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MUSCLE ACTIVATION ASYMMETRY IN PATIENTS AFTER HIP REPLACEMENT EVALUATED USING SURFACE ELECTROMYOGRAPHY

Cescon Corrado[1], Marco Barbero[1], Ruben Romano[2], Marta Garnero[2], Adele Occhionero[3], Massimiliano Lai[3], Alessia Daprà[3], Marco Trucco[2,3]

[1]Rehabilitation Research Laboratory 2rLab, Department of Business Economics, Health and Social Care, University of Applied Sciences and Arts of Southern Switzerland, Manno, Switzerland
[2] Presidio Sanitario San Camillo di Torino, Torino, Italy. [3] Corso di Laurea in Fisioterapia, Università degli studi di Torino, Torino, Italy

Background and aim

In the last years, surface electromyography (**EMG**) has been often used as a tool to assess and evaluate different diseases and disorders. Even though its effectiveness in analyzing muscle fatigue was largely shown [1-4], there is still lack of information regarding the evolution of muscle fatigue signals in people with hip replacement during sub-acute period.

The aim of this study was to evaluate **muscle fatigue** and **asymmetry** between healthy and operated limb, and to investigate how these parameters changed during a two-week rehabilitation program.

Materials and methods

Surface EMG signals were recorded from **vastus medialis (VM)** and **vastus lateralis (VL)** muscles of **43 patients** (28 females) with hip replacement using adhesive concentric ring electrodes (OT-Bioelettronica, Torino, Italy) during isometric squat.

A **force platform** was used to provide a visual feedback in order to have an equal distribution of the body weight on the two legs (Figure 1). Patients were asked to maintain a squat position for 60 seconds.

The measurements were repeated in three sessions:

- **T0** two-three days after the operation,
- **T1** after **one week** of rehabilitation
- **T2** after **two weeks** of rehabilitation.

Muscle force was measured separately during leg extension using a hand-held dynamometer. **Borg scale**, numeric rating scale (**NRS**) for pain, Timed Up and Go (**TUG**) Test, were collected during each session.

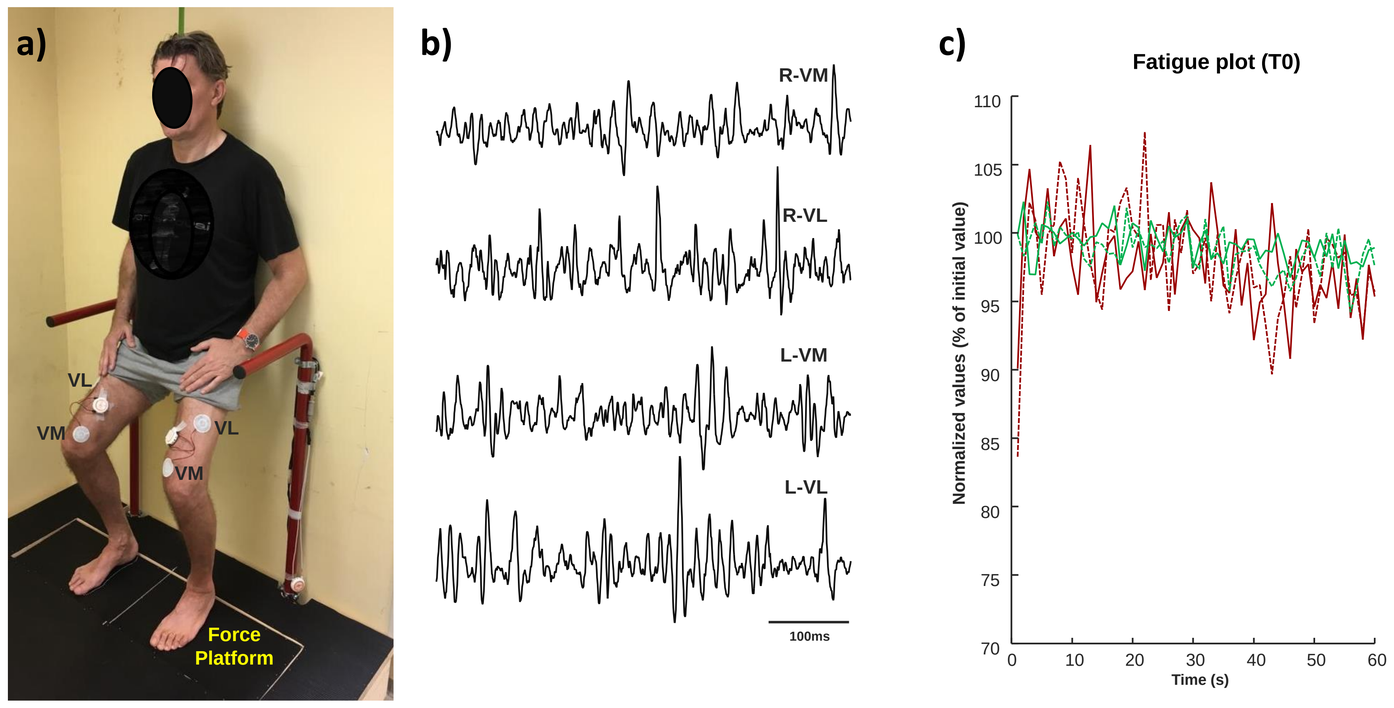
In addition, a **WOMAC** Index was used to assess pain, stiffness and physical function before the rehabilitation program and two months after the discharge from clinic, as well as a EQ-5D questionnaire to measure the health-related quality of life.

EMG signals were analyzed in order to extract amplitude (**ARV**), mean power frequency (**MNF**) and fractal dimension (**FD**).

Linear regression analysis was applied in order to extract initial values and slopes of the three variables (Figure 2).

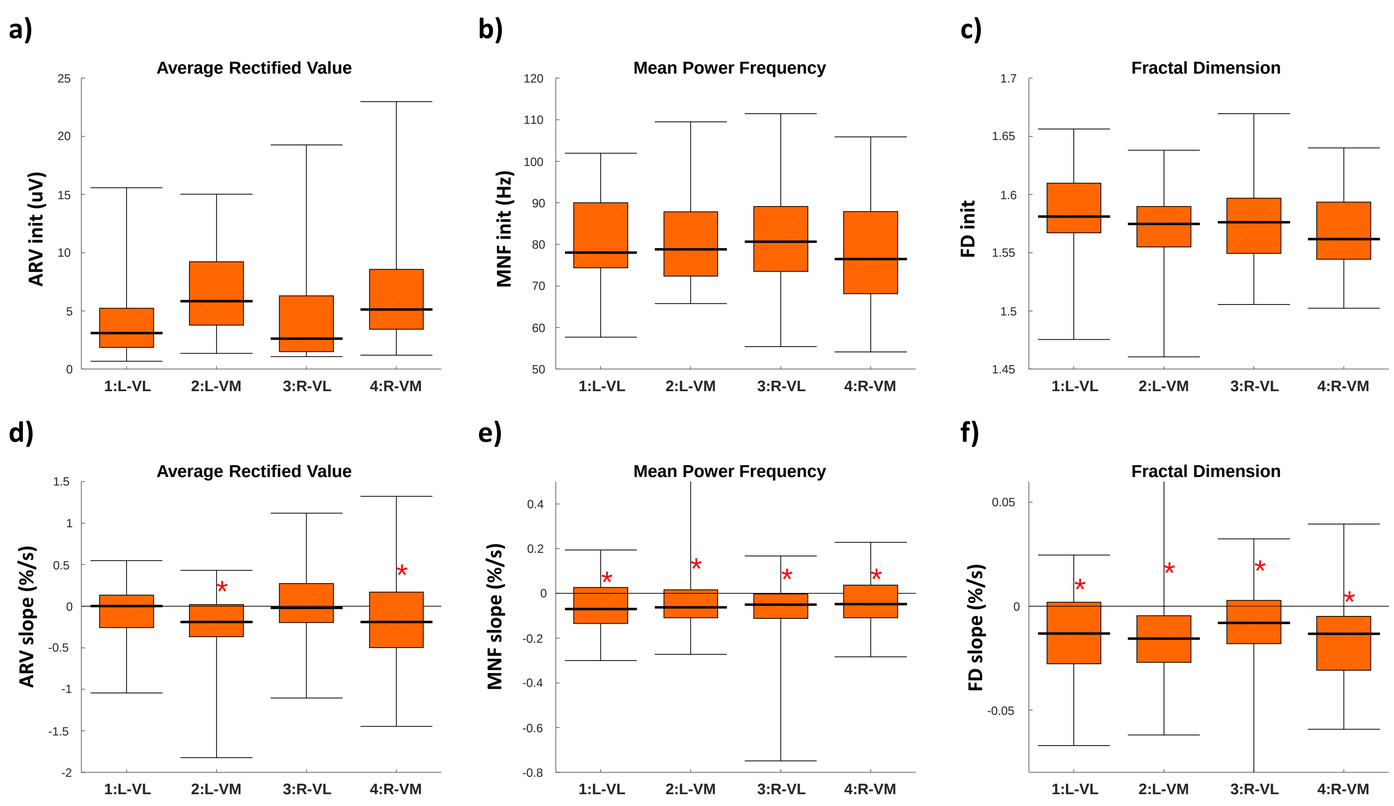
Statistical analysis was performed using non parametric paired tests between the two limbs (Wilcoxon signed-rank test).

Figure 1



a) Position of the subject during the measurements. The force platform is connected to a PC providing visual feedback on the distribution of weight between the two legs. Surface EMG electrodes are placed on VL and VM muscles. b) Example of signals detected on the four muscles. c) Fatigue plots of the EMG signals detected during isometric squat. MNF and FD are shown with normalize values, expressed in percentages with respect to the initial value (i.e. the intercept of the regression line with the vertical axis).

Figure 2



Distribution of initial values (a,b,c) and slopes (d,e,f) of the extracted variables (ARV, MNF and FD) in the four muscles during the first session of measurements.

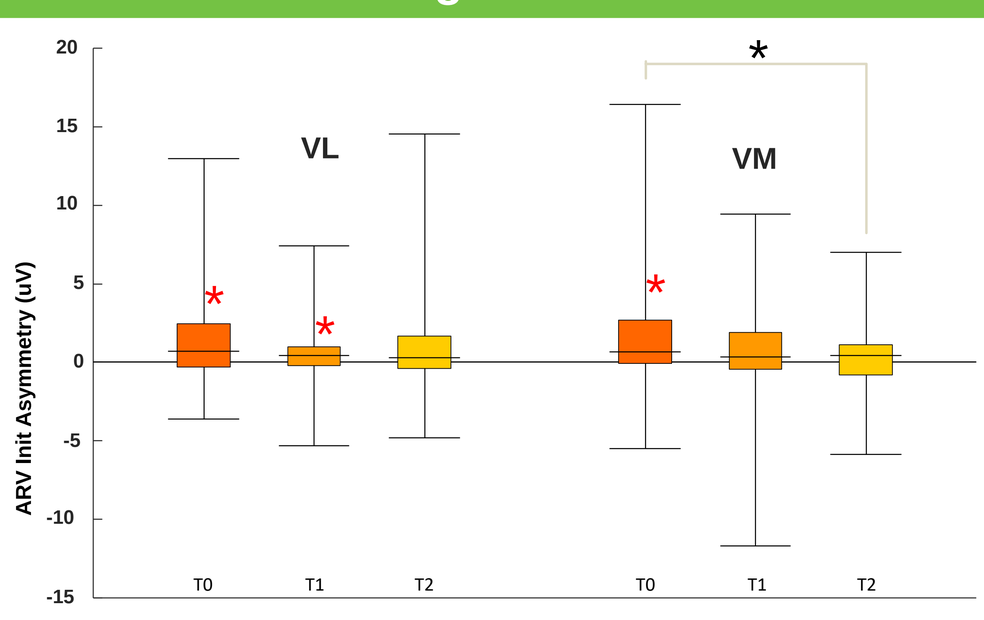
Results

MNF showed a statistically **significant decrease** in both legs indicating muscle fatigue during the task. A statistically significant **asymmetry of ARV** was observed between the two legs at T0, with the operated leg showing lower EMG amplitude as expected. The **asymmetry was progressively reducing at T1 and disappeared at T2**. A significant **correlation** was observed between amplitude **asymmetry and WOMAC** total score. MNF slope did not change significantly during the three sessions, indicating no variations of muscle fatigue in the vastii muscles.

Conclusions

An asymmetry of muscle activation was observed after the hip replacement, with lower EMG amplitude in the operated limb. Asymmetry progressively reduced during the rehabilitation period, and disappeared after two weeks. EMG signal amplitude asymmetry showed to be a promising tool to assess muscle activity during a rehabilitation period.

Figure 3



Behavior of amplitude (ARV) asymmetry between the two legs during the three sessions in the two muscle groups. Stars indicate statistical significance. During the first session (T0) the asymmetry was significantly different from zero, while it reduced at T1 and T2.

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e-mail: corrado.cescon@supsi.ch