Journal of Electromyography and Kinesiology 23 (2013) 1446–1450

Contents lists available at SciVerse ScienceDirect

Journal of Electromyography and Kinesiology

journal homepage: www.elsevier.com/locate/jelekin

Analysis of the neuromuscular activity during rising from a chair in water and on dry land ☆

A.I. Cuesta-Vargas [a,*,1], C.L. Cano-Herrera [a,1], S. Heywood [b,*,1]

[a] Department of Physiotherapy, University of Malaga, Av de Martiricos s/n, 29071, Spain

[b] The Melbourne Sports Medicine Centre, 250 Collins St., Melbourne 3000, Victoria, Australia

ARTICLE INFO

Article history:
Received 19 April 2012
Received in revised form 6 June 2013
Accepted 6 June 2013

Keywords:
Electromyography
Aquatic
Hydrotherapy
Functional task
Sit to stand

ABSTRACT

Purpose: The purpose of the present study was to analyze the neuromuscular responses during the performance of a sit to stand [STS] task in water and on dry land.

Scope: 10 healthy subjects, five males and five females were recruited for study. Surface electromyography sEMG was used for lower limb and trunk muscles maximal voluntarty contraction [MVC] and during the STS task.

Results: Muscle activity was significantly higher on dry land than in water normalized signals by MVC from the quadriceps-vastus medialis [17.3%], the quadriceps – rectus femoris [5.3%], the long head of the biceps femoris [5.5%], the tibialis anterior [13.9%], the gastrocnemius medialis [3.4%], the soleus [6.2%]. However, the muscle activity was higher in water for the rectus abdominis [−26.6%] and the erector spinae [−22.6%].

Conclusions: This study for the first time describes the neuromuscular responses in healthy subjects during the performance of the STS task in water. The differences in lower limb and trunk muscle activity should be considered when using the STS movement in aquatic rehabilitation.

© 2013 Elsevier Ltd. All rights reserved.

1. Introduction

Rising from a chair is a prerequisite for participation in many activities of daily living and fundamental for upright mobility, including walking, running, and jumping (Ploutz-Snyder et al., 2002). The sit-to-stand [STS] task involves balance challenges and is an unstable movement from a static, stable position to a quasi-static position (Vander Linden et al., 1994). Different determinants of the STS movement have been described in the literature. These have been grouped in three categories, related to the chair, the strategy and the subject (Janssen et al., 2002). Chair-related determinants include the height of the seat, armrest position, use of armrests, or the type of chair. Strategy-related determinants include speed, foot, knee and trunk position, arm use with armrest, attention and training. Lastly, subject-related determinants include age, disease, muscle force, and barefeet versus the use of footwear (Janssen et al., 2002). However, we designed an experimental set-up with standardized chair-, strategy-, and subject-related determinants to allow analysis of the difference between environments.

The STS movement has been studied using dynamometry, video analysis (Liao et al., 2007; Mazza et al., 2005), optoeletronic systems (Hughes et al., 1996), goniometry (Itokazu et al., 1998), and accelerometry (Goulart and Valls-Sole, 1999). These techniques measure details of movements (e.g., velocity, angular displacement, ground reaction forces) providing information about the possible processes underlying the observed movement patterns. The evaluation of the STS task is often considered in clinical assessment scales. The performance of the STS movement can objectively quantified and the functional limitations and compensatory motor patterns of individuals can be identified. The assessment of STS then assists with goal setting and can also form part of a rehabilitation program in the form of a facilitated movement or functional exercise.

Aquatic therapy, through an understanding of physics and physiology, is beneficial in the management of a variety of musculoskeletal, neurological and cardiopulmonary pathologies (Becker, 2009). Aquatic exercise is used in rehabilitation settings and may provide an enabling strategy for people unable to exercise successfully on land (Batterham et al., 2011). Clinically closed chain exercise such as squats and step ups are used in aquatic therapy programs have lead to significant improvements in mobility and

☆ Accepted for poster presentation, in part, at the International Society for Electrophysiology and Kinesiology conference (ISEK 2012), being held in Brisbane, Australia on 19–21 July, 2012.

* Corresponding authors. Tel.: +34 952137551/fax: 0034952051479 (A.I. Cuesta-Vargas).

E-mail address: acuesta@uma.es (A.I. Cuesta-Vargas).

[1] All authors were fully involved in the study and preparation of the manuscript.

1050-6411/$ - see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.jelekin.2013.06.001

functional outcomes in hip and knee osteoarthritis (Fransen et al., 2007) and hip and knee joint replacements (Rahman et al., 2009). The STS task is also used in aquatic programs for trunk and lower limb rehabilitation but to the authors knowledge the neuromuscular characteristics of the STS movement in water has not previously been described. Water has unique properties including density, buoyancy, hydrostatic pressure, viscosity and thermodynamics (Harrison and Bulstrode, 1987; Hall et al., 1990) leading to different physiological and biomechanical responses to exercise when compared to dry land (Alberton et al., 2011).

Changes in muscle activity in an aquatic environment around the trunk and lower limb have been studied in walking (Barela et al., 2006), running (Haupenthal, 2010), hopping (Triplett et al. 2009) and trunk exercises (Bressel et al., 2011). The surface electromyographic [sEMG] signal represents the electrical signal generated by skeletal muscles and detected over the skin surface (Merletti et al., 2009). sEMG can provide information on muscle activation and neural control strategies which are important in rehabilitation (Merletti et al., 2009). The aim of this study was to use sEMG to measure the neuromuscular activity during the STS task in water and compare this with the responses for the same task on land.

2. Methods

2.1. Subjects

10 healthy subjects [five males and five females [mean ± SD]: age, 22.0 ± 3.1 yr; height, 172.8 ± 9.0 cm; body mass, 63.9 ± 17.2 kg] agreed to participate in this study. Research Ethics Committee of the Faculty of Nursing, Physiotherapy, Podiatry and Occupational Therapy from the University of Málaga [Spain] approved the study. All volunteers were informed about the procedures and potential risks and gave their written informed consent to participate in the study.

2.2. Experimental procedures

Subjects participated in two sessions: (1) familiarization and (2) test session. The sessions were separated by at least 1 h.

Demographic data collection: Subject demographics were recorded [i.e. age, gender, height, weight].

Familiarization session: An initial practice session was carried out to orientate the subject with the timing of the STS task both in water and on dry land. All subjects practiced the STS at the same cadence of 20 beats per minute [bpm] provided by a digital metronome [Qwik Time QT-5 Metronome, China]. During this session, the subject received verbal feedback from the investigators regarding their form in the STS task. The subjects were instructed to keep their head facing forward, bend forward at the hips and transfer their weight upwards and forwards into standing with the final position in standing with an upright trunk and with extended hips and knees (Goulart and Valls-Sole., 1999). They started the most comfortable antero-posterior [bare] foot position, were also instructed not to move their feet from the starting position. The subject started sitting on the chair [47 cm high] with their arms crossed with hands resting on the opposite shoulder.

Test session: A telemetry EMG system was used [ME 6000, Mega Electronics Ltd, Kuopio, Finland] on the following muscles on the right side of the body: the quadriceps – vastusmedialis [VM], the quadriceps – rectus femoris [RF], the long head of the biceps femoris [BF], the tibialis anterior [TA], the gastrocnemius medialis [GM], the soleus [SOL], the rectus abdominis [RA] and the erector spinae [ES]. For each muscle, three disposable adhesive circular Ag – AgCl electrodes [Lessa, Barcelona, Spain] were placed on the belly of the muscle along the line of the muscle fibers. Anatomical guidelines for electrode placement were followed (Perotto et al., 2005). The inter-electrode distance was set at 2 cm. Before electrode placement, the skin surface was shaved [if needed] and cleaned with alcohol pads to minimize skin resistance (Silvers and Dolny, 2011). The same investigator did all the preparation for all subjects. The EMG leads were connected to a transmitting unit via customized long cables.

Maximum voluntary isometric contraction [MVC] tests were performed in order to estimate maximal EMG amplitude for each muscle. These MVC tests were carried out on dry land before the performance of the STS task on dry land. Each one was performed for 5 s [s]. The MVC values were used for further normalization of the EMG signal (Alberton et al., 2011). The electrode placement and tests were conducted in accordance with current recommendations for the use of surface EMG (Perotto et al., 2005).

After the MVC tests the subjects performed five repetitions for the STS task on dry land with the cadence [20 bpm] and using the same starting position, chair height and instructions as for the familiarization session. No encouragement was provided during the exercise and the same investigator visually determined proper execution of each repetition. If the exercise was performed incorrectly, it was repeated. Participants began each set on the verbal command "go". The EMG system was manually triggered before the command to record 5s of data for each set. The EMG system was then put into a waterproof cover and placed around the trunk of the subject with a rubber band. The room temperature was 24 °C. Subjects remained at rest at least for 15 min before starting the water procedure.

After the dry land procedure, the subject performed the same task in the water, inside a swimming pool with a depth of 100 cm. With the same height of the chair at 47 cm in the water the subjects in sitting started with water at the level of the xiphisternum and in standing at the completion of the STS task the water was approximately at waist height. The same instructions were used in the procedure in water. Ambient temperature was 33 °C and the water temperature was 30 °C. The transmitting unit was maintained above the water during the STS task at all times.

2.3. Data processing and reduction

The raw electromyographic signal was passed through a 12-bit analog-to-digital converter with a 1000 Hz sampling frequency, and then transferred to a computer for further analysis. Background noise in the filtered signal was less than 1_V. Filtering of the raw EMGs was performed with low- and high-pass filters [Butterworth type], with the bandwidth between 20 and 500 Hz. Average EMG data were normalized to the greatest 1-s average EMG during MVC from each muscle.

2.4. Statistical analysis

SPSS v15.0 was used for all statistical computations. Descriptive statistics [mean, standard deviation, minimum and maximum] were calculated for age, height, and Body Mass Index [BMI]. Standard procedures were used to calculate means and SDs. The central tendency and dispersion were observed in the study variables by Kolmogorov–Smirnov tests. Each dependent variable [VM, RF, BF, TA, GM, SOL, RA and ES muscle activity [%MVC [%]] was analyzed to compare values between the two conditions [water and land], using a paired *t*-test for parametric variables and Wilcoxon test used for non-parametric data. For all statistical comparisons, the α level was set at 0.05.

3. Results

The waterproofing appeared to successfully maintain the integrity or the sEMG recordings in all conditions. Descriptive analyses

Download English Version:

https://daneshyari.com/en/article/4064824

Download Persian Version:

https://daneshyari.com/article/4064824

Daneshyari.com