1H-MR-Spectroscopy of swine brain to investigate postmortem decomposition processes

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Purpose

^{1}H-MRS offers the possibility to evaluate non-invasively metabolic changes caused by postmortem decomposition processes in the brain. Compared to conventional indicators, like rigor mortis or livor mortis, metabolic changes take place during a relatively long period of time and may potentially be used to estimate the postmortem interval (PMI) more precisely in forensic autopsy examinations. The aim of this study was to investigate which decomposition products are observed in the postmortem brain and at which PMI new metabolites appear in ^{1}H spectra or other metabolites disappear due to degradation.

Methods and Materials

The heads of five young pigs (age: 8-9 weeks, weight: ca. 30 kg) were investigated with ^{1}H-MRS in a clinical whole body scanner (1.5 T). Immediately after decapitation the spinal canal was closed by a plug to prevent bacterial contamination of the brain. The heads were shrink-wrapped in synthetic foil with built-in ventilation and stored at room temperature (ca. 20°C). ^{1}H-MRS measurements were performed over a range of one to three weeks by using two different single volume selection sequences with different echo times (STEAM/TE = 10 ms; PRESS/TE = 135ms). The conventional transmit/receive quadrature head coil was used for spectroscopic and imaging measurements (TR = 1,5 s). The voxel position was controlled by T1-weighted images in all three orientations. Measurements started with a typical voxel size of 6 ml. Due to the decreasing field homogeneity over the time course of the experiments voxel size was reduced up to 3 ml and the numbers of averages increased. Depending on the scanner availability measurements were repeated in intervals of 8 to 24 h.

Results

In 2 of 5 cases measurements could be performed over the complete range of 3 weeks. Air bubbles were observed in the MR images already at a PMI of 5 - 7 days. Depending on the field inhomogeneity the investigation had then to be terminated. The spectra in Fig. 1 demonstrate metabolic changes during the first 2 weeks. New peaks with increasing intensity at 1.9, (metabolite 3) 2.4 (metabolite 5) and 2.9 ppm (metabolite 6), respectively, appeared during the first 5 days and were clearly identified. The decreasing intensity of metabolites which are typically observed in the healthy brain spectra, like N-acetylaspartate (NAA) Creatine (Cr) and choline (Cho), indicates degradation of this metabolites (Tab. 1).

Conclusions

The new signals at 1,9, 2,4 and 2,9 ppm were assigned to acetate (Ac), succinate (Suc) and free trimethylammonium (fTMA). Acetate and succinate are frequently observed in abscesses and necrotic tissues [1-2]. The signal at 2,9 ppm was also observed in postmortem measurements of sheep brain by Ith et al. [3] and identified as fTMA by using 2D HMBC (heteronuclear multiple-bond connectivity) experiments. Time points of appearance and disappearance of spectral resonances (Tab.1) as well as their quantitative changes may be used to estimate the range of PMI if the results are reproducible. However, the scatter of individual variances has still to be determined by further investigations.

Tab. 1

Postmortem intervals at which peaks of these resonances were observed.

Metabolite	PMI	Metabolite	PMI
Lac	between 0 and 160h	Suc	from 100 - 150h
Ala	between 0 and 500h	FTMA	from 100 - 150h
Ac	from 60h	Cr	between 0 and 180h
NAA	between 0 and 135h	TMA	between 0 and 180h

References

[1] Grand S *et al*. Radiology 213:785-793, 1999

[2] Ping H *et al*. ANJR 32:1369-1377, 2002

[3] Ith M *et al*. Magn Res Med 48:915-929, 2002

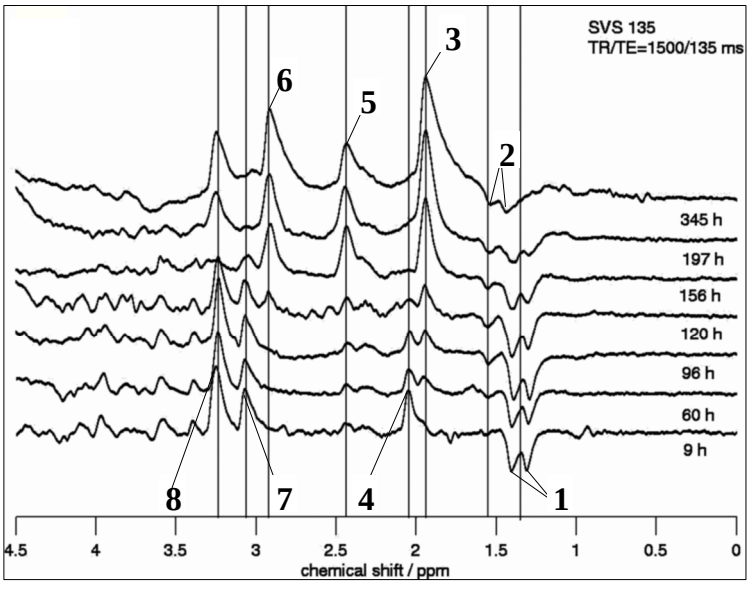

Fig. 1:

^{1}H spectra (TR/TE=1500/135ms) of swine brain during the first 2 weeks pm. The resonances were assigned to lactate (1), alanine (2), acetate (3), N-acetyl-aspartate (4), succinate (5), free trimethylammonium (6), creatine (7) and choline (8).