The influence of an arm sling on sit-to-stand of hemiplegic subjects

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1. Introduction

Arm sling is often recommended to hemiplegic patients to protect their paretic limb, but is not always mandatory, for example when the patient has some remaining control over the paretic limb. In this case, the paretic limb remains available for balance.

It might be relevant to investigate whether the arm sling is a real benefit for the patient. For example, this is not the case for gait, as the suppression of arm swing, by the mean of crossing the arms on the chest, has been proven to be unhelpful (Ortega et al. 2008; Umberger 2008). But, what about other daily activities? Among them, the sit-to-stand (STS) task is one of the most frequent tasks related to walking abilities. The STS can be realized with a handgrip to ease the task and allow more patients to successfully stand.

The purpose of this study was to investigate the impact of an arm sling on the STS task, when realized with a handgrip. The study is placed within Bobath concept, also known as neurodevelopmental treatment (Seneviratne & Reimer 2004). Following that concept, any assistive technique or device will be considered positively if the patient's behaviour gets closer to standard subject. Knee joints seem a wise spot to investigate the influence of arm sling on STS, as already done for gait (Umberger 2008). As hemiplegia is an asymmetric motor deficiency by nature, the impact of arm sling will be evaluated on the asymmetry of the STS task, based on knee joint moments and compared to a reference population.

2. Methods

The tested population was composed of eighteen healthy subjects (15 male and 3 female) and nine right hemiplegic subjects (5 male and 4 female) with remaining control over their paretic upper limb. Healthy subjects' age, body mass and height were 24 (±5) years, 72 (±11) kg and 173 (±5) cm, respectively (mean ± std). Hemiplegic subjects' age, body mass, height and functional independence measure (score for a non disabled: 127) were, respectively, 72 (±10) years, 82 (±14) kg, 169 (±7) cm and 111 (±5). A specifically designed device was built for experimentation, based on a handgrip and a chair, both adjustable in height and distance. The chair height was set, respectively, to 120% of subject's shank length and the chair-handgrip distance in a way that the subjects sat comfortably straight with the left hand on the handgrip. All subjects performed STS task with and without arm sling. The arm sling was used to immobilize the right upper limb. For both STS conditions (arm free and arm immobilized by an arm sling), subjects rose from their initial sitting position to an upright position using the handgrip, at a free speed.

The motion of the subjects was recorded using a VICON system. Two force plates, one for each foot, were used to measure the external contact loads between the subject and the floor. Reflective markers were placed on anatomical landmarks, following the ISB recommendations. External loads and inertial parameters (de Leva 1996) were used for computation of joint moments using inverse dynamics (Doriot & Cheze 2001) on the left and right lower limb open chains (foot, shank and thigh), and moments were normalized by body mass.

Asymmetry of task was given by the absolute difference between the sagittal maximal knee joint moments of both lower limbs. A statistical non-parametric test – Wilcoxon – was used to determine the significance of the studied variable between the two performances of one group (hemiplegic or healthy). Another statistical test – Mann–Whitney – was used to determine the significance of the studied variable between the hemiplegic and the healthy group.

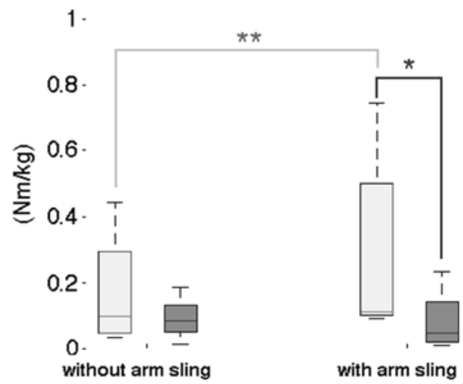

Figure 1. Absolute difference between knee joint moments, normalized to body mass (N m/kg), during STS without and with arm sling. White: right hemiplegic subjects; Grey: healthy subjects. *$p < 0.05$; **$p < 0.01$.

3. Results and discussion

Figure 1 shows that the use of an arm sling for hemiplegic subjects increased the asymmetry between the two knees by an average of 37% ($p = 0.004$), whereas the use of the same accessory for healthy subjects, did not significantly increase the asymmetry ($p = 0.76$). Also, between the two groups (healthy and hemiplegic), no significant difference was found when an arm sling was not used, whereas a significant difference was found when an arm sling was used ($p < 005$).

Our results show that the asymmetry was influenced by the presence of an arm sling only for hemiplegic subjects. This is coherent with previous observations from the literature: from STS studies, it has been shown that subjects swung more their arms at lower seat heights (Mazzã et al. 2004), and that STS become a more demanding task also at lower seat heights (Roy et al. 2006). Therefore, it seems to be a link between STS task difficulty, such as done by hemiplegic subjects, and arm swing. In this study, the arm swing being blocked by the arm sling, hemiplegic subjects were hindered, as shown by a STS task more asymmetric. Now, this study has some limitations. Firstly, results are limited by the low number of subjects who participated in the study (18 healthy and 9 hemiplegic subjects) and the lack of anthropometric match between the two groups, preventing inter group comparison. Secondly, the chosen asymmetry indicator is built from maximal joint moments and hides any chronological interpretation. This was preferred to an averaged torque, for example because not only it hides chronological aspect but also it levels any peak torque that brings an indicator of internal stress in the joint. Thirdly, knee joint was preferred because it showed the largest difference during previous studies on the influence of arm swing in gait (Umberger 2008). Some other joint moments or kinematic variable might have complementary information for describing the biomechanical effects of arm sling.

4. Conclusions

Influence of arm sling on STS task for hemiplegic subjects was investigated on the basis on Bobath concept. By immobilizing the upper limb with an arm sling, the STS task realized by hemiplegic subjects did not get closer to the behaviour of standard subjects, and went against Bobath concept, indicating an unhelpful technique. Moreover, if the symmetry of the movement seems a characteristic of the normal STS, the asymmetry observed in hemiplegic subjects might be a compromise between their remaining abilities and the biomechanical requirements of the task. Future works will investigate the relationship between asymmetry and other biomechanical parameters in STS. It might also be interesting to highlight the influence of an arm sling on daily activities.

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