TECHNICAL NOTE

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Detection of Phencyclidine in Hair

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ABSTRACT: Phencyclidine (PCP) can be detected in human hair with commercially available radioimmunoassay reagents. Hair samples of all subjects admitting PCP use were positive, while thin-layer chromatographic urine analyses were positive in only one of seven cases. Presumably the drug is incorporated into the hair during periods of drug use and then retained in that particular section of the hair for its lifetime. Earlier results in this laboratory in a more detailed study of opiate retention in hair indicated not only that nanogram levels of the drug could be measured in a single strand of hair, but also that sectional analysis of the strand could indicate the time of drug use. The PCP results again suggest that the hair sample could serve as a valuable tool in the determination of drug abuse histories. The sample accessibility and stability and the long-term retention of the drugs in hair exemplify the potential advantages of the hair sample over the body fluid sample.

KEYWORDS: pathology and biology, phencyclidine, hair

The limitations of body fluid analysis for drug screening are obvious. Drugs are often only detectable if a blood or urine sample is obtained within 24 h of intake. A novel approach for the monitoring of drug abuse was demonstrated by our earlier work on radioimmunoassay of hair for the detection of opiate abuse [*1*]. Our results showed that analysis of a single hair can indicate whether a certain drug has been used by the individual and that sectional analysis can provide information regarding the duration of use. Analysis of hair for drugs is not only advantageous for monitoring drug abuse, it is also potentially valuable in connecting an individual to a crime (for example, when a criminal who uses drugs transfers some of his or her hair to a victim).

Our work has now been extended to include phencyclidine (PCP). This drug is becoming of increasing concern to health and law enforcement agencies [*2,3*]. It was previously found that PCP is rapidly cleared from the body fluid but is concentrated in other body tissue, such as in the liver, probably because of the drug's lipophilic nature [*4*]. In this technical note we report results of our limited studies to date, which indicate PCP or its metabolites can be

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detected in small samples of hair obtained from PCP users. These results are quite encouraging but considerably more research is required before our technique can be considered ready for use in court.

Experimental Methods

Sample Collection and Preparation

Hair samples were obtained from admitted PCP users at a drug rehabilitation clinic. Urinanalysis and drug abuse histories were obtained at the time of hair sample collection.

It was necessary to wash the hair sample with a surgical detergent solution to remove external contamination by PCP. No such external contamination was found in our earlier work on heroin. Possibly because PCP is smoked, the hair can adsorb considerable amounts of the drug. From analysis of three sequential washing solutions followed by three water rinses of 1 mL each, it appears that this procedure effectively removes the PCP loosely bound to the outside of the hair (Fig. 1).

The hair is then dried and crushed with mortar and pestle and the drug extracted with methanol. Maximum extraction is achieved when a 1- to 10-mg sample is refluxed in 5 mL methanol for at least 3 h (Fig. 2). The hair is separated from the methanol by means of 20 min ($\sim 2000g$) centrifugation in Pyrex® centrifuge tubes. The methanol is then evaporated, and the residue is redissolved in 1 mL of a 0.1*M* phosphate buffer (pH 7.4).

Drug Assay

The radioimmunoassay (RIA) was carried out with RIA reagents prepared for the development of a commercial kit (Roche Diagnostics, Nutley, N.J.) for PCP analysis [5,6].

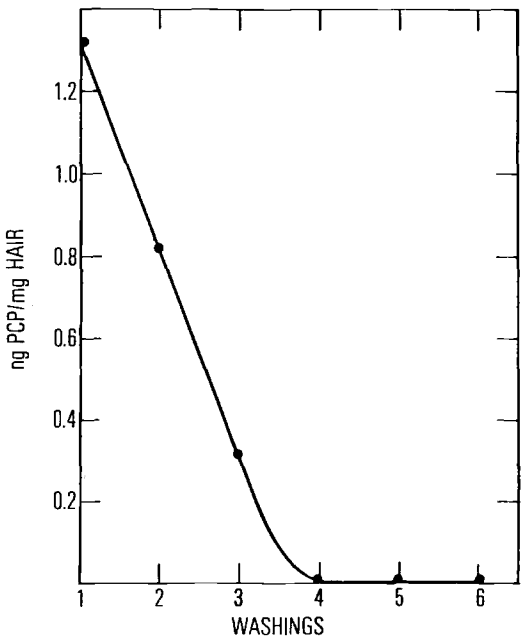

FIG. 1—*Amount of PCP found in successive washings of 1-mg hair sample; mean of data obtained from three samples.*

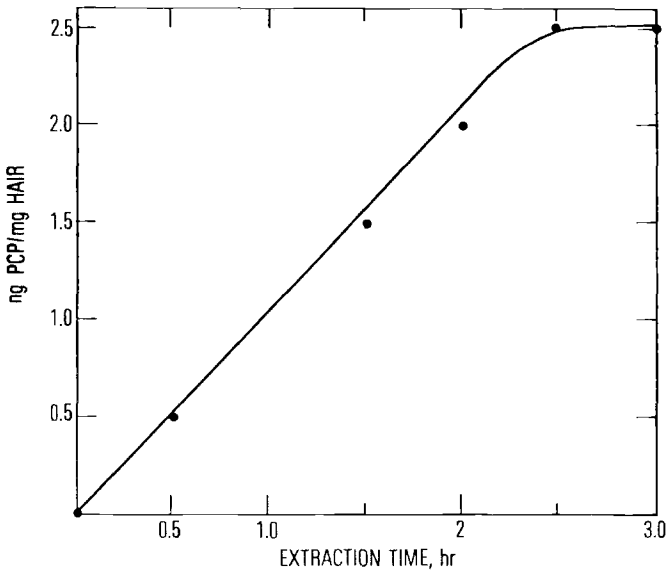

FIG. 2—*Total amount of PCP extracted from 1-mg hair sample after washing versus extraction time; mean of data obtained from three samples.*

This kit was designed for detection of PCP, and its 4-hydroxy derivative is the only reported metabolite with substantial cross-reactivity. One manufacturer claims that "to date, no substance has been found to interfere with this assay by cross-reaction" [*6*]. A calibration curve generated for the kit used in this experiment is shown in Fig. 3. Some modifications of the recommended procedure were necessary in order to adapt it for hair analysis, particularly the use of hair extracts as controls. In this note we refer to the detection of PCP but the reader should interpret that to include the monohydroxy metabolite and PCP analogs.

For the RIA, 0.1 mL extract (equivalent to approximately one human hair) is added to a test tube containing ^{125}I-labeled PCP. At this point antibody is added, and the labeled and unlabeled drug are then allowed to compete for binding sites on PCP antibody. After a 20-min incubation the bound antigen is precipitated with ammonium sulfate and separated by centrifugation, and the free antigen in the supernatant is counted with a gamma counter.

The drug rehabilitation clinic that provided the hair samples routinely collects urine samples that are analyzed by an independent clinical laboratory using a standard thin-layer chromatographic (TLC) procedure [*7*].

Results

All of the data are summarized in Table 1 and Fig. 4. It was possible to detect PCP or its metabolite in hair samples collected from the eight admitted PCP users. Five control samples were all negative. The TLC analysis of the users' urine, as might be expected, was negative whenever the subjects had been drug-free for more than 24 h. When unwashed hair samples are compared to washed ones, the high amounts of the PCP on the exterior of the unwashed hair may be an indication of recent drug use. Further work is required to determine whether PCP traces adsorbed on the outside of the hair are completely removed by this washing procedure; if so, one can clearly distinguish unequivocably between users and individuals who may have been exposed to PCP smoke.

As a possible indication of the sensitivity of the hair assay, an individual who reportedly

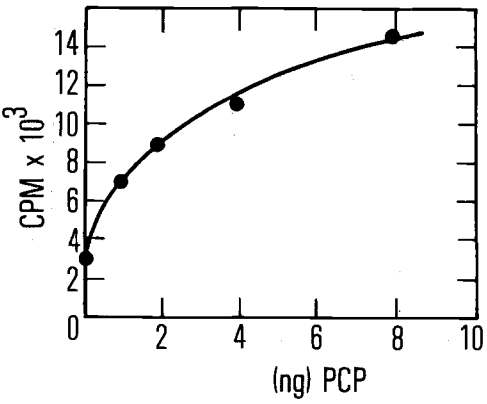

FIG. 3—*Calibration curve: counts per minute versus amount of PCP in nanograms.*

TABLE 1—*Summary of analyses of samples for PCP.*

Sample	Urinanalysis[a] for PCP	PCP History	PCP in Hair			
			Unwashed Sample		Washed Sample	
			Counts per Minute[b]	ng/mg	Counts per Minute[b]	ng/mg
1	−	high use,[c] 2.5 weeks drug-free[d]	12 750	5.0	10 185	2.8
2	−	medium use	12 010	4.3	9 747	2.3
3	not available	medium use	12 280	4.5	9 568	2.2
4	−	medium use, 1 week drug-free	11 055	3.5	9 904	2.5
5	+	medium use, less than 24 h drug-free	11 105	3.5	9 080	1.7
6	−	medium use	13 004	5.2	10 018	2.7
7	−	low use, 4 weeks drug-free	9 924	2.5	9 129	1.7
8	−	very low use, 4 weeks drug-free	5 120[e]	0.3	5 205[e]	0.3

[a]Urinanalyses reported as positive (+) or negative (−).
[b]Average of three 10-min counts.
[c]PCP use: high = 3 years, 10 to 12 "joints"/day; medium = 6 to 30 months; low = 4 months or less; and very low = five "joints" total over period of 6 months.
[d]Period of no drug use prior to sample collection as reported by subjects.
[e]The count per minute for the negative control was 3855.

had smoked only five "joints" over a six-month period (Sample 8 in the table) showed measurable drug concentrations in his hair. No drug was found on the outside of the hair of this occasional user.

Applications and Discussion

This preliminary study again demonstrates the advantage of RIA of hair over the conventional TLC of urine. The commercial RIA kit can easily be adapted for analysis in the 1 to 10

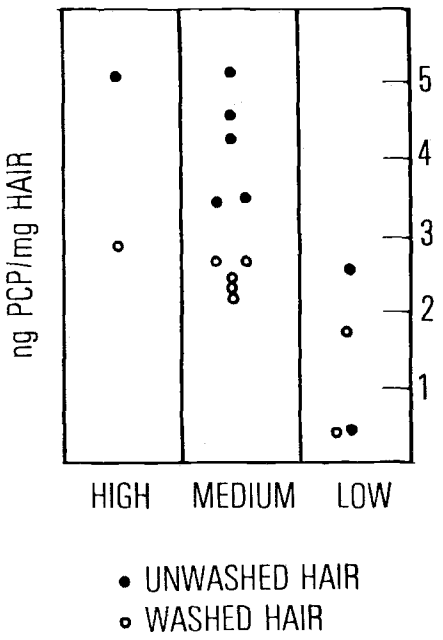

FIG. 4—*Correlation of PCP use with PCP in 1-mg hair samples: high, 3 years, 10 to 12 "joints"/day; medium, 6 to 30 months, 3 to 20 "joints"/week; and low, 4 months or less or total of 5 "joints"/6 months.*

ng/mg range. In the case of the opiates [*1*] and PCP the hair sample retains a record of drug use much longer than urine or serum does. This offers the possibility of obtaining information concerning an individual's use of drugs over a period of several months prior to sample collection. Analogous to our earlier results with the opiates [*1*], there appears to be a correlation between total drug content in whole hair and the extent of drug use (Fig. 4). To date no sectional analysis for PCP has been carried out. In our earlier work, hair was cut into sections representing recent growth (2.5-cm sections close to the scalp) and earlier growth (2.5-cm sections cut 10 to 15 cm from the scalp). This sectional analysis for the opiates made it possible to distinguish clearly among the three groups—long-, medium-, and short-term users—by the concentrations of drug found along the hair.

The ability to screen for drug abuse histories could prove invaluable to law enforcement agencies. It may aid in the identification of suspects through hair found at the scene of a crime. More significant, however, is its application to the detection and monitoring of drug abuse in parolees and prisoners. Current methods necessitate frequent testing because of the rapid clearance of drugs from the body fluids. Hair samples, because of their accessibility, their stability, their ease of handling, and their retention of drug evidence for long periods of time, could become an important complement to current urine and serum analysis.

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