Fat assessment in shoulder muscle: A comparison between spectroscopic and imaging techniques.

Gaëlle Diserens[1], Helen Anwander[2], Fabian Fuhrer[2], Chris Boesch[1], Mattias A Zumstein[2], and Peter Vermathen[1]
[1]*Depts. Radiology and Clinical Research, University Bern, Bern, Switzerland,* [2]*Dept. of Orthopaedic Surgery and Traumatology, University Bern, Bern, Switzerland*

PURPOSE

The tissue content of fat can be quantified by MR methods, like Dixon MRI and by MR spectroscopy methods. Imaging methods benefit from much higher spatial resolution, while spectroscopy methods may separate fat and water more reliably and can take more easily into account the complexity of lipid spectra. Dixon and spectroscopy comparisons have been the subject of several studies in different organs, such as in liver[1], and in back muscle with high amount of fat[2], and low fat content[3]. It has been shown that Dixon and Spectroscopy data do not correlate for low amounts of lipid in back muscle (psoas major)[3]. The aim of this study is to compare Dixon imaging and single voxel spectroscopy (SVS) for low fat content in muscles not prone to motion, as shoulder muscles (*infraspinatus* and *supraspinatus*), as part of a clinical study investigating rotator cuffs with a tear.

METHODS

Volunteers: Right and left shoulder muscles (*infraspinatus, supraspinatus*) of 15 patients (5 female, 10 male, age =51±8y, BMI=27±5 kg/m^2) were examined on two 3T MR-scanner (Trio and Verio, Siemens, Erlangen, Germany). **MR-Method:** A standard two-point DIXON sequence was used for fat-water imaging on both *supra-* and *infraspinatus* muscles simultaneously, with TR = 7ms, TE = 2.5/3.7 ms, FOV = 197×204mm^2, Voxel Size = 0.8×0.8×1 mm^3. SVS was acquired with 2 averages (TR = 2020ms, TE = 30ms) without water-suppression, with a size of 12x12x12 mm^3 for *supraspinatus* and 20x20x12 mm^3 for *infraspinatus* muscle. The SVS voxel was carefully placed in a region with low muscle fat content, based on Dixon lipid images, to avoid varying amounts of bulk lipids (Fig.1). **Data analysis:** Water and lipid peaks of the SVS spectra were fitted using jMRUI. Muscles were segmented and whole muscle fat content calculated from the Dixon data using an in house developed program for DICOM image segmentation, iSix (Image Segmentation in OsiriX)[4]. Correlations were used to compare results from SVS and Dixon.

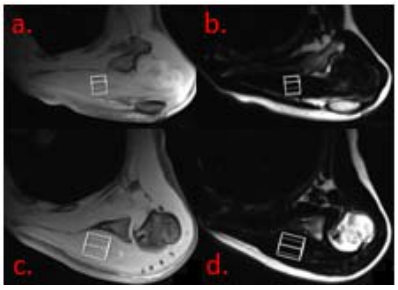

Fig. 1: Dixon images of shoulder muscles with SVS positions indicated. Images of m. supra-spinatus: a) H_2O, b) Fat image; Images of m. infraspinatus: c) H_2O, d) Fat image.

RESULTS

The fat content determined from Dixon MRI in m. *supraspinatus* and m. *infraspinatus* was 5.9±2.1% and 5.1±1.7%, respectively. When determined from SVS, the fat content was lower and was in m. *supraspinatus* and m. *infraspinatus* 2.6±2.0% and 2.9±1.8%, respectively. Fat contents estimated from Dixon MRI were significantly correlated with those from SVS in both muscles (Fig.2, p=0.0014). The fat content was significantly correlated between right and left shoulder (Fig. 3a,b) and between m. *supraspinatus* and m. *infraspinatus* (Fig. 3c,d) for both determination methods, i.e. by Dixon MRI and by SVS. The correlation coefficients were higher for Dixon MRI derived fat contents.

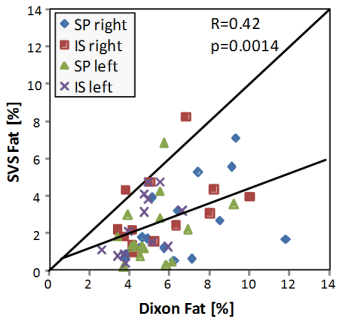

Fig.2: Correlation between the fat content determined by Dixon MRI versus that determined by SVS. SP: m. *supraspinatus*, IS: m. *infraspinatus*.

DISCUSSION

The results clearly demonstrate that also for low contents below 10%, the lipid content can be determined reliably by Dixon and SVS methods. This was shown by strong correlations between results from SVS and Dixon and between independent measures of right and left shoulders and between two different muscles.

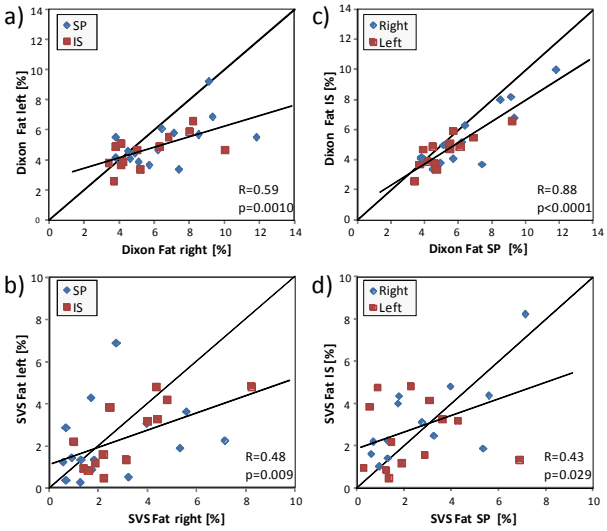

Fig.3: Correlations between fat contents in right and left shoulders determined a) from Dixon and b) from SVS; Correlations between fat contents in m. *supraspinatus* (SP) and m. *infraspinatus* (IS) determined b) from Dixon and d) from SVS.

The fat content from Dixon MRI was higher than that from SVS (i.e. the data are below the identity line, Fig. 2), which is due to Rician noise in magnitude images of low fat contents and that no correction for relaxation times was applied. In a previous study no correlation between SVS and Dixon results was reported for fat quantification in back muscles with low fat content[3]. This discrepancy is most likely due to the fact that lipid measurements in back muscles by Dixon methods are impaired by breathing artefacts, while shoulder muscle scans are not prone to movement artefacts, explaining the better correlation between SVS and Dixon results. Although more advanced Dixon type methods exists, the results for the standard two-point Dixon method applied here demonstrate the validity of the method for fat quantification in non-moving organs also for low fat contents.

CONCLUSION

SVS and Dixon MRI are both adequate for low fat content quantification in muscles not prone to movement, as shown here for shoulder muscles.

REFERENCES

1. Kim H. et al., Magn Reson Med, 2008; 59: 521. 2. Fischer et al., Radiology, 2013; 266: 555. 3. Diserens et al. Proc.Intl.Soc.Magn.Reson.Med. 22: 1234 (2014) 4. Valenzuela et al., "iSix (Image Segmentation in OsiriX)". ESMRMB Ann. Meeting 30: 697(2013)

ACKNOWLEDGEMENT: This work was supported by the Swiss National Science Foundation SNF grant #31003A-132935 and #320030-138150