

## Original Articles

# Rapid detection of methamphetamine in human fingernails by liquid–liquid extraction method and one-step methamphetamine test strip

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### ABSTRACT

**Background.** Methamphetamine cannot be detected through conventional urine screening tests or other analytical methods in methamphetamine abusers who have not used the drug for some time. In some instances, detection of methamphetamine in fingernails can be a good alternative. We aimed to determine the sensitivity and specificity of the one-step methamphetamine test strip used in the detection of methamphetamine in urine in the detection of methamphetamine in fingernails.

**Methods.** We took 72 fingernail samples, including 60 samples from methamphetamine abusers and 12 samples as controls from their relatives who had no history of methamphetamine use. The liquid–liquid extraction method was used on fingernail samples, and the resultant solution was tested with one-step methamphetamine test strip. We analysed participants' demographics including age, gender, duration of methamphetamine abuse and strip test results.

**Results.** The mean (SD) age of the participants was 25 (4.33) years. The mean (SD) duration of methamphetamine abuse was 10 (4.5) months. Of the 72 participants, 61 (84.7%) had positive and 11 (15.3%) had negative strip test results. All 60 methamphetamine abusers had positive test results. A positive or negative history of methamphetamine abuse was taken as the gold standard. The sensitivity and specificity of the test was 100% and 91.6%, respectively.

**Conclusion.** Performing liquid–liquid extraction on fingernails and using the strip test for detection of

methamphetamine is a simple, inexpensive, rapid and accessible method, and its high sensitivity and specificity make it appropriate for screening. This method may be preferred over other urine and blood methamphetamine detection methods when the patient has not used the drug for a few days.

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### INTRODUCTION

Opium and cannabis have been used in Iran for nearly 300 years, but the use of new drugs such as heroin, cocaine, tramadol, Ecstasy, Iranian crack, Iranian crystal and methamphetamine has become common in the past few decades.<sup>1</sup> Some drugs in Iran have names similar to those used in the West, but their composition is different. For instance, Iranian crack, which is largely heroin-based, may also contain morphine, codeine, caffeine, noscapine, papaverine, dextromethorphan, acetyl-codeine or corticosteroids. Iranian crystal is heroin and akin to Iranian crack may contain other substances, but no amphetamine or cocaine. Methamphetamine is another commonly used drug in Iran, and its street name is Shisheh.<sup>2–5</sup>

Drug abuse is common in many countries. In legal and administrative cases, immunoassay-based urine screening tests are used, but confirmatory tests are required when these tests are positive, or when there are chances of interaction with medicines or manipulation of samples. However, when a patient has not taken drugs for a few days, the result of any urine or blood test, albeit screening or confirmatory, will be negative.<sup>6–8</sup>

Methamphetamine gets incorporated in the saliva, sweat, hair and fingernails. These samples can, therefore, be used for the extraction of methamphetamine.<sup>9–12</sup> Methamphetamine can be detected in fingernails for 3–6 months after use, but in urine for only 2–3 days after use.<sup>6–8</sup> We aimed to determine the sensitivity and specificity of the one-step methamphetamine test strip in the detection of methamphetamine in fingernails following its extraction by the liquid–liquid extraction (LLE) method.

### METHODS

#### Study population

We included methamphetamine abusers attending the Substance Abuse Treatment Research Center of Arak University of Medical

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Sciences (Shahid Hashemi-Senjani Hospital-Arak). The samples were collected from October to December 2013. We determined a sample size of 72 patients.

The names of patients were drawn from the list of registered methamphetamine abusers. They were then called and the study method was explained to them. Written consent was obtained from those who met the inclusion criteria. Sufficient fingernail samples from the left and right hands (ten digits) were then taken by clipping to satisfy the required sample size (60 patients). Further, fingernail samples were taken from 12 non-users accompanying the patients. Samples were sent for tests to the Arak Forensic Laboratory.

The inclusion criteria were: (i) minimum of twice weekly use of methamphetamine in the past 3 months based on the history and psychological interview; (ii) no acute psychosis according to the history provided by families and psychiatric and psychological interviews; and (iii) no use of nail varnish in the recent week. The exclusion criteria were: (i) nail diseases (such as visible psoriasis, nail lesions, or the presence of chemicals, oil and paint under nails); and (ii) participant's unwillingness to be a part of the study. The duration of participants' methamphetamine abuse was determined through psychological interviews.

#### Preparation of fingernails and extraction stage

Fingernail samples were rinsed in water and ethanol. Samples from each participant were weighed and placed separately in a beaker. Methamphetamine was extracted from fingernail samples using the LLE method. To make acidic pH, 10 ml of hydrochloric acid was added to each beaker. Then, 15 ml of distilled water was added and heated for 20 minutes. Once cooled, the pH of the solution was raised to 8–9.5 with ammonia, and 250 ml of chloroform-isopropanol (80:20 v/v) solution was added. The resultant solution was placed in a shaker for 20 minutes, which turned the solution into organic and aqueous phases. The organic phase was separated with a decanter and placed in a boiling hot bath to evaporate the solvent.

#### Screening test

The screening test was conducted on the resulting evaporated remains of organic phase using the one-step methamphetamine test strip (made in China, Abon Biopharm Co. Ltd). Test results were reported as positive or negative. The cut-off level for methamphetamine test strips was 300 ng/dl (Fig. 1).

#### Statistical analysis

Data were analysed by SPSS software version 13.5 using chi-square, independent *t* and Spearman tests. One-step methamphetamine test strip results were compared with the gold standard (i.e. history, psychiatric examination and psychological

interviews) to determine its sensitivity and specificity. Spearman's rho method was used to assess the correlation of participants' age and duration of drug abuse with test results according to *r* criterion for each participant as follows:  $r \leq 0.5$  indicates absence of a strong linear correlation;  $0.5 < r \leq 0.7$  shows a strong linear correlation and  $0.7 < r \leq 1$  shows a very strong linear correlation.

#### Ethical considerations

Our study was approved by the Ethics Committee (proposal no. 92-156-18) of Arak University of Medical Sciences. The 26 codes of Ethics Committee were observed including obtaining participants' informed consent and taking only non-invasive samples (fingernail samples).

#### RESULTS

Of the 72 participants, 60 (83.3%) had a history of methamphetamine abuse. The mean (SD) age of the participants was 25 (4.33) years. The mean (SD) age of abusers of methamphetamine was 24.9 (4.4) years (18–34 years). Of the 60 participants with a history of methamphetamine abuse, 58 (96.7%) were men and 2 (3.3%) were women. The mean (SD) duration of abuse was 10 (4.5) months. Of the 72 participants, 61 (84.7%) tested positive for methamphetamine, 60 (98.4%) of whom had persistent twice weekly use over the past 2–6 months (chronic users). One participant with no history of methamphetamine abuse had a positive result (false-positive).

We compared this test with the gold standard and found 100% sensitivity, 91.6% specificity, 98.3% positive predictive value and 100% negative predictive value.

No strong linear correlations were found between participants' age and duration of their methamphetamine abuse ( $r=0.412$ ), between age and positive or negative test results ( $r=0.115$ ) and between duration of abuse and test results ( $r=0.151$ ).

#### DISCUSSION

Abuse of stimulants, especially methamphetamine and its derivatives, is a global problem. The prevalence of methamphetamine abuse is high among certain social groups including adolescents.<sup>13,14</sup> The increasing trend of methamphetamine abuse has become one of the most common illicit drug abuses in Iran.<sup>1,3,4</sup> Methamphetamine and its metabolites are incorporated in many biological substances in the body including urine, fingernails, hair, sweat and saliva. It can, therefore, be extracted through various laboratory techniques such as LLE as was done in our study.<sup>9–12,15–17</sup> To the best of our knowledge, the methamphetamine strip test used for urine has not been used for the detection of methamphetamine using LLE on fingernails.

In our study, all chronic abusers had a positive test result as well as one person in the control group who had no history of methamphetamine abuse, but an ambiguous history of use of cold medication and antihistamine compounds. Since methamphetamine is structurally similar to pseudoephedrine, which is its precursor, the positive test result in this case could be attributed to the interaction of cold medications.<sup>18</sup> We found a 100% sensitivity and 91.6% specificity for the strip test. In contrast, in their study of urine samples using simple urine and serial dilution test, Woodworth *et al.* found a sensitivity of 96% and specificity of 90% for this test.<sup>19</sup>

#### Conclusion

The method of extraction of methamphetamine from fingernails using the LLE technique and using the strip test is a simple, rapid,

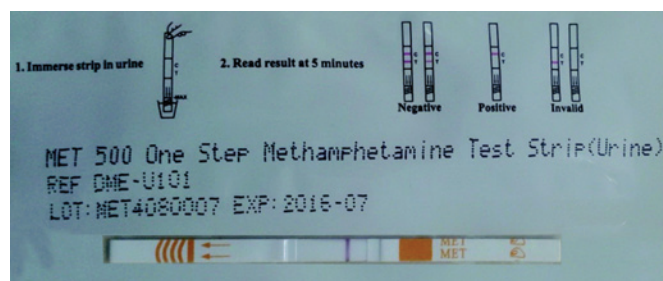


FIG 1. One-step methamphetamine test strip used in the current study

inexpensive, sensitive and specific test for screening potential chronic abusers of methamphetamine. This method can be used in chronic methamphetamine abusers who have not used methamphetamine for a few days and are likely to test negative on the urine screening test.

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*Conflicts of interest.* None declared

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