

# Comparison of accuracy and precision of image-based fat quantification with different flip angle approaches in skeletal muscle

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## Target audience

The results of this work are of importance for those working with MRI-based quantification of fat fraction (FF) in skeletal muscle or other tissues with low fat contents.

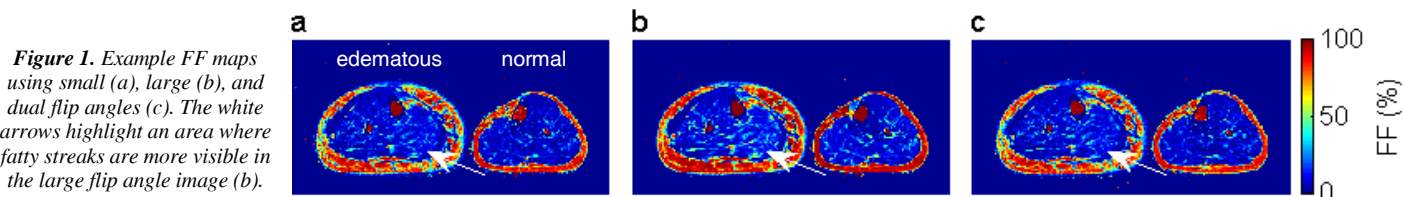
## Purpose

Fat quantification using multiple gradient echoes is a well-established technique for investigation of e.g. fatty liver. For quantification of fat in and between muscles, which is of importance in e.g. diabetes<sup>1</sup>, the expected FFs are likely lower. In these cases, a high SNR is crucial and may be achieved using either a higher flip angle (FA), causing overestimation of the FF due to T1 bias, or a dual FA approach which also corrects for T1 bias<sup>2</sup>.

*This study aims at investigating the potential gain in precision by using large or dual FAs for quantification of fat in skeletal muscles, compared to the commonly used approach with a small FA.*

## Methods

Five patients with leg lymphedema gave informed consent and were examined in a 1.5 T scanner (study approved by the local ethics committee). Two multiple gradient echo sequences with eight echoes and three 5-mm slices localized in the lower leg were acquired with TR = 600 ms and 10° and 85° FAs, respectively. An iterative linear least-squares approach with correction of off resonance and T2\* dephasing and a pre-calibrated multi-peak fat model was used to reconstruct FF maps<sup>3</sup>. Also, a dual FA approach was used to reconstruct T1-corrected FF maps from both data sets<sup>2</sup>. The result was three sets of FF maps: 1) small FA, 2) large FA, and 3) dual FA. In each image slice and leg, regions-of-interest (ROIs) were drawn in each of six muscle groups and within each ROI the average and standard deviation (SD) of the estimated FFs were calculated. In addition, ROIs were drawn in a homogenous part of the subcutaneous adipose tissue of each healthy leg.



**Figure 1.** Example FF maps using small (a), large (b), and dual flip angles (c). The white arrows highlight an area where fatty streaks are more visible in the large flip angle image (b).

## Results

Example FF maps of the three methods are shown as Figure 1. Streaks of fat in and between muscle groups are more visible in the large FA FF map. As expected, however, the large FA approach resulted in a clear overestimation of the FFs (Figure 2a). This bias was successfully corrected using the dual FA approach (Figure 2a). There was no apparent difference between the SDs of the three approaches in muscle ROIs (Figure 2b). In subcutaneous adipose tissue the SDs of the large and dual FA approaches were factors 0.6 and 1.0 of the small FA approach, respectively.

## Discussion

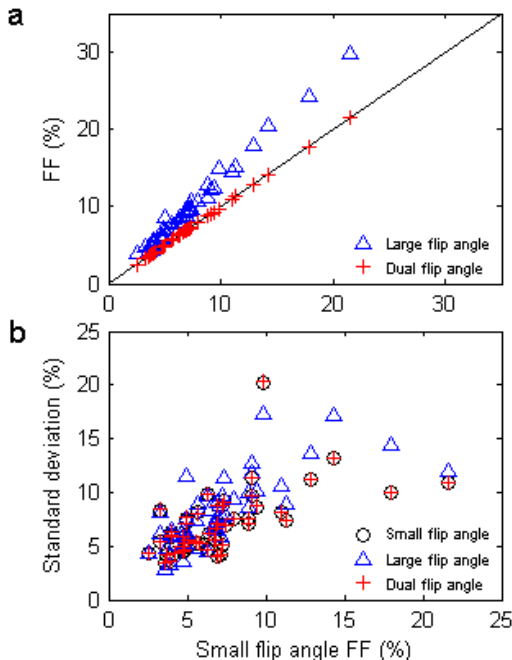
The lack of gain in precision in the estimated FFs using a large FA may be explained by anatomical variance as the T1 bias increases the difference in FF between muscle tissue and fatty streaks. This conclusion is conclusive with the improved precision in homogenous adipose tissue of the large FA approach. Regarding the dual FA approach, it is possible that other FAs may result in a better precision than that found here. Other FA pairs and approaches of T1 bias correction have been presented elsewhere<sup>4</sup>. For segmentation of adipose tissue within the muscle fascia, the improved contrast of the large FA approach may be valuable.

## Conclusion

There was no improvement in precision of FF quantification in skeletal muscle from using neither a large nor dual FA approach. As expected, the large FA approach also resulted in a clear overestimation of the FFs. In conclusion, a small FA approach is preferable for FF quantification in skeletal muscles.

## References

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**Figure 2.** a) Estimated FF (mean within ROI) with large and dual flip angles against small flip angle. b) Standard deviations within ROIs of the three methods against small flip angle FFs. There is no apparent difference in precision between the three methods.