

Assessing the benefits of head hair Analysis in Algeria

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Abstract—Research was conducted firstly to investigate if there is sufficient discrimination of hair evidence between Algerians in order to justify the benefit of this examination in the field of forensic science (in other words how much variation regarding hair evidence in Algeria) and secondly, to determine whether there are different characteristics between combed and pulled hairs from the same individual. Control sample of head hairs (combed and pulled hairs) were collected from 50 participants from different regions of Algeria. The microscopic examination demonstrated the presence of significant variation regarding hair evidence in Algeria, in other words there is a sufficient variation to allow discrimination between Algerians in terms of hair characteristics. In addition, there are different characteristics notably the hair colour between combed and pulled hairs within the same individual in the majority of hair sample which is also visible macroscopically to naked eye.

Index Terms—Forensic science, hair, evidence, Microscopic hair comparison.

I. INTRODUCTION

Hair is one of the most common trace evidence encountered in forensic cases; hairs found at the crime scene should be recovered, packaged and labelled in an appropriate manner, then submitted to the laboratory for examination (Fig.1).



Fig.1: Recovery of hair samples from crime scene.

The examination of hair evidence is made with a comparison microscope; it involves two steps, the identification of the recovered hairs and comparison with known hairs (control sample) [1], where the main goal is to determine whether the characteristics of recovered hairs including color, length, diameter, pigmentation (size, density distribution), and presence of artificially colored hair (dye or bleaching) match the characteristics of the control sample. Hair examiners can exclude individuals; however they cannot prove that a hair sample came from an individual, and therefore cannot identify the owner. The examination results will be reported and interpreted in a statement which will be introduced to the court (Fig.2).

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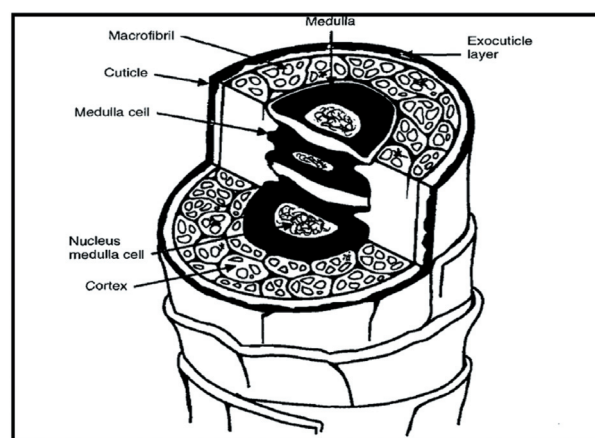


Fig.2: Schematic cut-away section of mature hair fiber. (Adapted from [5] page15).

Hair evidence is very important in forensic science as it helps link the suspect to the crime scene and/or to the suspect, furthermore it can indicate the human or animal origin of hair, the type of animal, any artificial treated such as dying or bleaching, whether it was removed forcibly and if it originated from the suspect. Furthermore, hair is a source of nDNA (the sheath material which covers the root).

There are many properties which make hair good evidence. First, hair is personal evidence that originates from individuals, it continuously falls from the body, it is easy to detect, collect and preserve; it is persistent, varies from one person to another and contains DNA [8].

The use of the microscopic examination of hair has been criticised in recent years especially after the widespread of DNA analysis, however some authors [3] pointed out that the preliminary microscopic examination of hair is highly recommended as it reduces the number of hairs that will be subjected to DNA analysis and confirmed the reliability, rapidity and reduced cost of the microscopic examination of hair remains.

II. GUIDELINES MATERIALS AND METHOD

Control samples of head hairs (combed and pulled out hairs) were collected from 50 participants from different regions of Algeria (29 participants from the east, 12 from the north, 8 from the west and 1 participant from the south of Algeria).

All participants signed a consent form and filled an information form with data useful for the experiment. Each participant was asked to collect their own hairs. First by combing (using a plastic comb) where at least 15 hairs should be collected, packaged in folded paper and labeled (Participant X combed). Then by pulling out hairs where at least 15 hairs should be recovered, packaged in folded paper and labeled (Participant X Pulled out). The two samples were then packaged in a polythene bag. The same procedure of hair collection, packaging and labeling was carried out with all participants.

12 hairs from each combed sample were selected and their length measured (cm) and recorded in a control combed hair form.

12 hairs from each pulled out sample were selected and their length measured (cm) and recorded in a control pulled hair form.

Hair form of each sample was recorded using the following scale:

- Straight, Wavy, Curly, Kinky, Woolly and Watchspring (Fig.3).

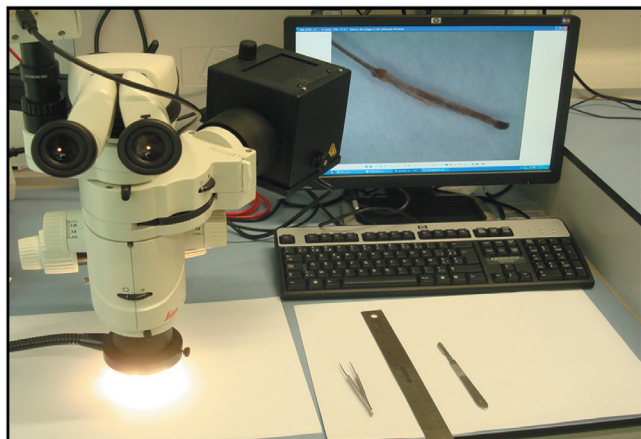


Fig.3: Macroscopic examination of hair.

All the selected combed and pulled out hairs were mounted on microscope slides under a fume cupboard, a layer of mounting fluid (Entellan) was put on the microscope slide, and then the hairs were placed onto the slide using forceps, covered with a cover slip and left to dry.

The microscope slides were then examined under the right hand stage of the light comparison microscope at x10 magnification (Fig.4).



Fig.4: Microscopic examination of hair.

The examination was carried out along the entire length of the hair; the width of hairs was recorded using the following scale:

- Fine, Coarse, Medium and Variable.

The colour range of hairs was recorded using the following scale:

- Colourless, Blonde (light, medium, dark), Brown (light, medium, dark), Black (light, medium).

The pigment distribution of hairs was recorded using the following scale:

- Uniform, Peripheral, One side and Clusters.

The pigment size of hairs was recorded using the following scale:

- Fine, Medium and Large.

The pigment density of hairs was recorded using the following scale:

- Light, Medium and Heavy.

The medulla classification of hairs was recorded using the following scale:

- Absent, Fragmentary, Discontinuous, and Continuous.

The presence and absence of cortical fusi and ovoid bodies, root appearance and tip were drawn.

III. RESULTS

The results obtained from the macroscopic examination can be summarized as follows:

- Regarding hair form, out of 50 participants, 29 participants had wavy hair, 10 participants had curly hair, 7 participants had straight hair and 4 participants had watchspring hair.

-The hair length varied significantly between participants, from very short hair (0.3 centimeter) to long hair (7.5 centimeter), and also within one individual between combed and pulled out hairs.

- Regarding tip appearance, out of 50 participants, 46 participants had cut tip and 4 participants tapering tip.

- All hairs were healthy and in good state, however some were cut in the middle of the hair.

- In relation to root appearance, the combed hairs were in telogen phase whereas the pulled out hairs were in the anagen phase.

The results obtained from the microscopic examination can be summarized as follows:

- The most significant results are related to the hair colour, where there is a difference in colour between combed and pulled out hairs of the same participant, the hairs that are combed are lighter in colour than the pulled out ones and the opposite is true, the pulled ones are darker than the combed ones.

- The majority of the participants have brown color hair (a mixture between light, medium and dark), colorless hairs were found in 12 participants, black hairs (light or medium) were found in 8 participants, and blond hairs (light) in 3 participants. One participant's (participant 36) hair was dyed with dark brown permanent colorant as indicated in the information sheet.

- The range of width varies significantly between individuals from fine to medium to coarse, and also between combed and pulled hairs within the same individuals, and also within one strand of hair (variable).

- Regarding pigment distribution, the uniform and peripheral pigment can be seen on the majority of the participants, 4 participants have uniform pigment, 4 participants have peripheral pigment, one side pigment was found in 6 participants and one participant have clusters pigment.

- As for pigment size, the majority of participants have fine and medium pigment within their hair samples, 2 participants have medium pigment and one participant has large pigment within their hair.

- Regarding pigment density, out of the 50 participants, 24 have medium and heavy pigments within their hairs, 19 participants have light, medium and heavy pigment within their hairs, 4 participants have light and heavy pigment, and 3 participants have light and medium pigment within their hairs.

- As for medulla classification, the majority of participants have no medulla (Absent), out of the 50 participants, 10 have no medulla within their combed and pulled hairs, 8 have absent and continuous medulla, 7 participants have absent and discontinuous medulla, 10 participants have absent and fragmentary medulla, 5 participants have absent and

discontinuous medulla, and the rest have a mixture of absent, fragmentary continuous and fragmentary.

-Regarding cortical fusi and ovoid bodies, the cortical fusi are present in all hairs of the participants.

IV. DISCUSSION

* The obtained results from the macroscopic examination showed that the majority of participants have wavy hair which is consistent with the premise that majority of Algerians have wavy hair. The other types of hairs such as straight, curly and watchspring are also present in the Algerian population, the 50 participants are not representative of the different regions of Algeria, since the majority are from eastern Algeria, this impacts the results where other types of hairs such as kinky and woolly hairs which are absent in our sample are present in the Algerian population especially in the south of Algeria where individuals are generally dark skinned (note: there is no dark skinned person within the 50 participants). Although there is a limitation in terms of participants (hairs from all participants do not represent all types of hairs that can be seen in the Algerian population) hair type might be a good indicator of body area and racial origin.

* The hair length varies significantly from very short to long hairs, short hairs can be linked to information given by participants, some noted cutting their hairs every week, however other participants declared cutting their hairs once a month at most. Similarly, variation can be seen within one individual between combed and pulled hairs, again as the 50 participants do not represent the whole range of hair length in the Algerian population, where some individuals have very long hairs, no participants have very long hair, hair length is an important feature as it can determine the possible body origin of the questioned hair. Based on the types of hair lengths exhibited, hair length can be a major or a minor feature as revealed by [2], it should not always be supposed that a meaningful comparison of two hairs must have the same length, the questioned hair can be excluded if its length differs considerably from the range of known sample, bearing in mind that a significant comparison can be made with two hairs which vary in length. An important factor that should be considered when collecting hair samples is ensuring that the number of known hairs is representative.

* Regarding tip appearance, almost all hairs have cut tip, this can be linked with the information provided by the participants cutting their own hair, and some hairs have tapering tip (the hair tip becomes tapered or rounded after 2 to 3 weeks after cut). Washing routines are almost the same for all participants, they use shampoo to clean their hair and some use gel afterwards, the absence of split tip indicates that the way they wash and brush their hair is optimal, this is not the case with longer and female hair where they have split tip caused by the way of brushing their hair.

* All hairs are in good state and healthy, this is related directly to the information provided by the participants, where no participant is taking medication, however hairs of some participants are cut along the hair, this is caused by the use of the forceps either to measure the hair's length or when placing the hairs on microscope slide.

* As for root appearance, the hairs combed are in a telogen phase (the end of the growth stage), and the hairs that are pulled out are in anagen or catagen phase, in this case the sheath material is attached to the root. However in some cases, some roots are in anagen or catagen phase and found in combed hairs, this occurs when a participant has short hair and it is difficult to get a good sample, therefore some force should be applied when combing hairs, as a result the roots that are in anagen or

catagen phase are removed forcibly and found present within the range of combed hairs.

During the examination, the factor that shows the highest degree of significance is hair colour, where there is a difference in colour between combed and pulled hairs within the same individual in the majority of hair samples, this can be seen also macroscopically, the hairs combed are lighter in colour than those pulled and the opposite is true. These results can impact sampling hairs, and confuse the examiner leading them to exclude individuals from an alleged crime where in fact they are involved. Therefore a good sample of combed hairs and pulled hair should be present to carry out a meaningful examination.

* Most of the participants have brown hair colour (light, medium and dark), however the colour is not exactly the same for all participants, for example the light brown colour of participant 1 is not exactly the same light brown colour of participant 3, the density of colour that was followed in this study was (light, medium and dark), however within a range of light, medium and dark brown colour, we can find many types of colours such as orange brown and golden brown. The variation is also within one hair where it can be one colour from root to tip (same density) or it can change from light to medium or to dark or from light to dark. Other types of colours such as colourless, black and blond are present within the participants at different percentages, these results do not represent the variation of colours that can be seen in the Algerian population because the participants are not from different regions from Algeria. For example the black colour is present with a small percentage in this study, however people who live in southern Algeria are mostly dark skinned and their dominant colour would be either black or dark brown as revealed by [6]. Participants were asked to provide some information, however they have no value except for one participant (36) who stated that they dyed their hair with dark brown permanent hair colorant, this was also confirmed by microscopic examination, and could be seen clearly in the colourless hair (the lower half is white and the top half is medium brown). In some instances artificially coloured hairs can be a good indicator during examination, it should be noted that dyed hair is not common for males in Algeria. The absence of grey colour is due to limitation in terms of participant age, where the range of age of the participants is between 27 and 34. Hair colour has a strong power of discrimination, especially for experienced examiners using good comparison microscope.

* Regarding hair width, there is much variation in width from fine, medium to coarse, this variation can be seen between combed and pulled hairs, and considerable variation can be seen along one hair (variable), this latter found especially in curly and watchspring hairs; hair diameter along an individual hair shaft has low power of discrimination as stated [4], however it can be used as an indicator of racial origin. The use of Scanning Electron Microscopy is highly recommended to measure hair width as it is more accurate.

* Regarding pigment distribution, size and density, as mentioned earlier, hair colour depends on size, density and distribution of granules, in study the majority of the participants have a uniform and peripheral pigment, and have a mixture of size from fine to medium and a mixture of light and heavy density within combed and pulled hairs, these featured attributes all together give the dominant colour of the participants (brown colour), the difference in colour between different hair is due to the type and density of the pigment.

* As for medulla classification, most participants have no medulla, this confirms that medulla is not present in all human

hairs, the width of medulla is not large as in animals hairs and can be very useful to differentiate human from animal hair using the medullary index (MI) [5], it should be mentioned that no double medulla was observed within the hairs of the participants.

* Finally, regarding cortical fusi and ovoid bodies, the cortical fusi are present almost in all hairs of the 50 participants especially near the root end of the hairs, however no ovoid bodies were observed.

V. CONCLUSION

Based on the results of this research and despite the limitations, it can be concluded that there is much variation of hair characteristics within the Algerian population, where different colours can be seen such as brown, black and blonde, different hair shapes were observed such as wavy, straight, curly and watchspring, in terms of hair length, it varies from very short to long hair, and also in terms of the width from fine to coarse, in other words there is sufficient evidence for hair discrimination between Algerians.

In addition, it can be concluded that there is a difference in colour between combed and pulled hairs (the colour of pulled hairs is darker than combed ones) within the same individual in the majority of hair sample; this can be observed macroscopically, therefore a special care should be undertaken when collecting and comparing hairs (either combed and pulled). The Forensic Science Service (FSS) recommended that to obtain a control sample from head hair a number of 25 hairs should be cut close to the root, and to obtain a control sample pubic hairs at least a number of 10 hairs should be cut close to the pubic bone [7], the authors would advocate that police officers should collect both combed and pulled hairs for the same individual.

This is a preliminary work which can form a basis for further research. This will be needed to provide background information on which to base interpretation of hair evidence in Algeria in the future.

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