KINETIC EVALUATION OF RIGHT SHOULDER AND ELBOW DURING SPICCATO TECHNIQUE VIOLIN BOWING

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INTRODUCTION

Musicians are a group particularly susceptible to overuse syndrome (OS), with up to 65% of professionals afflicted [1]. Violinists are at particularly high levels of risk for developing OS, due to the repetitive nature of the movements they use. Of 227 music students surveyed, string players reported shoulder pain more often than any other group at any other injury site [2]. Previous work has provided biomechanical descriptions of the legato (smooth bowing) technique during violin performance. It was discovered that kinetic considerations for risk of OS include the type and quantity of loading [3]. The current study examines the right shoulder (RS) and right elbow (RE) for the spiccato (bounced bow) technique.

METHODS

3-D motion capture using a nine-camera VICON v8i system (<0.76mm accuracy) was used to collect kinematic data. Inverse dynamic modeling technique was applied to capture data for obtaining joint kinetics. A ten-segment biomechanical model (upper body, violin and bow) designed for the capture was utilized. Subjects consisted of eight professional violinists. The protocol had the performers play G major scale cycles covering all four stings of the violin from the lateral G-string to the medial E-string and back at different tempi (varying bowing speeds) using the spiccato technique.

RESULTS AND DISCUSSION

Violin play can be described by two types of muscle load, the fundamental load from the process of moving the arm during a stroke, and the impact load resulting from overcoming the inertial forces of string crossings and bow direction changes (Fig. 1). In legato bowing it was found that fundamental loads dominated total joint moments at lower tempi, gradually giving way to impact loads at higher tempi [3].

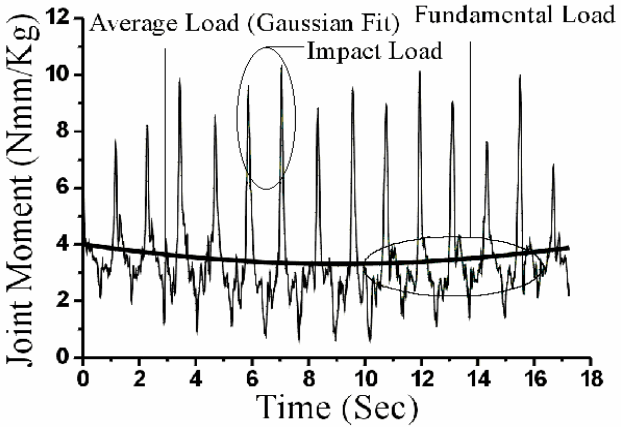

Figure 1: Wrist moment representative of legato bowing during the cycle of the scale at a low tempo.

Figure 2 shows spiccato bowing to produce a moment curve composed solely of impact load. Thus, playing spiccato even at low tempos exposes the muscles to loading patterns similar to those experienced during high tempo legato bowing. Impact loads have been identified as a significant factor in the cause of OS, and results suggest that spiccato bowing carries a higher risk for the development of OS than legato [4].

Kinetic analysis of spiccato bowing revealed that string played had a large effect on RS loads. RS moment is greatest when the G-string is played (88.9 Nmm/kg +/-SD 11.03) and lowest on E (64.2 Nmm/kg +/-SD 10.48). In contrast to the RS, the RE moment is greater for E than G-string bowing, although the difference is much smaller (31.13 Nmm/Kg +/-SD 5.05 vs. 29.97 Nmm/Kg +/- 4.61 respectively)

The height of the oscillations in Figure 2 gives an indication of the effect of string on moment range. Large ranges of moment indicate a more dynamic movement, while small ranges are indicative of quasi-static movement. There are some indications that static loads may increase risk of injury relative to more dynamic loads [3]. Moment ranges are larger when playing the E-string than G for both RS (41.44 Nmm/Kg vs. 34.68 Nmm/Kg) and RE (26.05 Nmm/Kg vs. 19.84 Nmm/Kg respectively).

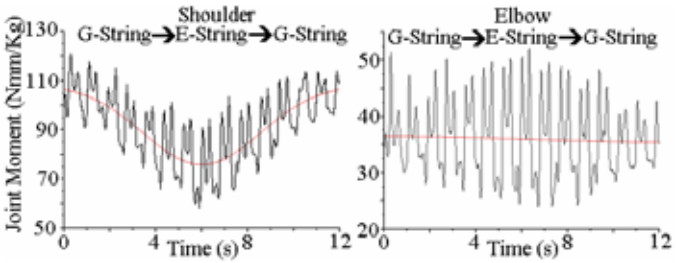

Figure 2: RS and RE joint moments at 144 bows/min during the cycle of a scale.

CONCLUSIONS

The current study reveals that playing on the G-string for extended periods using the spiccato technique increases risk of injury in the right shoulder, due to the higher overall loads and the narrower load range (approaching quasi-static conditions) experienced under these conditions. It follows that apportioning practice time with consideration of the factors identified should reduce the risk of RS injury due to overuse.

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