HANDLING OF IMPACT FORCES IN INVERSE DYNAMICS IN LANDING AFTER A JUMP

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INTRODUCTION

The relation between impact dynamics of a landing after a jump and the cause of chronic injuries, like patellar tendinopathy (jumper's knee), has been the focus for research for many years. During impacts, impact force produces a shock wave, which travels through the subject's extensor mechanism. Net joint moments are a measure of load of the extensor mechanism (patellar tendon).

The purpose of this study was to detect the real contribution of the ground reaction force (GRF) and segmental acceleration in the sagittal net knee moment during the first part of impact of a landing after a jump by comparing a standard inverse dynamic method (SM) with an accelerometer based inverse dynamic method (AM).

METHODS

Seven healthy well trained male volleyball players participated in this study. The subjects were asked to perform a maximal counter movement jump, which was performed according the subject's own preferred style.

Two different inverse dynamic based methods were compared to study the impact dynamics of landing: the SM, using accelerations from filtered (20 Hz) position data and GRF, and the AM, using accelerations from accelerometers and GRF. Measurements of both methods were applied to a three segment rigid body model of the right leg.

RESULTS AND DISCUSSION

The net knee moment, calculated by the SM, showed major differences compared to the AM. These differences mainly took place during the first part of impact, from the time of touch down till approximately 35 ms later. SM showed an extension moment peak during impact, where the AM showed an oscillating effect: flexion moment peak, directly followed by an extension moment peak (figure 1). It turned out that this flexion peak was the result of an 'overestimation' of the moment caused by the horizontal accelerations.

Comparison of the segmental acceleration from position data used in the SM and from the AM showed good correspondence, indicating correctness of method and measurement data. The overshoot in horizontal accelerations can be explained by an underestimated correction factor [1] used to determine the linear acceleration of the centre of mass, using angular velocity and acceleration, which are calculated from position data. Furthermore, our rigid body model assumes that the foot is one rigid segment. Finally, we use a rigid body model without damping [2].

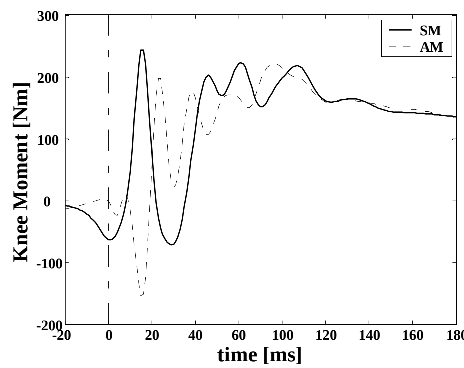

Figure 1. Net sagittal knee moment of a landing. Black line is the moment determined by the SM, and the dotted line is the moment determined by the AM

So, we can state that during impact the real contribution of GRF is for a great part neutralized by segmental acceleration of foot and shank, suggesting that the high impact peak moment shown by the widely used SM moment is be an artifact.

CONCLUSION

Our results showed major differences during impact in sagittal knee moment between the SM and AM. The SM, used in this study, is a widely used method to determine biomechanical parameters. When estimating net joint moments during impact in activities like running and jumping one should take into consideration the inaccuracy of the net joint moment during impact when using rigid body models. To our opinion, adjustments to the widely used filter techniques can overcome artifacts in net impact joint moments, by using the same cutoff frequency for both kinematic and force data. Complementary, we recommend not to consider impact peaks as the source of chronic overuse injuries, like jumper's knee.

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REFERENCES

1. Ladin Z., Wu G. *J Biomechanics* 24, 1173-1187, 1991
2. Gruber, K. et al. *J Biomechanics* 31, 439-444, 1998