A mathematical model of dynamic skate blade holders

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Summary

The design of ice hockey skates significantly impacts force generation, with the skate pitch angle being critical. Larger blade radii increase speed but reduce maneuverability, while smaller radii do the opposite. A dynamic blade holder with a radius rocker was developed to allow greater pitch angle variation without compromising ice contact. This study's mathematical model demonstrates that the rocker's curvature influences both the pitch angle and its amplification factor.

Introduction

The design of ice hockey skates impacts a player's force generation during skating, with the skate pitch angle (foot angle relative to ice) being a key factor (Figure 1, left). The longitudinal shape of the blade, usually shaped as a circle, influences both the range of pitch angles and the contact between the blade and the ice [2]. Blade radii between 9 and 13 feet (2.7–4 meters) are commonly used among players [1]. A larger radius leads to a smaller pitch angle and more ice contact, boosting speed but reducing maneuverability. Conversely, a smaller radius enhances maneuverability but decreases speed. To address this limitation and separate the need for a large ice contact area from skate maneuverability, a new dynamic blade holder has been developed, featuring a radius rocker positioned between the blade and the holder. Available in various sizes, the rocker rolls on the upper edge of the blade, avoiding direct contact with the ice (Figure 1, right). The purpose of this study was to create a mathematical model to understand and evaluate its functionality.

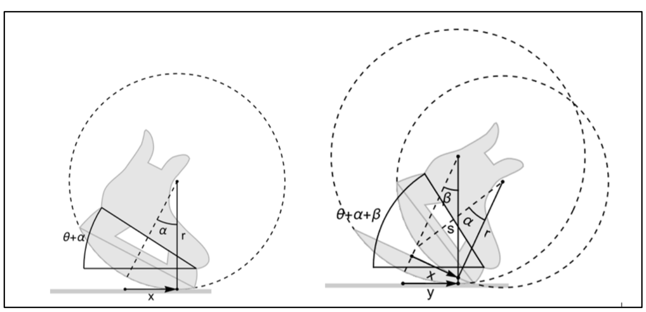

Figure 1. Illustration of a traditional (left) and a dynamic (right) skate holder for a forward-pitched skate. a, pitch angle due to blade radius curvature; θ, pitch angled due to differences in height between heel and toe; β, pitch angle due to the radius rocker within the blade holder; r, radius curvature.

Methods

Geometrical considerations were used to develop equations that describe the total pitch angle of the foot as a function of the contact point distance on the ice.

Results and Discussion

The rocker's radius of curvature (r) significantly impacts the pitch angle, while the blade's curvature (s) has a minor effect (Figure 2).

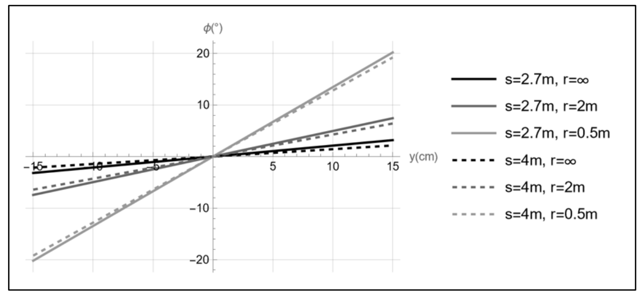

Figure 2. Total pitch angle of the foot as a function of the distance to the contact point with the ice along the blade for various values of the blade's radius of curvature (s) and the rocker's radius of curvature (r).

The pitch angle amplification factor increases as the rocker's curvature becomes more pronounced (Figure 3).

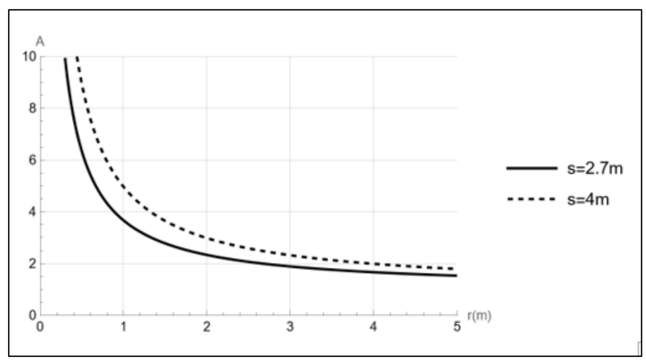

Figure 3. The amplification factor (A) of the foot pitch angle, for blade radii of 2.7 meters (solid line) and 4 meters (dotted line).

Conclusions

The dynamic blade holder allows for greater variation in skate pitch angle without affecting blade-ice interaction. The amplification factor of the pitch angle increases as the rocker's curvature decreases.

References

[1] Lockwood K et al. (2009). *Journal of ASTM International Journal*, 6: No 2.
[2] Pearsall DJ. (2000) *Exercise and Sport Science*; Lippincott Williams & Wilkin.