In vivo localized ^{1}H MR spectroscopy of the rat testis; Usefulness of lipid suppression technique by inversion pulse (STIR-STEAM)

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Introduction Although the usefulness of ^{31}P MR spectroscopy (MRS) for evaluating testicular function has previously been reported (1, 2), ^{1}H MRS was thought to be less informative. In-vivo ^{1}H MRS of the human testis at 1.5T demonstrated only limited number of metabolite resonances, because of heavy contamination with lipid resonances from inside and outside of the testis (3). If these lipid resonances were eliminated, more metabolite resonances could be observed. In this study, in vivo ^{1}H MRS at 4.7T was exploited for the evaluation of the metabolic status in normal and ischemic rat testes. Short TI inversion-recovery (STIR) was successfully utilized at STEAM sequence to suppress lipid resonances.

Materials and Methods All the measurements were performed on Varian (INOVA) spectorometer with a 4.7T magnet (JASTEC). A home built sine coil with 50 mm in diameter was used for the measurements. Male Wistar rats (250-500g) were anesthetized with 1% halothane in a gas mixture of O_2 / N_2O 1:1. Localized ^{1}H MR spectra were obtained by a STEAM sequence (TR /TM /TE = 5000-6000/30/2-272msec, VOI = 125-343mm^3, number of accumulation = 128-1024). For determination of the T_1 values of each peak, series of ^{1}H MR spectra with varying inversion-recovery times (TIR, 140-5400ms) were obtained (n=8). To suppress lipid signals, an inversion pulse was applied with STEAM sequence. The nulling time of lipid after the inversion pulse was set according to the acquired T_1 values. ^{1}H MR spectra were measured at various echo times (15,136, and 272 msec) in the normal and ischemic testis (n=3) to observe the TE dependence of resonances, such as T_2 decay and J-modulation. In the ischemic testis, the left spermatic cord including testicular artery and veins was ligated at the inguinal area on the left. ^{1}H MRS was measured 4-10 hours after the manipulation.

Results and Discussions Without an inversion pulse, the entire spectrum was contaminated with large lipid resonances. The lipid resonances were dramatically suppressed with an inversion pulse followed by an adequate duration (TIR = 320msec) before STEAM (STIR-STEAM). As a result, resonances from metabolites became clearly detected in the normal and ischemic testis (Fig.1 and 2). Intensity of resonances at 3.03, 3.21, 3.56, and 3.92ppm decreased exponentially dependent on TE without a modulation. Based on the chemical shift values, they were assigned to creatine [N (CH_3)], choline [N (CH_3)], glycine (C2-H_2), and creatine (C2-H_2), respectively (4,5). On the other hand, resonances at 2.09, 2.35, and 3.76ppm exhibited a J-modulation around 7 Hz. They were assigned to glutamate C3-H_3, C4-H_2, and C2-H, respectively. In the ischemic testis (Fig.2), C3-H_3 of lactate was clearly observed at 1.3ppm with TE = 15ms (Fig.2a) and TE = 272ms (Fig.2c). With TE = 136ms (1/J), only a small inverted signal was evolved from the zero quantum coherence (Fig.2b). To our knowledge, in vivo detection and assignment of resonances from glutamate, glycine, and lactate has not been done previously in the rat testis.

Conclusion High resolution ^{1}H MR spectrum of the rat testis was obtained to show resonances from creatine, choline, glycine, glutamate, and lactate. Suppression of lipid resonances is critical for detecting glutamate and lactate. STIR-STEAM ^{1}H MRS is considered to be a promising tool for evaluating testicular metabolic status in vivo.

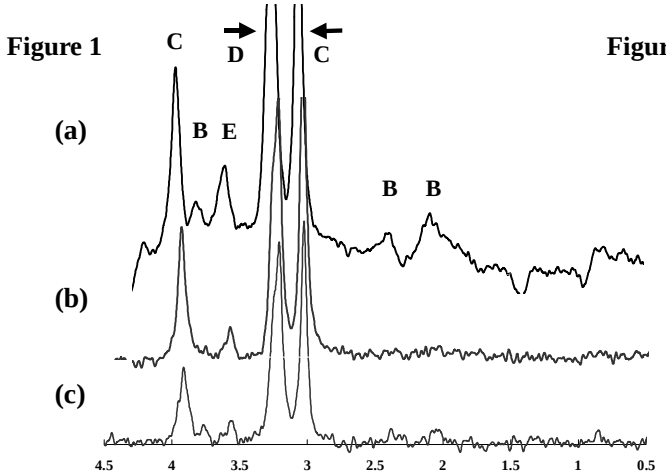

Figure 1 shows ^{1}H MR spectrum of the normal rat testis obtained by STIR-STEAM (TR/TM = 5000/30msec, TIR = 320ms, number of accumulation=1024, VOI=250 mm^3). Echo times (TE) are 15ms in (a), 136ms in (b), and 272ms in (c), respectively. Assignment of peaks; (B) glutamate (2.09ppm, 2.35ppm, 3.76ppm), (C) creatine (3.03,3.92ppm); (D) choline (3.21ppm); (E) glycine (3.56ppm).

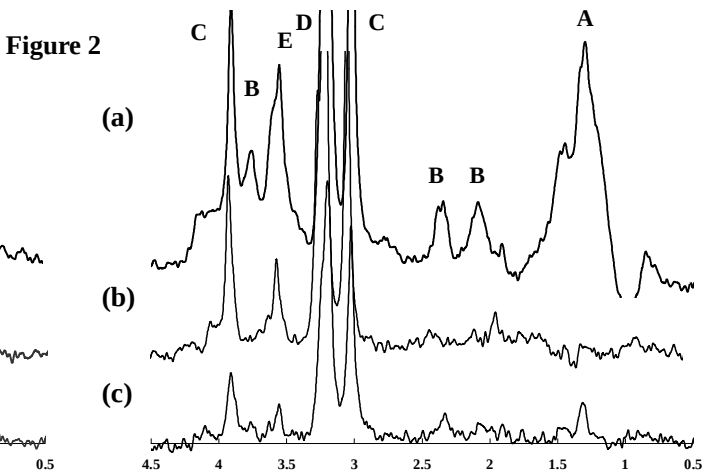

Figure 2 shows ^{1}H MR spectrum of the ischemic rat testis obtained by the same sequence and parameters as Fig. 1. C3-H_3 of lactate (A) was clearly observed at 1.3ppm at TE = 15ms (a), and TE = 272ms (c). At TE = 136ms (1/J), only a small inverted signal was evolved from the zero quantum coherence (b).

References

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