KINEMATIC AND DYNAMIC ANALYSIS OF LANDINGS IN VAULTING

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INTRODUCTION: Vaulting is a sport discipline combining gymnastics and dancing on a moving horse. Sport specific injuries are most frequently located in the region of the lower extremities, specifically the ankle joint. Landings were identified as one of the main causes of these injuries (Peiler, 2005). The authors assume that, among other causes, the landing height in combination with the forward motion of the horse may cause high lower extremity loading. Thus, the aim of this study was to identify the ground reaction forces and pressure distribution during vaulting specific landings as well as their contribution to kinematic characteristics of the corresponding motion sequences.

METHODS: 3 male vaulters participated in this study performing 7 different types of dismounts from a cantering horse. Ground reaction forces and plantar pressure were recorded at 100 Hz using the mobile PEDAR®-X system (Novel, Munich, Germany). These pressure measurements were supplemented by a three-dimensional video-analysis using the motion capture system Vicon (200 Hz). Ten infrared cameras were positioned in an indoor riding hall capturing the sector of a quarter circle with a volume of about 10x4x3m. Within this sector the different landings were performed. Peak force and pressure values for the total foot (TF) and the sections medial fore foot (MFF), lateral fore foot (LFF), medial heel (MH) and lateral heel (LH), as well as the times of peaks, were analysed in relation to trajectories, velocities as well as angular displacements and velocities of selected joints.

RESULTS: Table 1 presents the peak pressure values and time of peak in the four foot regions for one selected athlete in three different landings.

Table 1 Peak pressure and times of peak

	Simple dismount	Half flank dismount	Flik-Flak
Peak pressure [kPa/kg] MFF, LFF, MHF, LHF	7,7 / 4,0 / 9,6 / 9,6	4,7 / 3,2 / 6,1 / 9,1	9,2 / 2,1 / 9,3 / 8,5
Times of peak [ms] MFF, LFF, MHF, LHF	60 / 80 / 80 / 80	30 / 30 / 30 / 30	30 / 50 / 50 / 50

DISCUSSION: In comparison to drop landings of gymnasts from three different heights (1.0 m, 1.5 m, 2,0 m) under laboratory conditions (Janshen, 2001) the reported results seem to be unexpectedly low. This can be explained by the damping effects of the specific ground used in riding. Moreover, the large and partly non-systematic differences between the particular pressure areas are remarkable and point to a low steadiness of landing performance. The peak pressure values might have not been able to be detected due to the relatively low sampling-frequency of 100 Hz.

CONCLUSION: This study enables to assess force and pressure variables in vaulting specific landings. Further information about the optimal landing performance with respect to minimal loading in combination with the kinematic analysis is needed.

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