Fast profiling of sphingolipids alteration in hypertension by MRMS

Hypertension is characterized by endothelial dysfunction and vascular remodeling. Since lipids, and especially sphingolipids have been implicated in vascular tone and function, in this contribution we investigated the differences in plasma sphingolipids among hypertensive and normotensive patients by means of a fast and high-resolution magnetic resonance mass spectrometry (MRMS) approach using direct infusion electrospray (DI).

Keywords: MRMS, lipidomics, hypertension, sphingolipids, solariX

Authors: Eduardo Sommella[1], Fabrizio Merciai[1], Paola Di Pietro[1], Matthias Witt[2], Pietro Campiglia[1];
[1] Università degli Studi di Salerno, Fisciano, Campania, Italy; [2] Bruker Daltonik GmbH, Bremen, Germany

Introduction

Hypertension is one of the major worldwide causes of death. Although the precise cause-effect relationship is controversial, many studies have proposed that endothelial dysfunction may contribute to emergence of hypertension [1]. Sphingolipids are involved in the regulation of both vascular growth and vascular tone. Several reports have shown that in hypertension, essentially sphingolipids levels are altered. The profiling of sphingolipids is usually carried out by liquid chromatography coupled to tandem mass spectrometry (LC-MS/MS). As an alternative to LC-MS/MS, which suffers from long analysis time and lack of reproducibility due to retention time drift, direct infusion magnetic resonance mass spectrometry (DI-MRMS) provides short analysis time for sample screening including high mass accuracy as well as isotopic fine structure for metabolite identification, allowing analysis without the front-end separation step and derivatization. This MRMS workflow maximizes high throughput in metabolic profiling. In this study sphingolipid levels among healthy and hypertensive patients were investigated using DI-MRMS.

Methods

Extraction

Twenty-four patients with hypertension (defined as DBP ≥90 mmHg and/or SBP ≥140 mm Hg or on the basis of use of anti-hypertensive medication) and 9 healthy donor control subjects (non-smokers and non-diabetic) without previous cardiovascular events and not on statin therapy, belonging to the Campania Salute Network Registry, were studied. The database generation of the Campania Salute Network was approved by the Federico II University Hospital Ethic Committee. Signed informed consent was obtained from all the participants to use data for scientific purposes. Plasma samples were thawed and extracted with methanol (MeOH) and methyl-tert-butyl ether (MTBE). Briefly, 225 μL of MeOH was added to 20 μL of plasma and the mixture was vortexed for 10 seconds. Then 750 μL of MTBE was added and the obtained solution was incubated at 300 rpm for six minutes at 4°C. Afterwards, 188 μL of H_2O was added to induce phase separation and the mixture was vortexed for 20 seconds. After centrifuging for five minutes at 14,680 rpm, 650 μL of the upper organic phase was transferred into a new vial and dried. For mass spectrometric analysis, the sample (organic phase) was solubilized in 200 μL of 5 mM ammonium acetate 90%MeOH/DCM (2:1 v/v).

MS analysis

Analyses were performed by direct infusion using electrospray ionization following a previous protocol using flow injection with 250 μL syringe at a flow rate of 2 μL/min. Data were acquired on a solariX XR 7T (Bruker Daltonik GmbH, Bremen, Germany). The instrument was tuned and calibrated with a standard solution of NaTFA (0.1 mg/mL in 50% acetonitrile). Mass spectra were acquired

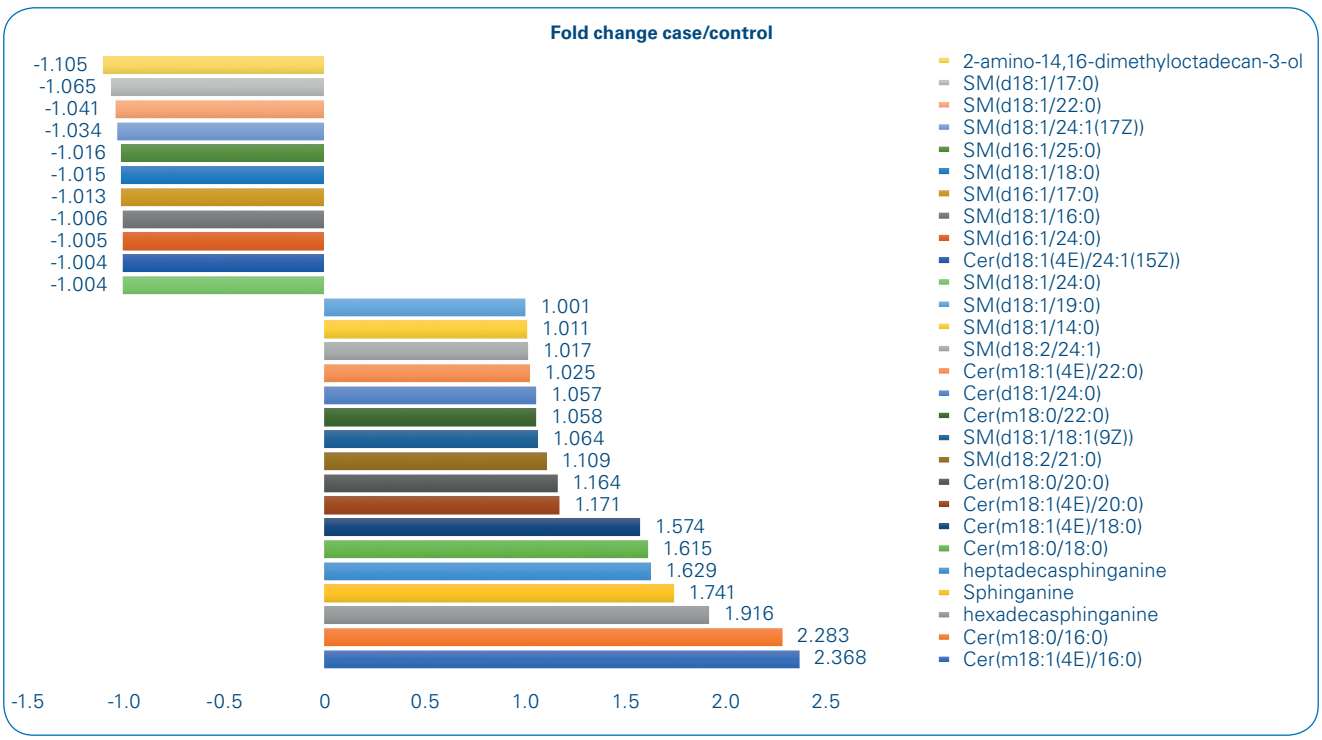

Figure 1: Ceramides as well as sphinganine levels are increased in hypertensive patients

in broadband mode in the range 100-1200 *m/z* with an ion accumulation time of 10 ms. 32 single scans were added for the final mass spectrum using 2 million data points (2M). Nebulizing gas pressure was set to 1 bar. Drying gas pressure was set to 4 L/min at a temperature of 200°C. Both positive and negative ionization modes were employed. Five measurement replicates of each sample were performed.

Data processing

Peak alignment and putative annotation of compounds based on accurate MS measurements was performed in MetaboScape 4.0 (Bruker Daltonik GmbH, Bremen, Germany). LipidMAPS was used as the analyte list for compound identification. Comparisons and differences of samples and patient groups were analyzed by two-way Anova test and Bonferroni post tests analysis for statistical significance.

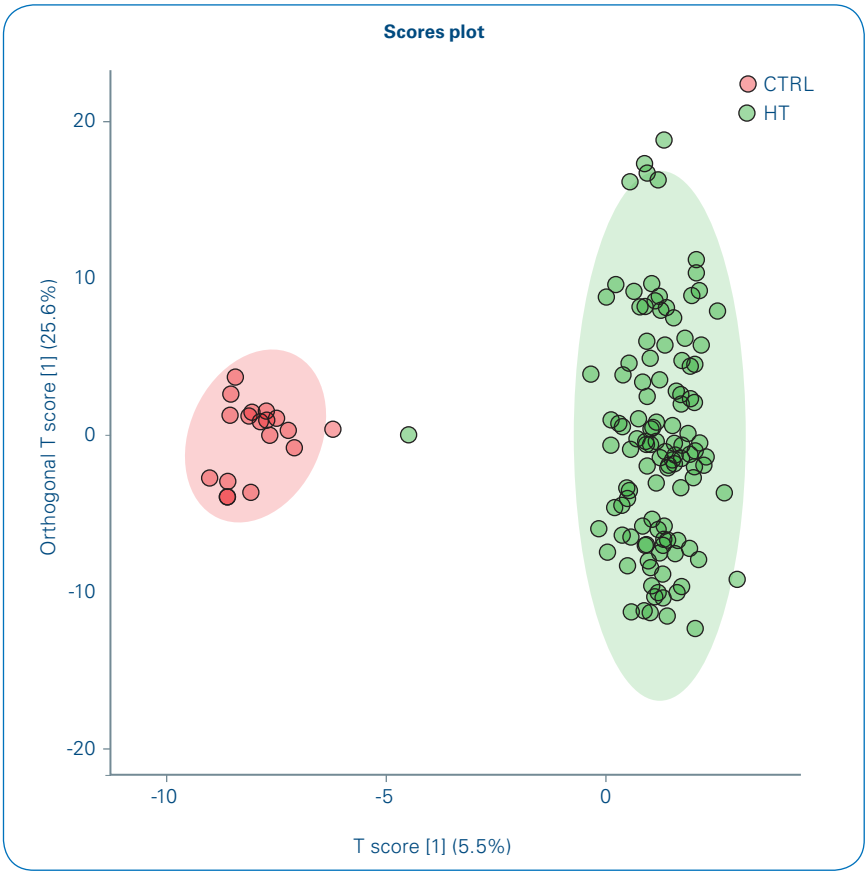

Figure 2: PLS-DA statistical plot (red: control, green: hypertensive)

Results

Total lipid extracts from 33 human plasma samples were analysed in this study. The analysis of plasma lipid extracts showed a very complex profile. Roughly 200 lipids (considering both positive and negative ionization) were putatively annotated, with very good mass accuracy (average error ≤ 0.1 ppm) and detected lipids belonging to different classes. Among them, as shown in Figure 1, different sphingolipids showed alteration between healthy and hypertensive subjects (patients). This is shown in Figure 1 reporting the fold change of mainly sphingolipids. Both groups, healthy and hypertensive, could be clearly separated in the statistic plot shown in Figure 2. In particular the ceramide level, especially medium-length ceramides such as Cer (18:1(4E)/16:0) showed an increase of hypertensive patients. This data is supported by a growing number of publications of hypertensive studies [2].

Acknowledgements

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Conclusion

- DI-MRMS is a fast and reliable method for sphingolipids profiling.
- Several sphingolipids levels alter by hypertensive disease when comparing the healthy patients. In particular these are ceramides with medium length.
- This data further highlights the role of ceramides associated to endothelium dysfunction.

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References

[1] Oscar A. Carretero OA, Oparil S (2000). *Essential Hypertension Part I: Definition and Etiology,* Originally published 25 Jan 2000 https://doi.org/10.1161/01.CIR.101.3.329 Circulation. **101**:329–335

[2] Meeusen JW, Donato LJ, Bryant SC, Baudhuin LM, Berger PB, Jaffe AS (2018). *Plasma Ceramides A Novel Predictor of Major Adverse Cardiovascular Events After Coronary Angiography,* Originally published 14 Jun 2018 https://doi.org/10.1161/ATVBAHA.118.311199 Arteriosclerosis, Thrombosis, and Vascular Biology. **38**:1933–1939

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Bruker Daltonik GmbH

Bremen · Germany
Phone +49 (0)421-2205-0

Bruker Scientific LLC

Billerica, MA · USA
Phone +1 (978) 663-3660

ms.sales.bdal@bruker.com – www.bruker.com