

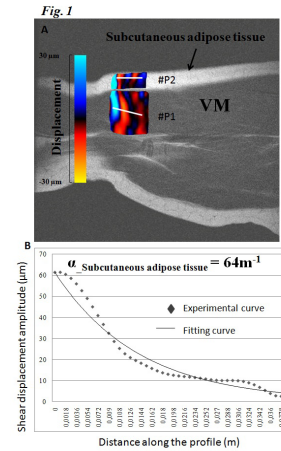
MR elastography thigh muscle data base to detect age and gender related changes

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Introduction

Age-related muscle changes have a huge impact on daily life activities in elderly people, such as gaiting, standing up, sitting down or stair climbing. Consequently, the development of adequate muscle rehabilitation programs will provide the elderly with more independence and better life. Thus, the objective of this study is to develop a MR elastography data base to measure age (20 to 80 years) and gender related changes on the passive and active muscles of the thigh. Additional measurements were also performed on the subcutaneous adipose tissue of the same subjects to elucidate the idea of fatty tissue infiltration with age.



Methods

Fifty-one subjects underwent magnetic resonance elastography (MRE) tests. Twenty-five young adults (11 males and 14 females, mean age 26 years, range 21-33 years), fourteen middle-aged adults (6 males and 8 females, mean age 56 years, range 52-60 years) and twelve elderly subjects (6 males and 6 females, mean age 76 years, range 70-81 years) underwent a MRE test. Each subject lies supine inside a 1.5T MRI machine (GE, Signa HDxt) with the right leg resting on a custom MR compatible leg press, capable of measuring the applied load. Then, a pneumatic driver consisting of a remote pressure driver connected to a long hose was wrapped and clamped around the subject's thigh [1]. Shear waves were induced through the thigh muscles at 90Hz (f). MRE phase images (Fig. 1A) were collected using a motion sensitizing gradient echo sequence, a flip angle of 45°, a 24 x 24 cm FOV, a 256 x 64 acquisition matrix, TE/TR = 23ms/55 ms and four offsets were recorded. White profiles were manually placed in the direction of the wave propagation in the belly of the vastus medialis (VM) muscle (#P1) and in the subcutaneous adipose tissue (#P2) (Fig. 1A). The attenuation coefficient (α) was calculated from the shear wave displacement amplitude as a function of the distance. An exponential fitting curve $Ae^{(\alpha d)}$ is used to determine the attenuation coefficient, with A and d representing the displacement amplitude value and the distance along the profile, respectively (Fig. 1B) [2]. The attenuation coefficient (α) was measured when the VM muscle was relaxed and contracted (20% MVC) and inside

the subcutaneous adipose tissue for each age group.

Results

At rest, both women and men, aged between 20 to 60 years, showed a similar attenuation coefficient (α) inside the VM muscle. From 70 years old, a significant increase of this mechanical parameter was found for both sexes. Moreover, this increase is greater for the elderly woman ($103.6 \pm 11.6 \text{ m}^{-1}$) than for men ($65.8 \pm 1.7 \text{ m}^{-1}$). For the active vastus medialis muscle, the attenuation coefficient (α) revealed no significant difference according to age and gender. Nevertheless, it can be noticed a trend to increase for elderly people without gender difference (Fig. 2).

The measurement of the attenuation coefficient (α) inside the subcutaneous adipose tissue showed no significant difference for both young women and men (Fig. 3). By the age of fifty, the attenuation coefficient was significantly different between women and men. Thus, elderly women revealed an increase of the attenuation coefficient ($78 \pm 4.3 \text{ m}^{-1}$), while no increase was found for men, probably due to the important standard deviation measured for young (6.5 m^{-1}) and middle-aged (10 m^{-1}) men.

The attenuation coefficients (α), measured for women as a function of age, exhibited the same behavior for the passive VM muscle and the subcutaneous adipose tissue, with a strong increase for the elderly women. This parallel was not followed for men's groups, certainly due to the large range of attenuation coefficient values, found for young and middle-aged men.

Discussion

The present study demonstrates that Magnetic Resonance Elastography technique is capable of providing additional mechanical parameters, such as attenuation coefficient, to detect age and gender related changes. The increase of this parameter demonstrated a strong effect of age on the passive vastus medialis muscle and also on the subcutaneous adipose tissues, particularly for the elderly women. Indeed, this phenomenon may be attributed to age and gender related structural changes in the muscle and the subcutaneous adipose tissues, such as the cross-linking of the collagen fibers [3], the changes in fat mass as well as a redistribution of the fat to other tissues, such as muscles [4]. The present data may be used as a reference data base by the clinicians to follow age-related changes or to assess adequate muscle rehabilitation programs for the elderly subjects in the future.

References

[1] Bensamoun et al., JMIR 23(2): 242-7, 2006. [2] Domire et al., J Appl Biomech 25(1): 93-7, 2009. [3] Kirland et al., Experimental gerontology 37 : 757-767, 2002. [4] Avery et al., Scand J Med Sci Sports 15(4): 231-40, 2005.

