# Measurements of Taurine Distribution in Human Calf Muscle by 1H 2D-CSI at 7 Tesla

**J. Ren[1,2], I. Dimitrov[1,3], A. D. Sherry[1,4], and C. Malloy[1,5]**

[1]Advanced Imaging Research Center, University of Texas Southwestern Medical Center, Dallas, Texas, United States, [2]Department of Radiology, University of Texas Southwestern Medical Cente, Dallas, Texas, United States, [3]Philips Medical Systems, Cleveland, Ohio, United States, [4]Department of Chemistry, University of Texas at Dallas, Richardson, Texas, United States, [5]VA North Texas Health Care System, Dallas, Texas, United States

## Introduction

Taurine ($^{+}H_3N$-$CH_2$-$CH_2$-$SO_3^-$) is the most abundant free amino acid in most mammalian tissues with intracellular concentration of 20-70 mmol/kg in heart and skeletal muscle (1,2). Taurine plays a role in a numerous physiological processes such as cell volume homeostasis, antioxidant defense, protein stabilization, stress response, detoxification and intracellular $Ca^{2+}$ homeostasis. In muscle cells, a high concentration of taurine is associated with the excitation-contraction coupling mechanism of muscle fibers (3). A taurine deficiency in mice results in loss of skeletal muscle function and total exercise capacity (4). To explore the role of taurine in human skeletal muscle, it is important to establish the normal levels of taurine in different muscles. Here, we present a $^1$H 2D chemical-shift spectroscopic imaging (2D-CSI) study of human calf muscle at 7T, with focus on analysis of the distribution of taurine across the different muscles.

## Methods

The protocol was approved by our Institutional IRB. The study was done on 20 healthy volunteers using a 7T Philips Achieva 90-cm bore scanner. Axial T2w images of calf muscle were collected for localization. Water-suppressed, single-voxel STEAM and 2D CSI spectra were acquired using a quadrature surface coil. Typical acquisition parameters: BW 4 kHz, number of data points: 4 k, NSA = 256, TR = 2 s, TE = 20 ms, and matrix size 15x15 for 2DCSI. Spectral fitting was done in Matlab and verified with ACD software (Advanced Chemistry Development, Inc.).

## Results and Discussion

**A typical** T2w image of the calf muscle of a male volunteer at 7T is shown in Fig.1(left). Major muscle groups include: Gastrocnemius medial and lateral heads (GA(M)) and (GA(L)), Soleus (SO), Flexor hallicus (FH), Tibialis posterior (TP), Popliteus (PO), Flexor digitorum (FD), Peroneus longus and brevis (PL) (Right) Single-voxel $^1$H MRS of SO (1 $mL^3$) at short and long TEs. Figure 1(right) shows taurine spectra in soleus muscle, with two clusters of signals appearing between $CH_2$ and $CH_3$ of Cr/PCr (Show the ppm scale under the figure). Its upfield signal (~3.3ppm) is partially overlapped with trimethylamino (TMA) (3.25ppm) resonances of other metabolites, but the downfield signal at 3.4ppm is well-resolved and has comparable intensity to Cr/PCr-$CH_2$ at 4 ppm. The 3.4ppm signal has an exponential decay dependence on TE (data not shown), with $T_2$ value of 90.9 ms, slightly longer than that of Cr/PCr-$CH_2$ (74.1 ms) determined under same condition. Figure 2 shows the heterogeneous distribution of taurine in human calf muscle. A high level of taurine (~15-25 mM) was found in SO and GA muscles, but below detection limits in the FH and TP muscles. This is in contrast to the levels of Cr/PCr and TMA resonances in these same muscles. Such a sharp contrast may be related to particular role of taurine in SO and GA muscles. Further studies are underway.

## Conclusion

The 7T $^1$H MRS data indicate significant heterogeneity in taurine distribution in calf muscle cross-sectional plane, with high content in SO and GA, but below detection limit in FH and TP, an observation to be further explored.

## References

1) Huxtable, RJ, *Physiol. Rev.* 1992: 72, 101-163.
2) Chapman, RA, *et al.*, *Cardiovas Res.* 1993: 27, 358-363.
3) De Luca, A, *et al.*, *Adv. Exp. Med. Biol.* 2000:483, 45-56.
4) Warskulat, U, *et al.*, *The FASEB J.* Jan20, 2004.

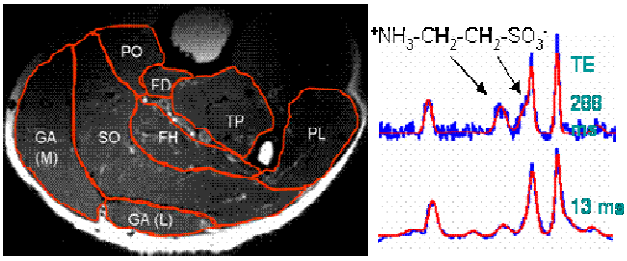


Figure 1. (Right) T2W image showing different muscle groups within the calf. (Left) Taurine spectra from the soleus at two different TEs. The red traces showing the result of spectral fitting

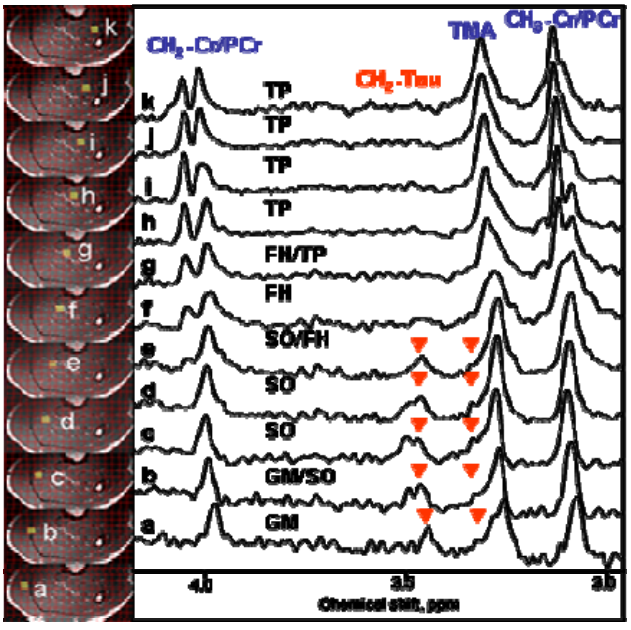


**Figure 2** 7T $^1$H 2D CSI spectra from 10 selected voxels (a-k) across various muscles in a single plane through the calf of a healthy volunteer. The taurine-$CH_2$ signals are marked as triangles.