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Influence of Moderate Prophylactic Compression on Sport Performance

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Abstract. Bernhardt, T., and G.S. Anderson. Influence of moderate prophylactic compression on sport performance. *J. Strength Cond. Res. 19(2):292–297. 2005.*—This study examined the impact of using elasticized compression shorts on performance measures and proprioception at the hip. Thirteen healthy subjects completed 2 randomized testing sessions—one while wearing the Coreshorts compression shorts and one while not wearing the shorts. During each trial, active range of motion at the hip; joint angle replication during hip flexion, abduction, and hyperextension; leg power; agility; speed; and aerobic endurance were measured, and subjective information pertaining to the fit of the shorts was collected. The use of the prophylactic brace did not limit performance on any measure except active range of motion during hip flexion ($p < 0.05$). Subjective data revealed 93.3% of subjects felt the shorts were supportive, although proper fit was an issue. The present results support the use of moderate compression at and around the hip for the purpose of injury prevention. Continued research is necessary to determine the efficacy of hip bracing within an injured population and their potential prophylactic benefit for active individuals.

Key Words. compression shorts, injury prevention, athletic performance, proprioception, aerobic capacity

Introduction

Groin injury can be a debilitating experience for athletes competing in sports that require quick acceleration and sudden directional changes. Groin pain is common to a broad range of injuries that occur in the abdominal, hip, pelvic, or thigh areas (16, 17, 25), although such pain is most frequently associated with muscle strain (2, 15, 37). Although approximately 5% of the active population seen for clinical treatments report groin pain, groin injury accounts for a disproportionately large amount of lost competition time in athletes (3).

Those who suffer a groin injury are considered to be at increased risk of recurrence, and subsequent injuries are typically more severe and require longer rehabilitation than the original injury (3, 26). These injuries often occur in multidirectional sports with sudden high-velocity or high-force contractions and decelerations. For example, of the groin or abdominal injuries reported in the National Hockey League, 76% were groin injuries, with 68–82% involving the adductor muscle group. The risk of injury was found to increase with years of play in the National Hockey League, with a significant rate of reinjury (17–23%). Most of the groin injuries were attributed to internal causes, with 91% of the injuries not involving contact. Of possible causes studied, no associations were found between injury and peak isometric adductor torque, abductor flexibility, or skate blade hollow, whereas off-season training decreased risk (15, 16).

In an attempt to reduce sport injuries, many athletes are turning to prophylactic and functional braces for protection, support, compression, restriction of movement, immobilization, and proprioceptive enhancement (46). Although the effectiveness of a brace varies depending on brace design, use, and the athlete's inherent joint stability, braces have been found to be comparable or superior to athletic tape in restricting range of motion (ROM) and providing support (39, 43). However, Verhagen et al. (43) caution that restricted ROM does not necessarily increase protection. The influence of bracing on performance has been a point of contention for many competitive athletes. Although braces have been frequently used during the care of acute injuries, they are becoming more popular in injury prevention.

The use of compression shorts in injury prevention and rehabilitation has become popular during the last decade with the commercialization of compression-type athletic wear. Although light compression (via spandex) has not been found to hinder performance (22, 23), garments that offer more compression have not been well studied. To fill this niche, this study examined issues of performance and proprioception at the hip with the use of elasticized compression shorts that offer considerably more compression and resistance to movement (similar to athletic training compression wraps using tensor bandages). Specifically, this study examined measures of active ROM (AROM), balance, agility, proprioception, endurance, and power of healthy young adults both wearing and not wearing elasticized compression shorts.

Methods

Experimental Approach to the Problem

Using a randomized crossover study design, this study examined the performance of active young adults while they were wearing compression shorts (Coreshorts, Abbotsford, Canada) designed to offer elastic and compressive support to the anatomic structures of the hip (Figure 1). This allows comparison of performance with and without the compression shorts across several variables, allowing determination of the ergogenic or detrimental effects of wearing the compression shorts during performance of fitness and proprioceptive tasks.

Subjects

Ten men and 3 women (mean age 25.69 years) participated in the present study. All subjects were apparently healthy, active young adults recruited from a university population. Subjects were screened for size to ensure the brace prototype would fit properly, because only 2 sizes of the prototype were available. Written informed consent

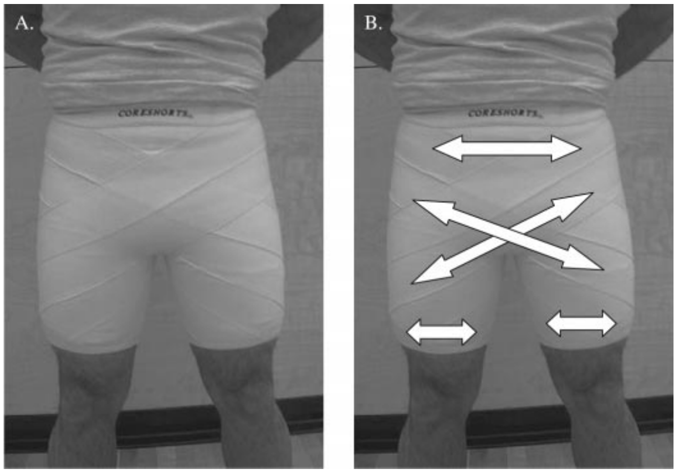

FIGURE 1. A, Photograph of the Coreshorts prototype and the elastic arrangement. B, Photograph with vector lines representing lines of tension.

was obtained before all testing, whereas subjects were medically screened for apparent health disorder or unresolved musculoskeletal injury. Ethical approval for the study was obtained from the university research ethics committee.

Coreshorts

Coreshorts are elasticized compression shorts that offer both compression and resistance to increased ROM. The compression offered is significantly more than would be found in spandex compression shorts, similar to that described by Doan et al. (14). In a static standing position the garment offers circumferential compression, whereas on movement the diagonal band orientation provides multidirectional tension. The design mimics the functional anatomy of the hip area and, in particular, the anterior and posterior diagonal slings as described by Vleeming et al. (44). Duplicating the diagonal slings allows the Coreshorts to support force closure for the core and hip areas, providing support for injury prevention and functional return to activity after injury during multidirectional activities.

Procedures

All subjects completed the test battery twice, once while wearing Coreshorts and once without. The trial performed while wearing the compression shorts was the first activity performed in the shorts after determining proper fit. A randomized crossover design was used with 7 subjects performing with and without the shorts on each trial. The AROM measurements were performed using a Leighton Flexometer (Leighton Flexometer, Inc., Spokane, WA) placed on the anterior or lateral aspect of the subject's thigh. Supine hip flexion, prone hip hyperextension, and standing hip abduction were each measured twice. A standing measure of joint angle replication was performed with the hip flexed, abducted, and then hyperextended to 30°. The subject was actively moved to the target angle and cued to remember that position. The subject then attempted to replicate the target joint angle twice (similar to Barrack et al. (4)).

Balance was assessed using a stork stance while the subjects had their eyes closed. One timed trial was allowed. The Canadian Physical Activity, Fitness, and Lifestyle Appraisal (10) vertical jump protocol was used to assess leg power, with each subject completing 2 trials. The T-test was used to assess agility with 1 timed trial (33, 38, 43). One trial of a timed 20-m dash was conducted to test speed, whereas the 20-m multistage shuttle run was performed to assess aerobic capacity (27, 28).

Subjects who completed the test battery while wearing the Coreshorts were asked to complete a subjective evaluation of the device. The subjects were asked to indicate their level of agreement for 6 statements regarding comfort, fit, support, hindering or enhancing performance, and whether they would wear Coreshorts during sporting activities. Each statement was ranked on a 5-point scale from strongly disagree (rated as 1) to strongly agree (rated as 5). Subjects were given space to specify which sport they play and were also encouraged to write any additional comments on the questionnaire.

Statistical Analyses

The largest angle produced during each of the AROM movements was used for analysis. Similarly, the best of 2 trials was used for the power measurement. The value from the 2 joint replication trials that was closest to the target joint angle was used for assessment. This value was represented as absolute error in degrees. All other tests used the value obtained during the single trial. A comparison of means between the braced and unbraced condition for each test was performed using an analysis of variance. The criterion for statistical significance was set at $p \leq 0.05$. Interclass correlations were performed between braced and unbraced conditions to determine the relationship between scores in both experimental conditions. The percentage of subjects who responded to each statement of the subjective evaluation in the same way was calculated.

RESULTS

Test results (mean $\pm$ *SD*) are summarized in Table 1 for the 10 men and 3 women who completed both experimental conditions. No statistical differences ($p \leq 0.05$) between the braced and nonbraced conditions were found except for AROM during hip flexion ($p = 0.016$). Interclass correlations were high ($r > 0.80$) for hip hyperextension, agility run, vertical jump, speed, and aerobic capacity measures. Interclass correlations were poor ($r < 0.05$) for joint AROM duplication during abduction and hip flexion.

Responses to the 6 statements of the subjective evaluation indicate that subjects did not find the shorts to hinder performance. To the statement *I feel the shorts are comfortable,* 46.15% disagreed, 30.77% neither agreed nor disagreed, and 23.08% agreed. A total of 61.53% of subjects disagreed or strongly disagreed to the statement *I feel the shorts fit properly,* with 23.07% who either agreed or strongly agreed. A total of 93.31% of the subjects agreed or strongly agreed with the statement *I feel the shorts are supportive,* with only 7.69% responding neutrally and no disagreement. Results for the statements *I feel the shorts hindered my test results* and *I feel the shorts would enhance my performance* were identical. There were no strongly agree or strongly disagree responses for either statement, whereas 61.54% had a neutral response. Slightly more subjects agreed (23.08%) than disagreed (15.38%) with the statements. Finally, to the

Table 1. Test results for each test condition.*

Test	Mean ± *SD*		p value
	No Coreshorts	Coreshorts	
Active range of motion			
Flexion (n = 13)	98.25 ± 8.86	88.50 ± 8.80	0.016
Hyperextension (n = 13)	37.67 ± 10.60	38.67 ± 6.48	0.799
Abduction (n = 13)	64.83 ± 13.88	69.25 ± 23.71	0.745
Joint angle replication (°)			
Flexion (n = 13)	2.58 ± 3.09	2.33 ± 2.81	0.755
Hyperextension (n = 13)	1.75 ± 2.25	2.33 ± 2.88	0.219
Abduction (n = 13)	1.42 ± 2.00	2.08 ± 2.73	0.572
Balance (s)			
Stork stance (n = 13)	24.22 ± 28.39	24.21 ± 18.78	0.896
Power (m)			
Vertical jump (n = 13)	0.46 ± 0.9	0.46 ± 0.11	0.850
Agility (s)†			
T-test (n = 12)	11.81 ± 1.07	11.68 ± 1.17	0.993
Speed (s)			
20-m dash (n = 13)	3.46 ± 0.39	3.43 ± 0.36	0.885
Aerobic capacity (ml·kg·min^{-1})			
20-m shuttle run (n = 13)	49.64 ± 8.34	49.88 ± 8.70	0.719

* $F_{1,24}$ $p < 0.05$ for all tests unless otherwise indicated.
† $F_{1,22}$ $p < 0.05$.

statement *I would wear these shorts during sporting activities,* 30.76% either disagreed or strongly disagreed, whereas slightly more (38.46%) agreed or strongly agreed.

Before participation in the study, subjects tried on the shorts and were asked if they would feel comfortable wearing the shorts for 1 hour and if they would be able to perform running and jumping activities while wearing the shorts. However, because there were only 2 sizes of the prototype shorts available (a medium and large based on proportionate waist, hip, and thigh girth), short fit was an issue. Subjects complained of elastic compression over the gonadal area and tightness around the lower thigh with subjects who exhibited wide ranges of thigh girth for a given hip and waist girth. The only area where constant compressions could not be maintained was at the inguinal crease during flexion at the hip. No sex differences in responses were apparent.

Discussion

Results from previous studies that examined the efficacy of joint bracing vary, depending on the joint, testing procedure, and brace selection, although it is generally agreed that braces have little adverse effect on most activities other than vertical jump (8, 9, 29). Because these studies were not conducted with hip braces, it was necessary for this pilot work to examine the effect of hip bracing on performance in a healthy population before proceeding to injured individuals. Although long-term brace use has been found to have no effect on muscle firing (13), reduced electromyographic activity has been recorded during brace use (32, 45). The research of Osternig and Robertson (32) indicates there may be a change in neuromuscular control of the lower extremity due to a significant change in ROM for braced subjects during running. Whether electromyographic activity and neuromuscular control changes are related is unclear. Subjective evaluations of brace use are generally positive, with subjects feeling more confident and less pain due to delayed-onset muscle soreness and reporting that the brace enhanced test performance (7, 24, 25).

Subjective evaluations of the compression shorts used in the present study are similar to those reported previously for neoprene compression sleeves (7, 24, 25). The Coreshorts prototype used in the present study was designed to provide multidirectional support, offering increased resistance to excessive motion at the hip joint in each plane of motion. Subjective evaluations suggest that most subjects (93.31%) felt the shorts were supportive. When asked if the brace hindered their test results and if the brace would enhance their performance, the results were identical. These statements appear contradictory; however, additional comments provided by the subjects and the responses to the statement about comfort (46.15% disagreement) clarify this discrepancy. Only one size of the Coreshorts prototype was used for this study. Although all subjects were able to fit into the brace, the comments on the questionnaire centered around sizing changes that would enhance comfort and result in performance enhancement. Therefore, when responding to statements about the current test, the subjects felt supported; however, discomfort made them feel hindered. When responding to the statement *I feel the shorts would enhance my performance,* an addendum for proper fit was often included. Although the subjects recognized a benefit to the use of the brace, sizing changes were necessary. Specific suggestions for changes to sizing included separate thigh and waist measurements or the addition of a lacing or strap system to achieve a more customized fit.

The only significant performance difference between the braced and unbraced condition was found in AROM during hip flexion, similar to the findings of Doan et al. (14). The fact that there were no differences in AROM during hyperextension and abduction of the thigh may indicate a restriction in ROM only with large changes in joint angle, which may be beneficial in preventing injury while allowing functional movement. The increasing resistance offered by the elastic brace material when it is lengthened applies a progressive force to limit movement into an individual's end ROM. This may prevent injury in itself and/or work by aiding thigh deceleration during such movements as the follow-through of a soccer kick.

It has been hypothesized that the resistance provided by a brace will fatigue muscles more quickly, resulting in an increased risk of injury as proprioceptive control is decreased. Previous research has found a decrease in an individual's ability to distinguish different movement speeds, replicate joint angles, or detect thresholds of movement after fatigue (11, 34, 41), whereas many others have not found any significant decrease in test measurement (18, 41). Although differing protocols, joints, and targeted mechanoreceptors make comparisons difficult, the present results (which found similar aerobic capacity during compression shorts and noncompression shorts trials) do not support the notion that compression shorts contribute to fatigue in repetitive movement. The present results support previous work that found no significant differences in postexercise lactate levels in individuals wearing elastic tights (5) and reports of increased venous blood flow during compression garment use (31). These results are supported more recently by Kraemer et al. (22), who found no improvement in single maximal jump powers but found compression shorts helped maintain higher jumping power during repetitive vertical jumps.

Proprioception allows an individual to know where body segments are in space, direction and speed of movement, and amount of force applied through information received from mechanoreceptors located in the skin, muscles, tendons, ligaments, and joint capsules (7). Each mechanoreceptor is found in a different location and responds in a unique way to specific stimuli. Researchers know that factors such as aging, joint effusion, and anesthesia have a negative impact on an individual's proprioceptive ability (35); however, the specific contribution of each proprioceptor to the total control mechanism is not certain (18). An individual's inherent proprioceptive capability appears to be an important component in the effectiveness of any intervention. Several studies have found that individuals with poor inherent stability or proprioception derive the greatest benefit from an external support (7, 9, 35). Initial research into proprioception concentrated on the role of capsular receptors that were believed to be a major contributor to stability (18, 41); however, the focus has recently shifted to the response of muscle spindles (18, 42).

Activation of cutaneous tactile mechanoreceptors or electrical stimulation of mechanoreceptive afferents has been shown to reduce presynaptic inhibition in both the leg (20) and the arm (1). Since proprioception is affected by input from muscle spindle afferents, this would have the net effect of increasing proprioceptive sensitivity. Although it is reasonable to suggest that compression shorts strongly activate cutaneous mechanoreceptors around the hip, similar improvements in proprioceptive sensitivity may result from their use (although there is no direct evidence to support this).

There is growing evidence that movement of skin overlying stretching muscle triggers cutaneous receptors to send important joint position information to the brain (30, 40). Skin stretch has been found to be an important source of proprioceptive information (12). If compression enhanced this effect, it might also yield increased sensitivity, supporting the use of bracing material around the joints. The compressive quality of elastic braces is thought to make the stimuli of underlying muscle movement more prominent, thereby enhancing activation of these cutaneous receptors (9, 40). Due to the number and complexity of different receptors active in proprioception, it is not surprising that current results are equivocal. Differing test protocols and the specific movement and receptor placement patterns of each joint make research challenging. Although some researchers have found no beneficial effect of bracing on proprioception (6, 21, 36), many others have found a significant improvement (19, 35, 39). Using neoprene and rubber compression shorts that would offer increased compression similar to the shorts used in the present study, Doan et al. (14) found countermovement vertical jump height and 60-m sprint times to be enhanced.

With no significant difference between joint angle replication during the braced and unbraced conditions, the present results do not support enhanced proprioception at the hip during periods of compression. However, the use of apparently healthy, active individuals in the current study may account for the lack of significance, since their proprioceptive abilities were not hindered by injury. Birmingham et al. (7), Callaghan (9), and Perlau et al. (35) suggest that there is an inverse relationship between inherent proprioceptive ability and benefit from brace use. Therefore, individuals with poor inherent proprioceptive ability would derive the greatest benefit from a brace. Further research with injured subjects would be necessary to confirm this association.

Practical Applications

The purpose of this study was to examine potential benefits and disadvantages of wearing elasticized compression shorts during various sporting activities. Using information from research on other joints, it was hypothesized that the use of compression shorts may hinder speed, agility, and aerobic capacity, while enhancing proprioception. However, our results could not support either hypothesis. The use of elastic compression shorts did not appear to affect performance and may be useful for injury prevention and during recovery from injury, offering mechanical support and potentially enhancing neural input (14) .

Our results were consistent with that of others who suggest bracing does not significantly limit performance (9, 14, 22, 23, 29). Although the research by Burks et al. (8) found that sprint and vertical jump were negatively affected, the results from the current study do not support this conclusion. This discrepancy is likely due to the use of a hip brace in the current study, as opposed to Burks' use of ankle bracing. Limitations to performance as a result of bracing may be more marked when bracing distal joints of the lower extremity.

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