INTRODUCTION

Gait initiation results from the control of the gravity forces by the muscular forces. Toe walking is frequently observed in patients suffering from Becker Muscular Dystrophy (BMD) and supposed to be the consequence of an important muscular weakness induced by the pathology (Johnson, 1977). In this study, on the basis of a gait initiation analytical model (Couillandre et al., 2002), we studied some of the consequences of a lower limb strength deficit on the gait initiation process.

MATERIAL AND METHODS

Five BMD and six healthy subjects (Control group) participated in this experiment. Firstly, they performed gait initiation from an erected spontaneous posture on a force platform at three different speed instructions (slow, normal and fast). Secondly, they performed a quantified muscular assessment on an isokinetic dynamometer. The following muscular functions of the lower limb were tested bilaterally during a maximal voluntary isometric contraction: i) ankle dorsiflexion and plantarflexion, ii) knee extension and flexion. Surface EMGs from muscles Soleus (Sol), Tibialis anterior (TA), Vastus lateralis (VL) and Biceps femoris (BF) were bilaterally recorded during both protocols.

RESULTS

Whatever the tested lower limb muscular function and side, the maximum torque value was significantly lower for the BMD group than for the Control group, the strength deficit of the extensors (Sol and VL) being higher than that of the flexors (TA and BF) (ratios of respectively 1/4 and 1/10 for the extensors, 1/3 and 1/2 for the flexors in comparison to the Control group).

As far as gait initiation is concerned, our results showed that a lesser motor performance in terms of anteroposterior velocity of the centre of gravity at the end of the first step (V) was achieved by the BMD group than by the Control group. However, a significant linear relationship was achieved by the BMD group than by the Control group, as attested by the absence of significant difference between the slopes of the \( x'_{TO} \) \( f(V) \) relationships (figure 1). Nevertheless, for the BMD group, \( x'_{TO} \) contribution to V was similar for the BMD and Control group, as tested by the absence of significant difference between the slopes of the \( x'_{TO} \) \( f(V) \) relationships (figure 1).

Figure 1: linear relationship between V and \( x'_{TO} \) for the BMD group and the Control group.

\( s: \) slope of the linear regression. \( r: \) correlation coefficient.

DISCUSSION AND CONCLUSION

As gait initiation results from the control of the gravity forces by the muscular forces, and particularly from the ones of the lower limb extensors, the lesser motor performance observed for the BMD group could be partly explained by the decrease of the extension muscular torques assessed on the lower limbs. As a matter of fact, the strength deficit was more important on the lower limb extensors than on the lower limb flexors.

Despite a lesser motor performance, the BMD group seems to keep in mind a clear image of the velocity to reach at the end of the first step because it displays an important feature of gait initiation programming which is to reach an initial velocity, \( x'_{TO} \), predetermining the final velocity, V (Brenière et al., 1987), the step execution being ballistic. However, at the opposite of healthy subjects (Lepers and Brenière, 1995), TA activity does not anymore contribute by itself to \( x'_{TO} \) for the BMD group, despite TA higher excitation level. TA is probably combined to other muscular synergies in order to palliate the strength deficit assessed on the ankle dorsiflexors.

REFERENCES


ACKNOWLEDGEMENTS

This work was partly supported by funds from AFM. We are grateful to Professor Bruno Eymard for selecting the patients and to Isabelle Ledoux, biomedical engineer, for her technical assistance.