The effect of lumbar support on holding shoulder electromyography and trunk kinematics in collegiate violinists

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Introduction

- Playing a musical instrument is a risk factor for developing playing-related musculoskeletal disorders in professional musicians (PRMDs).[1]
- Few quantitative approaches to studying movements in musicians (similar to an athletic approach) has been performed in the bow arm performing repeated isolated movements, but not in left arm under performance environments (ie playing a musical piece).
- Violinists are particularly susceptible to postural-related injuries commonly located in the neck and holding shoulder due to arm and shoulder support mechanics and lower back pain associated with sitting posture.[2, 3]
- Lifetime prevalence for PRMDs is 62% to 93%, suggesting that PRMDs may not be attributed solely to overuse, but due to instrument postural demands.[1]

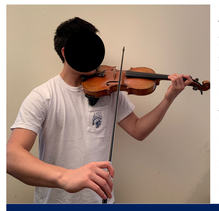


Figure 1. **Standard Violin Posture.** The player's chin rests on the chinrest, 70º abducted from the midline. Displacement of head and repetitive long-term lateral bending and rotation trigger an asymmetrical cervical posture. Mechanical stress causes unilateral neck pain.[4] Musicians still rely almost entirely on qualitative approaches to performance technique feedback for quality of sound rather than body mechanics used to achieve desired sound. [2]

Hypothesis

HYPOTHESIS 1

Lumbar support will decrease mean left holding shoulder musculature activation.

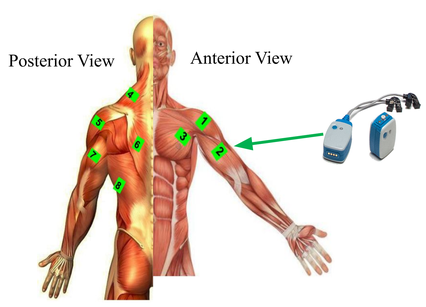
HYPOTHESIS 2

The addition of a lumbar support will increase postural variability as measured by trunk, thigh, and hip flexion angles in violin players.

EMG Placement

Figure 2. **EMG Placement on Violinist**.
A. Frontal anterior view.
B. Sagittal left view.
C. Posterior view.

Figure 3 . **EMG locations.** Myoelectric activity recorded using pairs of surface Ag/AgCl electrodes perpendicular to belly of muscle fibers on 1) Anterior Deltoid 2) long head of Bicep Brachii 3) clavicularis Pectoralis Major 4) upper fibers of Trapezius 5) Posterior Deltoid 6) lower fibers of Trapezius 7) lateral head of Triceps 8) Abductor Latissimus.[5]



Methods

Measurements	Mean±SD	Variables	n
Age (years)	19.6±1.5	Female	6
Height (m)	1.71±0.1	Male	5
Mass (kg)	66.9±8.0		
BMI (kg/m^2)	22.8±2.4	Exercise Level (days/week)	
Experience (years)	10.8±3.9	0	1
Time played in a week (hrs)	11.7±8.9	1-2	3
		3-4	3
		5+	4
		Previous Injury	7
		No Previous Injury	4

Figure 4. **Data Collection and demographics.** EMG normalized to ROM (left arm and shoulder flexion extension, transverse abduction and adduction, elbow flexion and extension, deltoid downward resistance, and overhead elbow extension against gravity). Participants played the music piece (See *Figure 5*) twice with a lumbar support and without lumbar support.

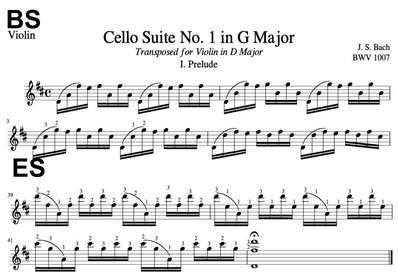


Figure 5. **EMG analyzed Beginning Section (BS) and End Section (ES).** Similar note patterns indicated similar movement patterns, allowing EMG and kinematic angles comparison between BS and ES. Root-mean squared EMG was normalized to ROM and full-wave rectified after ECG artifact suppression to 100 ms time window. mean EMG was found using standard amplitude analysis.

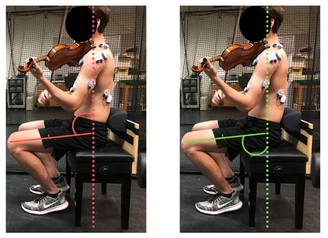


Figure 6. **Kinematic angles determined with respect to vertical normal in both lumbar support and no support trials.** Red indicates trunk angle, green indicates thigh angle, both computed as mean of 6 values at 0, 20, 40, 60, 70, 80, and 100% time intervals in BS and ES. Hip angle computed below:

$$\Theta_{\text{relative angle of the hip}} = \Theta_{\text{absolute value of the trunk}} - \Theta_{\text{absolute value of the thigh}}$$

Results: Kinematics

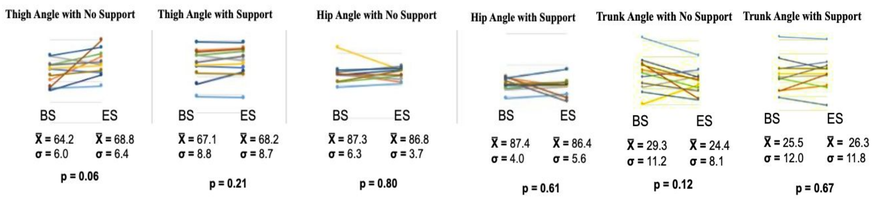


Figure 7. **No kinematic changes (absolute trunk and thigh angles, relative hip angle) between Beginning Section (BS) and End Section (ES).** Paired t-test ($p<0.05$) were performed for trunk kinematic values between lumbar support trials and time (BS or ES).

Results: EMG

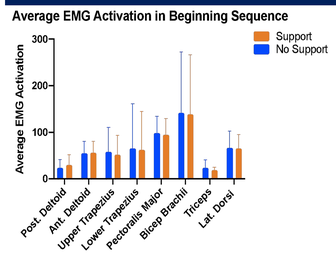


Figure 8. **Comparison Trend of Mean EMG Activation in Beginning Sequence Between Support or No Support Trials.** Upper trapezius lower trapezius, pectoralis major, bicep brachii, and triceps brachii showed a decrease in RMS EMG from no lumbar support to lumbar support.

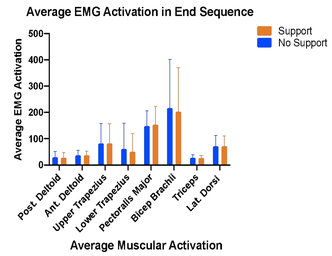


Figure 9. **Comparison Trend of Mean EMG Activation in End Sequence Between Support or No Support Trials.** Posterior deltoid, upper trapezius, lower trapezius, bicep brachii, triceps brachii, and latissimus dorsi showed a decrease in mean RMS EMG from no lumbar support to lumbar support.

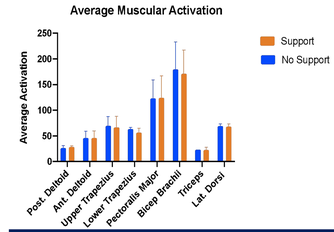


Figure 10. **Comparison of EMG magnitudes between support and no support trials.** Intervention of a lumbar support may lead to the expectation of an increasing ROM of the left holding shoulder musculature. Thus, mean activation of the left holding shoulder musculature directly involved in the task should either experience no change or a slight increase in change.

Conclusions & Further Applications

- **Conclusion:** Lumbar support does not significantly affect EMG or trunk, thigh, and hip kinematics. The amount of time playing may influence the variability in these measures.
- **Kinematics:** Motion Capture markers on the acromion process, anterior superior iliac spine, and lateral condyle of the tibia are needed for more accurate kinematic measurements and changes in real time.
- **EMG:** Slight movements of musical expression may have masked slight holding shoulder musculature activation changes caused by the lumbar support intervention.
- **Next Steps:** Utilize a control group without PRMDs and longitudinal lumbar support intervention.
- **Further applications:** Variation in seated posture inter-subjects adds to the

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