Does sitting posture prior to testing single leg dynamic balance influence performance?

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Introduction

- The forward head, rounded shoulders, and flexed thoracolumbar position of the spine that characterizes the "slumped-forward head" sitting posture predisposes a variety of anatomic structures to mechanical stress and strain.
- "Painless motor radiculopathy" has been described as a compression of the anterior nerve root at the neuroforaminal entrance leading to a motor deficit and coinciding atrophy without inducing a pain response.[1]
- This "painless motor radiculopathy" has been thought to be caused by the "slumped-forward head" sitting posture. Additionally, previous research has shown a significant correlation between faulty posture in the cervical spine and strength in the upper extremities.[1,2]
- The "slumped-forward head" sitting posture has been noted to result in a reduction in glenohumeral external rotator strength while "erect" sitting has been noted to favorably influence strength in the muscle group.[2]
- Similar clinical observations have been observed which demonstrate changes in hip muscle strength in an apparent response to assuming various sitting postures, specifically erect-sitting and slumped sitting.
- It is not clear if the reduced strength related to sitting posture leads to a decrease in function.

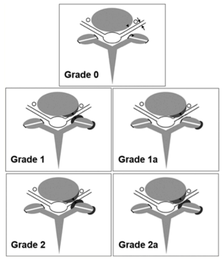

Figure 1: *Diagram from Siller et al. (2018), demonstrates the compression of the anterior nerve root at the neuroforaminal entrance leading to the aforementioned "painless motor radiculopathy". This anterior nerve root compression is primarily seen in Grade 1a and Grade 2a stenosis.[1]*

- The purpose of this study is two-fold:
  1. To systematically monitor isometric muscle strength in the hip abductors in response to time spent in the "slumped-sitting" and "erect-sitting" postures.
  2. To determine if those that experienced a significant hip abductor strength decline between "erect-sitting" and "slumped-sitting" postures (greater than or equal to 10% decline) also experienced a decline in functional hip strength as evident by poorer performance on the single-leg Y-balance test, specifically in the posterior-medial direction.[3,4]

Subjects

- Participants in the study were found using convenience sampling at Misericordia University. Given the large population of student-athletes on campus, a large percentage of participants in the study had previously played or were actively participating in a Division III sport.
- **Exclusion Criteria:** history of lumbar spinal surgery, current lumbar pain, history of lumbar pain with symptoms radiating below the knee, hip surgery, or hip injury within the last year, as well as subjects younger than 18 and older than 26 years of age.

Table 1. ***Subject Profile***

Subject Profile	Mean	SD	Maximum	Minimum
Age (years)	20.39	±1.44	23	18
Height (inches)	67.04	±4.48	75	60
Weight (pounds)	173.32	±47.53	290	115
Leg Length (inches)	33.30	±2.81	38.25	28.25
Pelvic Width (inches)	14.52	±1.29	17.5	12

Methods: Part I

- While the subject's sitting posture was assessed, stool height required to maintain the subject's leg at 10 degrees of abduction while in the side-lying testing position was calculated using the following equation: $\sin(10^\circ)$(leg length) + (pelvic width).
- Prior to assuming the side-lying testing position, the subjects were asked to complete 15 active dominant leg hip abductions in standing as a "warm up" for hip abductor musculature.

Figure 2: *During testing posture, subjects assumed a side-lying position with their dominant leg up. Dominant leg was maintained at 0° hip extension, 0° knee extension and 10° hip abduction maintained with the dominant leg resting on pre-adjusted leg stool. The non-dominant leg was maintained at 30° of hip and knee flexion.*

- Subjects performed two sub-maximal hip abduction trials and one maximal hip abduction trial in order to acclimate to the testing procedure. Hip abduction strength data was collected by the same researcher throughout the study using a handheld muscle testing dynamometer.[5]
- After the subjects were acclimated to the testing procedure, they were asked to assume the prone position for five minutes in order to neutralize the spine. After five minutes, the subjects assumed the same side-lying testing position.
- Subjects were then asked to complete two maximal effort hip abduction trials. If the maximal strength values weren't within 10% of each other, a subsequent trial was completed as to eliminate any outliers due to testing error. This data collection method was conducted in the same manner after the maintenance of each posture.

Figure 3: *Prone posture utilized to neutralize the spine (left), slumped-sitting posture (middle) characterized by maximal thoracolumbar flexion without upper extremity support, and erect-sitting posture (right) characterized by maximal lumbar lordosis.*

- Following the prone posture, subjects were asked to either assume slumped-sitting posture or erect-sitting posture (figure 3). The posture which was assumed first alternated between subjects.
- After the subjects assumed either slumped sitting posture or erect sitting posture for five minutes, their hip abduction strength was measured again. They were then asked to assume the prone position for five minutes, with subsequent hip abductor testing.
- The last posture the subjects assumed was either erect-sitting or slumped-sitting for five minutes (which ever posture was not yet assumed). The subjects then completed one final set of maximal hip abduction trials.
- Following each subject's data collection, the researchers determined if there was a greater than or equal to 10% decline in strength between the erect and slumped-sitting postures. Those who showed the difference were asked to come back for part two of this study.

Methods: Part II

Disclaimer: Due to the unforeseen COVID-19 pandemic, part two of this study was not able to be completed. Understanding this, part two of our study has been reformatted into a protocol study that may be utilized to recreate our study in full at a later date.

Figure 4: *Subject positioning assumed during completion of the Y-balance test in the posterior-medial direction. After demonstration from researcher, the subject is allowed 6 trials to acclimate. The posterior-medial direction of the Y-balance test most positively correlates with hip abductor strength.[3,4]*

- After the subjects are acclimated to the procedure, they should be asked to assume the prone position for five minutes. After five minutes in prone, the subjects are to complete six trials of the y-balance test.
- The testing procedure should continue in the same order as part one of the study, with the only difference being instead of recording two max hip abductor strength measurements after assuming the four postures, the subjects should instead complete 6 trials of the Y-balance test.

Results

Table 2. ***Non-Normalized Hip Abductor Strength (pounds)***

	Mean	SD	High	Low
All Conditions	59.34	±13.89	96.7	34.4
1st PL	60.15	±14.42	91.4	35.0
ES	59.82	±13.82	91.2	37.6
2nd PL	59.63	±13.87	96.7	37.7
SS	57.70	±14.07	94.1	34.4

Table 3. ***Normalized Strength Means to 1st PL Means***

	N	Mean	SD	Maximum	Minimum
1st PL	28	1	0.00	1	1
ES	28	0.99	0.96	1	1.07
2nd PL	28	0.99	0.96	1.06	1.07
SS	28	0.96	0.98	1.03	0.98

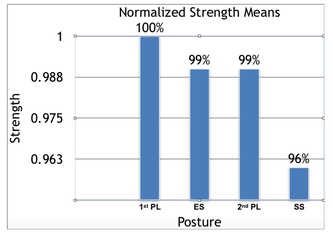

Figure 5: *Strength values were normalized due to the wide variation in hip abductor strength. Normalized values were calculated by taking the mean of each position divided by the mean of the first prone-lying trial. The mean decline in strength noted in slumped-sitting was 4 %.*

- Of the 28 subjects tested in Phase 1 of the study, 17 demonstrated some deficit in hip abductor strength following maintenance of the slumped-sitting posture.
- 7 of 28 subjects experienced a greater than 10% decline in hip abduction strength.
- In the 25% subpopulation that demonstrated > 10% strength decline, the mean decline in hip abductor strength was 12.57%.

Discussion

- The available results of this study suggest that hip abduction strength is diminished as a result of five minutes time spent in slumped-sitting posture.
- The authors of this study believe this finding to be clinically relevant as it correlates with data from aforementioned studies regarding the relationship between strength and posture.[2]
- Additionally, although part two of the research was halted, it can be hypothesized that a strength decline of 12.57% would likely lead to a decrease in function as measured by a Y-Balance Test.
- Therefore, as a result of the available data gathered in this study, it is our stance that clinicians should be more aware of the influence of lumbar posture when evaluating the hip since it has been demonstrated that the maintenance of a slumped-sitting posture may result in a relative decrease in hip abductor strength.

References available upon request

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