed that the size of the cross-section of the hair is different from one section to the other. This is supported by Gliaster, (1931) who recorded that it is obvious that hairs not only vary very greatly in the thickness of their calibre throughout their shaft, but also, individually.

In this study using SEM for examination did not add addional details but in contrary it damage hair fiber in some examined samples by its electron beam. These results were in agreement with Joshua and Cryil, (1980), who stated that SEM is a destructive technique and little additional information obtained by this method. Also Robertson, (1999) mentioned that SEM requires quite extensive preparation of hairs prior to examination.

**In conclusion:** In medicolegal investigation of hair, the first important step is to exclude hair found at the scene of the crime from being human in origin from morphological examination of the longitudinal plane of the hair.

Freezing technique is the best method for making cross-section of the hair to be examined by the light microscope. Cross-section of a hair present on the body of the
victim or an accused person or at the scene of the crime helps to determine if the obtained hair is from the scalp or pubic region of the body. This is of great importance in cases of rape and other sexual crimes. But, cross-section of the hair is not an accurate method for identification of sex.

It is not necessary to use SEM in medicolegal investigation of hair because it is not always available, expensive to operate with the possible damage to the hair fiber from the electron beam and in addition it does not give additional details than that what light microscope can do.

**RECOMMENDATION:**

From the obtained results of this study it is recommended that:

- In medicolegal investigation of sexual crimes, presence of hair at the scene of the crime or on the body of the victim or the accused person should never be omitted, even when only a single hair is available as a solitary hair could be the only clue to the solution of an important sexual crime.

- Head hairs and pubic hairs are routinely held as more significant than hairs from other body areas.

- The transverse section of hair is one of the most important lines of examination if the hairs are to be
identified. It is of great importance in the determination of the likely part of the body from which the hair has been derived. Also, in identification of the original form of the examined hair.

- Freezing technique is the best method for making cross-section of the hair to be examined by the light microscope.

- The significance of hair examination results is dependent on the method of evidence collection used at the crime scene, the evidence processing techniques employed, the methodology of the hair examination process, and the experience of the hair examiner.

- Finally, further studies are recommended on medico-legal investigation of human hair as human hair has been the subject of only few studies.
Acknowledgement

I would like to thank Dr. Hosny Hassan Mohammad, Professor of Ophthalmology, Al-Azhar University, Cairo, Egypt for his valuable advice during preparing this work.
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Fig. (1): Longitudinal plane of the human hair.

a) Dark hair shows thin cuticle, wide cortex with dense pigmentation and absent medulla.

b) The same as (a) with interrupted medulla.

c) Blond hair shows very thin cuticle wide cortex with less density of pigmentation and absent medulla.