Volumetric magnetic resonance imaging of gastrocnemius muscle in a patient with facioscapulohumeral dystrophy

Gościk E.[1*], Kułak P.[1], Sienkiewicz D.[2], Kułak W.[2], Okurowska-Zawada B.[2]

[1] Department of Pediatric Radiology, Medical University of Białystok, Poland
[2] Department of Pediatric Rehabilitation, Medical University of Białystok, Poland

ABSTRACT

Introduction: Magnetic resonance imaging (MRI) is a nonradiographic, non-invasive method to visualize and quantify muscle cross-sectional areas and volumes.
Purpose: To evaluate a gastrocnemius muscle volume in a 15-year-old male with facioscapulo-humeral dystrophy (FSHD) using MRI.
Material and methods: The patient with FSHD was given subcutaneously recombinant human granulocyte colony-stimulating factor - filgrastim (5μg/kg body/day) for 5 consecutive days during the first, second, and third months. The Siemens Magnetom 0.3T MRI scanner was used to acquire the images of the right calf of the patient. The analysis of MR images used advanced biomedical imaging software-Analyze 10 Biomedical Imaging Software.
Results: The patient with FSHD after 6 month of the treatment compared with baseline had greater volume of the gastrocnemius muscle volume of the right calf. Muscle volume increased from 60,567.5 mm^3 to 70,795.6 mm^3. The increased of muscle volume of this patient correlated with the improvements of muscle strength and EMG.
Conclusion: MR imaging can provide quantitative, reproducible volumetric measures of muscles in the patients with FSHD.
Key words: Magnetic resonance imaging, gastrocnemius volume, facioscapulohumeral

***Corresponding author:**
Department of Pediatric Radiology
Medical University of Bialystok
Waszyngtona 17, 15-274 Białystok, Poland
Tel: +48 857450633
e-mail: rtgdsk@wp.pl

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Case report

Magnetic resonance imaging (MRI) is a nonradiographic, non-invasive method to visualize and quantify muscle cross-sectional areas and volumes. These areas and volumes can be segmented (i.e. separated) into bone, lean tissue (muscle), and fat tissue according to the intensity (brightness) of the individual voxels [1].

Usually, in patients with muscular dystrophies, manual muscle testing, hand-held dynamometry strength tests, and muscle biopsies of single muscles are used.

MRI can measure specific changes in fat replacement of muscle over time, demonstrating the variability in rates of natural progression between muscle groups and identifying those muscles suitable for use as biomarkers in clinical trials [2, 3].

Moreover, MRI has been used to provide a qualitative assessment of thigh muscles and to examine proton spin lattice relaxation time (T_1) in female carriers at a low magnetic field strength [4].

Herein, we present a part of the results of study (NeupoStem). A 15-year-old male with facioscapulohumeral dystrophy (FSHD) has been under the care of the department of Pediatric Rehabilitation for three years. The onset of disease was noted at 12 years of age. His mother also suffers from FSHD and currently uses a wheelchair. The patient had decreased muscle strength of the upper and lower extremities. He was able to walk 300 meters within 6 minute walk test. EMG demonstrated findings consistent with a myopathic disorder. Laboratory tests were also performed. Creatine kinase and muscle creatine kinase were slightly elevated.

Currently, there is no effective treatment available for patients with FSHD [5].

Granulocyte-colony stimulating factor is a glycoprotein that stimulates the bone marrow to produce granulocytes and stem cells and release them into the bloodstream [6]. Recent studies have indicated that granulocyte-colony stimulating factor can potentially be used for the treatment of spinal cord injury, stroke, and neurodegenerative diseases [7-9].

The patient was given subcutaneously granulocyte colony-stimulating factor (5μg/kg body/day) for 5 consecutive days during the first, second, and third months. Laboratory data and adverse events were analyzed. Abdominal ultrasonograph with a spleen assessment was performed before and after seven days of granulocyte colony-stimulating factor administration.

The Ethic Committee of the Medical University of Bialystok approved the study, and written informed consent was obtained from patient and parent.

Therefore, the purpose of this study was to evaluate a gastrocnemius muscle volume of this patient after six months of granulocyte-colony stimulating factor compared to baseline.

MRI

The Siemens Magnetom 0.3T MRI scanner was used to acquire the images of the right calf (Siemens Medical Systems, Inc., Germany) of the subject. The subject was placed in a supine position with a Siemens circularly polarizing (CP) no-tune transmit/receive extremity coil placed over the right calf muscle. The following MR parameters were used to acquire T1 and PD weighted MR images: TSE/ TR 4500ms, TE 24 ms, in images SE, TR 468 ms TE 15 ms. The layer thickness was 4 mm, the distance between the layers 1 mm, matrix 512 x 512, 512 x 384.

The analysis of MR images used advanced biomedical imaging software-Analyze 10 Biomedical Imaging Software. (Analyze Direct, Overland Park, KS, USA). Analyze software system is the product of more than 25 years of research, design and development at Mayo Clinic's Biomedical Imaging Resource. It provides direct and automatic (user transparent) support for reading most standard computer image and picture formats, including the emergent DICOM standard for radiologic images. Analyze software system is designed to run on all modern workstation platforms and today's powerful "PC" systems. Used by thousands of imaging researchers worldwide, Analyze represents a mature, feature-rich, tested and proven product with a long history and internationally recognized tradition of continuous innovative development and reliable support [10].

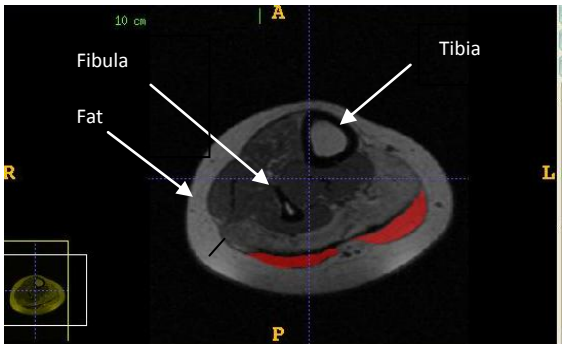


Figure 1a. Sample MRI slice depicting calf muscle of the patient with FSHD, transversal view. The bones (tibia and fibula are marked by white arrows). The fat saturated images make segmenting the bone from the muscle (authorship own)

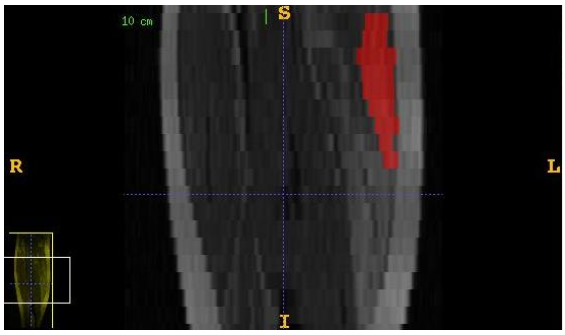
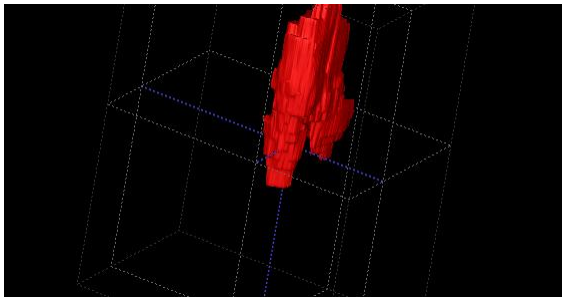


Figure 1b. MRI slice depicting calf muscle of the patient with FSHD, frontal view. Authors' photo.



Fiure 1c. 3D view of the gastrocnemius muscle volume. . Authors' photo.

Calf muscle, bones, and subcutaneous fat of the patient were easily seen in MRI findings (Figure 1,ab,c). Gastrocnemius muscle volume increased from 60,567.5 mm^3 to 70,795.6 mm^3 after six month of the treatment. The increased of muscle volume of this patient correlated with the improvements of muscle strength and EMG. Our results indicate a good reproducibility for volumetric measures of muscle tissues in the calf using MRI.

Conflict of interest

The authors declared no conflict of interest

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