FOREARM MUSCULAR ACTIVITY DURING THE REAL VS VIRTUAL BOX & BLOCK TEST

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Introduction

The use of virtual environments for rehabilitation in patients with neurological diseases is becoming increasingly common, such as the simulation of the Box and Block dexterity test (B&B). The use of virtual tests in rehabilitation has the advantage of being able to adjust the level of difficulty/demand to the patient's condition. Although there are several works that have validated this test in virtual rehabilitation [1,2], these have focused on studying the correlation between the results of the real and virtual tests, and the kinematic requirements of the arm, but without checking if muscular demands of the hand and wrist are similar to the real ones, which is the proposal of this work.

Material and Methods

The experiment, approved by the ethics committee, consisted of recording the muscular activity of the right forearm of 9 healthy subjects by means of seven surface electromyography (EMG) sensors (Biometrics Ltd) placed in seven representative spots obtained in a previous work [3]. Both the real test and the virtual one, which uses the Leap Motion [2], were performed while the subjects were instrumented (Figure 1). EMG signals were properly filtered and normalized with 7 maximum voluntary contraction (MVC) actions according to [3] to obtain the muscle activity of all the spots.

Figure 1: Subject instrumented with 7 EMG electrodes (left) while performing the real (centre) and virtual test (right).

Five repetitions of each test were performed. In each repetition, subjects were asked to move 3 cubes from one container to another as fast as possible. The descriptive statistics (mean and range) of the 9 subjects for each record (real and virtual) were obtained. A repeated measures ANOVA was performed by spot with Bonferroni adjustment to check for significant differences (p ≤ 0.05) between repetitions, and an analogue ANOVA to check for differences (p<0.05) between the real and virtual test (considering only the last repetition of each)

Results

No significant difference in muscular mean and range was found between repetitions in both real and virtual test. Table 1 shows the statistics across subjects (mean values and standard deviation in brackets) of the mean and range EMG activity in last repetition for both tests, and cases with significant differences are in bold and underlined.

Spot	REAL B&B Mean	REAL B&B Range	VIRTUAL B&B Mean	VIRTUAL B&B Range
1	**_0.052(0.037)_**	0.084(0.016)	**_0.025(0.016)_**	0.051(0.025)
2	**_0.025(0.015)_**	0.041(0.023)	**_0.017(0.011)_**	0.031(0.026)
3	**_0.030(0.009)_**	0.058(0.024)	**_0.019(0.009)_**	0.051(0.020)
4	0.035(0.019)	0.073(0.041)	0.037(0.022)	0.089(0.061)
5	0.058(0.026)	0.081(0.031)	0.057(0.032)	0.097(0.063)
6	0.062(0.025)	0.088(0.033)	0.049(0.034)	0.082(0.053)
7	**_0.037(0.014)_**	0.059(0.041)	**_0.025(0.011)_**	0.042(0.024)

Table 1: Statistics across subjects (mean(SD)) of mean and range EMG activity between real and virtual B&B. Significant differences in bold and underlined. Spot 1: wrist flexion and ulnar deviation; spot 2: wrist flexion and radial deviation; spot 3: digit flexion; spot 4: thumb extension and abduction/adduction; spot 5: finger extension; spot 6: wrist extension and ulnar deviation; spot 7: wrist extension and radial deviation.

Discussion

Muscular ranges are not affected by the type of test, real or virtual, but there are muscular differences in the mean values in some spots. In general, all spots present greater mean values during the real test. In particular, in the real test there are significant greater mean muscular values of wrist and digit flexors, as well as in wrist extensors and radial deviators. The results are in accordance with the hand kinematics observed in a previous work [4], where greater flexion of the proximal interphalangeal of the index, and the median posture of the interphalangeal of the fingers were found. These differences may be due to these hand posture differences but also to the fact that picking up a real cube require exerting enough pressure to avoid slipping. The wrist extensors in the real test requires a greater mean value, probably due to the difficulties of controlling virtual spatial limits. It is necessary to check if there are differences in the kinematic and muscular patterns in case of patients.

Acknowledgements

References

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