

Time-Course Mass Spectrometry Imaging for Depicting Drug Incorporation into Hair

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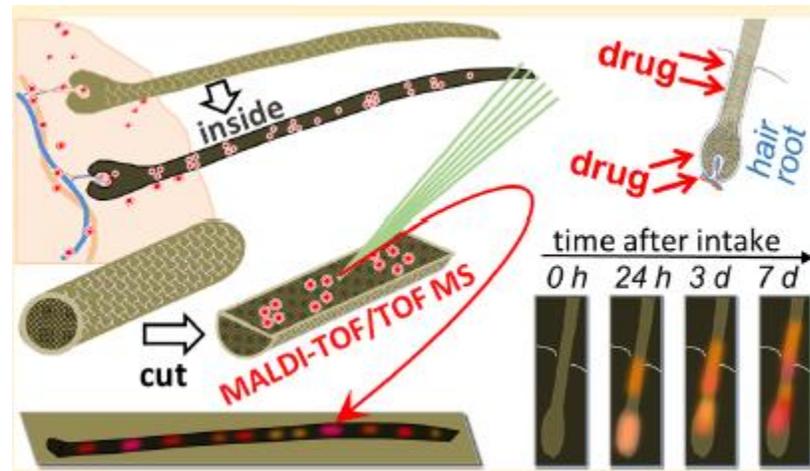
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Anal. Chem., 2015.

(DOI: 10.1021/acs.analchem.5b00971)



A. Suganya, 18 May 2015

Introduction

- Hair – Tape recorder for drug use history.
- Hair drug test recently appeared more frequent in forensic toxicology.

How drug incorporates in hair?

Biosynthetic incorporation of the ingested drug directly from the bloodstream into the hair matrix cells in hair bulbs

contribution of diffusion from skin tissue, sebum, and sweat.

In this paper

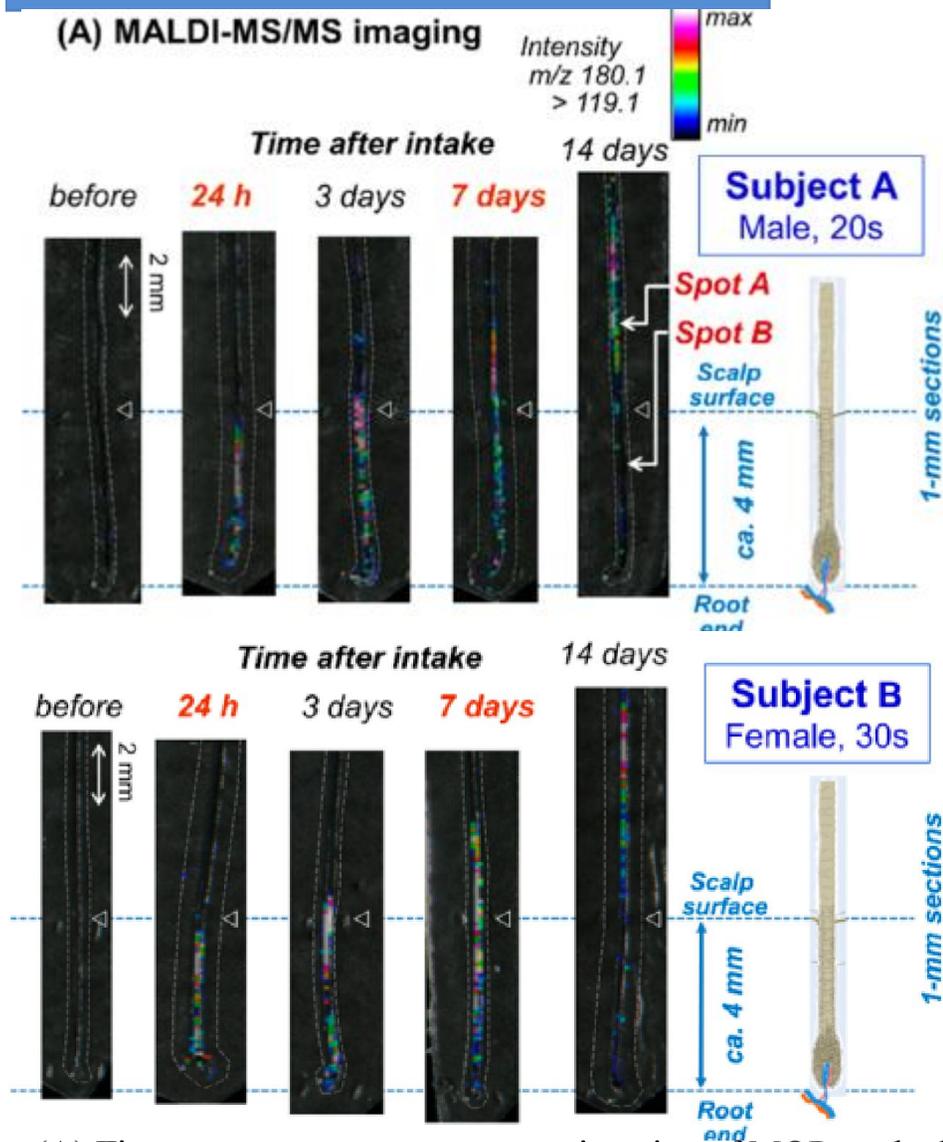
- Study was designed to depict the incorporation of ingested drug into scalp hair by IMS.
- Experiments were performed by selecting MOP, a nonregulated o-methoxy analogue of the potent illicit drug MA, as a model drug.
- MALDI-time-of-flight (TOF) IMS was performed in the TOF/ TOF mode on the longitudinal sections of single scalp hair shafts plucked with the roots intact, at regular time intervals, from five volunteers after a single oral administration of MOP.

Experiment

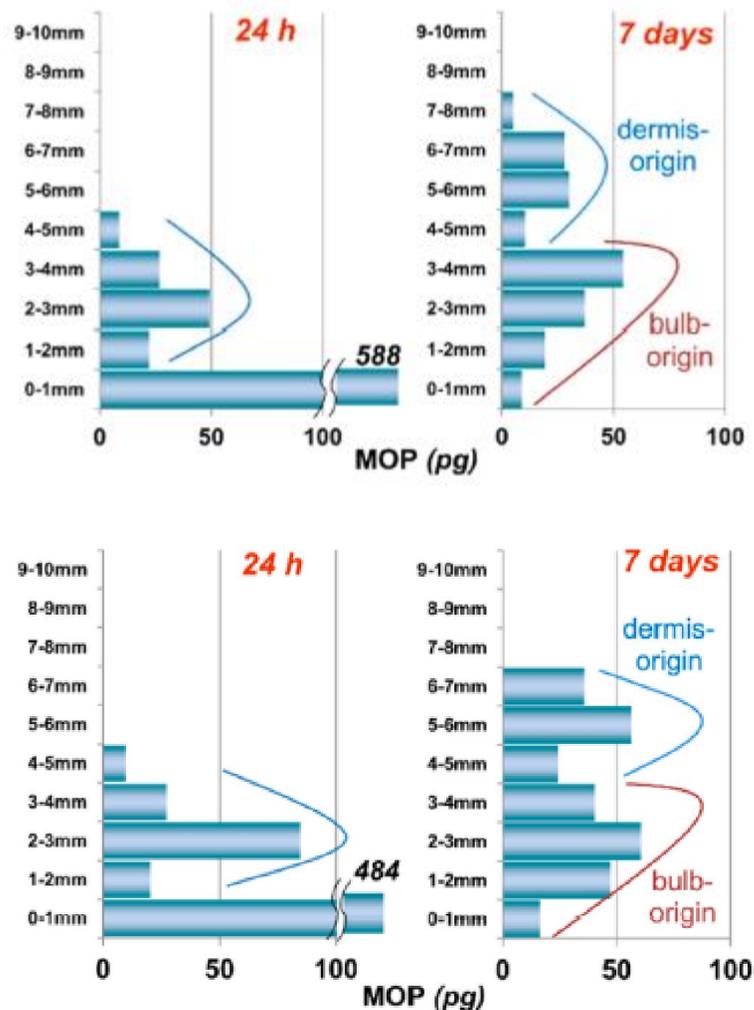


Longitudinal-cutting of a single hair shaft established based on freeze-sectioning.

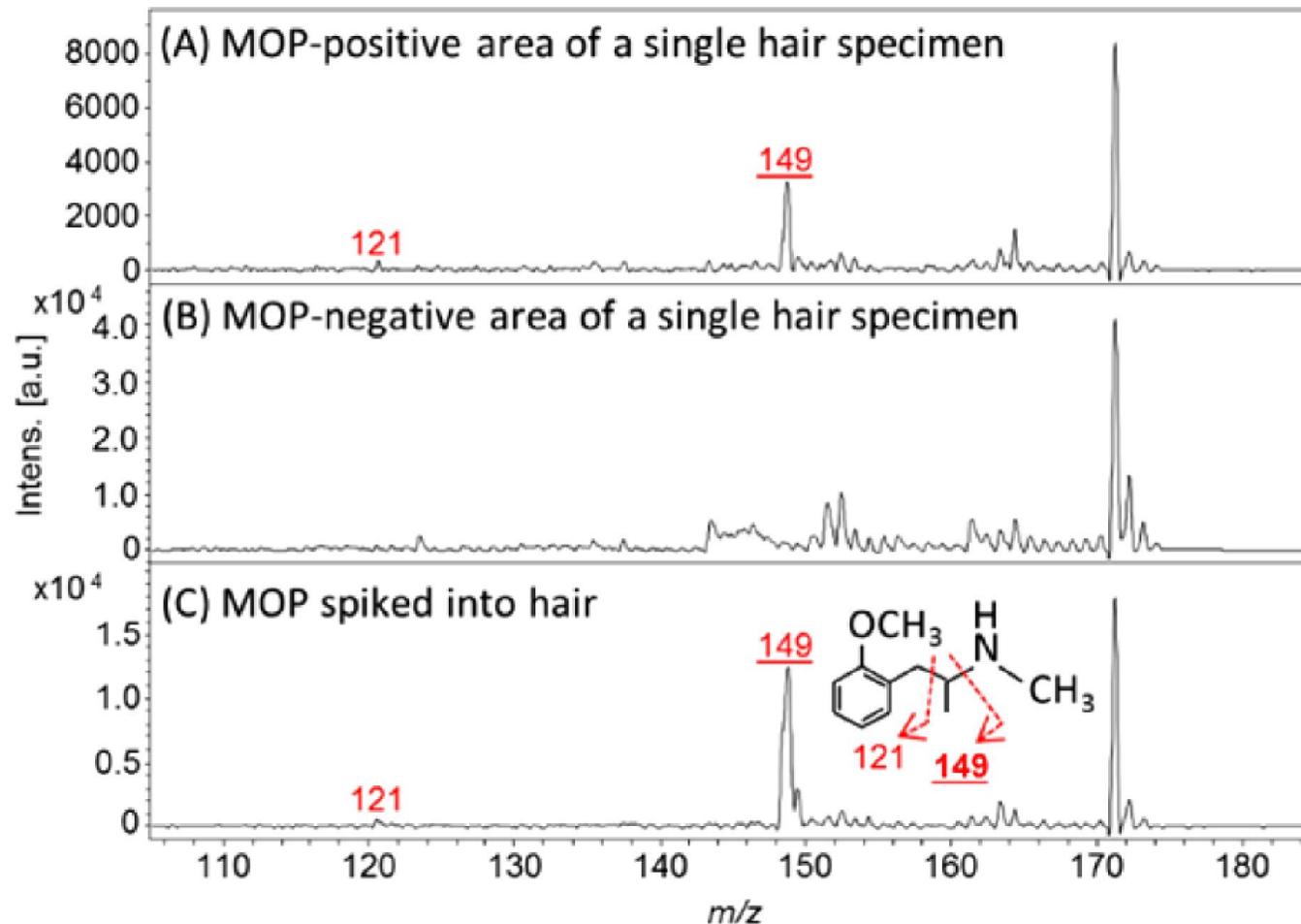
Results and Discussion



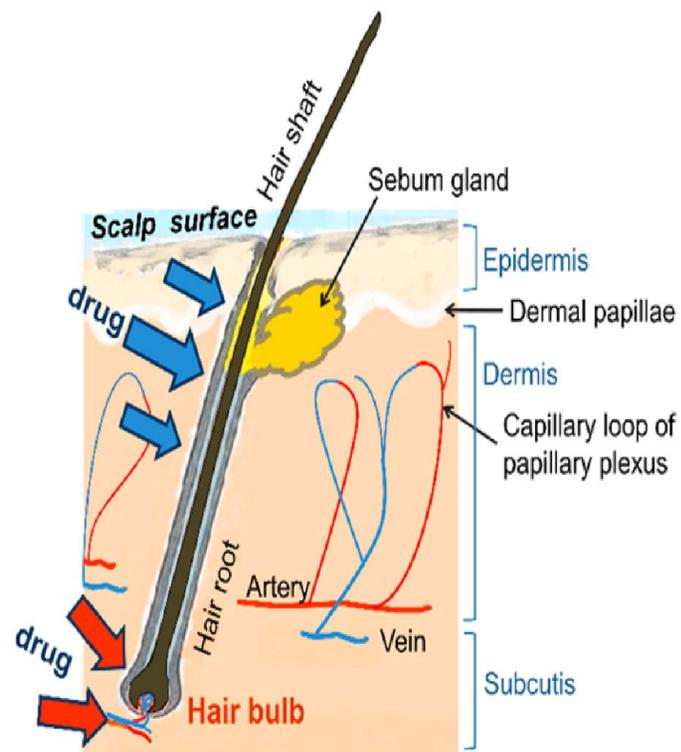
(B) LC-MS/MS determination



(A) Time-course mass spectrometry imaging of MOP on the longitudinal sections of single hair specimens, plucked from subjects A–B who orally ingested a single dose of 50 mg of MOP hydrochloride. Δ indicates the position of the scarp surface. (B) Amount of MOP detected by LC–MS/MS in each 1 mm segment of single hair specimens from subjects A–B, plucked 24 h and 7 days after the single oral dose of 50 mg of MOP hydrochloride.

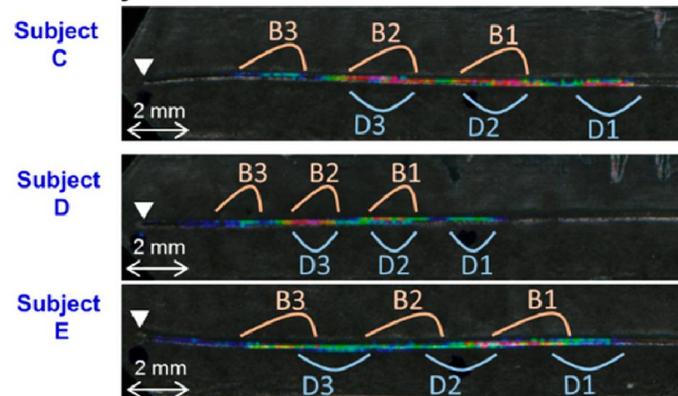


MALDI-TOF MS/MS spectra for identifying MOP incorporated into hair. (A) MOP-positive and (B) MOP-negative areas of a single hair specimen from subject A who took 50 mg of MOP hydrochloride 14 days before sampling. (C) Spiked hair with MOP (found to contain 26 ng/mg hair by the conventional LC-MS/MS procedure). Precursor: m/z 180.1 (protonated MOP).

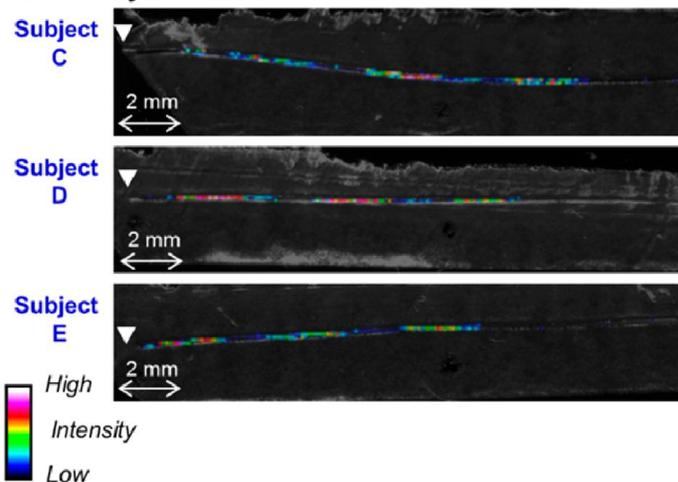


Schematic diagram of a scalp hair shaft indicated with incorporation sites of MOP.

Seven-day intervals x 3



Eleven-day intervals x 3



Localization of MOP on the longitudinal sections of single hair specimens from volunteers C–E who orally ingested 150 mg of MOP hydrochloride/day, on three administration days scheduled at 7- day and 11-day intervals. Specimens were sampled 14 days after the third administration day, by cutting at the level as close as possible to the scarp skin (indicated with ▽). D1 and B1 indicate possible dermis origin and bulb-origin MOP positive areas generated by the ingestion of 150 mg of MOP hydrochloride (within 12 h) on the first day. B2, D2, B3, and D3 indicate those generated by the second and third 150 mg ingestion, respectively, at a 7-day interval between administrations.

Conclusion

- This study demonstrated that MALDI-IMS is a promising tool which allows for the direct detection and visualization of drugs incorporated inside the hair.
- Also, the method established here is useful in obtaining chronological information on drug exposure from a single hair.

Possible work

- Root imaging with the nanoparticle effect in time study.