COMPARATIVE EFFICIENCY OF HAIR AND URINE ANALYSIS WHEN ASSESSING DRUG CONSUMPTION

Carmen JURADO, Teresa SORIANO, Manuel MENÉNDEZ, Manuel REPETTO
Instituto Nacional de Toxicología, Sevilla, Spain

ABSTRACT: The aim of this study was to compare the effectiveness of hair analysis and urinalysis in identifying drug-using individuals. The comparison was performed with hair and urine collected from 153 subjects. The study demonstrated that both samples are useful in establishing drug addiction. However, hair analysis is better to assess chronic drug consumption.

KEY WORDS: Hair analysis; Urine drug analysis; Drugs of abuse.

Problems of Forensic Sciences, vol. XLII, 2000, 137–142
Received 9 September 1999; accepted 16 May 2000

INTRODUCTION

Drug consumption is an important international problem. The correct diagnosis of drug abuse is a key step in dealing with drug addicts. Toxicological analysis for drugs of abuse can be performed on all biological fluids or tissues.

Traditionally, these analyses have been performed mainly on urine, even though blood has also been employed. More recently new matrices have been introduced as alternative analytical methods for drugs of abuse. These new matrices are, above all, hair as well as sweat and saliva. Each provides different information and, consequently, has both advantages and disadvantages.

One of the differences between samples is the time window of detection after drug administration. The analysis of urine gives a diagnosis time which ranges from 12 hours (for LSD, for example) to 30 days (for chronic abusers of cannabis), but, in general, the time window of detection is two or three days after consumption. Hair, on the other hand, is a complementary sample to urine. Drugs can be detected 2 or 3 days after consumption (when they disappear from urine) and the detection time may range from a week to several months. Only the length of the hair limits it.

For these reasons, the objective of this study was to compare the effectiveness of hair analysis and urinalysis in identifying drug users.

MATERIAL AND METHODS

The comparison was performed with 153 subjects. Urine and hair were collected from all of them. 76.5% of the samples were from men and the rest, 23.5%, from women.

With respect to the population included in the study, the majority of our cases, 70%, were from divorce proceedings, and the remaining 30% from prison inmates.

In all the urine samples a systematic toxicological analysis was performed. However, in this study we will focus on the results for opiates, cocaine and cannabis.

Firstly we performed a screening by EMIT. Later, and in spite of the results obtained in the screening, a systematic toxicological analysis was performed on all samples. This includes solid phase extraction, identification by GC-NPD and confirmation and quantification by GC/MS after derivatization. For cannabis, liquid-liquid extraction and direct analysis by GC/MS, also after derivatization.

The method for hair analysis involved decontamination with methylene chloride, followed by two consecutive hydrolyses. First a soft hydrolysis with 0.1 N HCl, SPE and derivatization with BSTFA for the analysis of opiates and cocaine. The remaining hair was submitted to a stronger basic hydrolysis with KOH to extract cannabis compounds from the protein matrix of the hair. Liquid-liquid extraction and derivatization with HFBA-HFPOH then followed.

Analysis in both fractions was performed by GC/MS.

Table I shows the cut-off we have applied in our study, in each one of the three families of compounds and in both samples urine (with both methods, EMIT and GC/MS) and hair.

TABLE I. POSITIVE CUT-OFF VALUES FOR OPIATES, COCAINE AND CANNABIS IN URINE AND HAIR

Compound	Urine [ng/ml]		Hair [ng/mg]
	EMIT	GC/MS	GC/MS
Opiates	300	100 (morphine)	0.5 (6-MAM)
Cocaine	300	100 (BE)	0.5–1 (cocaine)
Cannabis	20	5 (THC-COOH)	0.04 (THC)

RESULTS AND DISCUSSION

Table II shows hair results, both positives and negatives, as compared to urine results, also positives and negatives. At the beginning we expected to validate all positive hair results by positive urine results. However, this expectation was not met, since hair analysis identified more drug users than did urinalysis. In the 153 samples included in this study, hair analysis revealed that 75.2% of the subjects (115 individuals) had used drugs; in contrast, urinalysis identified only 58.8% (90 individuals).

TABLE II. SUMMARY OF THE QUALITATIVE RESULTS FOR THE COMPARISON STUDY IN HAIR AND URINE

Urine	Hair		Total
	Positives	Negatives	
Positives	87	3	90
Negatives	28	35	63
Total	115	38	153

Table III shows the effectiveness of hair and urine analysis in identifying drug use, as specified by family of drugs.

TABLE III. EFFECTIVENESS OF HAIR ANALYSIS AND URINALYSIS IN IDENTIFYING DRUG USE

Drug	H+ U+	H– U–	H+ U–	H– U+
Cocaine	51	53	46	2
Opiates	37	86	27	2
Cannabis	45	71	22	14

In the case of cocaine, hair and urine agreed on 51 positives and 53 negatives; however, hair detected 46 additional positives that urine did not detect and failed to detect 2 urine positives.

For opiates, the results were in agreement on 37 positives and 86 negatives. There was concordance (2 subjects) with the data from cocaine in the number of hair negative urine positives. And 27 opiate abusers were identified by hair analysis, but missed by urinalysis.

Concerning cannabis, urine and hair agreed on 45 positives and 71 negatives. Hair identified 22 additional positives, which urinalysis failed to detect, and urinalysis detected 14 positives which hair failed to detect.

The high number of hair positives and urine negatives for cocaine could be due to the analyses being applied under conditions where a positive result had adverse consequences for the subject (above all in divorce proceedings), thereby encouraging the use of evasive maneuvers. In addition the analyses were previously announced, in the majority of the cases; consequently, drug users could avoid drug consumption for 3–4 days before sampling, thus avoiding a positive result in urine, but not in hair. This assumption was confirmed by the fact that 30 out of the 46 cocaine users that urinalysis missed admitted to drug use during the trial. With respect to opiate and cannabis abusers, the disagreement between hair and urine results was lower, because heroin users undergoing the abstinence syndrome find it quite difficult to stop drug consumption for several days. In the case of cannabis the reason could be attributed to the wider cannabis detection window in urine relative to the other drugs.

The high number of cases for cannabis where urinalysis was more effective than hair analysis could be explained by the fact that cannabis is the most challenging analysis performed in hair, because of the low incorporation rate of THC and THC-COOH in hair [5] (about 2000 times lower than cocaine). Consequently, high sensitivity is required of the method, and, in spite of all, sporadic consumers of cannabis may be missed by hair analysis.

In summary, the data from this table show that hair is considerably more effective than urine in identifying drug addicts, above all, cocaine abusers. Only in the case of cannabis were the results from both samples more balanced. This is due to the fact that cannabis analysis is the most challenging analysis in hair.

Another aim of this study was to determine the influence of the severity of drug consumption on the ability of the urine test to confirm hair positive results.

TABLE IV. INFLUENCE OF THE SEVERITY OF CONSUMPTION IN IDENTIFYING DRUG USE

Drug	Severity index	Concentration [ng/mg]	Number of positives		U+ relative to H+ [%]
			Hair	Urine	
Cocaine	Light	0.5–10	47	14	29.79
	Intermediate	10–20	20	13	65.0
	Heavy	> 20	29	24	82.76
Opiates	Light	0.5–5.0	34	17	50.0
	Intermediate	5.0–15	12	8	66.66
	Heavy	> 15	17	12	70.59
Cannabis	Light	0.04–0.1	5	1	20.0
	Intermediate	0.1–0.4	33	22	66.66
	Heavy	> 0.4	29	22	75.86

The severity of use was established on the basis of the drug concentrations found in hair. For cocaine compounds, the index of severity was based on cocaine concentrations; for opiates, on 6-MAM concentrations; and for cannabis, on THC concentrations. Table IV presents the number of positive cases found in hair and urine in each one of the ranges and the percentages of urine analysis which confirm positive hair analysis. In this way, the light cocaine users were identified by urinalysis with 29.8% efficiency as compared to hair analysis, the intermediate-user group with 65.0% efficiency, and the positive rate of urinalysis increased to 83% in the heavy-user group.

The results obtained for opiates and cannabis follow the same pattern and can be explained in a similar manner.

Figure 1 shows graphically that the efficacy of urinalysis in confirming positive hair analysis results increases with increasing drug levels in hair.

In the light-use category, from 20% to 30% of the positive hair samples were positive when determined by urinalysis, except for opiates, where the percentage was around 50%. As drug use increases, to intermediate and heavy, so does the positive rate of urinalysis, reaching 80% in the heavy-use category.

The explanation for this trend is that heavy drug users have a higher probability than do light users for the 3-day positive detection window of urinalysis to coincide with the urine test.

CONCLUSION

In conclusion, our study demonstrates that both samples, urine and hair, are useful in establishing drug addiction. Nevertheless, hair analysis is able to assess chronic drug consumption, and therefore gives a more real picture of drug use than that provided by

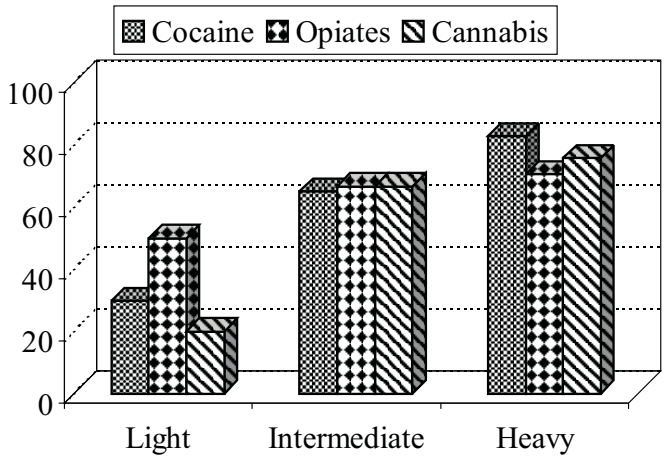

Fig. 1. Influence of the severity of consumption in the ability of urinalysis to confirm hair positive analysis.

standard urinalysis. Not only by confirming positive results, but also by avoiding negative analytical reports due to temporary abstention.

References:

1. Baumgartner W. A., Hill V. A., Hair analysis for organic compounds: methodology, reliability issues and field studies, [in:] Kintz P. [ed.], Drug testing in hair, CRC Press, Boca Ratton 1996, pp. 223–265.
2. Feucht T., Stephens R. C., Walker M. L., Drug use among juvenile arrestees: a comparison of self-report, urinalysis and hair assay, *Journal of Drug Issues* 1994, vol. 24.
3. Mieczkowski T., Barzelay D., Gropper B., Wish E., Concordance of 3 measures of cocaine use in arrestee population: hair, urine and self-report, *Journal of Psychiatric Drugs* 1993, vol. 23, pp. 241–249.

4. Mieczkowski T., Newel R., Comparing hair and urine assays for cocaine and marijuana, *Federal Probation* 1993, vol. 57, pp. 59–67.
5. Nakahara Y., Takahashi K., Kikura R., Hair analysis for drugs of abuse X. Effect of physicochemical properties of drugs on the incorporation rates into hair, *Biological and Pharmaceutical Bulletin* 1995, vol. 18, pp. 1223–1227.
6. Tabernero M. J., Bermejo A. M., Strano-Rossi S., Chiarotti M., Mandatory hair analysis in spain and correlation with urine measure and self-report, International Conference and Workshop Hiar Analysis in Forensic Toxicology, Abu Dhabi, The United Arab Emirates, 19–23 November, 1995.