The relationship between pelvic-hip musculature and functional ambulation in patients with Myelomeningocele

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INTRODUCTION

Myelomeningocele (MM) is a neuromuscular disorder that results in bulging of the spinal cord and subsequent muscle paralysis and/or weakness. The lower the level of defect, the more function is preserved. Consequently, patients with defects at the lower lumbar level and below preserve their walking ability. However, our clinical observations suggest that a group of them maintains the ability to walk independently with the use of orthotics (IAs), while another group requires the use of external support, i.e., assistive devices, such as walkers or crutches (NIAs). Currently, to the best of our knowledge, there does not exist any comprehensive literature explaining the underlying cause of this discrepancy. Therefore, the purpose of this study was to investigate if the ambulatory status of patients with lower lumbar MM, IAs compared to NIAs, is related to their muscle strength.

CLINICAL SIGNIFICANCE

Currently, to the best of our knowledge, there does not exist any comprehensive motion analysis studies relating the ambulatory status of patients with lower lumbar level MM to their muscle strength. If this information were known, then more targeted interventions could be identified so that, potentially, NIAs can progress to IAs.

METHODS

This is a retrospective study involving 50 patients with MM who underwent three-dimensional gait analysis (3DGA) in our laboratory as part of their health care plan. For the purposes of this investigation, we focused on their walking pattern characteristics, along with the lower extremity Manual Muscle Test (MMT) portion of their physical exam. Muscle strength from the MMT was translated from the clinical scale [1] to a continuous scale from 1 to 24, where a score of 1 is the equivalent of 0 in the clinical scale, defining the lack of any ability to contract the muscle. A score of 24 in the continuous scale is the equivalent of 5 in the clinical scale, meaning that the patient can move the distal end of the joint it attaches to, through the full range of motion of that joint against maximum manual resistance. Kinematic and temporal-spatial characteristics were determined by the 3DGA involving implementation of a modified Helen-Hayes marker set using specific anatomical landmarks of the segments of the lower body (pelvis, thighs, lower legs, and feet). The averages from each parameter for each group were statistically analyzed using an ANOVA. Statistical significance was achieved at $\alpha \leq 0.05$.

RESULTS

Table 1 shows the relationship between muscle strength for specific muscle groups and ambulatory status. Of the muscle groups investigated, the iliopsoas, sartorius, and gluteus maximus were stronger in the IAs group (p=.0003, p = 0.014, and p=.0002, respectively). Additionally, the group of IAs demonstrated a higher velocity and cadence (p=.02 and p=.005, respectively). Of the kinematic variables assessed, pelvic protraction was greater for IAs (p=.02) and downward pelvic obliquity was greater for the NIAs (p=.02) (Table 2).

Table 1: Statistical output comparing the muscle strength between patients who ambulate independently and those who do not. Muscles tested: adductors (Add); quadriceps (Quad); iliopsoas (Ilio); sartorius (Sar); gluteus maximus (Glut Max); gluteus medius (Glut Med).

Parameter	Add	Quad	Ilio	Sar	Glut Max	Glut Med	Vel	Cad	Stride Length
IA Average ± std. dev.	**18.10** ± 4.99	**20.79** ± 3.36	**20.12** ± 3.58	**18.11** ± 4.23	**10.69** ± 4.37	**7.48** ± 3.31	**0.798** ± 0.03	**0.944** ± 0.02	**0.852** ± 0.03
NIA Average ± std. dev.	**17.45** ± 4.10	**19.71** ± 3.16	**15.25** ± 2.99	**15.00** ± 1.85	**5.92** ± 2.19	**6.88** ± 2.50	**0.643** ± 0.03	**0.761** ± 0.17	**0.833** ± 0.02
p-value	0.7008	0.3661	*0.0003*	*0.0136*	*0.0002*	0.5607	*0.0243*	*0.0049*	0.7504

Table 2: Comparison of the kinematics of pelvic rotation and pelvic obliquity between IAs and NIAs.

Parameter	Pelvic Protraction	Pelvic Retraction	Pelvic Obliquity Upward	Pelvic Obliquity Downward
IA Average ± std. dev.	**18.26** ± 7.41	**-16.70** ± 8.24	**6.74** ± 3.49	**-2.88** ± 4.11
NIA Average ± std. dev.	**13.74** ± 5.54	**-12.54** ± 6.51	**8.44** ± 4.42	**-6.56** ± 4.90
p-value	*0.0229*	0.0652	0.1997	*0.0178*

DISCUSSION

The purpose of this study was to investigate the relationship between ambulatory status of patients with lower lumbar MM who are IAs or NIAs and their respective muscle strength. The stronger hip flexors and extensors seen in the IAs group can provide greater hip stability which can facilitate independent ambulation. Furthermore, the greater velocity of the IAs, which, however, appears to be a function of increased cadence, may be further reflective of the improved ability of the IAs to control their gait compared to the NIAs. The greater excursion range for pelvic rotation in the IAs group may reflect that they achieve their stride length, partly, from pelvic rotation. The assisting devices, on the other hand, may be the limiting factor for the decreased pelvic rotation seen in the NIAs group. The decreased pelvic obliquity in the cohort of IAs may suggest that they have greater pelvic control while ambulating. One limiting factor of this investigation may be the discrepancy in sample sizes between the groups (35 IAs versus 15 NIAs). It is possible, therefore, that there may be some outliers influencing the results.

REFERENCES
1. Kendall, F.H. (2005) *Muscles, Testing and Function,* pp. 19-23.

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DISCLOSURE STATEMENT
The authors have nothing to disclose with respect to this investigation.