Judicial applications of hair testing for addicts in Crete: sectional hair analysis of heavy heroin abusers

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SUMMARY. Laboratory examination of hair from drug users has been employed for the last 5 years in Crete, in addition to the psychiatric or other forensic clinical examinations necessary for the confirmation of a person's use of drugs. The present study reports results of total and sectional head, axillary and pubic hair analysis of imprisoned abusers under interrogation and awaiting presentation at the Crime Court. Morphine levels in total head hair samples 1, 2 and 4 months after preliminary imprisonment ranged from 1.2 to 38.2, 0.5 to 22.5 and 0.1 to 4.9 ng/mg of hair respectively, while the maximum morphine levels amongst all studied groups of those arrested were found in the sections of axillary and pubic hair. Notably high morphine levels in head, axillary and pubic hair sections (13.7, 8.4 and 18.1 ng/mg respectively) were measured, even in abusers who had been imprisoned between 2 and 4 months. Hair tests may considerably assist to evaluate the systematic present and past abuse of heroin and other drugs. Consequently, it may be used as valuable expertise evidence during questioning and in court.

INTRODUCTION

Issues regarding the application of hair testing for the service of law and other forensic purposes have been extensively discussed in the USA and Europe. A substantial amount of research has been performed in recent years towards the validation of this expertise and there are a lot of data showing the strengths and limitations of hair testing. In the recent past, hair testing for drugs has been characterized as an infant science owing to the numerous questions being asked concerning its reliability, its sensitivity, the problems with external contamination, other bias such as hair colour and structure etc. Although such questions continue to be asked, testing of hair for drugs is a valuable analytical tool and we have a responsibility to learn how to apply and interpret the obtained results.

The purpose of this paper is to point out issues of hair testing regarding the service of the law in Crete.

Our studies of the previous 5 years concerning the laboratory evaluation of drug users are presented.

Our data collected from investigations regarding drug use in Educational Institutes, arrests for illegal drug use and impaired driving owing to drugs of abuse, address the prevalence of drug misuse in Crete in the last decade. Our records of deaths associated with heroin abuse in Crete showed a rapid increase over the last 4 years. To date, one death in a 30 000 population is attributed to heroin abuse. This number is similar to that observed in Athens and other large cities in Europe and the USA. The incidence of drug use in the populations of schools and universities was evaluated using anonymous questionnaires and hair testing simultaneously. The incidence of drug use in high school students (by hair testing) was about 3%, while in university students it was over 7% for the years 1993–1994. The majority of the above drug users were found to be smokers of cannabis products. This was a cause for concern to the local authorities.

Data collected from arrests for possession and/or cultivation of cannabis also indicated an increase in the narcotics problem in Crete (a total of 500 arrests from 1991 to 1996). Arrests for heroin possession rapidly increased in 1994–1995 (280 arrests). The number of arrests for heroin and benzodiazepines
possession were similar to those for cannabis. Arrests for possession of benzodiazepines stimulants (amphetamines, LSD and cocaine) were significantly smaller than those for cannabis, heroin or benzodiazepines. 9

Drug addicts and traffickers arrested for possession and for use or trade of drugs are routinely examined in forensic medicine departments whilst in custody. Apart from the forensic pathologist, a forensic psychiatrist and a toxicologist are required to determine the state of drug dependence in an arrested person. All the above should determine whether the addict is able to terminate the drug abuse on their own. Laboratory evaluation in the majority of cases includes urine analysis, while hair testing is only ordered under special circumstances when blood or urine and external examination is not helpful.10-11

MATERIALS AND METHODS

Hair and urine sampling from detained drug users

Head, axillary and pubic hair samples from 23 detainees (18 male and five female) aged between 18 and 55 years old were selected for the study. All detainees admitted chronic heroin abuse, predominately chasing. Some reported occasional intravenous heroin administration in the past. The majority confirmed smoking of cannabis products on a daily basis, while only few of them were taking benzodiazepines or opiate analogues. None of the detainees developed withdrawal syndrome on the day of sampling, and external examination revealed nothing of importance, apart from tattoos on many of them. Hair samples were cut from the head (posterior vertex), axillary and pubic area, as close as possible to the skin, taking at least 200 mg of hair from each area. Segments of equal length from these hair samples were analysed. Hair of healthy individuals were used as a blank control. All sampled hair was predominately of dark colour.

Urine samples and hair samples were collected from the detainees simultaneously in order to detect possible recent use. Detainees cooperated well with the sampling procedures.

Hair sampling from addicts

Head, axillary and public hair were sampled from eight well-known addicts in Crete, who were contacted through friends, lawyers or police officers. These addicts exhibited the most common profile of heavy heroin abusers in Crete. The self-reported heroin use was an average of six doses daily, taken by chasing, intravenously or by smoking. Sampling was carried out twice for each subject over a 2-month period.

Hair treatment and hair analysis

Hair treatment was performed according to a slightly modified procedure used routinely in Miami. 12 The procedure includes hair homogenization, dissolution and solid phase extraction of the analytes of interest. Approximately 30 mg of hair was weighed in a glass tube, washed twice with 1 ml of methanol and filtered under vacuum. The washed hair was homogenized in the Minibead cell disrupter (Biospec Products Inc, Barkesville, USA) in special polystyrene vials together with five glass beads (2.5 mm D). The powdered hair (30 mg) was incubated in 2 ml 1 N HCl with [H1] morphine as internal standard for 3 h at 65°C. The solution was cooled, the pH adjusted to 6 and the organic contents were extracted using Clean Screen SPE columns (World-wide monitoring). Analytes were eluted twice with 4 ml portions of 2% ammonia solution in methylene chloride: isopropanol (80:20). The dried residue was derivatized with hexafluoroisopropanol/pentafluoropropionic anhydride for 30 min at 90°C for GC-MS analysis or dissolved in 100 μl of methanol for HPLC analysis. Confirmation analysis of heroin and metabolites for the selected samples was conducted by GC-MS and/or HPLC.

The GC-MS analysis conditions were as follows: GC oven-90°C/1 min; 150°C/min to 290°C, GC column-15 m FSOT capillary, 0.25 id, DB-5MS (J&W scientific). Mass spectrometer: Finnigan 4500, Electron Impact (EI). Masses (+0.5 amu): 282, 285, 414, 417. Calibration curve: RS=0.9999.12

HPLC analysis was conducted in a Spectra Physics 86100 instrument equipped with an Apex Cyano RP 5U, 25 cm column. The elution system was acetonitrile: water (1:1), flow rate 1.5 ml/min and detector wavelength 211 nm.4 The retention time for morphine under these conditions was 8.1 min.

Preliminary screening and qualitative data were also obtained using immunoassay technique. For this purpose the organic residue from the solid phase extraction was dissolved in 200 μl of saline and was measured in ADx systems of Abbott.16

RESULTS

The results of hair analysis are presented in Tables 1 and 2. Table 1 depicts data of hair morphine concentrations in total hair samples from the head, axillary and pubic regions of imprisoned abusers.

In the cases where sampling was performed in the 3rd or 4th month following arrest, concentration of
morphine in hair was very low. Table 2 depicts data of preliminary imprisonment.

<table>
<thead>
<tr>
<th>Section</th>
<th>Sample I</th>
<th>Sample II</th>
<th>Sample III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>60.6</td>
<td>28.3</td>
<td>13.7</td>
</tr>
<tr>
<td>Axillary</td>
<td>84.3</td>
<td>38.1</td>
<td>8.4</td>
</tr>
<tr>
<td>Pubic</td>
<td>99.1</td>
<td>37.4</td>
<td>18.1</td>
</tr>
</tbody>
</table>

*Section containing maximum level of morphine. Sampling performed up to 1 month (I, seven cases), up to 2 months (II, eight cases) and up to 4 months (III, four cases) after preliminary imprisonment.

DISCUSSION

Law regulations regarding prohibition of use, cultivation and trafficking of cannabis products and opium derivatives appeared in Greece in 1919–1920 for the first time. The currently acting legislation for controlled drugs is included in laws 1729/87 and 2161/93. The first is entitled ‘Fighting Against the Spread of Narcotics, Protection of Youth and Other Regulations’ and the second, recently ratified, contains modifications and amendments to the law 1729. Article 12 of law 2161/93 states the factors that must be examined in order to determine whether a quantity of drug is for personal use. These factors are: the kind, the quantity and the purity of the confiscated substance. It also states the quantity limits that relate to a drug use over a certain period.11,13

It should be pointed out that for each of the controlled substances from groups I–IV it is equally forbidden to be in possession of and to use without any differentiation (e.g. the law equally punishes the possession and use of heroin, cannabis products and ecstasy tablets). In practice, judges give longest sentences for the possession/use of the so-called heavy drugs, such as heroin, within the frame of their jurisdiction.14

The jurisdiction of the judge when encountering the punishment is wide. Sentences range from 10 days to 5 years for minor crimes and from 5 years to 20 years for felonies.

Drug addicts must have special treatment according to the law. In order to determine whether an arrested person is an addict or not, a clinical and a laboratory examination is performed.11,13 This aims to clarify the existence of dependence and the extent of dependence. After the examination, a report is submitted to the Examining Judge or District Attorney. The report must contain data concerning the dependence of the person on a certain substance, the daily dose required to avoid withdrawal syndrome, and the influence of the drug on the behaviour and conscience of the addict. Finally, it should suggest a suitable treatment. According the Ministerial Enactment, the arrested person may be enclosed for 5 days in a hospital or specialized unit for detailed medical observation and evaluation of the development of withdrawal syndrome.

Hair testing for drugs of abuse, which is not specially referred in any law or decision of any specialized committee or ministry, has been employed in Crete as ordered by District Attorneys (Prosecutor) to help elucidate legal issues such as: confirmation of drug use, extent of drug use history, systematic drug use and severity of abuse. Arrest for drug possession is followed by clinical/laboratory examination of the detainee by evidence analysis and the case is presented by the Drug Enforcement Unit to the District Attorney (Prosecutor). The Prosecutor is empowered to decide whether the case is sent to the Minor Crime Court or to the Examining Judge, who may order preliminary imprisonment of the offender until the time of trial.

In our experience, hair testing has been ordered mainly by the Examining Judge during interrogation in severe cases.14 Medical examiners and forensic psychiatrists who have been instructed to examine the detainees may also ask for toxicological analysis which includes hair testing.13 This usually occurs when the arrested are heroin smokers without any evidence of injections or nasal inflammation.10,11 It must be said that considerable time may have elapsed from the time of arrest until the receipt of the order for hair testing and the visit to the detainee. Finally, while visiting prisoners for hair collection it was evident that many of them had cut their hair short, were in prison for a
Table 3  Morphine levels in hair of drug abusers (ng/mg)

<table>
<thead>
<tr>
<th>Author/Country</th>
<th>Journal/Year</th>
<th>range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goldberg et al, USA</td>
<td>J Anal Tox, 1991</td>
<td>0.0-2.85</td>
</tr>
<tr>
<td>Marigo et al, Italy</td>
<td>J Anal Tox, 1991</td>
<td>0.08-15.7</td>
</tr>
<tr>
<td>Cone et al, France</td>
<td>J F S Intern, 1993</td>
<td>0.0-1.52</td>
</tr>
<tr>
<td>Kintz et al, France</td>
<td>JFSCA, 1993</td>
<td>0.4-24.2</td>
</tr>
<tr>
<td>Jurado et al, Spain</td>
<td>FS Intern, 1995</td>
<td>0.34-45.7</td>
</tr>
<tr>
<td>Tsukali et al, Greece</td>
<td>Psychiatristi, 1995</td>
<td>2.5-12.0</td>
</tr>
</tbody>
</table>

long time or had no head hair. In most of these cases head hair testing would give no results. Pubic hair and axillary hair were the samples of choice in these cases. 11 The hair testing report should be submitted in due course, but it is not compulsory. The final Crime Court will usually take place in less than 1 year from the time of preliminary imprisonment. During trial all interrogation data will be presented. 11, 14

Morphine levels in the hair of drug abusers as reported in the literature (Table 3) varied significantly. 15-22 This is because there is no grouping of this data into samples of occasional drug users, systematic drug users and heavy users, 11 in addition to many other already mentioned factors, such as ethnic background, melanin content, lipophilicity of hair matrix etc. 24 In order to determine the levels of morphine in the hair samples of heavy users, we sampled eight addicts having the most common profile of drug abuse in Crete. Morphine levels in total hair samples from these heavy heroin abusers were found to be above 20 ng/mg and up to 87 ng/mg. Such high morphine levels were also detected in other studies (Table 3) conducted in Spain, France and Italy.

Our data on morphine levels in total hair samples from imprisoned abusers showed that even up to 4 months after preliminary imprisonment detection is possible (Table 1). In cases where head hair was not available, axillary and pubic hair may be tested with equal validity. The concentrations found for the 1st month of sampling are consistent with those reported previously by Kiniz and Magin, Jurado et al and Tsukali et al 14-20  (Table 3). The lower limit in the range of concentrations is slightly elevated, which reflects the fact that the sample selection contained heavy users. Results (Table 1) generally indicated a higher concentration of total morphine in hair from the axillary region and pubis than from the head. For three addicts from group II (total number of addicts eight), axillary hair showed the highest concentration of morphine. Urine analysis gave positive results for morphine for none of the above addicts, indicating that recent use of morphine had not occurred. The advantage of hair testing in comparison to the urine is, thus, obvious. The case of occasional heroin use while in prison cannot be excluded, as it was not specially controlled for in our study, but there was certainly no chance of receiving the drug systematically.

Sectional analysis of the samples obtained from the imprisoned abusers revealed high levels of morphine, i.e. from 8.4 to 18.1 ng/mg even 4 months after imprisonment (Table 2). Mean values were calculated from the range of sections with maximum values. It is noteworthy that pubic and axillary hair sections showed the highest concentrations of morphine. Similar results for pubic and axillary hair levels were also obtained from a study concerning carbamazepine 21 and phenytoin. 22

The data from the tables strongly supports the possibility of applying hair testing (pubic, head and axillary) to evaluate the systematic drug use of heroin, even when considerable time has passed with obligatory abstinence.

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