JURA

NSERC CREATE Summer Student Symposium • August 2012 • Vol. 2, No. 1

Rate and Time of Breath in One and Two Skate Cross Country Skiing

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Abstract

Skate cross-country skiing presents a unique human gait where four limbs are used for propulsion. Within skate skiing there are two primary techniques, the one and two skate. While both involve similar lower body movement, the difference lies in the upper body movement. In one-skate, poles are planted simultaneously with every skate stride, while in two-skate, poles are planted with every second skate stride. It has been observed that dogs synchronize their breathing cycles with their fore-limb movements (Bramble and Jenkins, 1993). Here we investigate whether breathing rate is synchronized with poling rate in the two skiing techniques. We hypothesized that as speed and effort of the skier increase, the rate and timing of breathing becomes directly related to the movement of the upper body and the associated poling cycle. A strain sensing strap was fixed around the chest of 11 trained cross-country skiers. This measured chest expansion due to breathing and was synchronized with force sensing poles. The tests were done at a constant speed of 12km/hr at increasing grades from 0% to 8% in increments of 2%. At each grade, one- and two-skate skiing was performed for 2 minutes. This gradual increase in grade allowed the breathing timing and rate to be compared to the upper body poling action for both techniques. We observed that the breathing became more synchronized with the poling cycles as effort increased in both techniques. In the one-skate technique, skiers breathe every second poling cycle. In the two-skate technique at low effort, skiers pole 1.25 times per breath, indicating that the breathing and poling cycles are not synchronized. However, at a highest effort of skiing (8% slope), one poling cycle was synchronized with one breath. Skiers were found to exhale in the early stages of pole ground contact and inhale towards the end of the ground contact and during the pole recovery phase. It appears therefore that chest compression during poling and chest expansion during recovery are used to help the chest musculature in exhaling and inhaling, respectively, thereby saving metabolic energy for breathing at high efforts of skiing.

References

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