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Driving under the influence of drugs — evaluation of analytical data of drugs in oral fluid, serum and urine, and correlation with impairment symptoms

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Abstract

A study was performed to acquire urine, serum and oral fluid samples in cases of suspected driving under the influence of drugs of abuse. Oral fluid was collected using a novel sampling/testing device (Dräger DrugTest® System). The aim of the study was to evaluate oral fluid and urine as a predictor of blood samples positive for drugs and impairment symptoms. Analysis for cannabinoids, amphetamine and its derivatives, opiates and cocaine was performed in urine using the Mahsan Kombi/DOA4-test, in serum using immunoassay and gas chromatography–mass spectrometry (GC–MS) confirmation and in oral fluid by GC–MS. Police and medical officer observations of impairment symptoms were rated and evaluated using a threshold value for the classification of driving inability. Accuracy in correlating drug detection in oral fluid and serum were >90% for all substances and also >90% in urine and serum except for THC (71.0%). Of the cases with oral fluid positive for any drug 97.1% of corresponding serum samples were also positive for at least one drug; of drug-positive urine samples this were only 82.4%. In 119 of 146 cases, impairment symptoms above threshold were observed (81.5%). Of the cases with drugs detected in serum, 19.1% appeared not impaired which were the same with drug-positive oral fluid while more persons with drug-positive urine samples appeared uninfluenced (32.7%). The data demonstrate that oral fluid is superior to urine in correlating with serum analytical data and impairment symptoms of drivers under the influence of drugs of abuse.

Keywords: Saliva/oral fluid; Serum; Urine; Driving under the influence; Drugs of abuse; Impairment symptoms

1. Introduction

A wide variety of illicit drugs can be found in blood samples of drivers [1] where cannabis, cocaine, opiates, amphetamine and its derivatives are those with the highest prevalence as shown in the EU-project Rosita (www.rosita.org). An efficient and reliable on-site test for drugs of abuse may enable police officers to identify drivers under the influence of drugs. Roadside urine testing is usually performed but it is time-consuming and has the risk of infections and potential disease transmission. Oral fluid testing has been proposed as an alternative [2] and has shown its usability in roadside studies [3–7]. Results can be obtained within a few minutes and sample contacts can be minimized by special sampling devices. It is assumed that drug detection in oral fluid is based on drug diffusion from blood and/or

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contamination of the oral cavity with drug substance [8] reflecting an actual drug influence [4,9] while urine provides a wider window for drug detection and is not correlated with blood levels. A reliable correlation of pharmacologic effects can only be based on blood/serum concentrations as oral fluid concentrations are elevated shortly after drug-use because of a contamination of the oral cavity [10,11]. In Germany, legal consequences for drivers depend upon the detection of drugs of abuse in blood. Blood sampling and consecutive toxicological analysis is mandatory in all cases where the driver shows signs of drug-use (e.g. blood-shot eyes or a delay in pupil reaction to light) and/or a drugs of abuse screening test is positive. Therefore, the application of easy-to-use roadside tests has gained increasing interest in Germany. The presence of any of the substances amphetamine, 3,4-methylenedioxymethamphetamine (MDMA), 3,4-methylenedioxyethylamphetamine (MDEA), morphine, benzoylecgonine or Δ^9-tetrahydrocannabinol (THC) in blood is prosecuted as an administrative offence (zero tolerance). The detection of any centrally active substance in blood in addition to signs of impairment represents a criminal offence. Administrative offences lead to lower sanctions (driving ban for 1–3 months) than criminal offences (driver's license revocation for at least 6 months). Police officers are advised to start investigation according to a criminal offence in cases where impaired driving or more severe psycho-physical disturbances are observed, e.g. motor dysfunctions, sleepiness, markedly dilated or constricted pupils with no or only weak reactions to light. In these cases, the results of a medical examination provide the primary evidence of the driver fitness [12–14] but with an increasing efficiency of trained police officers their testimony is also regarded as important evidence [15–19].

In the present study, analytical data of serum, oral fluid, and urine drug detection is correlated with impairment symptoms as an extension of previous evaluations [11,20].

2. Experimental

2.1. Study design and biological samples

A pilot study was organized to evaluate the prototype of the new Dräger DrugTest® system. Saarland State Police Officers collected samples of oral fluid in 168 cases of suspected driving under the influence of drugs at actual roadside conditions using the Dräger DrugTest® oral fluid collection device between August and November 2001. Informed consent was obtained from the offenders. The Dräger on-site test was performed preliminarily without further evaluation of the results and the collection device was saved for confirmation analysis using gas chromatography–mass spectrometry (GC–MS). In 131 cases, a urine sample was obtained and a Mahsan-Kombi/DOA4-test (Mahsan Diagnostika, Reinbeck, Germany) was performed on-site for cannabinoids, amphetamine and derivatives, opiates and cocaine–metabolite without a further confirmation analysis. In addition, a blood sample was taken by a physician about 1 h later (0.1–3.0 h, median 0.9 h) which was also submitted for toxicological analysis.

2.2. Analysis of oral fluid and blood samples

Toxicological analysis of blood samples was performed as described elsewhere [20]. After centrifugation of blood, serum was tested using the Bio-Rad CODA system and respective Pyxis 24 Serum Drug Screening tests (Bio-Rad, Munich, Germany). Cut-off values used were 2.0 μg/L for cannabinoids, 10 μg/L for opiates, 10 μg/L for cocaine–metabolite, 20 μg/L for amphetamine and derivatives. Confirmation analysis was performed in positive cases using established GC–MS procedures [20] for the following analytes using the given limits of detection: cocaine (8 μg/L), benzoylecgonine (BZE, 8 μg/L), ecgonine methyl ester (8 μg/L), morphine (MOR, 5 μg/L), 6-acetylmorphine (2 μg/L), dihydrocodeine (2 μg/L), codeine (2 μg/L), methadone (MTDN, 15 μg/L), amphetamine (AMP, 3 μg/L), methamphetamine (MAMP, 5 μg/L), 3,4-methylenedioxymethamphetamine (4 μg/L), 3,4-methylenedioxyamphetamine (2 μg/L), 3,4-methylenedioxyethylamphetamine (1 μg/L), 3,4-methylenedioxy-*N*-methylbutanamine, Δ^9-tetrahydrocannabinol (THC, 0.5 μg/L), 11-hydroxy-THC (0.5 μg/L), 11-nor-9-carboxy-THC (THCA, 1 μg/L). Blood alcohol was assayed using the routine headspace–gas chromatography–flame ionization detection procedure, only values above 0.05 g/L were considered positive.

The analysis of oral fluid samples was performed as described previously [20] consisting essentially of an elution of the DrugTest® collection device with 1 ml of a buffer–methanol mixture of which 0.5 ml were analyzed using mixed-mode solid-phase extraction in two fractions, trimethylsilylation as derivatization and GC–MS in the selected ion monitoring (SIM) mode for the analytes listed above with limits of detection between 5 and 20 μg/L [20]. For quality assurance within analytical series, the successful detection of 50 μg/L AMP, 20 μg/L MAMP, 5.0 μg/L MOR, 2.5 μg/L MTDN and 2.5 μg/L BZE in 0.5 ml of OraSure DOA Oral Negative Control Intercept® (Bethlehem, PA, USA) was used.

2.3. Reports of police observations and medical examination reports

In each case, a report of the police officers on observations of driving performance and impairment symptoms was available. In Table 1, the reported observations and possible choices are given. A report was also available from the medical examination (Table 2) which was performed prior to blood sampling. To enable assessment of an actual impairment the choices of the behavioral criteria tested were rated from 0 (normal) to 3 (strongly impaired). For the evaluation of the ratings of the police officer's observations, a score was