Selective motor control and muscle volume predicts gross motor function in bilateral spastic cerebral palsy

Noble JJ, MSc1,2, Turner S, Physiotherapy BSc1, Gough M, FRCSI1, Shortland AP, PhD1

1 Guy’s & St Thomas’ NHS Foundation Trust, London, United Kingdom
2 Division of Imaging Sciences& Biomedical Engineering, King’s College London, London, United Kingdom

INTRODUCTION

Individuals with cerebral palsy experience a range of impairments that limit their functional ability. However, limited studies have been performed investigating the contribution of muscle weakness, reduced selective motor control, and spasticity on gross motor function. In this study we investigate the predictive nature of these factors on the gross motor function measure (GMFM-66) in bilateral spastic cerebral palsy (BSCP).

METHODS

10 male adolescents and young adults with BSCP (15.7±3.7 years, Gross Motor Function Classification System levels I [n=1], II [n=4], III [n=4], and IV[n=1]) took part in this study.

Magnetic resonance images were acquired on a 3.0T Achieva system (Philips Medical Systems, Best, The Netherlands), with a quadrature body coil. A three point mDixon sequence (TE/TR=2.11/5.2 ms, echo time shift = 0.76 ms (120° echo phase shift), 10° flip angle, 1.2 x 1.2 mm in-plane voxel size, number of averages = 2, 5 mm slice thickness) were acquired of both lower limbs. Muscle volumes were manually segmented in Osirix (version 5.8.2; Pixmeo, Geneva, Switzerland) for 18 muscles in both legs (medial gastrocnemius, lateral gastrocnemius, soleus, tibialis anterior, tibialis posterior, vastus medialis, rectus femoris, vastus intermedius and lateralis composite, semimembranosus, semitendinosus, gracilis, sartorius, biceps femoris long and short head, adductors composite, gluteus maximus, gluteus medius, and gluteus minimus). Muscle volumes were normalised to body mass and averaged between legs for each individual. GMFM-66, SCALE, Modified Ashworth scale (MAS) were also assessed.

Statistical analysis

Pearson’s correlations were used to investigate relationships between the measured parameters, and forward stepwise multiple linear regression analysis used to identify which clinically significant factors (SCALE, modified Ashworth, and normalised lower limb muscle volume) predicted gross motor function. All statistical tests were performed using SPSS (version 20.0; IBM SPSS) with significance set to p≤0.05.

RESULTS

GMFM-66 is strongly positively correlated to SCALE (r=0.915, p<0.001) and total lower limb muscle volume (r=0.749, p=0.013). GMFM-66 was moderately negatively correlated to MAS although this was not statistically significant (r=0.575, p=0.082). Forward stepwise multiple linear regression analysis showed that SCALE and lower limb muscle volume explained 90.3% of the variation in GMFM-66 (p≤ 0.001) (Equation 1, Figure 1).

GMFM-66 = 22.678 + 1.781 × SCALE + 0.477 × Muscle Volume

Eq. 1.

DISCUSSION

Despite the limited subject numbers, the results of this study suggest that selective voluntary motor control and lower limb muscle volume are the significant factors limiting gross motor function in ambulant individuals with bilateral spastic cerebral palsy. However, the stronger correlation between SCALE and GMFM-66 compared to muscle volume suggests that strength training may only have a limited beneficial impact on an individuals functional ability. This may explain the limited improvements in functional ability that occur after resistance training of lower limb muscles in cerebral palsy1,2.

REFERENCES

1. Scholtes et al. Dev Med Child Neurol 52(6) e107-e113 2010

Contact Information: jonathan.noble@gstt.nhs.uk