

The turnout paradigm in ballet dancers: contribution of the lateral rotation in the lower limb joints during unipedal jump in fifth position

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Summary

This study investigated the contribution of the lower limb joints lateral rotation to the turnout during an unipedal jump with lateral displacement in fifth position - Sissone Ouvert devant. Fifteen pre-professional ballet dancers, each with 11 years of ballet practice, had their rhythmic jump kinematics recorded. The peak lateral rotation of hip, knee and ankle joints was analyzed across the preparation, flight, and landing phases of the Sissone. Significant differences were observed in the contributions of each joint to lateral rotation in all phases of the ballet jump. The hip joint contributed the most to turnout in all phases, increasing its rotation peak from prep to flight and maintaining it through landing. The knee contributed less compared to the hip and exhibited a reduction in rotation across the phases, while the ankle had its highest contribution during preparation, lost rotation during flight, and recovering upon landing.

Introduction

The turnout is a key element in classical ballet which involves large hip rotations. Misalignment of the lower limb joints during the dynamic execution of the turnout increases injury risk and compromises the ballet technique^{1, 2}. To date, the turnout movement has been mostly analyzed during quasi-static tasks and postures. Little is our understanding of the turnout biomechanics during unipedal jumps which are a challenging movement for maintaining the lateral rotation of all joints, especially during flight phase. This study aimed to provide insights into the biomechanics of ballet technique by analyzing the contributions of lateral rotation in the hip, knee, and ankle to the turnout movement during the Sissone Ouvert Devant, an unipedal jump, in fifth position with lateral displacement.

Methods

An 8-camera motion capture system (Vicon Vero, 100Hz) was used to acquire lower limbs kinematics in 15 experienced ballet dancers (11.5 years of practice) while performing the Sissone jump. Rigid clusters of markers and skin markers were used to track the kinematics of lower limb joints. Visual 3D (C-Motion) was used to calculate the peak angular rotations of hip, knee and ankle joints in three jump phases: jump preparation, flight and landing. Peak joint rotations were compared across phases and joints via repeated measures ANOVAs ($\alpha=0.05$) and Newman-Keuls post-hoc.

Results and Discussion

Significant differences were observed in the contribution of each joint to the lateral rotation in all phases of the jump ($p<0.001$). The hip contributed the most to the turnout movement in all phases and showed an increase in the peak rotation from prep to flight, and maintained the peak in the landing phase. The knee exhibited a progressive reduction in its contribution to turnout across the phases. The ankle reached the peak lateral rotation in the prep phase, lost some rotation during flight, and recovered some rotation upon landing.

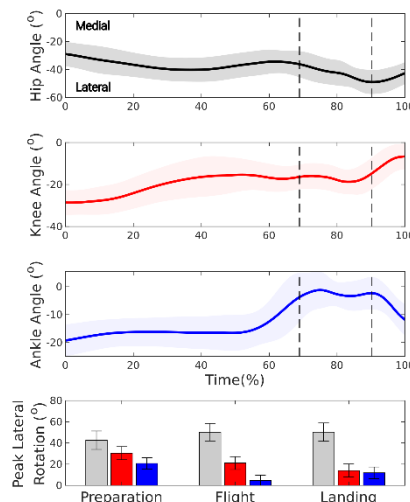


Fig. 1: Mean time series (± 1 SD bands) of hip, knee, and ankle joint angles in the transverse plane during Sissone. Bottom: mean (SE) of hip, knee, and ankle peak rotations in the 3 jump phases.

Conclusions

The study highlighted the important role of the hip for correct execution of the turnout movement by maintaining lateral rotation during the whole jump duration. The smaller contributions of the knee and ankle to the turnout suggest a supporting role to dynamic adjustment for jump execution.

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References

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