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Impact of the Posture – Standing or Sitting – on the Kinematics of the Violinist's Right Upper Limb

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1. Introduction

Professional musicians spend several hours every day practicing their instrument. Among professional violinists, 86.8% reported pain-related musculoskeletal disorders (PRMD) mainly located in the upper body in the last twelve months, for 8.1% of them, it led to activity interruption (Kochem and al., 2017).

Violinists tend to practice both sitting down and standing up respectively for orchestral playing and for individual lessons. These different playing postures may have an influence on upper limb kinematics (Spahn and al., 2014), since modifying the spine curvatures can modify the scapula orientation and thus the whole upper limb kinematic chain.

Since kinematic variations can be beneficial in terms of PRMD prevention, it would be interesting to quantify the upper limb kinematics difference generated by different postures. The aim of this study is to investigate how the posture conditions influence this kinematics on professional violinists.

2. Methods

2.1 Protocol

Eight professional violinists played long notes on the four strings in two postural conditions: sitting upright and standing up. Fifty markers were positioned on their body. Participants all played the same violin and bow. Five and six additional markers were placed respectively on the bow and the violin. Ten Qualisys cameras were used to record the markers' coordinates (240 Hz). A metronome set to 80 bpm in an earpiece was used to control the tempo.

2.2 Data processing

Kinematics of each upper limb joint were extracted according to Wu and al. (2005), using a multi-segment open-loop model. In this model, the gleno-humeral (GH) joint has three degrees of freedom (DOF): flexion-extension, abduction-adduction and intern-extern rotation. The elbow and wrist have 2 DOF. The elbow has flexion-extension and intern-extern rotation whereas the wrist has flexion-extension and abduction-adduction. The multibody optimizations were performed with Bionc an open source library.

Data from all participants were aligned using the lateral movement of the bow relative to the violin using an Amerced Dynamic Time Warping (aeon toolbox, Hermann and al., 2023). ADTW were used to divide the music piece depending on the string played. For each string and for the full piece of music the range of motion (ROM (max − min)), the maximum, the minimum and the mean of the joint angles were computed.

2.2 Statistics

Parameters of each joint were compared for the 2 conditions using Wilcoxon tests. A difference was considered statistically significant when the p-value was below 0.02.

3. Results and discussion

Data from seven participants were finally used since one participant had too many markers' trajectories losses.

Between sitting straight and standing up, 4 DOF showed significative differences on at least one parameter.

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These discrepancies were always observed on the two lowest strings of the violin (Table 1).

Table 1. Confidence interval (CI) of parameters for each joint DOF showing a significant difference (p<0.02).

Joint	DOF	Parameters	Sitting straight (CI in °)	Standing (CI in °)
Wrist	Abd/Add	Max	[17.3 ; 27.1]	[16.5 ; 23.3]
		ROM	[5.5 ; 12.6]	[3.6 ; 9.9]
Elbow	Flex/Ext	Max	[99.9 ; 112.9]	[94.5 ; 111.7]
GH	Flex/Ext	Min	[-165.4 ; -145.8]	[-161.0 ; -144.5]
	Abd/Add	Max	[41.2 ; 64.5]	[47.5 ; 73.7]
	Abd/Add	Mean	[30.5 ; 56.4]	[37.9 ; 65.6]

On the shoulder, the maximum and mean abduction-adduction were greater when standing whereas the minimum flexion-extension was smaller when standing versus sitting.

For the elbow, the maximum flexion-extension was greater when sitting versus standing.

For the wrist, the maximum abduction-adduction and its ROM were greater when sitting compared to standing.

The largest influence on the CI was on the shoulder joint. No differences were shown on the two highest strings of the violin.

Spahn et al. (2014) showed differences on the maximum lordosis angle between standing and sitting positions. This could explain why these different postures could generate different scapula postures. The kinematics differences at the shoulder were then compensated at the elbow and wrist levels.

The present results are consistent with those from Tomezzoli et al. (2022) who revealed proximal upper limb kinematics differences during technical tasks performed with two different spine postures. The distal wrist's differences may be explained by the nature of the tasks in this study: its kinematics having a direct effect on the produced sound, it is paramount to adapt it to maintain a similar sound. Violinists would therefore compensate for the different postures by adapting their kinematic chain proximally and even distally to maintain a similar sound in various positions.

4. Conclusions

In conclusion, this study demonstrated an influence on the upper limb kinematics, especially the proximal shoulder kinematics between sitting and standing postures in violinists, on the two lowest strings played. A larger cohort would be required to increase statistical power and expand the present conclusions.

Conflict of Interest Statement

None.

Contributor Roles

A Roy: Formal analysis, Investigation, Writing-original draft. A Naaim: Supervision, Writing – review & editing. T Hoegy: Investigation. F Verdugo: Supervision. S Duprey: Funding acquisition, Conceptualization, Project administration, Writing – review & editing.

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