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MRI-based Three dimensional shape analysis of thigh muscles: people with Chronic Obstructive Pulmonary Disease versus healthy older adults.

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Background. Loss of thigh muscle mass and strength has been documented in Chronic Obstructive Pulmonary Disease (COPD). However, the distribution of the atrophy among individual thigh muscles has not been studied. As lower limb muscles are different in architecture and function, the systemic effects of the disease affect them differently and non-uniformly. The purpose of this study was to detect shape abnormalities in individual knee extensor and flexor muscles in people with COPD compared to healthy people.

Hypothesis. We hypothesized that people with COPD will demonstrate more deficits in global (for the whole muscle) and local (for portions of the muscle) shape descriptors as compared to the healthy group.

Methods. Twenty COPD patients and twenty healthy adults (55-79 years) underwent magnetic resonance imaging, providing 100 axial slices of each subject's thigh. Slice by slice segmentation of individual knee extensor and flexor muscles was performed, and the 3D shape of each muscle was obtained using specialized software (ITK-SNAP). Eight shape descriptors were computed both globally and regionally using MATLAB software.

Results. Two-tailed t-tests with a modified Bonferroni correction were used to compare group differences. In the global analysis, significant between group differences ($p<0.01$) were found for vastus intermedius (5 descriptors), semimembranosus (4 descriptors), and rectus femoris (1 descriptor). The results of regional analysis revealed significant between group differences ($p<0.01$) for rectus femoris, vastus medialis, vastus intermedius, vastus lateralis, and semimembranosus. A support vector machine classifier was able to differentiate healthy from COPD muscles with 95% to 100% accuracy.

Conclusion. The finding of this study shows that the distribution of atrophy and size changes is distributed uniformly across knee extensor and flexor muscles in COPD. Further research is required to explore the underlying mechanisms of muscle shape discrepancies in COPD. The fact that COPD can affect major muscles of the lower limbs differently have implications for addressing muscle weaknesses and imbalance and could be useful designing strength training programs, and prescribing therapeutic modalities for affected muscles and affected muscle regions in chronic diseases such as COPD.