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Distal Thigh Compression Garment Improves Female Athlete Knee Control and Sports Movement Safety Perceptions

D. Boschert[1], J. Nyland[1], J. Matsuno[1], S. Pletz[1], W. Polio[2]

[1] MSAT Program, Kosair Charities College of Health and Natural Sciences, Spalding University Louisville, Kentucky, USA

[2] Department of Orthopaedic Surgery, University of Louisville, Louisville, KY, USA

CORRESPONDING AUTHOR:
John Nyland
Kosair Charities College of Health and Natural Sciences
Spalding University
901 South 4th Street
Louisville, KY 40203
Phone: 502-873-4224
E-mail: jnyland@spalding.edu

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SUMMARY

Introduction. This study measured knee frontal plane projection angle (FPPA) and sports safety and performance perceptions of female athletes during a single leg forward hop down and stabilization (SLFHS) for 3 conditions (standard knee sleeve, no device and distal thigh compression garment (DTCG)). The hypothesis was that the DTCG group would display superior dynamic knee valgus FPPA compared to the standard knee sleeve and no device groups.

Methods. Eighteen healthy college athletes participated in this prospective cohort study with a randomized device order. FPPA was measured during SLFHS using two-dimensional biomechanical techniques to estimate dynamic knee valgus loading. A 10-cm visual analog scale survey collected data regarding subject perceived knee control, sports movement capability and overall satisfaction for each condition. Pearson correlations delineated knee valgus, safety and performance relationship perceptions ($p < 0.05$).

Results. Mean/maximum dynamic knee valgus FPPA was lowest during the DTCG condition ($8.7 \pm 6°/12.2 \pm 7°$), or a 19.4%/21.3% range of motion reduction compared to the standard knee sleeve ($10.8 \pm 7°/15.5 \pm 8°$) and a 21.6%/17% reduction compared to the no device ($11.1 \pm 7°/14.7 \pm 7°$) conditions. Chi-square tests revealed that the T:25 group displayed a greater proportion of subjects with a "1" score (≤threshold value) than the standard knee brace or no device groups for both mean (one-sided p value = 0.02) and maximal (one-side p value = 0.049 FPPA). In relationship to maximum dynamic knee valgus FPPA, the DTCG was the best overall condition ($r = 0.61$, $p = 0.007$), relating more strongly to perceived knee control ($r = 0.63$, $p = 0.005$) and sports movement capability ($r = 0.64$, $p = 0.004$).

Conclusions. Compared to standard knee sleeve and no knee device conditions, the T:25 device provided better dynamic knee valgus FPPA control and stronger subject perceptions of best overall condition, knee control and sports movement capability.

KEY WORDS

Anterior cruciate ligament; injury prevention; knee bracing

INTRODUCTION

Poorly controlled dynamic knee valgus (frontal plane knee motion) during activities greatly increases non-contact knee injury risk, particularly among athletic girls and women (1-3). The combination of poorly controlled, hip adduction-internal rotation and knee abduction that occurs with the sudden single leg loading of many athletic maneuvers can transmit injurious loads to the medial collateral ligament, medial meniscus, and anterior cruciate ligament and may also contribute to lateral patello-femoral joint dislocation (1-3). Previous studies have evaluated how knee brace or sleeve use can help prevent knee injury (5-8). These studies have evaluated the influence of knee sleeve or brace use on standing balance, coordination, proprioception, and ground reaction forces (5-8). Little is currently known about the influence of knee brace or sleeve use on dynamic knee valgus during sports task performance.

Prophylactic knee bracing may help decrease subsequent knee injury frequency and severity during collision injury mechanisms in sports such as downhill skiing (9). However, prophylactic knee braces are also known to alter knee joint kinematics and lower extremity neuromuscular activation patterns (10-12) and supportive efficacy evidence is limited (2). Extraneous brace movement during athletic performance can make fit maintenance difficult, leading to poor device function and reduced wear compliance. Properly fit thigh compression sleeve or garment-based devices may provide greater comfort and less extraneous movement than strap-based devices which attempt to approximate the knee joint center with the axes of collateral hinges. Additionally, they do not provide the same level of rigid support. Athletes who are predominantly at risk for non-contact knee injuries may benefit from a thigh compression sleeve device that controls frontal plane knee motion without compromising athletic movement capability.

A distal thigh compression garment (DTCG) may enhance frontal plane dynamic knee stability through enhanced medial quadriceps femoris, medial hamstring and iliotibial tract-fascia lata function (13,14). The T:25 device (CEP Topical Gear, Whitsett, NC, USA) is a DTCG designed with two buttress pads positioned over the medial quadriceps femoris and the medial hamstring muscle groups to improve dynamic knee stability through enhanced neuromuscular control (**figure 1**) (15). The purpose of this prospective cohort study with randomized device order was to evaluate subject dynamic knee valgus frontal plane projection angle (FPPA) (16) and perceptions of sport performance and injury prevention capability during a single leg forward hop down and stabilization (SLFHS) task under three conditions (DTCG, standard knee sleeve (Procare Knee Support, DJO, LLC, Vista, CA, USA), and no sleeve at all. The hypothesis was that the DTCG group would display superior dynamic knee valgus FPPA and perceptions of sports performance and injury prevention capability compared to the standard knee sleeve and no device groups.

MATERIALS AND METHODS

Participants

University Research and Ethics Committee approval was sought and obtained. Subjects were recruited through university email carrying an electronic flyer with study information and through contact with the university coaching and athletic training staffs. All subjects that met study inclusion criteria and agreed to study participation signed a written consent. Eighteen subjects agreed to study participation. Inclusion criteria required that subjects were active university women athletic team members. Subjects were required

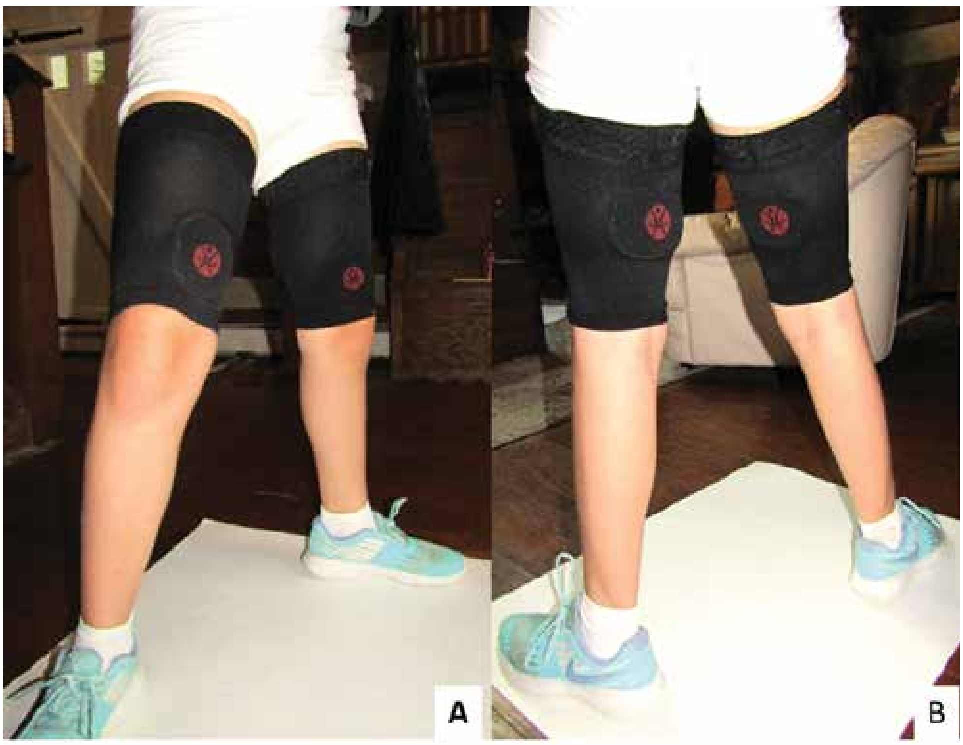

Figure 1. The DTCG group wore the T:25 device (CEP Topical Gear, Whitsett, NC, USA) (A) front, (B) back.

to be ≥ 18 years and could not have any knee injury history or current lower limb injuries. All subjects were healthy and between 18-22 years of age. Height ranged from 162-176 cm with a 166.7 cm mean. Weight ranged from 54.4-104.3 kg with a 75.6 kg mean. Six soccer players, 5 softball players, 3 basketball players, 3 volleyball players, and 1 track and field athlete participated in this study.

Two-dimensional kinematic data collection

Testing took place in the university athletic training laboratory. Subjects wore low top athletic shoes and snug fitting running shorts and tops during testing. Following a 10 minutes warm-up riding a stationary bicycle at a comfortable intensity and volitional stretching, subjects were instructed in SLFHS task performance from a 30.5 cm tall step. The dominant lower extremity was defined as the side that subjects preferred to use when kicking a soccer ball. While standing on the step, subjects were instructed to lift their non-dominant leg from the step and perform a forward hop down while landing with a flexed knee, while maintaining the landing position for three seconds. After performing 3 practice trials, retro-reflective markers were applied 13 cm distal to the anterior superior iliac spine (approximately anterior hip joint center), over the center of the patella (approximately knee joint center), and at the anterior leg 13 cm proximal to the medial malleolus (approximately lower leg sock line). Prior to data collection, subjects selected a sealed envelope that contained a device use order list. Following this, 3 SLFHS test trials were performed for each condition using the dominant lower extremity. A digital camera (120 Hz) (IPAD, Apple Inc., Cupertino, CA, USA) positioned 1.83 m from the step base and two-dimensional kinematic analysis software (Hudl, Agile Sports Technologies, IA, USA) were used to evaluate knee FPPA alignment during relaxed single leg stance and following ground impact. Both mean and maximal dynamic FPPA magnitudes were analyzed. Pilot testing revealed intraclass correlation coefficients of 0.91 and 0.89 for static and dynamic knee FPPA measurements, respectively, indicating very good measurement reliability (17). Subjects completed the perceived knee function survey immediately following task completion for each condition.

Perceived Knee Function Survey

Subjects completed several 10-cm visual analog scale (VAS) survey questions about their perception of the best overall condition, best knee control condition and best sports movement capability condition**.** The survey was modified from sports or exercise-induced symptom surveys (18-20). With end range descriptors of *Strongly Agree* and *Strongly Disagree* subjects responded to the following statements after completing each test condition: this condition provides better knee control; this condition best enables sports movements; and this condition is best overall. The survey was piloted tested for clarity and understanding on an age and gender matched group of college student-athletes prior to study use.

Statistical analysis

A priori statistical power analysis revealed than a minimum of 10 subjects would be needed to identify a 2° knee FPPA change at a beta error level of 80% and an alpha level of $p < 0.05$. Statistical analysis was performed using SPSS version 24.0 software (IBM-SPSS, Armonk, NY). An alpha level of $P < 0.05$ was selected to indicate statistical significance. A Kolmogorov-Smirnov Test revealed that data displayed normal dynamic knee valgus FPPA and survey response distributions. Based on overall cohort performance and the report of Jones et al (16), the mean FPPA threshold of good dynamic knee valgus control was set at 10° and the maximum FPPA threshold of good dynamic knee valgus control was set at 14°. Based upon these threshold values, subjects in each group were classified either as displaying a knee FPPA that was ≤ each threshold angle (=1) or > each threshold angle (=2). Following these classifications, Chi-Square tests were used to compare the proportion of subjects within each group that were assigned a score of 1 for mean or maximum knee FPPA. Pearson product moment correlations were used to determine relationship strength between dynamic knee valgus during SLFHS task performance and subject perceptions of condition-specific sports performance capability and knee safety.

RESULTS

Mean/maximum dynamic knee valgus FPPA was lowest during the DTCG condition (8.7 ± 6°/12.2 ± 7°), or a 19.4%/21.3% range of motion reduction compared to the standard knee sleeve (10.8 ± 7°/15.5 ± 8°) and a 21.6%/17% reduction compared to the no device (11.1 ± 7°/14.7 ± 7°) conditions. Chi-square tests revealed that the T:25 group displayed a greater proportion of subjects with a “1” score than the standard knee brace or no device groups for both mean (one-sided p value = 0.02) and maximal (one-side p value = 0.049) dynamic knee valgus FPPA (**figure 2**). Perceived Knee Function Survey results are presented in **figure 3**. Statistically significant differences were not evident with the exception of the knee sleeve condition which was scored the best overall condi-

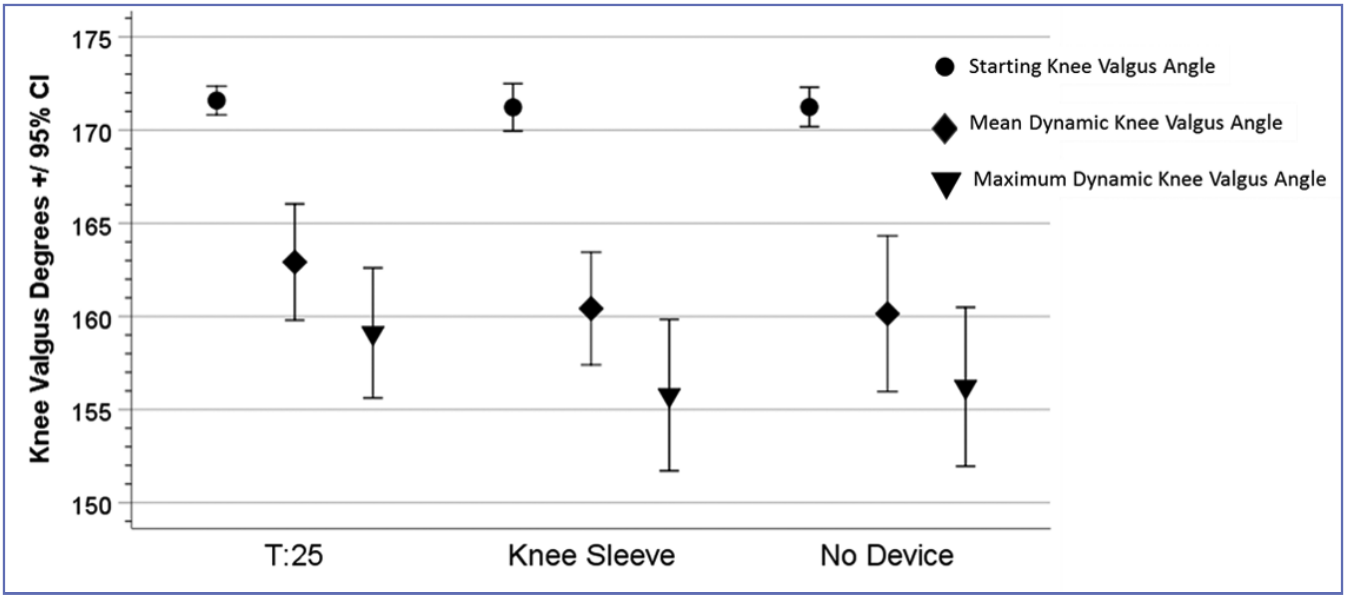

Figure 2. Chi-square tests revealed that the T:25 group displayed a greater proportion of subjects with a "1" score than the standard knee brace or no device groups for both mean (≤ 10°, one-sided p value = 0.02) and maximal (≤ 14°, one-sided p value = 0.049).

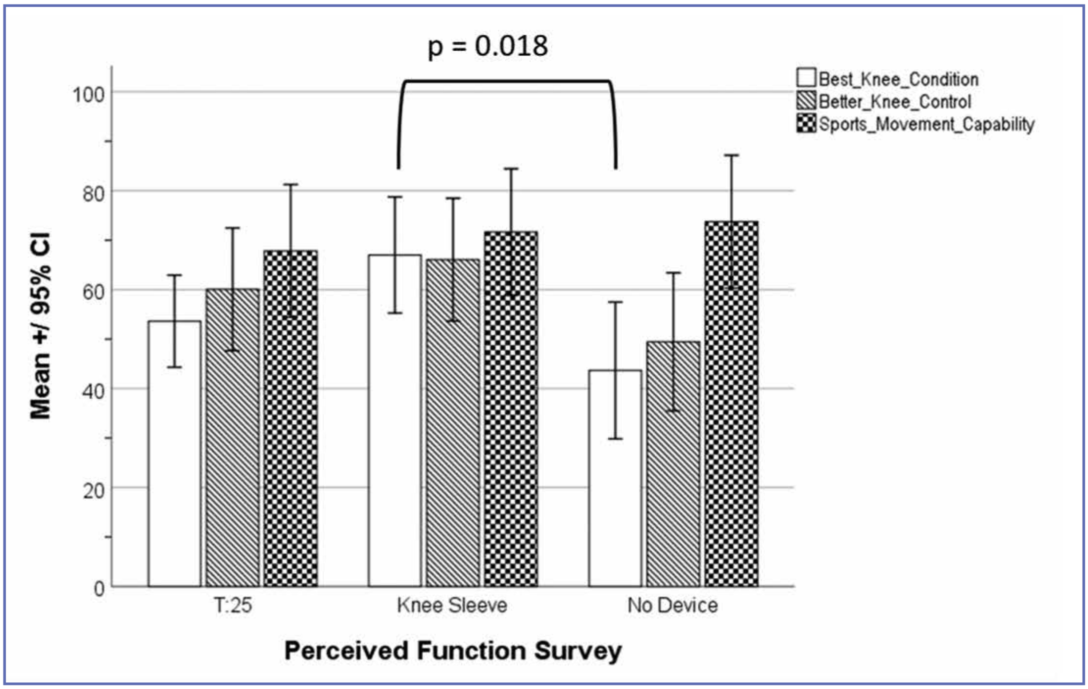

Figure 3. Perceived knee function survey data only revealed statistically significant group differences for the knee sleeve condition being superior to the no device condition.

tion compared to the no device condition. The only condition that displayed a statistically significant relationship between maximum or mean dynamic knee valgus FPPA during SLFHS, perceived best overall condition, best knee control, and best sports movement capability was the DTCG group (17). In relationship to both maximum and mean dynamic knee valgus FPPA values during SLFHS performance subjects perceived DTCG use as the best overall condition (r = 0.61, P = 0.007/r = 0.42, p = 0.04) (**figure 4**) to be more strongly related to sports movement capability (r = 0.64, p = 0.004/r = 0.53, p = 0.01) (**figure 5**) and to perceived knee control (r = 0.63, p = 0.005/r = 0.46, p = 0.03) (**figure 6**) than either the standard knee brace or no device conditions.

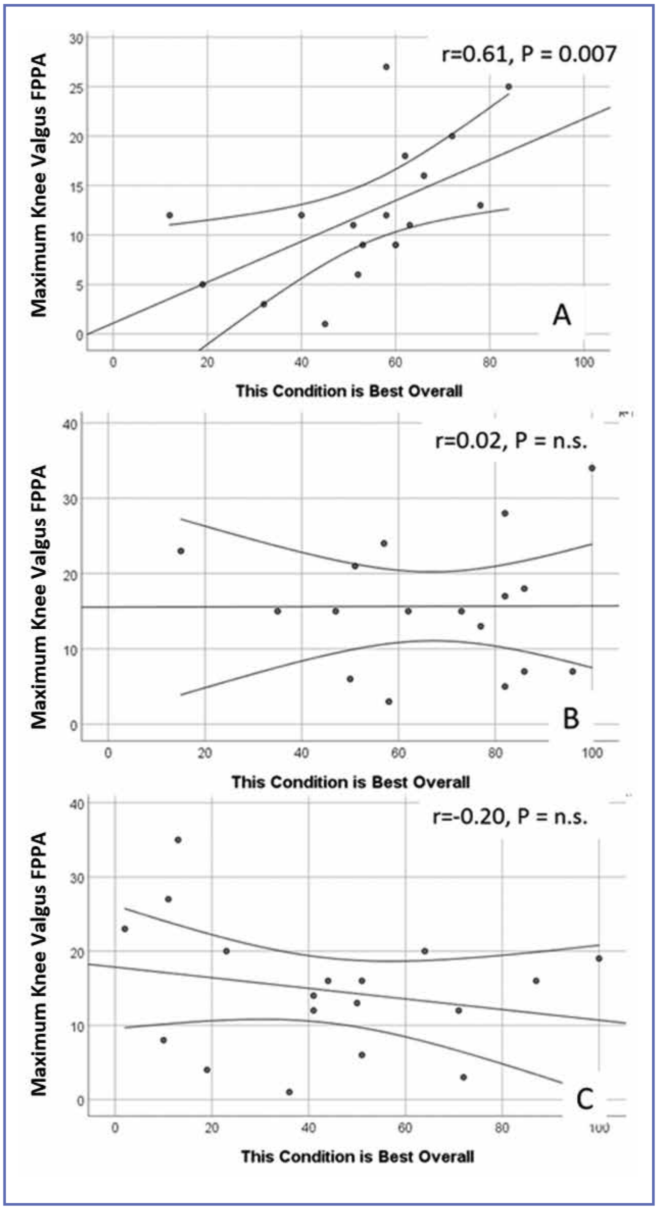

Figure 4. The DTCG (T:25) was the only condition that displayed a significant relationship between maximum dynamic knee valgus FPPA during SLFHS and subject perceptions of the best overall condition (A)(r = 0.61, P = 0.007); (B) standard knee sleeve; (C) no device.

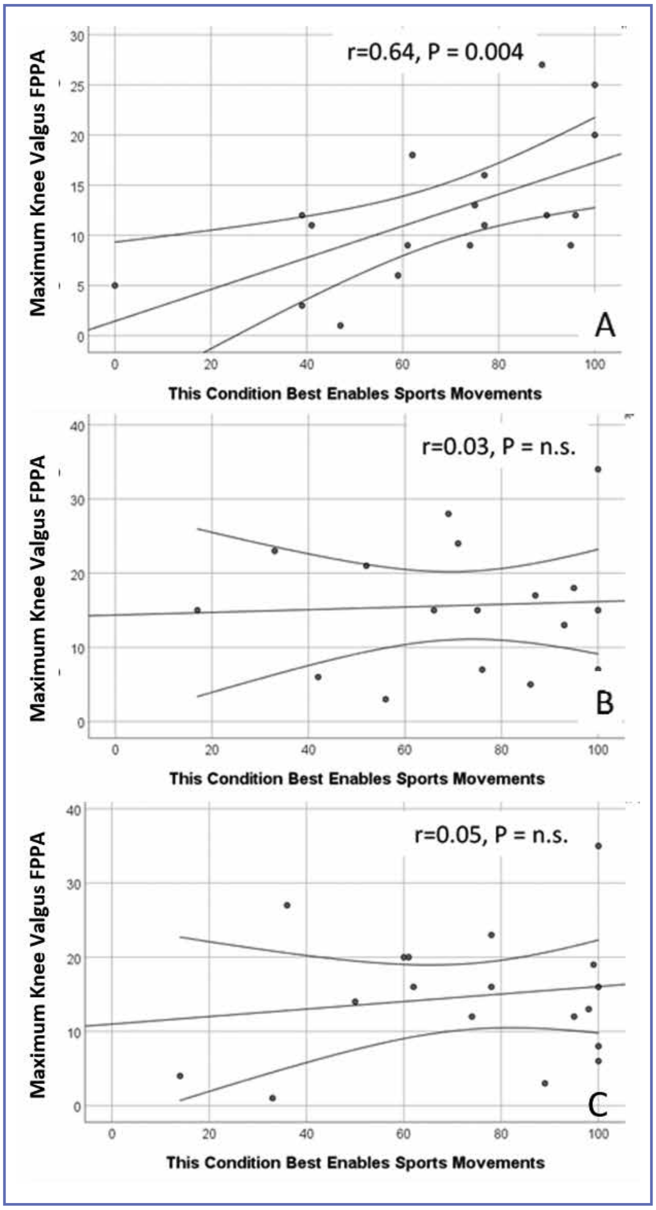

Figure 5. The DTCG (T:25) was the only condition that displayed a significant relationship between maximum dynamic knee valgus FPPA during SLFHS and subject perceptions of the condition that best enabled sports movements (A) (r = 0.64, p = 0.004); (B) standard knee sleeve; (C) no device.

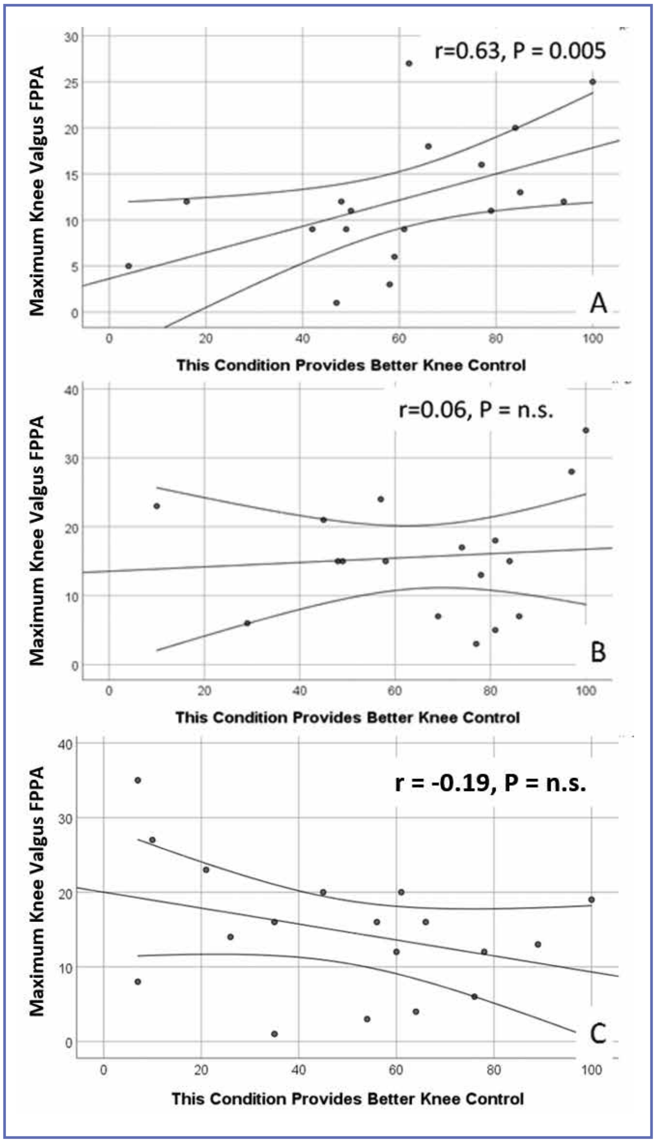

Figure 6. The DTCG (T:25) was the only condition that displayed a significant relationship between maximum dynamic knee valgus FPPA during SLFHS and subject perceptions of the condition that provided better knee control (A) (r = 0.63, p = 0.005); (B) standard knee sleeve; (C) no device.

DISCUSSION

The most important study finding was that most subjects had their lowest mean and maximum dynamic knee valgus FPPA during SLFHS performance with DTCG use. Secondly, DTCG use was the only condition that displayed significant mean and maximum dynamic knee valgus FPPA and perceived best overall condition, knee control and sports movement capability relationships. These findings provide both objective and subjective evidence that T:25 garment use provided superior dynamic knee valgus FPPA control during SLFHS task performance compared to standard knee sleeve or no device use.

The efficacy of prophylactic knee brace use (**table I**) and functional brace use post-ACL reconstruction (**table II**) remains questionable. Regarding prophylactic braces, several studies have shown that in comparison to non-braced conditions, brace use better controlled knee kinematics during single leg hop, cut, pivot and jump landing tasks (6,21-23). Some studies have also reported improved knee proprioception (5,24), while others did not observe improved proprioception compared to non-braced conditions (7,25). Some studies have also reported improved knee kinetics during hop landings or at least knee kinetics that did not compromise performance (26,27). However, others have reported altered knee kinematics and neuromuscular activation patterns with brace use (11). Some have concluded that if brace migration or movement is negligible then prophylactic knee brace use does not adversely influence running speed or agility (10,28). When the outcome variable focuses exclusively on injury prevention several studies reported increased (29-31) rather than decreased knee injury rates and one specifically mentioned fear of decreased performance adversely influencing brace use compliance (32).

For functional knee brace use post-ACL reconstruction, several studies have supported their potentially positive influences on knee kinematics, particularly lower leg rotational control (33-36), while others have supported their use for improving hop distance symmetry, but not landing mechanics symmetry (37). Their use, however, does not appear to improve clinical outcomes (38,39). When focusing solely on re-injury rates or secondary prevention following ACL reconstruction, supportive knee brace use efficacy could not be identified (40) and some suggest that avoiding their use better achieves improved subjective patient outcomes and reduced failure rates as defined by instability, stiffness or persistent pain (41).

Whether evaluating prophylactic or post-ACL reconstruction knee braces, two major considerations become evident. In controlled laboratory settings many braces display lower extremity kinematic control characteristics that suggest a potential capacity for knee ligament protection. However, when injury or re-injury rate reductions are the outcome variable, neither knee brace type displays strong efficacy. Traditional brace use for the purpose of contact or collision knee injury prevention has led to the development of more rigid designs, which rely on tight circumferential strapping to secure proper knee joint alignment. To date, little evidence supports this purpose. A current opinion report suggested that compression from functional knee brace

Table 1. Prophylactic Knee Bracing (VJ = vertical jump, GRF = ground reaction force, PF = patellofemoral, LE = lower extremity, IR = internal rotation, ER = external rotation).

Study	Study Type	Subjects and Condition	Measurement	Key Finding
Baltaci et al., 2011	Prospective cohort	Compared 5 different braces and non-braced condition among 24 healthy subjects during VJ, one-leg hop and squatting performance	Balance, coordination and proprioception	Hinged "H" brace was best for balance. Economy hinged brace was best for proprioception, coordination and squat force production.
Bodendorfer et al., 2019	Prospective cohort	Compared sleeve, hinged brace and no device conditions as 10 healthy subjects performed single leg drop VJ and single leg squats	Knee kinematics	Both devices reduced knee abduction during squats compared to no device. Hinged brace also decreased VJ knee abduction.
Bottoni et al., 2013	Prospective cohort	Compared brace with collateral hinges/ PF stabilization, sleeve with collateral bars and no brace among 20 healthy sports students	Threshold to detection of passive knee movement	Neither brace influenced proprioception compared to the non-braced condition.
Ewing, Begg, Galez & Lee, 2016	Prospective cohort	Compared bilateral braces to no braces among 15 recreational athletes during 0.3 and 0.6 m double-leg drop landings	LE kinetics	Increased knee flexion at peak GRF, increased peak hip negative power and work without changing knee/ankle energetics.
Giotis, et al. 2011	Prospective cohort	Compared hinged brace, PF sleeve or no device among 21 healthy subjects during single leg landing and pivoting movements	LE kinematics	Hinged brace with proximal and distal straps decreased lower leg rotation compared to the other conditions.
Grace et al., 1988	Prospective cohort	Compared 247 American High School football players who wore braces to 250 matched players who did not over two seasons	Knee Injury Rate	Braced group had more knee injuries and more foot and ankle injuries.
Greene, Hamson, Bay & Bryce, 2000	Prospective cohort	Evaluated the effects of braces on the speed and agility of 30 fully equipped American college football players	40-yard dash, agility drills, brace movement	Brace use did not reduce speed or agility, however, brace migration tendencies could negate protection and performance findings.
Hanzlikovaa et al., 2016	Prospective cohort	Compared braced and non-braced conditions among 12 healthy subjects during single leg step down, drop jump, pivot turn jump tasks	Knee kinematics	Brace use reduced knee valgus and IR.
Hobara, Hashizume & Kobayashi, 2017	Prospective cohort	Compared the effects of braces on leg stiffness of 13 healthy males during one-legged hopping	Knee kinetics	No knee stiffness changes. Braces do not significantly interfere with dynamic hopping activities.
Kaminski & Perrin, 1996	Prospective cohort	Compared braced and non-braced condition of 36 healthy subjects	Proprioception, postural sway, and balance	Center of balance and sway differed between braced and non-braced conditions, but bracing did not influence position sense
Marchini et al., 2014	Prospective cohort	Compared standard brace with new generation braces among 16 healthy subjects	Muscle forces, proprioception, balance, perceived function.	New generation braces had better muscle force accuracy, knee proprioception, subject comfort and perceived performance
Mortaza et al., 2012	Randomized controlled trial	Compared the effects of a brace and two neoprene sleeves on the performance of 31 healthy men	Single leg VJ, crossover hops, isokinetics	Braces and sleeves did not inhibit performance. Further studies needed to evaluate effects at adjacent joints.
Osternig & Robertson, 1993	Prospective cohort	Compared braced and non-braced conditions during running	LE position and muscle activation	Braces altered knee kinematics and LE neuromuscular activation patterns.
Pietrosimone et al., 2008	Systematic review	Studied brace use efficacy for decreasing American college football player knee injuries	Knee Injury Rate	3 studies found decreased injuries, 4 studies found increased injuries.
Rishiraj, et al., 2009	Systematic review	Evaluated the efficacy of bracing to prevent knee injury and maintain performance among healthy subjects	Knee Injury Rate, sports performance	Braces may help disperse impact ground reaction forces. Limited use efficacy due to fear of performance hindrance and poor use compliance.
Salata, Gibbs & Sekiya, 2010	Systematic review	Evaluated bracing efficacy for medial collateral ligament injury prevention among American football players	Knee Injury Rate	One study reported reduced injuries, two studies reported increased injuries. Did not support.
Sinclair, Vincent & Richards, 2017	Prospective cohort	Evaluate the effects of brace and no brace use during netball sport movements	Knee kinematics/ kinetics during running, cutting, VJ and perceived function	No difference in kinetics. Decreased IR-ER and better perceived knee stability with brace use.

Table 2. Post-ACL reconstruction brace use.

Study	Study Type	Subjects and Condition	Measurement	Key Finding
Giotis et al., 2016	Prospective cohort	Compared brace use, PF sleeve use, and no device among 20 men post-HS autograft ACL reconstruction during two-legged jump lading from a platform and pivoting on one foot	Lower leg rotation	Although not as good as at non-surgical knee, both brace and sleeve decreased excessive tibial rotation
Giotis et al., 2013	Prospective cohort	Compared brace use, PF sleeve use, and no device among 20 men post-BPTB autograft ACL reconstruction during two-legged jump landing from a platform and pivoting on one foot	Lower leg rotation	Although not as good as at non-surgical knee, both brace and sleeve decreased excessive tibial rotation
Hanzlikova, Richards, Hebert-Losier & Smekal, 2019	Prospective cohort	Compared proprioceptive knee brace compared to no brace among 15 subjects at 2-10 years post-ACL reconstruction (8 BPTB, 5 HT autograft, 2 allograft) during a pivot turn jump and single leg drop tasks	Knee kinematics	Brace use reduced peak knee external rotation and total transverse plane range of motion and increased maximum knee flexion angular velocity. Most subjects perceived easier task performance with brace use
Lowe, Warth, Davis & Bailey, 2017	Systematic Review	Using PubMed and Embase databases, 15 articles were identified that compared braced and non-braced conditions	Clinical and in vivo biomechanical including kinematics, strength, function, and proprioception	Brace use may benefit in vivo knee kinematics and help protect the graft. Limited evidence exists to support use for decreasing re-injury rate.
Martinek & Friederich, 1999	Meta-analysis	Compared experimental and clinical efficacy of brace use to prevent re-injury following ACL reconstruction	Knee Re-injury Rates	Could not identify supportive efficacy for post-surgical knee brace use
Naik, Das & Kamat, 2019	Retrospective cohort	Evaluated the functional outcome of 32 consecutive patients between 3-12 months post-ACL reconstruction using HS autograft and no braces.	Lysholm knee score, failure rates	Mean Lysholm knee score improved from 88 at 6 months to 91 at 12 months. Avoidance of bracing prevents ACL graft re-rupture.
Peebles, Miller, Moskal & Queen. 2019	Prospective cohort	Compared hop testing symmetry of 28 patients post-ACL reconstruction after being released to sport and again 3 months later with and without knee brace use.	Kinetics, LSI, single, triple and crossover hop for distance.	Brace use improved hop distance symmetry during the early return to sport period, however, asymmetrical loading mechanics persist.
Rodriquez-Merchan. 2016	Systematic Review	Using the Medline database, 28 articles were identified about brace use following ACL reconstruction and published between 1995-2013	Influence of post-ACL reconstruction bracing on pain, function, rehabilitation or stability.	Post-operative bracing post-ACL reconstruction does not seem to influence pain, function, rehabilitation or stability.
Yang, Feng, He, Wang & Hu, 2019	Systematic Review	Compared RCT for efficacy of post-ACL reconstruction brace use	Knee function scores and stability evaluations	Bracing did not appear to improve the clinical outcomes and stability of ACL-reconstructed knees.

use abnormally elevates thigh and leg intramuscular pressure beneath knee brace straps decreasing blood flow and muscular oxygenation, inducing pre-mature fatigue, impairing muscle function and decreasing performance (12).

The T:25 was better at controlling mean and maximum knee FPPA (dynamic valgus) than a standard knee sleeve or no device. Additionally, T:25 use was the only condition tested that displayed a significant relationship between mean or maximum dynamic knee valgus FPPA and subject perceptions of its use being the best overall condition, best for sports movement capability, and best for knee control. Significant relationships between these variables were not observed for the standard knee sleeve and no device conditions. Study findings suggest that T:25 sleeve use may help prevent the dynamic knee valgus that is highly related to non-contact injuries among female athletes (4).

The T:25 manufacturer suggests that localized pressure provided by oval-shaped buttress pads positioned over the medial quadriceps femoris and medial hamstring muscle groups enhances the neuromuscular activation that improves dynamic frontal plane knee stability (15). Since the current study did not include electromyographic analysis, we cannot support or deny this premise. However, the extensive gluteus maximus muscle insertion to the iliotibial tract suggests that it functions as its tendon of insertion in transferring hip region forces to the lower leg (14). Given the powerful hip joint extension and external rotational forces generated by the upper gluteus maximus (13) through the femur proximally and distally through lateral tibia abduction-external rotational forces, one can better appreciate its capacity to resist excessive or poorly timed dynamic knee valgus loading. In addition to any direct neuromuscular effects generated through medial quadriceps femoris and medial hamstring muscle group activation, the compressive forces generated across the iliotibial tract and fascia lata proximal to the knee joint likely improves gluteus maximus muscle activation efficiency, kinesthetic acuity, or both. Further studies are needed with other sports and athlete populations who are at high non-contact knee injury risk such as soccer, team handball, basketball and tennis.

There is a growing understanding and appreciation for fascial system linkages through the thoracodorsal fascia, iliotibial tract, fascia lata and quadriceps tendon (14,42) with dynamic intersegmental contributions from powerful gluteus maximus (43) and latissimus dorsi muscles. Rehabilitation clinicians continue to search for innovative ways to decrease knee injury risk without the over constraint from rigid knee braces that creates maladaptive primary or adjacent joint compensations, increased discomfort, decreased performance and reduced use compliance. Subjective athlete perceptions of the T:25 suggests that use compliance would likely be good. Devices such as the T:25 may represent the threshold of a significant shift in protective and performance enhancing knee protective device development (24).

Limitations

This study is limited in that kinetic evaluation of lower extremity joint moments and electromyographic evaluation of neuromuscular activation patterns were not performed. Further studies are needed to evaluate these important factors. Another limitation was that we did not control for menstrual cycle phase which is known to influence female athlete ACL injury risk (44). However, each subject performed each condition in a randomized assignment order, thereby controlling for this possible confounder. These factors withstanding, study findings based on kinematic and subject perception data provide encouraging results. Non-contact knee injuries in all athletes, but particularly among females are known to be associated with excessive, or poorly controlled frontal plane knee motion (1,3,4,45). Although compression garment use above the knee has not been found to improve proprioception through dynamometer target angle position tests, these findings likely differ considerably from the knee joint neuromuscular control demands associated with functional movements (46). Most knee ligament injuries that require surgery are associated with non-contact mechanisms associated with poorly aligned or controlled biomechanical joint forces during running directional changes, sudden stopping-starting, and single leg jump landings (4,45). Across widely diverse sports, it has been shown that non-contact knee injuries are the predominant mechanism for medial collateral ligament, meniscus and anterior cruciate ligament knee injuries. Therefore, devices that enhance dynamic neuromuscular knee control rather than increased mechanical constraints are of primary importance.

CONCLUSIONS

Compared to standard knee sleeve and no knee device conditions, the T:25 device provided better dynamic knee valgus FPPA control and stronger subject perceptions of best overall condition, knee control and sports movement capability.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

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