BIOMECHANICAL ASSESSMENT OF THE STOKO K1 SUPPORTIVE TIGHT

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Prepared by:

Calvin T.F. Tse[1]
Ryan Baker[2]
Joseph Ardell[2]

1. Graduate Programs in Rehabilitation Sciences, University of British Columbia, Vancouver, BC
2. Stoko Design Inc., Vancouver, BC

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Introduction

Knee bracing is commonly used to support weightbearing activities in individuals with knee injuries or instability [1]. Conventional knee braces use a rigid hinged frame for structural support, and Velcro straps for attachment onto the thigh and lower leg. After long periods of wear, these braces can become uncomfortable or migrate down the leg from their intended positions. The K1 (Stoko Design Inc., Vancouver, BC) is a novel knee bracing device that integrates an adjustable network of inelastic cables (spans across the knee joint, anchors around pelvis) into the fabric of a compressive athletic tight designed to support the knee (Fig. 1). During tests using a simulated triaxial knee loading apparatus, a white paper released by Stoko Design Inc. reported the K1 reduced external frontal plane knee moments similar to an industry-accepted 'gold standard' brace [2]. Considering its departure from traditional bracing design, a biomechanical assessment of the K1 is warranted to understand its effects during in vivo weightbearing activities.

Methods

Lower body biomechanics of ACL-deficient adults (n = 20, 8M/12F, mean age = 34.5 [8.8]) were assessed during overground walking, treadmill running, and single-leg drop landing (SL-Drop). In a randomized order, all activities were performed in the K1 and a control athletic tight. 3D motion capture of the lower body and ground reaction force (GRF) data were measured synchronously. Relative angles and external joint moments were calculated for the hip and knee with Visual 3D.

Self-perceived knee stability in each apparel condition and activity was rated on a 0 – 10 scale (0 = completely unstable, 10 = perfectly stable). A SL-Drop time to stabilization (TTS) was calculated as the time elapsed from initial contact to maintenance of vertical GRF between 95-105% bodyweight for one unbroken second. Differences in outcomes between the K1 and control tights were explored with T-Tests ($\alpha<0.05$).

Results and Discussion

Table 1 summarizes selected outcomes comparing the K1 with the control tight. At the knee, the peak valgus angle was reduced with the K1 during running and SL-Drop. At the hip, the frontal plane angle was more abducted with the K1 during all activities. This combined effect at the knee and hip suggests the K1 may serve to position the lower extremity further from the body's midline in the frontal plane. Considering the dynamic valgus knee injury mechanism involves both knee valgus angle and hip adduction, the observed changes in knee and hip frontal plane mechanics, as well as perceived stability with K1, could have implications for improving confidence in movement, and potentially injury risk.

Figure 1. Marker placements while donning Stoko K1

A negative correlation between the SL-Drop TTS (control) and the change in TTS with K1 was observed (Fig. 2). This suggests that individuals who are less stable (long TTS-control) may also experience greater improvements in TTS when supported with K1 (larger reduction in TTS).

Significance

The Stoko K1 is a novel knee brace that addresses many pitfalls of conventional rigid hinged frames while providing similar levels of support. Early investigation of the K1 indicates this brace may shift knee and hip joint angles away from joint positions frequently identified as injury mechanisms. Improved perceived stability could also benefit K1 users prophylactically and functionally support individuals recovering from injury.

Acknowledgments

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References

[1] Chew, Kelvin TL, et al. "Current evidence and clinical applications of therapeutic knee braces." American journal of physical medicine & rehabilitation 86.8 (2007): 678-686.

[2] Ardell & Bakker, 2020. Stoko K1 Support Verification

Table 1. Knee and hip biomechanical and perceived stability outcomes during activities with control tight and the change with Stoko K1.

Activity:	Walking		Running		Single-Leg Drop Landing	
Observed Outcome	Control	Mean Change	Control	Mean Change	Control	Mean Change
Knee Valgus Angle Peak (°) *	1.3 [3.1]	- 0.6 [1.4]	- 2.1 [2.8]	**- 1.1 [2.0]**	- 0.7 [3.7]	**- 0.8 [1.7]**
Knee Adduction Moment Peak (Nm/kg)	0.53 [0.14]	- 0.02 [0.07]	–	–	0.85 [0.32]	+ 0.05 [0.11]
Hip Adduction Angle Peak (°) *	5.6 [2.8]	**- 5.5 [2.5]**	7.8 [3.2]	**- 6.3 [2.4]**	0.6 [4.2]	**- 5.0 [2.0]**
Hip Adduction Moment Peak (Nm/kg)	0.79 [0.13]	**- 0.07 [0.11]**	–	–	1.27 [0.26]	- 0.06 [0.17]
Perceived Stability (0 – 10)	8.6 [1.0]	**+ 0.7 [0.7]**	7.5 [1.4]	**+ 1.5 [1.5]**	6.4 [1.7]	**+ 2.1 [1.4]**

Values reported as mean [standard deviation]. Bolded values indicate a significant difference between control tights and K1 ($p < 0.05$).
* Positive/negative angles indicate valgus/varus for the knee, and adduction/abduction for the hip, respectively.

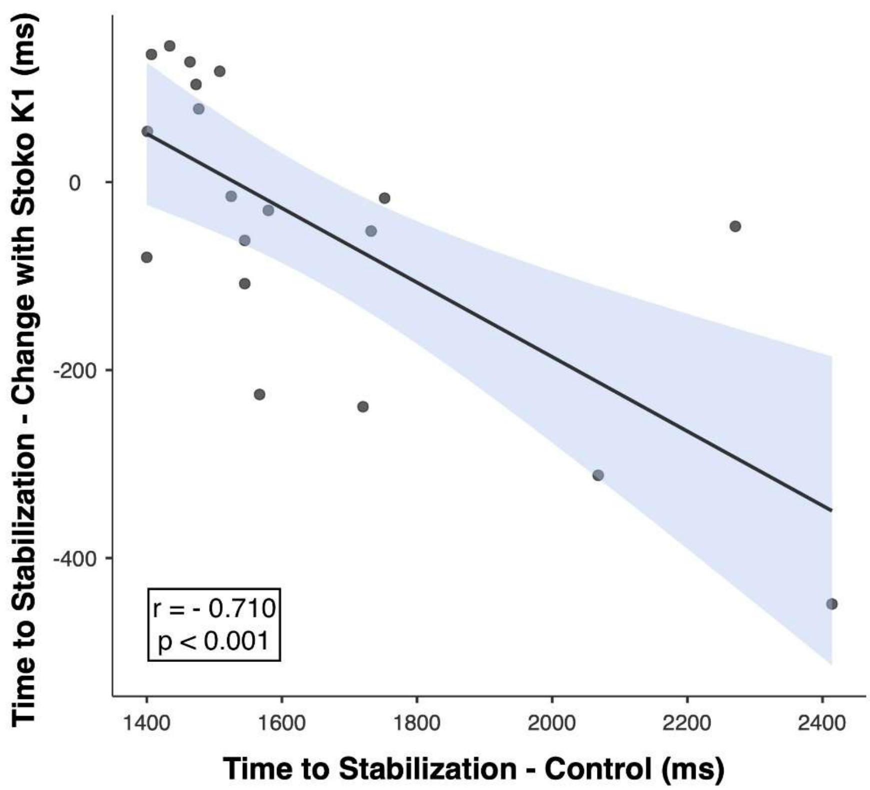

Figure 2. Correlation between TTS-Control and TTS-Change with K1