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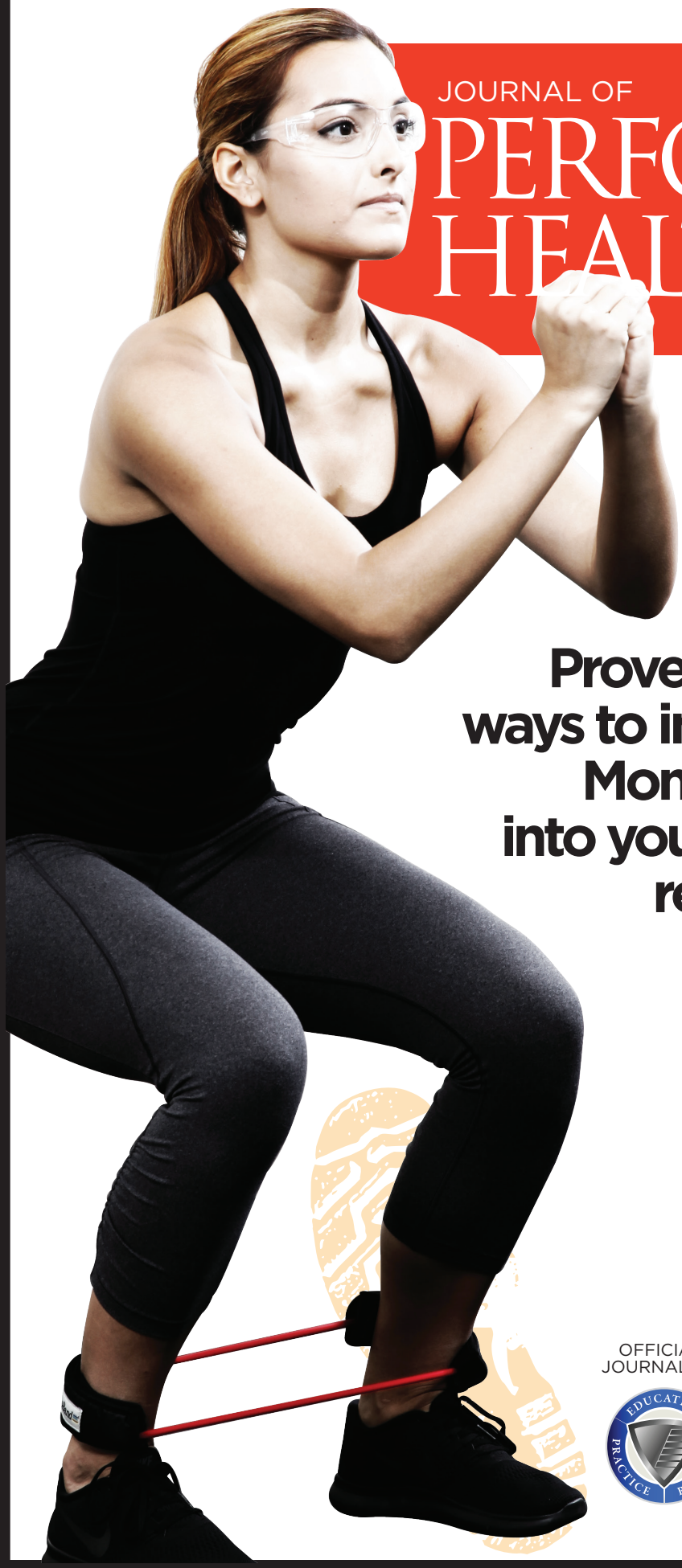
HANDS ON SCIENCE.



INSIDE:

Proven effective ways to incorporate Monster Walks into your therapy– results from 5 studies.

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EDITORIAL

Phil'sPage

Phil Page, PhD PT, ATC, CSCS, FACSM
Editor In Chief, Journal of Performance Health
Global Director of Clinical Research & Education
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From the Editors Desk

18 years ago, TheraBand Academy was created to provide research and education for the clinical use of TheraBand products. At that time, "evidence-based practice" was in its infancy—and the Hygenic Corporation, manufacturer of TheraBand, knew the importance of providing research to support their products used by practicing clinicians. TheraBand was one of the first manufacturers in the physical therapy industry to invest in research and education through the TheraBandAcademy.com website and an annual international research meeting, the TheraBand Research Advisory Committee, known as "TRAC." For the past 18 years, the annual TRAC meeting of our Scientific Advisory Committee has produced several hundred scientific studies.

With the acquisition of other clinical brands such as Biofreeze, Cramer, and BonVital, Performance Health renamed the Academy, "Performance Health Academy" to support the science for a growing number of products. The Academy houses the largest database on Performance Health products ranging from TheraBand to Biofreeze and Cramer Sports Medicine. Today, the Academy has over 2,200 research references available, including over 500 randomized, controlled clinical trials, the highest level of clinical evidence. Each year, the Academy supports up to 40 independent research projects, as well as 200 international speakers and educators.

Now in 2016, we are proud to announce the launch of the next level of research and education. The Journal of Performance Health (JPH) is dedicated to publicizing research and evidence-based based applications of Performance Health products. The Performance Health Scientific Advisory Committee will serve as the editorial board, contributing both content and peer review.

In full disclosure, it's important for our readers to remember that the Journal of Performance Health is just that: an industry publication from a manufacturer. Readers should always be aware of the potential for bias; however, in today's world full of 'pseudo-journals,' sometimes providing for-a-fee online publication of poor science and questionable peer-review, the JPH maintains credible peer review and free access.

Consistent with the Academy, the mission of the JPH is to provide research and education to support clinical practice globally. Clinicians and researchers in physical therapy, occupational therapy, athletic training, massage therapy, chiropractic, podiatry, and exercise science will benefit from content including scientific studies and practical 'how-to' articles with immediate clinical application. The common theme of all JPH content is set on its vision: to support scientifically based application of Performance Health products.

JPH issues will include original research as well as translation of research through article summaries and reviews, and practical applications. We're proud to welcome you to the next level of evidence-based practice.

Journal of **Performance Health**
Editorial Board 2016

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TRAC

TRAC 2016

Nineteen clinicians and researchers met in Copenhagen, Denmark in July to present and discuss their research on Performance Health products. This was the 18th year of 'TRAC,' the annual meeting of the Performance Health Scientific Advisory Committee. Researchers representing various clinical disciplines (physical therapy, athletic training, chiropractic, massage therapy, exercise science, and sports medicine) from 6 countries presented a record 34 studies using products from the Performance Health portfolio including TheraBand™, Biofreeze®, Cramer®, Therapearl® and BonVital®.

TRAC research supports the evidence-based use of Performance Health products, providing a scientific basis for clinical application. "Our Scientific Advisory Committee brings the latest research to us that helps clinicians make evidence-led decisions, which ultimately benefits patients and clients," said Dr. Phil Page, Global Director of Clinical Education and Research for Performance Health.

"This group represents the commitment of Performance Health to research and education over the past 18 years"

The prestigious members of the Performance Health Scientific Advisory Committee are appointed each year based on their scientific contributions, and are invited to present their studies at the annual TRAC meeting. TRAC researchers often collaborate, providing both international and inter-disciplinary insights.

Dr. Michael Rogers, Professor and Chair of the Department of Human Performance Studies at Wichita State University has participated in TRAC for over 15 years. Dr. Rogers noted, "TRAC provides me with opportunities to develop and conduct research studies with a group of incredibly knowledgeable and experienced international scholars. Through the sharing of ideas and the pooling of resources in our laboratories and clinics, we are able to complete a wide-range of projects focusing on innovative exercise programming and clinically-relevant outcomes. Such collaborative efforts would be incredibly difficult to perform without Performance Health as a catalyst."

Highlights from this year's research presentations included:

- TheraBand resistance provides similar strength curves (1), muscle activation (2), and strength gains (9) as traditional isotonic resistance training.
- TheraBand CLX can be used as a training aid to improve the biomechanics of a squat movement (4 - 6)
- TheraBand exercises in the workplace can improve strength and reduce musculoskeletal pain and pain medication use (7, 8)
- Hospitalized patients in acute care may benefit from TheraBand CLX exercises (11, 12)
- The new Cramer Active Ankle Eclipse I and II ankle braces can provide ankle protection with minimal impact on performance (13)
- New research suggests foam rolling and roller massage work through neurological mechanisms in addition to targeting myofascial structures, suggesting the term "neuromyofascial" rolling may be more appropriate (14-20)
- Roller massage applied at a pain level of "5 out of 10" is as effective as higher pain levels (15)
- Myofascial rolling may inhibit antagonist muscles; therefore isolated rolling of agonist muscles (such as the quadriceps in the knee) may not be recommended (18)
- Biofreeze provides long-lasting pain relief (5 hours) of exercise-induced muscle soreness (23)
- Applying Biofreeze spray over TheraBand Kinesiology Tape stays on for 3 days without increasing irritation, providing more immediate satisfaction and sensation than RockTape + RockSauce with similar adhesion (26,27)
- Applying TheraBand Kinesiology Tape to shoulder rehab patients using a progressive increase in tension does not improve outcomes compared to tape applied without tension. (28)

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- TheraBand Kinesiology tape can potentially enhance baseball pitchers' recovery by reducing exercise-induced muscle soreness when applied after throwing (29)
- For neck pain, TheraBand kinesiology tape can enhance pain reduction after cervical manipulation (31), but may not enhance neck massage (30)
- TheraBand Kinesiology Tape can improve static balance in older women with a history of falls, thus potentially reducing fall risk (32)
- TheraBand Kinesiology Tape helps reduce pain and swelling in stroke survivors with chronic shoulder and hand pain and edema due to complex regional pain syndrome (CRPS) (33)

The 2016 members of the Performance Health Scientific Advisory Committee are:

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18th Annual **TRAC** Meeting

July 21-23, 2016 **Copenhagen, Denmark**

DAY ONE

Bob Topp	Comparing torque generated by TheraBand CLX elastic resistance and isotonic resistance
Dave Behm	Muscle activation comparisons between elastic and isoinertial resistance: A meta-analysis
Dave Behm	Eccentric & concentric jumping performance during augmented jumps with elastic resistance: A meta-analysis
Duane Button	TheraBand CLX Increases Medial Knee Collapse during an Overhead Barbell Squat
Mike Voight	The impact of hip abduction resistance training on frontal plan knee kinematics in female volleyball athletes: a pilot study
Barb Hoogenboom	Two-Dimensional Video Analysis of the Effects TheraBand CLX Neuromuscular Exercises on the Overhead Deep Squat
Emil Sundstrup	Physical exercise in the rehabilitation of upper limb chronic pain among slaughterhouse workers: single-blind, randomized controlled trial
Markus Jakobsen	Effect of workplace- versus home-based physical exercise on musculoskeletal pain, perceived exertion and physical function among healthcare workers

Comparing torque generated by TheraBand® CLX elastic resistance and isotonic resistance.

Topp R, Page P, Maloney P, Jaeger E, Labbe A, Stewart G

Problem Statement: During rehabilitation exercise, elastic resistance and isotonic resistance are often used interchangeably although there is limited research comparing the torque curves generated by these two forms of resistance.

Purpose: The purpose of this study was to quantify and compare the torque production of the seven intensities of the TheraBand® CLX elastic resistance with the torque generated by isotonic resistance.

Research Questions: 1.) Are torque curves generated by each of the seven intensities of TheraBand CLX elastic resistance similar to the torque curves generated by an amount of isotonic resistance equivalent to 125% elongation?

2.) What amount of isotonic resistance will generate a similar amount of torque as each of the seven intensities of TheraBand CLX elastic resistance at 90˚ of motion arm rotation (perpendicular to gravity)

Methods: A randomly selected 3 loop length of each of the 7 colors of TheraBand® CLX elastic resistance bands were separately tested. Each length of band included a continuous loop at each end of the test band (approximately 50cm). The terminal loop of each band was anchored to the floor and to a motion arm of the same length as the band being. The motion arm was attached to a Biodex 3 isokinetic dynamometer (Biodex, Shirley NY) that resulted in no slack or tension in the band (0% elongation) when the motion arm was perpendicular to the floor (0 degrees). The Biodex was placed into

passive mode and torque values were collected at 60 degrees per second every 10ms (100hz) as the motion arm moved over a 180-degree arc resulting in 200% elongation of the band. Only data collected within ±1 degree of the predetermined motion arm speed was included in the analysis in order to eliminate varying motion arm speeds at the beginning or end of the motion arc. Data were collected during a single elongation following 9 elongations. Keeping the Biodex lever arm at the same length as when assessing the elastic band, isotonic resistance comparable to the resistance generated at 125% elongation of the specific band was attached to the Biodex lever arm. Torque values were collected at 60 degrees per second every 10ms (100hz) during a single trial as the motion arm moved over a 180-degree arc with the 7 comparable isotonic resistances attached to terminal end of the lever arm. Similar to the elastic resistance bands, only data collected within ±1 degree of the predetermined motion arm speed was included in the analysis. Spearman rank correlations and paired t-tests were used to address question 1. quadratic regression equations were constructed to predict torque from the angle of the motion arm (including 90°) for all equivalent isotonic resistances and the seven intensities of the TheraBand CLX elastic bands to address question 2.

Results: The data collection procedure resulted in 273±2 measures of torque for each trial of the TheraBand CLX elastic bands and equivalent isotonic weights. Spearman rank correlations indicated a high degree of correlation ($r>.99$, $p<.001$) between all of the torque values generated by the TheraBand CLX elastic resistance and the corresponding equivalent isotonic resistance. Although the torque values generated by these two forms of resistance were highly correlated, paired t-tests indicated that the mean torque of the equivalent of the isotonic resistance was consistently significantly higher ($p<.001$) than the corresponding resistance generated by the TheraBand CLX elastic resistance. Quadratic regression equations indicated that the angle generating the peak torque were no more than 3 degrees different between the all of the TheraBand CLX elastic and equivalent isotonic resistance. As well, the peak torque generated by all of the TheraBand CLX elastic and equivalent isotonic resistance were on average approximately 5% different. The torque of the TheraBand CLX elastic resistance and equivalent isotonic resistance when the motion arm was at 90°(parallel to the floor) was no more than 2.67 ft/lbs different. Finally, using the quadratic equation generated by the torque values of the TheraBand CLX elastic resistance, an equivalent isotonic resistance was determined that would generate a similar torque as the TheraBand CLX elastic resistance when the motion arm was at 90 degrees. These values were consistently lower than the actual isotonic resistance employed in the study by no more than 1.31lbs (average .45lbs) than the resistance generated by the respective TheraBand CLX elastic resistance.

Conclusion: The correlations indicate that the torque curves generated by the TheraBand CLX elastic resistance and an equivalent isotonic resistance are very similar. When the motion arm is at 90° the generated by the TheraBand CLX elastic resistance elongated to 125% is similar to the torque generated by corresponding isotonic weight resistance.

Clinical Relevance: Practitioners can prescribe TheraBand CLX elastic bands to generate a similar 'muscle strength curves' as isotonic resistance based on 125% band elongation resistance values. This will help clinicians dose an appropriate amount of resistance, or avoid over-prescribing elastic resistance when weight lifting restrictions are present in post-operative patients.

Color of CLX elastic resistance at at corresponding isotonic resistance	Concentric Mean Torque over 180 (foot pounds)		Statistical Comparisons of Torque values over 180				Torque at 90 (foot pounds)		
	CLX elastic resistance	Isotonic resistance	t-value	p<	rs	p<	Torque of CLX elastic resistance at 90	Torque of isotonic resistance at 90	Estimated isotonic resistance to generate equivalent torque as CLX elastic resistance at 90
Yellow vs. 3.54 lbs.	6.50 + 2.75	6.91 + 2.73	20.47	.00	.99	.00	9.55	9.89	3.42
Red vs. 4.63 lbs.	7.37 + 3.01	8.49 + 3.22	40.18	.00	.99	.00	10.71	11.88	4.20
Green vs. 5.33 lbs.	8.26 + 3.57	9.31 + 3.60	33.19	.00	.98	.00	12.08	13.05	4.93
Blue vs. 6.44 lbs.	9.81 + 4.21	10.48 + 4.10	15.20	.00	.99	.00	14.47	14.95	6.23
Black vs. 8.41 lbs.	11.91 + 5.18	13.00 + 5.01	20.42	.00	.99	.00	17.59	18.47	8.00
Silver vs. 12.59 lbs.	17.24 + 7.25	18.63 + 7.25	13.45	.00	.97	.00	25.23	26.49	11.99
Gold vs. 16.87 lbs.	21.76 + 9.17	24.28 + 9.36	21.26	.00	.98	.00	31.81	34.48	15.96

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Muscle activation comparisons between elastic and isoinertial resistance: a meta-analysis

Aboodarda SJ, Page P, Behm DG

Background: Elastic resistance has been commonly used in the therapeutic and fitness setting; however, the ability of elastic resistance to overload and activate muscles has been questioned due to its ascending resistance curve properties. The purpose of this meta-analysis was to examine the available literature on muscle activation associated with isoinertial and elastic resistance exercises, and to provide a quantitative summary comparing the two resistance training modes.

Methods: In a random-effects model, the Hedge`s g effect size (ES) was used to calculate the biased corrected standardized mean difference between the elastic and isoinertial resistance activation of prime movers (agonist), antagonist, synergist and stabilizer muscles.

Findings: There was a lack of significant difference with the prime movers (ES= -0.037, CI: -0.202 to 0.128, p = 0.660), antagonists (ES= 0.089, CI: -0.112 to 0.290, p = 0.385) and synergists (ES= -0.133, CI: -0.342 to 0.076, p = 0.213) muscle electromyography activity when comparing elastic and isoinertial resistance. There was a non-significant trend (ES= 0.142, CI: -0.006 to 0.289, p = 0.060) for greater stabilizer electromyography activity with elastic versus isoinertial resistance.

Interpretation: Elastic resistance provides similar prime mover, antagonist and synergist muscle activation as isoinertial resistance; contradicting the traditional criticism that the elastic band's initial slack would not elicit comparable levels of muscle activation as conventional isoinertial resistance exercise. The elastic resistance's multi-planar movements would contribute to the trend for increased stabilizer muscle activation. Both elastic and isoinertial resistance can provide similar muscle activation levels in a resistance-training program.

Eccentric and concentric jumping performance during augmented jumps with elastic resistance: a meta-analysis

Aboodarda SJ, Page P, Behm DG

Introduction: The initial rapid eccentric contraction of a stretch-shortening cycle (SSC) activity is typically reported to accentuate the subsequent concentric jump performance. Some researchers have rationalized that adding elastic resistance (ER) to explosive type activities (e.g. countermovement jumps and drop jumps) would increase excitatory stretch reflex activity and mechanical recoil characteristics of the musculotendinous tissues. The purpose of this meta-analysis was to examine the available literature on jumping movements augmented with ER and to provide a quantitative summary on the effectiveness of this technique for enhancing acute eccentric and concentric jumping performance.

Methods: In a random-effects model, the Hedges`s g effect size (ES) was used to calculate the biased corrected standardized mean difference between the augmented and similar non-augmented jumps.

Results: The results demonstrated that augmented jumps provided a greater eccentric loading compared to free jumps (Hedges`s g ES = 0.237, p = 0.028). However the concentric performance was significantly impaired, particularly if the downward elastic force was used during concentric phase as well (ES= -2.440, p <0.001). Interestingly, no performance decrement was observed in those studies, which released the bands at the beginning of the concentric phase (ES = 0.397, p = 0.429).

Discussion: We postulated that the excessive eccentric loading might trigger reflex inhibition, alter the muscle stiffness, increase downward hip displacement and dissipate mechanical recoil properties. These results suggest that the release of elastic force at the beginning of the concentric phase seems to be a critical point to avoid impairment of acute concentric performance in augmented jumps.

Theraband® CLX Increases Medial Knee Collapse during an Overhead Barbell Squat

Forman DA, Forman GN, Holmes MWR, Button DC

Introduction: The use of a resistant band wrapped around the distal end of the femur may act as a proprioceptive aid to reduce medial collapse of the knee during squats [1]. No studies have examined this corrective technique on less-commonly used, but mechanically advanced exercises, such as the overhead barbell squat. The purpose of this study was to examine the influence of the TheraBand® CLX on lower body kinematics during an overhead barbell squat.

Methods: 8, resistance-trained males participated in the study. 3D kinematics were assessed using motion capture (3D Investigator, Northern Digital Inc., Waterloo, Canada) and sampled at 50 Hz. Kinematics were captured using rigid bodies consisting of active, infrared markers placed bilaterally on the mid-segmental areas of the foot, shank, thigh and thorax. Participants warmed up with a single set of bodyweight squats for a self-selected number of repetitions, followed by two sets (band and no-band) of overhead barbell squats with a load of 25% of their bodyweight. Sets were performed for 12 repetitions, or to voluntary failure, at a controlled tempo. The order with which the TheraBand CLX (gold) was used was randomized. Medial knee collapse was calculated using a knee width index (KWI) as a ratio of the distance between the distal thigh segments and the distal shank segments. KWI was evaluated for both concentric and eccentric phases.

Results: The maximum knee flexion angle across the 12 repetitions was not different between the band and no-band conditions (P = 0.18). However, the average KWI was smaller with the band condition for the concentric phase (band: 0.96 3 0.6; no-band: 1.0 3 0.06, P < 0.05) and eccentric phase (band: 0.97 3 0.06; no-band: 1.0 3 0.05, P < 0.05). Maximum KWI was also smaller for the band condition for the concentric phase (band: 1.0 3 0.06; no-band: 1.04 3 0.05, P < 0.06) and eccentric phase (band: 1.0 3 0.05; no-band: 1.04 3 0.06, P < 0.05).

Discussion: KWI during the overhead barbell squat was significantly smaller with the use of the TheraBand CLX. Familiarity may have played a role in this finding as none of the participants had any prior experience with band-assisted work. As the gold colored band is the strongest offered by TheraBand CLX, the use of the band may have actually enhanced medial collapse rather than improve it. These results highlight the importance of proper, exercise progression.

References: [1] Gooyers et al. (2011). Sports Biomech. 11(3): 391-401

The impact of hip abduction elastic-resisted neuromuscular feedback on frontal plane knee kinematics in female volleyball athletes: a pilot study

Voight M, Page P

Background: The knee is one of the most commonly injured areas of the body in female athletes. One movement pattern that has been identified as a risk factor for knee injury is uncontrolled frontal plane knee motion or "valgus collapse". This motion has been observed in videos of athletes at the time of their ACL tears and has also been linked to the development of patellofemoral pain syndrome. While often seen during a body weight squatting maneuver, the valgus collapse is magnified when the athlete either lands from a jump or attempts to accelerate into a jump. Knee injury prevention programs emphasizing knee separation have demonstrated the ability to diminish the loss of valgus control and are associated with decreasing knee injury risk.

Purpose: The purpose of this study was to examine the impact of a elastic-resisted neuromuscular feedback intervention on frontal plane knee abduction during the performance of a counter jump maneuver.

Methods: Twenty female volleyball athletes mean age 16.7 +/- 1.6 years (age range 15-18) were recruited to participate in this study. Subjects were excluded from participation if they exhibited a functional squatting pattern from SFMA screen or had pain or lower quarter injury in the past year, a positive finding on a LQ screen, or structural dysfunction in the lower extremity (positive dorsiflexion wall test and/or positive finding of femoral version with a Craigs test. The distance between the hips, knees, and ankles was measured during a drop-jump test via Dartfish Pro video analysis software (Fribourg, Switzerland). Reliability of testing was established by testing ten subjects one week apart. Absolute centimeters of hip separation distance was measured between sessions and found to be highly reliable (ICC 0.94) which provided the basis for normalization for knee and ankle separation.

The separation distance between the knees (mid-patella width) and ankles (lateral malleolus width) was normalized by the hip separation (greater trochanter width) distance and measured at both landing, and takeoff. Athletes were then randomized into either a control group or neuromuscular intervention group utilizing a squat guide (Movement Guides, Boise ID) and variable resistance manually applied to the distal femur to resist hip abduction using a TheraBand® CLX band (Performance Health, Akron OH). Prior to a practice session, the athletes in the intervention group performed 30 repetitions of a deep

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squat with variable resistance applied around the distal thighs and a squat guide to provide feedback on proper lower quarter positioning. During this time period, the control did not participate in any activity. Following the neuromuscular intervention, the jump landing characteristics of both groups were immediately re-examined before practice started and again at 60 minutes at the conclusion of practice.

Results: The means and SDs for the absolute centimeters of knee and ankle separation distance and for the normalized knee and ankle separation distance were calculated. After an elastic resisted neuromuscular training intervention the trained athletes immediately had significant increases in both absolute centimeters and normalized knee and ankle separation distances on landing and takeoff as compared to the control group ($P < .001$). This significant increase lasted for a minimum of 60 minutes post intervention

Conclusion: Female volleyball athletes recruited from this study demonstrated a valgus knee alignment during the drop test upon video analysis. After an elastic resisted neuromuscular training intervention, the trained athletes had improved knee and ankle separation distances on landing and takeoff as compared to the control group.

Two-Dimensional Video Analysis of the Effects TheraBand® CLX Neuromuscular Exercises on the Overhead Deep Squat

Hoogenboom B, Huyser A, Stinson A, Suter M

Introduction: The overhead deep squat (OHDS) is a common functional movement used for screening and assessment by rehabilitation and movement specialists. Failure to demonstrate movement competency on the overhead deep squat may be due to mobility or stability deficiencies. Little is known about the results of neuromuscular interventions geared at enhancing stability or motor control during the OHDS maneuver in those who fail to pass the screen due to stability causes.

Purpose: The purpose of this study was to examine the short-term effects of various squat-based corrective exercises performed with pattern assistance using the TherBand® CLX on subjects who demonstrate stability deficits during performance of the OHDS.

Study Design: Cohort observational, short-term intervention study.

Methods: Twenty healthy, uninjured volunteers were recruited for the study. Subjects were included that demonstrated an OHDS score of "2" or "1" during a squat (pre-screen), according to FMS™ scoring criteria. OHDS performances were then operationally defined as being stability/motor control related according to the OHDS SFMA algorithm. Subjects were excluded if they scored a "3" or "0" on the FMS™ had sustained surgery or injury to the low back, hips, knees, ankles or feet in the prior six months or if they had a balance disorder.

Procedures: Subjects performed five minutes on an exercise bicycle. Bright pieces of TheraBand Kinesiology tape were used to mark important bony landmarks on the hips, pelvis, trunk, knees, and ankles. Subjects were then video taped (pre-int) using standard frontal and sagittal views, concurrently (Pinnacle Studio 16), during the performance of a single repetition of the OHDS per FMS™ protocol (without cueing), with the feet on a foot tracing. Based upon the deficits identified in the pre-screen, one of four squat-based corrective exercises for stability using appropriate CLX resistance was chosen, that allowed subjects to perform 3 sets of 15 repetitions of the chosen neuromuscular exercise at "easy" or "low" demand on the RISE scale. Sixty seconds of rest was given between sets. After the final set, two final minutes rest was given and post-intervention (post-int) video recordings were completed, using the same foot tracing as during the pre-intervention videos. All video data were analyzed using Dartfish Motion Analysis software.

Results: Twenty subjects (16 females, 4 males, mean age 24.95; range 21-37) were included. Most commonly observed dysfunction was forward trunk and valgus, followed by forward trunk. Mean pre-int Hip:knee ratios ranged from 0.96-1.32, mean squat depth at deepest squat was 111.1°, mean trunk angle @60° of 57.7°, @fulldepth 39.5°. Post-intervention mean Hip:knee ratios ranged from .95-1.32, mean squat depth at deepest squat 107.4°, mean trunk angle @60° of 57.4°, @ fulldepth 41.6°. Statistically significant differences in performance from pre- to post-intervention were seen in maximal squat depth ($p=0.019$) and trunk angle at full depth ($p=0.009$). Neither Hip:knee ratio at any measurement nor trunk control at 60° were statistically different after intervention.

Discussion: Many healthy, normal individuals failed to "pass" the OHDS screening test due to stability dysfunction. Neuromuscular CLX interventions were chosen and assigned based upon demonstrated dysfunction during the squat, using CLX to achieve a motor control stimulus that was low on the RISE scale during interventions. Neuromuscular exercises induced statistically significant changes in maximum depth achieved during the OHDS and trunk angle at full depth squat, with less squat depth and enhanced trunk control (closer to maintenance of an upright trunk) being demonstrated. Additional subjects are being recruited in order to achieve statistical power, and in-depth subset analysis and appropriate regression analyses will be conducted on the full sample (n=88). Although squat depth and trunk angle at full depth were statistically significantly different, the magnitude of change may not be clinically relevant.

Physical exercise in the rehabilitation of upper limb chronic pain among slaughterhouse workers: single-blind, randomized controlled trial

Sundstrup E, Jakobsen MD, Brandt M, Jay K, Persson R, Aagaard P, Andersen LL

Introduction: Chronic pain and disability of the arm, shoulder and hand severely affect labor market participation. Ergonomic training and education is the default strategy to reduce physical exposure and thereby prevent aggravation of pain. An alternative strategy could be to increase physical capacity of the worker by physical conditioning. The aim of the study was to investigate the effect of two contrasting interventions, conventional ergonomic training (usual care) versus strength training, on pain, work disability, work ability and physical capacity in individuals with upper limb chronic pain exposed to highly repetitive and forceful manual work.

Methods: Sixty-six workers with chronic upper limb pain and work disability were allocated to a 10-week intervention period of either strength training or ergonomic training (usual care control group) at the slaughterhouse. Participants in the strength training group performed high intensity strength exercises using elastic resistance (TheraBand) for the painful muscles in the shoulder, arm and hand for 10 minutes, three times a week during the 10-week intervention period. The ergonomic training involved training and guidance in how to correctly handle the individual work stations at the work plant and took place during the initial weeks of the intervention period, corresponding to the standard worksite ergonomic prescription at the slaughterhouse.

Results and conclusions: Short term strength training at the workplace led to marked reductions in chronic pain intensity and work disability along with improved physical function in slaughterhouse workers with chronic upper limb pain and work disability. Notably, the strength training intervention also prevented deterioration of work ability.

Clinical relevance: Strength training appears to represent an effective workplace based strategy to rehabilitate upper limb chronic pain and its consequences, thereby reducing the potential imbalance between individual capacity and work demands among workers in physically demanding occupations with chronic pain and work disability.

Effect of workplace- versus home-based physical exercise on musculoskeletal pain, perceived exertion and physical function among healthcare workers

Jakobsen MD

Introduction. The prevalence and consequences of musculoskeletal disorders are substantial among healthcare workers, allegedly due to high physical work demands during patient handling. Previous studies have shown promising results of physical exercise for relieving musculoskeletal pain among different occupational groups, e.g. office workers, laboratory technicians and slaughterhouse workers. However, the optimal context in which such exercise should be performed to maximize adherence and reduce musculoskeletal pain is not known. An ongoing discussion is whether such physical exercise should be performed at the workplace or conducted as home-based exercise. Performing physical exercise at the workplace together with colleagues may increase motivation for some employees and thus increase adherence, whereas others may favor exercising alone. Yet, physical exercise performed during working hours at the workplace may be costly for employers in terms of time spend. It therefore seems relevant to compare the efficacy of workplace- versus home-based exercise on musculoskeletal pain, physical exertion during work and physical capacity. The aim of this study therefore, was to investigate the effect of workplace (WORK) versus home-based (HOME) physical exercise on musculoskeletal pain intensity in the back, neck and shoulders, physical exertion during work and muscle response to sudden trunk perturbation, respectively.

Methods. Two hundred female healthcare workers from eighteen departments at three Danish hospitals were recruited to participate in the study (Copenhagen, Denmark, Aug 2013 – Jan 2014). Participants were randomly allocated at the cluster level to 10 weeks of: 1) workplace physical exercise (WORK) performed during working hours with elastic tubing (TheraBand) and kettlebells for 5x10 minutes per week and up to 5 group-based coaching sessions on motivation for regular physical exercise, or 2)

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home-based physical exercise (HOME) performed with elastic tubing (TheraBand) during participant's own leisure time for 5x10 minutes per week. Average pain intensity in the low back and neck/shoulder (primary outcome) and secondary outcomes; physical exertion during work, use of analgesics, fear avoidance, muscle strength and sudden trunk perturbation were measured before and after the ten week intervention period.

Main findings and conclusions. This study demonstrates that performing physical exercise together with colleagues at the workplace is more effective than home-based exercise in 1) reducing musculoskeletal pain, 2) reducing physical exertion during work, 3) reducing the use of analgesics for musculoskeletal pain, and 4) increasing muscle strength among healthcare workers. Observed between-group differences in training adherence and quality of the training may explain the results. Yet, the additional training volume in WORK compared with HOME did not promote between-group differences in neuromechanical characteristics when tested in a reliable trunk perturbation test.

DAY TWO

Juan Colado	Effects of a long-term resistance training program with different intensities and devices on fitness, body composition, cardiometabolic risk, immune system, and well-being of older adults
Dave Behm	Muscle activation comparisons between elastic and isoinertial resistance: A meta-analysis
Mary Sanders	Overweight/obese patient preferences for equipment: dumbbells vs. CLX; attitudes about a short burst CLX circuit program; and functional fitness outcomes during a 12-week study
Leo Wang	Effects of Early Active Mobilization on the Physical Function and Subjective Responses among Intensive Care Unit Patients
Lars Anderson	Which TheraBand CLX strengthening exercises are feasible and effective for patients lying in a hospital bed?
Tony Brosky	A comparison between single and double upright ankle braces on ankle range of motion, functional performance, and satisfaction of brace characteristics

Effects of a long-term resistance training program with different intensities and devices on fitness, body composition, cardiometabolic risk, immune system, and wellbeing of older adults

Colado, JC, Tella, V, Benavent, J, Benitez, JC, Casaña, J, Iradi, A, Sáez, G, Estañ, N, Hernando, A, Gargallo P, Juesas A, Muñoz V, Fritz N

Purpose: To assess effects of resistance training program during 32-weeks with different devices and intensities on motor function, body composition, bone mineral density, well-being, and biomarkers of bone, cardiometabolic risk and immunology health in older adults.

Material and methods: A prospective longitudinal study with a quasi-experimental design with pre, inter and post treatment measures was carried out. 276 community older adults (68.9 3 5.12 years old) was distributed in 7 natural groups in the absence of randomization: 6 training groups with different devices (TheraBand® elastic bands; TheraBand exercise station®; aquatic equipment; free weights) and/ or intensities (high, moderate-high and moderate; i.e.: 6/10/15 repetitions, respectively) and a control group. A global strength-training program was applied 2 days at week during 32 weeks. Variables analyzed were: motor function (maximum isometric strength, dynamic strength, flexibility, balance and aerobic capacity); body composition (fat mass, fat-free mass, and percentage of fat mass); bone mineral density (spine and hip) and bone biomarkers profile (pro-peptide of type 1 collagen and Ð-CrossLaps); cardiovascular risk (total cholesterol; triglycerides; HDL, LDL, VLDL cholesterol; ratios HDL/LDL and total cholesterol/HDL; hemoglobin A1c); immune system (leukocytes, neutrophils, lymphocytes, monocytes, eosinophils and basophils); and well-being indicators (Short Form Health Survey -Sf-36). Nonparametric tests were applied.

Results: The three groups that used the elastic bands at the three different intensities showed significant improvements on motor function body composition and well-being ($p \leq 0.016$). The high intensity group showed the greatest and significant improvements on isometric (+73.97%) and dynamic (+86.67%) strength of upper extremities, flexibility of lower extremities (+900%), aerobic capacity (+14.47%) and cardiovascular and immune system biomarkers. The moderate-high intensity showed the greatest and significant ($p \leq 0.016$) improvements on flexibility of upper extremities (+500%), and dynamic balance (+27.80%), while the moderate intensity group improved significantly ($p \leq 0.016$) the three parameters of body composition, isometric (+114.485%) and dynamic (+108.33%) strength of the lower limbs. There were no significant differences in bone mineral density of the spine and hip, however the high and moderate intensity groups showed significant and similar improvements ($p \leq 0.016$) in bone formation biomarkers (+17.26% and +23.95%, respectively).

Regarding the use of different devices, elastic band group obtained the greatest improvements on maximum isometric trunk strength (+70%), upper extremities flexibility (+500%), dynamic balance (+27.80%) and percentage of overall fat (-5.63%) ($p \leq 0.016$). Exercise station group showed biggest significant improvements in both isometric (+118.53) and dynamic strength (+120%) for lower extremities and in overall health (+36.36%). Aquatic devices group obtained the majors improvements on isometric (+91.71%) and dynamic (+76.47%) strength of upper extremities. During the first 16 weeks the elastic groups experimented significant increments in the maximum isometric lower extremities strength regarding the free weights group. The control group had not got significant improvements in any parameter evaluated.

Conclusions: Elastic devices are efficient equipment for improving health and function in older adults although could provoke different adaptions if are compared between them due to the different stability conditions during their use. Aquatic resistance exercises are equal of efficient that traditional devices when are used in older adults. Training methodology followed in this study had a significant effect on motor function, body composition, bone formation, cardiovascular and immunological markers, as well as well-being in the different intensities applied. These results confirm the necessity of long-term training programs over 16 weeks for obtaining significant effects on body composition and bone remodeling, and the need to combine different training periods with different equipment for obtaining the best cross adaptations.

*This Project has been developed in the mark of reference of the Research Grants Ignacio H. Larremendi of Mapfre Foundation 2014. This is only a divulging summary

Overweight/obese patient preferences for equipment: dumbbells vs. CLX; attitudes about a short burst CLX circuit program; and functional fitness outcomes during a 12-week study.

Sanders M, Rogers M

Home-based elastic resistance training was found to improve health and mobility during weight loss by overweight /obese patients. Little is known about preferences, perceptions or attitudes toward resistance equipment types, program design and functional fitness/mobility outcomes during a home-based, flash drive delivered program for clinical populations.

Purpose: The purpose of this study was: 1) To identify equipment preferences and opinions about dumbbells vs. CLX bands during a 6 week traditional upper body resistance program; 2) To evaluate attitudes about a 6 week full body TheraBand® CLX Circuit program; 3) To measure health and functional fitness outcomes at the end of 12 weeks of the combined training program.

Method: Overweight/obese participants (n=21, 51.5 yrs, BMI 33.2 $kg \cdot m^{-2}$) enrolled in the HMR diet program self selected to join the study and were assessed for baseline health and mobility, then randomized into 2 groups: 3 weeks of isotonic resistance followed by 3 weeks of elastic resistance (10-20 min/day, 2-3 days/wk, 6 wks) using a cross-over design. Participants then performed full body CLX-only circuit exercises (20 min/day, 2-3 days/wk, 6 wks). Both home-based programs were delivered via written handouts and flash drive. Opinion surveys and focus groups were used to determine attitudes and preferences. Functional fitness/mobility was assessed using standardized tests. Repeated measures ANOVA were conducted and a p-level of <0.05 was used to indicate significant changes. Health Management Resources (HMR) Healthy Solutions patients not enrolled in the study were evaluated for comparison on selected variables (N=10).

Results:: Participants exercised 3 days/wk for 6 weeks using a flash drive video and written handouts for instructions. Their opinions were that they "Liked using" both dumbbells and CLX equally (86%). Opinion surveys trended preferences for the dumbbells vs. CLX under categories "Comfortable" (100% vs. 91%); "Motivates me to exercise" (66% vs. 54%); "Likely to continue using" (90% vs.77%). Trends in preferences for CLX vs. dumbbells were expressed for "Easy to use" (95% vs.81%) and "Easy to adjust intensity" (68% vs.48%).

Focus groups (n=6) revealed further insights: "I get different benefits for both, so…I would alternate between both"; "With [CLX] you can put your hands inside of them which makes it much easier…so these are easier than the other [no loop] type";

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"Bands let me work out my arms and legs at the same time and are more versatile"; "I am definitely going to continue using [CLX] to focus on different muscle groups that bells can't work". Participant opinions about the circuit workouts revealed they "Liked" the program overall (75%), said they "Felt good" (70%), were "Convenient to do" (85%), "Liked the flash drive delivery" (85%) and would "Continue the program" (85%). At the end of 12-weeks (83% compliance), functional fitness improved for chair stand (26%), arm curl (35%), aerobic endurance (25%), and flexibility in both legs (4% right, 2% left). There were no changes or differences between exercise and comparison for weight and BMI, however the exercise group increased physical activity kcal (9%), while the comparison group decreased activity kcal (24%).

Conclusions: Among this clinical overweight/obese population, both CLX bands and dumbbells were acceptable for upper body exercise. Opinions about CLX indicated preference for ease in gripping, adjusting intensity, and convenience. Participants enjoyed short-duration CLX circuit workouts delivered via flash drive which resulted in positive home-based exercise compliance and functional fitness improvements. These gains may lead to better diet and exercise program adherence over time. Further study is needed.

Acknowledgements: Karmella Thomas, RD, LD, CDEÒ & Taylor Reynolds, Wellness & Weight Management Center, Reno School of Medicine, University Nevada, Reno.

Effects of Early Active Mobilization on the Physical Function and Subjective Responses among Intensive Care Unit Patients: A Protocol

Wang Y, Wang Y, Kou O, Feng B, Wang L, Zhang X

Introduction and Purpose: Critical illness has a high risk of intensive care unit-acquired weakness (ICUAW), persistent functional disability and decreased quality of life (QOL) for years after hospital discharge. Evidence has shown that early mobilization combined with reduced sedation in critically ill patients is feasible and safe. This study aims to investigate the effect of an active exercise training program which is combined with circuit resistance training (CRT) using TheraBand® CLX and aerobic exercise training, on the physical function and subjective responses among those patients in ICU.

Methods: This is a randomized controlled trial and will be conducted by the Dept. of ICU and Rehabilitation Medicine at The Six Affiliated Hospital of Sun Yat-sen University. Thirty patients will be recruited based on the eligibility criteria and randomly allocated into two groups, early active mobility group (EAM) or control group. Patients in control group will perform the routine physical therapy 5 days per week; and those in EAM group will receive an active cycling exercise session and a 20-30 min CRT) session additionally.

Primary outcome measurement is six-minute walk distance (6MWD) as measured at hospital discharge. Secondary outcomes are handgrip force (Jamar), quadriceps force (Hoggan), MRC score, the ability of daily living (modified Barthel Index scale) and quality of life (SF-36). Mechanical ventilation duration in 28 days, ICU and hospital length of staying, and incidence rate of adverse events also will be recorded. All data will be computed with SPSS version 17.0. The significant level is set as $p < 0.05$.

Expected Results: All functional indicators are improved in both groups, and there is a more significant improvement in EAM group, especially 6MWD, handgrips and quadriceps force. The mechanical ventilation duration in 28 days, ICU and hospital stay are lower in the EAM group than that in control group. No fatal events occur.

Conclusion: The early active exercise intervention as combined with cycling training and CRT will have a remarkable benefit for patients with critical illness.

Clinical Relevance: Previous studies have shown the feasibility and safety of early mobilization among ICU patients. However, few studies focus on the patients' active participate and effective exercise intensity, which results in the limited benefits. This study not only considers the active participate and effective exercise intensity, but also combining with the CRT (TheraBand CLX) and cycling exercise, can have significant effects on the physical function and subjective responses in ICU patients.

Which TheraBand® CLX strengthening exercises are feasible and effective for patients lying in a hospital bed?

Vinstrup J, Jakobsen M, Sundstrup E, Andersen LL

Background: The direct and indirect costs associated with occupational injuries in the healthcare sector are substantial. In the US, healthcare workers injury rates equal or exceed rates in other industries that are traditionally considered hazardous. Back pain related to patient-handling tasks significantly contributes to the high burden of work-related injuries and disorders among nurses and aides in hospitals and nursing homes. According to the US Bureau of Labor Statistics, non-fatal occupational injuries among healthcare workers resulted in 283 lost workdays per 10,000 full-time workers in 2010. We have recently shown that among healthcare workers at Danish hospitals the intensity of work-related musculoskeletal pain can be reduced by physical exercise at the workplace. An alternative strategy could be to strengthen the patient when lying in the hospital bed. Thus, improving the muscle strength of the patient could make the patient handling task easier for the healthcare worker and thus reduce the risk of occupational injuries.

Aim: To compare the level of muscle activity during a range of different strengthening exercises with TheraBand CLX when lying in a hospital bed.

Methods: A convenience sample of 22 adults were recruited in Copenhagen, Denmark. A total of 14 different exercises thought to activate the large muscles of the lower body were developed and tested. EMG was obtained from the hip flexors, thigh, hamstring, lower leg, using a wireless EMG datalogger system (Noraxon) and processed according to procedures previously used in our lab. For each respective muscle, the filtered and normalized EMG amplitude were compared between the different TheraBand® CLX exercises. The study was approved by the ethical committee (H-3-2010-062).

Results: For the thigh muscles, the most effective exercise was the one lying supine while extending the knee against resistance of the CLX with support below the knee from a cylindrical cushion ("muscle setting"). Altogether, 73% of participants were satisfied or very satisfied with this exercise. For the hamstring muscles, the most effective exercise was the one lying prone while flexing the knee against resistance of the CLX. Altogether, 81% of the participants were satisfied or very satisfied with this exercise.

Discussion and conclusion: Improving muscle strength of patients lying in bed at hospitals could potentially lead to earlier patient discharge and reduced burden for the healthcare workers performing the patient handling task, i.e. reduced risk of occupational injuries. In conclusion, the present study shows that 1) several exercises using TheraBand® CLX effectively activates the major muscles of the lower body, 2) the majority of participants are satisfied or very satisfied with the exercises. Thus, these exercises have the potential to be implemented at hospitals and speed up recovery of patients lying in a hospital bed.

A comparison between single and double upright ankle braces on ankle range of motion, functional performance, and satisfaction of brace characteristics

Brosky T, Topp R, Levay E, Dierker, K

Background/Purpose: Ankle sprains are one of the most commonly occurring musculoskeletal injuries and management typically involves rehabilitation often including ankle bracing to return to sport or work. Ankle braces are also used prophylactically among non-injured athletes participating in sports considered high risk for ankle sprains (e.g. volleyball, basketball, soccer). There have been a limited number of empirical studies comparing the range of motion (ROM), functional performance, and characteristics of single vs. double upright ankle braces. The purpose of this study was to compare the ROM, functional performance and satisfaction of brace characteristics between 3 conditions: no brace, a single upright brace (Active Ankle Eclipse I) and a double upright brace (Active Ankle Eclipse II) when worn by active college age adults.

Subjects: 30 healthy adults (9 males/21 females), mean (SD) age 23.0 yrs. (3.0), mean BMI 23.3 (2.6).

Materials/Methods: Participants were recruited from a university setting, who were at least 18 years old, without current injury and regularly involved in moderate to vigorous physical activity. After explanation of the study and consent was obtained (IRB #415-2), each participant underwent ankle ROM assessment (PF: plantarflexion, DF: dorsiflexion, IN: inversion, EV: eversion) and functional performance testing on both lower extremities under 3 conditions: unbraced, bilateral single upright brace (E1), bilateral double upright brace (E2). The 3 different conditions were randomized in order of testing with the following functional performance tasks: figure 8 hop, side hop, 6m single-limb cross-over hop, and a square hop. Time to complete each test was recorded to the nearest 0.01 second. The two braced conditions involved completion of a questionnaire immediately following the test protocol. The questionnaire consisted of eight items using a 7-pt. Likert scale ranging

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TRAC endorsements

For the last 9 years, I have been fortunate enough to participate in TRAC. Over that time, I have grown leaps and bounds as a researcher, and that has dramatically improved the patient care that we deliver to our patients at Sport and Spine Rehab every day. In addition, I have been able to meet intelligent professionals from all over the world which has greatly enhanced my professional development and career. The healthcare and fitness world should be immensely grateful to Performance Health for organizing these TRAC meetings.

Bart Bishop, PT, DPT, SCS, CSCS

TRAC provides an opportunity for multidisciplinary scientists from around the world, to critically evaluate innovative research that leads to solving problems while inspiring new questions that expand knowledge for science to practice. As a team we sharpen each others scientific investigative skills and develop new insights for creative thinking. Our TRAC members encourage each other to buff up our intellectual biceps, and set our sights on conducting those unique studies that make a difference in health and wellness globally. It is an honor for me to collaborate with Performance Health, a company with strong core values that include evidence-based decision making which serves to ground their marketing messages and education.

Mary E. Sanders, PhD, RCEP, CDE®, FACSM

As a team we sharpen each others scientific investigative skills and develop new insights for creative thinking.

...the science interaction is quite unique to Performance Health and drives the products.

TRAC provides a unique opportunity to disseminate laboratory findings to the professionals in the field. Since TRAC members are composed of internationally recognized scientists as well as practicing physiotherapists, occupational therapists, massage therapists and chiropractors, the scientists receive immediate feedback regarding the real world applications of their findings. The practitioners not only provide feedback but help to direct subsequent research based on their observations and practice in their clinics. This practice – science interaction is quite unique to Performance Health and drives the products.

As a scientist it is invigorating to see our research being used to directly help patients in rehabilitation, health and fitness oriented individuals and all aspects of society to stay healthy and injury free.

David Behm, PhD

...an incredible opportunity for me to engage in clinically meaningful and innovative ideas that can have immediate impact on the rehabilitation, health, and wellness of patients and clients.

Why do I like TRAC?

Being a member of the TRAC Team has been one the most rewarding and enjoyable parts of my professional career and I'm grateful for the opportunity to collaborate with a dedicated and talented team of clinicians, researchers, academicians, and product development innovators from around the world. I am also truly grateful for the professional collaboration and personal relationships developed through TRAC.

What TRAC does for me.

TRAC support provides an incredible opportunity for me to engage in clinically meaningful and innovative ideas that can have immediate impact on the rehabilitation, health, and wellness of patients and clients. TRAC also allows me as an educator/researcher to positively influence new/young investigators (e.g. physical therapist doctoral students) about the importance of clinical applied research, and engage them in dissemination of findings at national meetings.

How TRAC Research influences me and patients/clients and students.

The ability to take proven products and improve, modify or enhance their effectiveness and also promote use of products in classroom and clinical teaching. One of the most effective marketing strategies may be to put products/materials in the hands of professional students in training and expose them to the unique features and benefits of evidence-based Performance Health products. These young professionals are the same future clinicians and consumers who will use these tools/products to enhance patient/client care by empowering and educating their patients to effectively self-manage their conditions with evidence-based methods.

Tony Brosky, Jr., PT, DHSc, SCS

TRAC provides an opportunity for multidisciplinary scientists from around the world, to critically evaluate innovative research that leads to solving problems while inspiring new questions that expand knowledge for science to practice. As a team we sharpen each others scientific investigative skills and develop new insights for creative thinking. Our TRAC members encourage each other to buff up our intellectual biceps, and set our sights on conducting those unique studies that make a difference in health and wellness globally. It is an honor for me to collaborate with Performance Health, a company with strong core values that include evidence-based decision making which serves to ground their marketing messages and education.

Mary E. Sanders, PhD, RCEP, CDE®, FACSM

I have been a member of TRAC team for 5 years now and have met many international research clinicians and scholars. I get to learn about cutting edge research on performance and rehabilitative equipment that is used worldwide. In addition I also get to do research that helps add to the usefulness of this equipment. Some of my most cited research is based on work I have done as part of TRAC. Finally, one of the best aspects of TRAC are the individuals involved and the friendships I have developed. I hope to continue being part of TRAC for years to come and contribute to ongoing research.

Duane Button, PhD, CSEP-CEP

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TRAC Endorsements

TRAC provides me with opportunities to develop and conduct research studies with a group of incredibly knowledgeable and experienced international scholars. Through the sharing of ideas and the pooling of resources in our laboratories and clinics, we are able to complete a wide-range of projects focusing on innovative exercise programming and clinically-relevant outcomes. Such collaborative efforts would be incredibly difficult to perform without TRAC as a catalyst.

Michael E. Rogers, PhD, CSCS, FACSM

TRAC is one the most valuable moments of the year for me. It allows me to collaborate during some days of intense work both with significant scientists and professionals of the sport and rehabilitation area, as with one of the most prestigious company in the world. This environment helps me to generate new ideas and motivation that pushes me to create more applied concepts with which I can develop new studies and conceptual guidelines. However, after eight years attending it, I can highlight that one of the strongest reasons I want to return each year is the great human value of each of its members.

Juan Colado PhD

...one of the strongest reasons I want to return each year is the great human value of each of its members.

As a healthcare provider, the TheraBand research advisory committee conference is one of the most important events of the year for me. Knowledge translation from clinical research to clinical practice is an important element of evidence-based healthcare and providing the best outcomes for our patients. The investment that Performance Health makes in research innovation and patient care is truly extraordinary.

Jay Greenstein DC, CCSP

CLINICAL CORNER

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HANDS ON SCIENCE.

What's the best way to perform Monster Walks?

By Phil Page PhD, PT, ATC, CSCS, FACSM

Frankenstein must do them.

"Monster Walks." I'm not really sure where the name for that exercise came from, but I'll bet everyone has a little variation of the exercise they perform. Generally, an elastic band loop is placed between the knees or ankles while stepping laterally. So what's the best way to perform the "Monster Walk?" Hopefully we can use research to find the answer.

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CLINICAL CORNER

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HANDS ON SCIENCE.

Let's start with a little background.

Recently, the hip has become en vogue in rehab and sports training, particularly the gluteal muscles (maximus and minimus). It started with the realization that the hip extensors and abductors play an important role in stability and function, yet are often neglected and weak. More hip surgeries in younger patients, coupled with the focus on hip strengthening led to the popularity of the "Monster Walk", however, a better name for this exercise is a "lateral band walk" (LBW).

As with most new clinical exercises, the popularity of the LBW was likely spread through continuing education, word of mouth, or some internet 'guru' rather than research of its efficacy. Knowing that research often lags clinical practice (and vice-versa), clinicians continued to perform this exercise in their own ways... often without knowledge of the true muscle activation levels.

To date, 5 studies have analyzed the muscle activity of hip muscles with EMG during the lateral band walk. Each study looked at different components such as band placement (knee, ankle or foot), posture (upright or minisquat), muscles (gluteus medius, gluteus maximus, TFL), and leg (moving or stance leg). Each study used different elastic resistances and some variation of elongation. The results from these studies have given us a pretty good idea of the best way to perform the LBW exercise. Note that all of these studies were performed on healthy subjects, which may not be representative of an injured population.

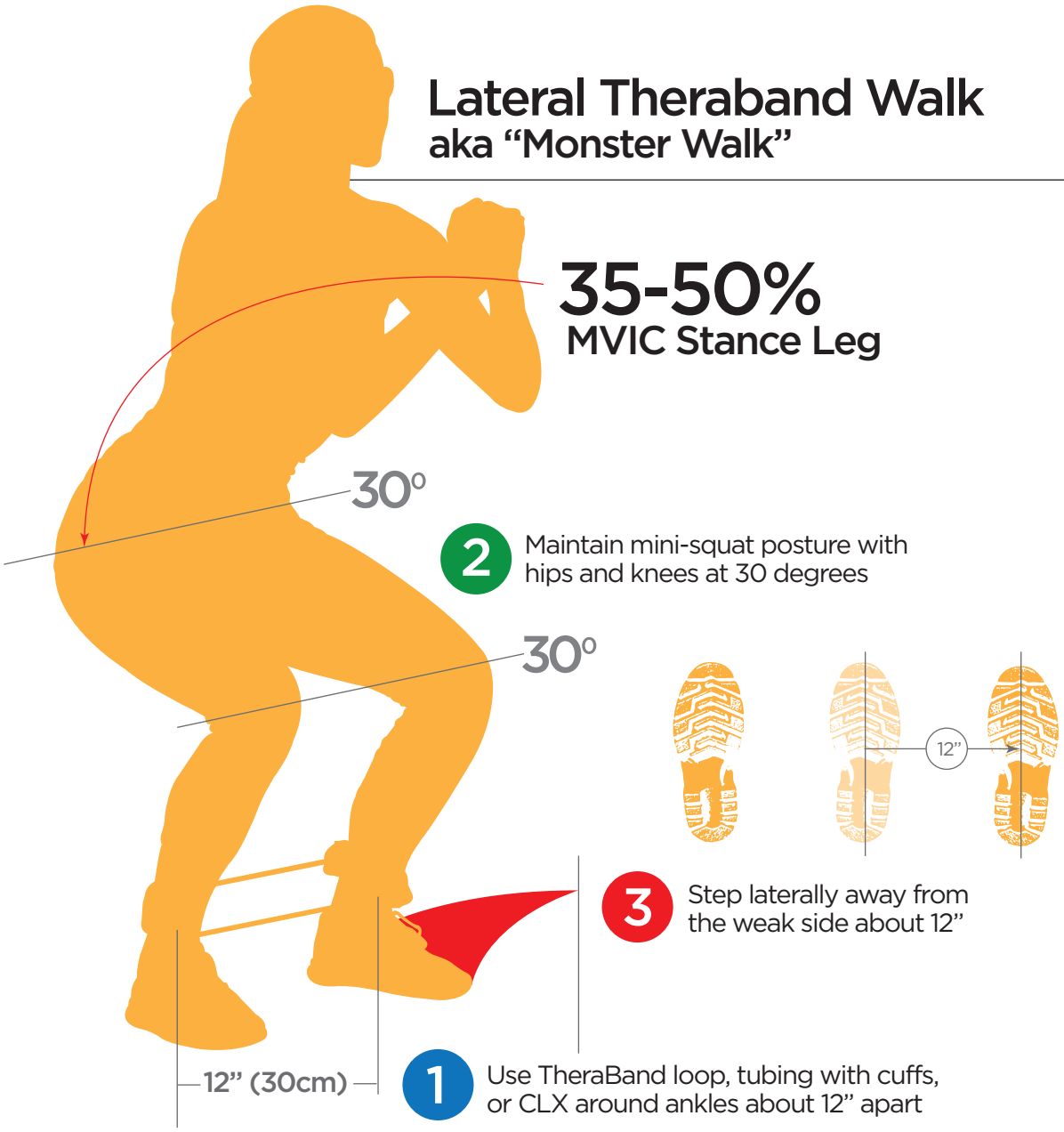
Here's what we know from these studies:

- The primary target muscle of this exercise, the gluteus medius, is activated anywhere between an average of 36-50% MVIC (maximal contraction) on the stance leg, compared to 19 to 33% on the moving leg.
- The TFL is also activated during this exercise, which may be considered undesirable in patellofemoral rehab, particularly associated with muscle imbalance.
- Lower TFL activation is seen in the squat position than an upright position
- The squat position has higher activation than the upright posture while performing this exercise
- The stance leg has more activation of muscles than the moving leg
- The ankle or foot placement of the resistance produces more EMG than at the knee

Based on what we now know, here are the recommendations for performing the lateral band walk exercise with elastic resistance for preferential activation of the gluteus medius muscle, particularly in patients with hip abductor weakness. Several TheraBand products can be used for this exercise including the TheraBand Band Loop, TheraBand Tubing with Cuffs, and TheraBand CLX.

1. Place the resistance at the ankle or foot, rather than the knee (although the exercise may be regressed with knee placement)
2. Perform the exercise in a mini-squat position with about 30 degrees of hip and knee flexion during movement. This provides more gluteus medius activation and less TFL activation
3. Step laterally away from the injured (weak) side. Don't lead with the weaker hip, more muscle activity is seen in the stance leg. Don't perform this exercise "side-to-side" in both directions, particularly in knee patients with hip weakness.

Lateral Theraband Walk
aka "Monster Walk"



While EMG studies are important to determine what's happening during the exercise, more research is obviously needed in patient populations who may benefit from this exercise, including anterior knee pain, patellofemoral pain syndrome, hip osteoarthritis, and ITBand Syndrome. Exercise dosage and time-under-tension studies may be helpful, as well as outcome studies.

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CLINICAL CORNER

Can I assess strength with elastic bands?

By Phil Page PhD, PT, ATC, CSCS, FACSM

There are several ways we can assess muscle strength. We can use manual muscle testing (MMT), dynamometry (handheld device or isokinetic machine), or by using the "repetition maximum" (RM) method. The RM is the amount of resistance that can be moved a specific number of repetitions, and no more; so a "1-RM" is the amount of resistance that can be moved through one repetition, while a "10-RM" is the amount of resistance that can be moved through the motion only 10 times.

While MMT and dynamometry can provide valid and reliable measurements of isolated muscle strength in clinical and research populations, RMs are often used to assess the strength (and progress) of an individual during a specific resistance exercise or compound movement (ie, bench press, squat, etc) in order to prescribe the appropriate amount of resistance for training.

General strength training recommendations are to use a resistance of 60 to 80% of 1RM; however, determining a true 1RM in a clinical population is not possible. Some have recommended using charts or formulas to predict 1RM based on the amount of resistance and the number of repetitions, but these formulas are specific to the exercise and population, and not always generalizable, particularly in a clinical population.

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In addition, RM testing can be used to assess strength gains in a strengthening program. If the individual RM increases, then its safe to say the muscular strength has increased as well. However, the RM testing is often performed with free weights or machines, which may not be portable or feasible outside of the clinic or gym. In addition, RM testing may be more appropriate for compound movements involving multiple planes and joints, rather than the isolated testing of MMT or dynamometry.

In 1998, Dr. Robert Topp and colleagues[1] described a "Strength Index" that established an objective measure of strength by having subjects perform a particular exercise with TheraBand elastic resistance bands. The total number of repetitions was multiplied by the force of the TheraBand at the end of the exercise movement. The TheraBand Strength Index provides a repeatable measurement of any movement or functional activity involving multiple joints and planes of motion that can be used as an assessment of strength (see table 1).

TheraBand Strength Index (100% Elongation)

Repetitions	Yellow	Red	Green	Blue	Black	Silver	Gold
1	3	3.7	4.6	5.8	7.3	10.2	14.2
2	6	7.4	9.2	11.6.	14.6.	20.4	28.4
3	9	11.1	13.8	17.4	21.9	30.6	42.6
4	12	14.8	18.4	23.2	29.2	40.8	56.8
5	15	18.5	23	29	36.5	51	71
6	18	22.2	27.6	34.8	43.8	61.2	85.2
7	21	25.9	32.2	40.6	51.1	71.4	99.4
8	24	29.6	36.8	46.4	58.4	81.6	113.6
9	27	33.3	41.4	52.2	65.7	91.8	127.8
10	30	37	46	58	73	102	142

Table 1 provides the TheraBand Strength Index for exercises elongating the band 100% (twice resting length). If a patient completes an exercise that elongates a red band* 10 times, the strength index would be 37. If the patient progresses to the green band for 10 repetitions, the strength index would increase to 46.

Table 1: TheraBand Strength Index at 100% elongation

*All TheraBand brand bands, tubes, and CLX have the same resistances within the same colors (both red tube and band produce 3.7 pounds at 100%)

In their book, Age-Defying Fitness[2], (www.agedefyingfitness.com), Drs. Marilyn Moffat and Carole Lewis recommend using TheraBand resistance bands in 6 and 12" loops to measure upper and lower body strength (see page 73). Similarly, a popular assessment of strength in the field was recommended in the "Senior Fitness Test" by Rikli and Jones in 1999[3]. Upper extremity muscle strength and endurance was assessed using a standard dumbbell by counting the number of repetitions completed over 30 seconds during a seated elbow curl in older men and women.

In 2006, we published a paper in the Journal of Geriatric Physical Therapy on the validity and reliability of using TheraBand bands to measure elbow flexion strength in older adults over 65 years old[4]. We used Rikli and Jones' elbow flexion test and isokinetic dynamometry to validate healthy subjects' elbow flexor strength with TheraBand resistance band curls for 30 seconds. We used green TheraBand for women and blue TheraBand for men, as Rikli and Jones recommend 5 pound and 8 pound dumbbells for women and men respectively. Our study showed moderate correlation between all 3 strength measures ($r = 0.46$ to 0.62) and good consistency ($\alpha=0.72$). Therefore, we concluded that TheraBand resistance was a valid and reliable measure of elbow strength in older adults, making it a viable alternative to testing with dumbbells in the Senior Fitness Test.

In 2014, Swedish researchers, Andre Nyberg and his colleagues[5] investigated the accuracy of using TheraBand elastic resistance in measuring muscle strength by testing the relationship between 1RM elastic resistance and isokinetic dynamometry during shoulder flexion in healthy older adults. The researchers combined various individual bands to achieve the 1RM levels of resistance. They found moderate to excellent agreement between elastic and isokinetic strength measures, and excellent agreement and no difference between 1RM elastic resistance and peak isokinetic force ($\alpha=0.85$). They concluded, "It is possible, in healthy older individuals, to evaluate the effects of resistance training on muscle strength with the use of elastic resistance bands."

Dr. Nyberg published a similar study in 2016[6] on the "Validity of using elastic bands to measure knee extension strength in older adults." They first measured peak knee extension torque on an isokinetic dynamometer, and then combined multiple TheraBand elastic bands to create the 1RM resistance. The researchers concluded that 1RM testing with elastic resistance bands could be a very valid measure ($r=0.90, \alpha=0.86$) of knee extension strength in older adult, although there was variation within individuals.

In younger subjects, TheraBand elastic resistance has also been found valid and reliable for measuring strength in younger subjects. Swiss researchers used a multiple RM with TheraBand elastic bands for knee flexion and extension in healthy adults[7]. Using a prediction equation (1RM = resistance in kg/(1.0278 – (0.0278 x reps), the researchers estimated the subjects 1RM and assessed the maximal isokinetic strength of knee flexors and extensors. They found high validity and reliability ($r=0.93, \alpha=0.98$-$.99$) using TheraBand elastic resistance to test maximal strength of knee flexion and extension in healthy subjects.

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Most recently, Danish researchers led by Dr. Lars Andersen assessed the validity and reliability of the new TheraBand CLX "consecutive looped bands" in assessing shoulder muscle strength[8]. Rather than isokinetic dynamometer torque, the researchers used an isometric force transducer to measure maximal strength of shoulder abductors at 90° abduction. They had healthy subjects perform bilateral standing shoulder abduction to 90° with a progressive combination of CLX bands (See Table 2). They reported excellent validity (r=0.96) and reliability (α=0.99).

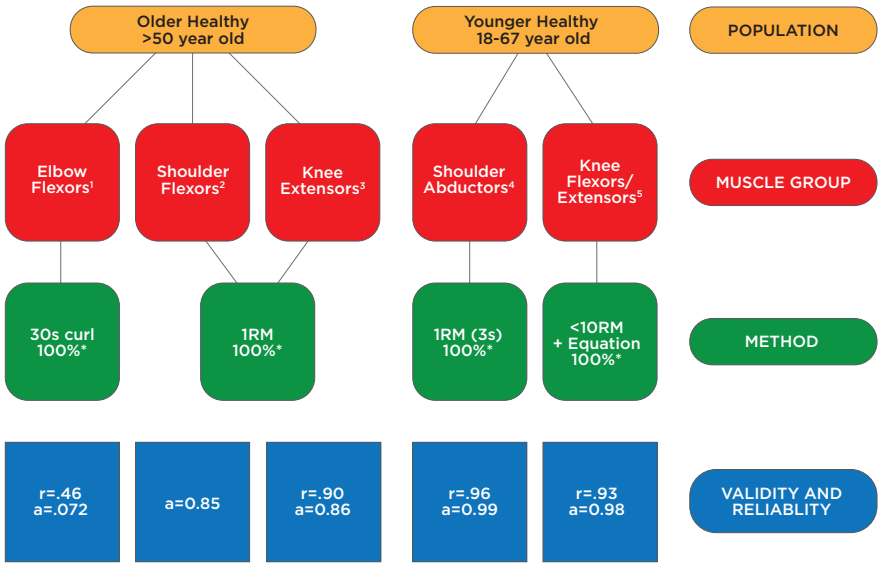
So what can we conclude? Elastic resistance is a valid and reliable measure of strength in older adults.

Table 2: Progressive resistances using TheraBand CLX from Andersen et al. 2016[8]

Level	Resistance in pounds at 100% stretch length	Resistance in Newtons at 100% stretch length	Color of elestic bands
1	3	13.3	Yellow
2	3.7	16.5	Red
3	4.6	20.5	Green
4	5.8	25.8	Blue
5	7.3	32.5	Black
6	10.2	45.4	Grey
7	14.2	63.2	Gold
8	17.2	76.5	Gold / Yellow
9	17.9	79.6	Gold / Red
10	18.8	83.6	Gold / Green
11	20	89.0	Gold / Blue
12	21.5	95.6	Gold / Black
13	24.4	108.5	Gold / Grey
14	27.4	121.9	Gold / Grey / Yellow
15	28.1	125.0	Gold / Grey / Red
16	29	129.0	Gold / Grey / Green
17	30.2	134.3	Gold / Grey / Blue
18	31.7	141.0	Gold / Grey / Black

So what can we conclude? Elastic resistance is a valid and reliable measure of strength in older adults. Figure 1 provides an evidence-based decision-making chart for assessing muscular strength with TheraBand elastic resistance. Simply identify the population and muscle group to find the method and its reliability and validity.

TheraBand Strength Assessment



*100% elongation of Theraband
[1]Manor 2006 [2]Nyberg 2014 [3]Nyberg 2016 [4]Anderson 2016 [5]Guex 2015

Figure 1: TheraBand Strength Assessment Decision Tree

However, there are different methods and muscles used in these studies, limiting generalizability. Several researchers noted individual variability in the measurements, as well as gender differences[5,8]. It's important to remember these studies provided validation and reliability for specific shoulder and knee muscles within specific populations. These results allow us to use TheraBand elastic resistance to measure strength within individuals and within studies, but we may not be able to compare different methods between individuals or studies. For example, as noted by Dr. Andersen et al[8], "For example, if a man improves muscle strength 15% based on elastic band test, this would likely reflect true improvement in muscle strength, but for a woman this change is within the range of measurement error and therefore not necessarily a true improvement."

Elastic resistance strength assessment has its limitations, but it does have benefits when properly utilized. The portability and low cost of elastic bands can provide strength measurements outside of lab and clinic settings, such as in the home. TheraBand can likely provide a valid and reliable measure of 'functional strength' (compared to isolated dynamometric measures).

It would be interesting to validate elastic resistance strength measures with functional ability, particularly in older adults in the community. In addition, research is needed for validity and reliability of using elastic resistance to measure strength in diseased or disabled populations.

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ACADEMY INSIGHT

Introducing the Bandcizer®: Bringing High Tech to Low Tech Rehab.

By Phil Page, PhD, PT, ATC, CSCS, FACSM

Wearable technology is undoubtedly growing in exercise and sports as 'high tech' devices continue to shrink in size. In today's world of technology, elastic bands offer 'low tech' exercise solutions. A new device from scientists in Denmark is helping researchers use a high tech solution to measure and quantify elastic resistance exercise.

The Bandcizer is a small device (slightly larger than a quarter) that attaches to TheraBand resistance bands. The Bandcizer wirelessly measures the tension of the band while it's stretched. Because the Bandcizer is calibrated to TheraBand resistance, it offers researchers and clinicians another tool to quantify elastic resistance exercise, particularly with home exercise programs.

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Because the Bandcizer is calibrated to TheraBand resistance, it offers researchers and clinicians another tool to quantify elastic resistance exercise, particularly with home exercise programs.

Quantifying elastic resistance exercise is important for several reasons. Clinicians and researchers can accurately assess exercise dosage and adherence, as well as the quality of exercise. A relatively novel concept in quantifying exercise dosage is "Time Under Tension" (TUT).

Time Under Tension is a measure of how long a muscle is contracting during concentric, eccentric, and isometric phases of a resistance exercise set[8]. A greater TUT is associated with increased myofibrillar protein synthesis[1]. When combined with data on the number of repetitions, the Bandcizer can provide an accurate measure of exercise dosage to quantify training stimulus. TUT provides a more accurate measure of dosage because it takes the speed of exercise into consideration, rather than simply the number of repetitions.

University researchers in Denmark validated the Bandcizer for measuring TUT with shoulder exercises[4], and have used the Bandcizer TUT to measure adherence and compliance of home exercises for the shoulder[5] and hip and knee[6]. The Bandcizer allowed researchers to find that a majority of subjects did not correctly perform their shoulder exercises after 2 weeks[2].

In addition to measuring tension and repetitions, the Bandcizer has a 3D gyroscope that can measure angular rotation, thus providing data on the quality of exercise movements. The Bandcizer was validated for assessing the quality of home-based shoulder exercises[3,5].

Michael Rathleff PhD and his colleagues[7] recently found that the Bandcizer was feasible for measuring the quality and dosage of home exercises for adolescents with knee pain. Using the Bandcizer, they found that only 5% of patients performed the appropriate amount of TUT, noting that 90% did not receive the prescribed exercise dosage.

In conclusion, the Bandcizer is the first device to validly and reliably quantify and monitor home exercise program dose and quality in shoulder and knee exercises. This novel device can help healthcare providers and researchers determine if home exercise programs are correctly performed (both in quality and quantity), rather than relying on less reliable self-reporting, which is often over-reported.

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Dr. Phil Page talks with

Dr. Michael Rogers

Over the years Performance Health Academy has had a long history of working with outside research starting 18 years ago with a meeting called TRAC. Each year this group of researchers meets to present their research on Performance Health products and discusses opportunities for further research.

Dr. Michael Rogers is the Chair of the Department of Human Performance studies at Wichita State University. Dr. Rogers has been on the Performance Health Scientific Advisory Committee for 15 years and has several publications and presentations, mostly focusing on the older adult population. I have the pleasure of working very closely with Dr. Rogers as co-author, co-investigator, as well as presenting internationally on a variety of topics.

This is the transcript from my interview with Dr. Rogers.

Dr. Michael Rogers, the Chair of the Department of Human Performance studies at Wichita State University. Dr. Rogers has been on the Performance Health Scientific Advisory Committee for 15 years and has several publications and presentations, mostly focusing on the older adult population.

How did you get started working with Performance Health products?

DR. MICHAEL ROGERS

It's been about 15 years. I had the pleasure of running into you at the American College of Sports Medicine Conference back in 2000 and started talking about some of the stuff I was doing with older adults, which was a community based exercise program addressing fall risk and we were trying to improve balance and strength. At the time I was using elastic resistance bands and couch cushions that I had bought from a furniture supply store and was having older adults stand on those to try to challenge their balance. In talking with you, you had mentioned that you were coming out with a new product which were foam pads called Stability Trainers and asked me to test them out and I was happy to do that.

What did working with Performance Health products lead to?

DR. MICHAEL ROGERS

Through that, it led to the development of our Standing Strong program which focuses on strength and balance for older adults, primarily in community based settings. It has been a decade and a half of working not only with those products but several others including kinesiology tape and Biofreeze.

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You've made such an impact internationally teaching your programs around the world. As a matter of fact, aren't you going to be teaching in Honduras?

DR. MICHAEL ROGERS

Yes, I will be at the Latin American Medical Association of Rehabilitation speaking to a number of Physical Therapists and other healthcare professionals from Latin America, Central America, and South America about our programs, including those that target balance. In this case it will be on the older athlete. Like you said, we've done a number of things around the world, particularly in Japan where we have a number of studies going on and programs throughout the country. Also throughout Europe a number of groups have picked up our programs and continue to utilize it.

What do you like about the Performance Health product line, such as the TheraBand and Stability Trainers?

DR. MICHAEL ROGERS

I think there is a number of things. One, I am working with a number of older adults who want things that are

affordable and certainly the products are that. Also, storage is an issue, whether that be in the home, community center, or a retirement community. We can't be taking up an entire room with exercise equipment. Much of the equipment available through Performance Health can be easily stored in a box or a closet and can be pulled out when necessary. That is one of the big attractions I have for the products. The other is the fact that we can progress people through a number of different exercises, whether that be strength or balance. The intensities can be varied with elastic resistance bands as well as stability trainers, which allows us to follow our exercise specifications and take a person who has low mobility and challenge them as they progress.

What is it about those products that draws you to them, not just for your research but also for your programming?

DR. MICHAEL ROGERS

It is the fact that in these community based exercise programs I can have a number of people at different levels of ability all performing the same exercise at the same time. This is better than having them do it individually and is much more time effective. Because of the variety of intensities available with these tools, we can have the individuals performing the same exercise together as a group.

DR. PHIL PAGE

That's one of the things that I really enjoy about your programming, that you're engaging the older adults together in a group. This really opened my eyes to being able to provide a larger scale intervention, rather than a one-on-one intervention as a Physical Therapist. We're able to do things more in a group, which we know with older adults becomes a social event. Part of what your programs have done is increase that socialization and bring older adults together, helping each other motivationally to perform exercises better as they move forward in the program.

DR. MICHAEL ROGERS

You're absolutely right. In many cases the number one reason older adults participate in an exercise program is for that social engagement. A group environment allows them for new relationships and friendships, not only with peers but with students of the younger generation. That's not just beneficial for the older adults, but certainly for my students to gain a better appreciation for the older generations and determining how they can help them throughout the rest of their careers.

What are you doing now in terms of research with Performance Health? Can you tell us a little bit about your study of kinesiology tape on older adult balance?

DR. MICHAEL ROGERS

What we had shown last year looking at kinesiology tape was that it did have some effect on balance in younger adults, particularly when they were standing in very challenging postures such as standing on thick foam with the eyes closed. We were curious as to whether or not we could replicate that to some extent in an older adult population, particularly those that were at risk for falls. One of the biggest risks is suffering a previous fall, where you are much more likely to have a subsequent fall. We found 14 older women ages 75-88 who had reported a fall in the past 6 months and we brought them into our human performance laboratory at Wichita State University. We then applied kinesiology tape to them at 50% tension and had them stand on our balance platform. The balance platform itself assesses postural sway, how much

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you move forwards, backwards, right, and left as you are trying to maintain a stable position. You may think you are standing still and you're not moving, but when in fact that center pressure is moving between your feet.

How did you measure their balance?

DR. MICHAEL ROGERS

We have the older adults stand in a variety of different foot positions, some a little easy and some a little bit more challenging, either with 50% kinesiology tape tension or in a controlled condition where they had no tape. We had them do several different positions with their feet side-by-side, side-by-side on foam, and a semi-tandem position, almost like you are taking a half step, it narrows down the medial-lateral base of support. We did that on a stable surface and a foam surface. Finally, we had them stand with their heel to their toe on a firm surface. I should mention that these were different postures than what we had used with the younger adults. I was reluctant to have the older adults stand in these very challenging positions on foam with their eyes closed and of course risk another fall. We found that these positions were still quite challenging to these older women and we were able to see some differences between our controlled condition and our taped conditions. With the 5 stances that we did, we did three trials with each condition. They had their eyes open, and we looked at 10 seconds of sway for each condition and were able to quantify the amount of medial-lateral and anterior-posterior sway, as well an overall stability index.

What were your findings?

DR. MICHAEL ROGERS

What we ended up finding was that kinesiology tape really didn't have an effect of any measure of balance standing on the firm surface with the feet side-by-side, but when you put them on a foam surface it improved the medial-lateral sway. So when you put them in a more challenging position, kinesiology tape did seem to have some effect at least in the medial-lateral direction. It did not affect anterior-posterior, or overall sway. Then as we looked at the other conditions, the semi-and full-tandem stance on the firm surface and the semi-tandem on the foam. We saw improvements on the anterior-posterior, and the overall sway index for the kinesiology tape compared to the controlled conditions, but the medial-lateral sway did not improve. So it didn't improve all components and all conditions, but it does seem to have an effect on anterior-posterior, and overall sway index in the most challenging of those foot positions. We can conclude that it could possibly have an effect on postural sway which could lead to an improvement of balance, which ultimately could lead to a reduced risk of falls.

What were some of the limitations that you saw in doing this in your study? Is there anything that we need to watch out for when we are trying to translate this into practice?

DR. MICHAEL ROGERS

Balance is very complicated. In this case we looked just at static balance, we didn't look at dynamic balance. One could argue that the risk for falls is higher when you are moving through the environment which would include dynamic balance, a component that we did not look at. That opens up the opportunity for future research in determining whether kinesiology tape has an effect as well with moving through the environment.

DR. PHIL PAGE

That's a good point, this study just tells us that people who had a fall previously may be able to improve their static balance, but as you said there are so many other factors in balance and falls, so this opens up many opportunities for more research. Obviously, falls are multi-factorial, this is just another factor that we can look at or another tool to help with balance confidence. I think even looking at self-efficacy while someone wears tape throughout the day is another great idea for researching someone that has had falls before.

DR. MICHAEL ROGERS

Yes, absolutely. It might reduce the fear of falling which is very common, particularly in those who have fallen. I would be interested to look as well at the effects of the tape in combination with the exercise programs that I talked about earlier. Such as, can we do long term studies and combine that with the application of tape?

You did a study on applying Biofreeze to the quadriceps of individuals who had induced delayed onset muscle soreness and looked at them over the course of time. Can you tell us a little bit about what you did and what you found?

DR. MICHAEL ROGERS

I will say that this was a particular interest for me, not only because it does potentially tie in with strength training in older adults, but also as a Certified Strength Conditioning Specialist through the National Strength Conditioning Association, I've had a long standing interest in resistance training. I'm interested in how to improve the effects of particular programming, but also how we can minimize the side effects of weight training, one of those being delayed onset muscle soreness.

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How did you perform this study?

DR. MICHAEL ROGERS

We took a group of our students and subjected them to some fairly intense squatting. 20 recreationally active men came into our lab and we tested them for one rep max on a deep squat. We put bolsters on the back side so that they would have to go down and tap that at the low point in the squat range of motion, so we could ensure with each rep that their thighs were parallel with the ground. Once we got the one rep max, we calculated 60% of that and had them do 10 sets of 10 with two minutes of rest in-between sets. I would challenge anybody to go try that and wake up the next day and not be sore, and that is essentially what happened. Everybody came in the next day and you could tell their gaites had changed substantially because they were quite sore afterwards. We got interested in seeing what would happen if we put Biofreeze on them.

What did you find?

DR. MICHAEL ROGERS

Biofreeze reduced the amount of perceived pain that they had in the quadriceps, so 24 hours after that exercise we applied Biofreeze to one thigh and put a placebo on the other thigh and asked them to rate their level of pain for 4 hours afterwards. We had them fill out a survey and questionnaire about their level of pain 0-10 and come back to the lab 48 hours afterwards and we repeated the process just switching the placebo and Biofreeze applications to the thighs. What we ended up finding out is Biofreeze did reduce the pain that they perceived up to 4 hours and at 4 hours it was still low. Unfortunately we had stopped collecting data at 4 hours so we really couldn't conclude how long Biofreeze is going to last.

What did you conclude from your study on Biofreeze?

DR. MICHAEL ROGERS

What we concluded is yes, it does reduce pain 24-48 hours. So we had to go to step 2 and redo the study. We went out and got another group of young men and women and had them repeat the one repetition max and the squat protocol. We then brought them back in 24 hours later and applied Biofreeze to one leg and placebo to the other. They filled out the same pain scale, but this time they went up to 8 hours instead of 4 hours.

What were your findings when students left Biofreeze on for 8 hours?

DR. MICHAEL ROGERS

The pain that they experienced for those 24 hours afterwards was exactly the same in each leg, which combined was about 6.7 on a 10-point scale. Then after we put the gel on, the pain declined to a minimum at 60 minutes. It went from 6.7 down to 5.3, from severe pain to moderate pain, about a 21% decline overall. What we were able to conclude, is that Biofreeze does reduce pain. It takes about 60 minutes for it to have its maximum effect and then it maintains that effect for approximately 5 hours afterwards before the pain starts to increase.

DR. PHIL PAGE

What I liked about that story is how we do research and don't necessarily get the right answer the first time. It doesn't mean we don't get the answer we're looking for per say but we had to change our methodology a little bit to truly be able to answer the question. In your case, the methodology in the first study was 4 hours and they still had declining pain, so we needed to find out exactly how long it lasted and simply

repeat it. It also gives you an opportunity to make your protocol better because you learned from the first one. One of the things I'd like to point out with Biofreeze and what you've shown is that the pain didn't go away totally, you are not going to get 100% pain relief with Biofreeze. What we're trying to do is help manage the pain a little bit better. It was great for you to be able to show us lasting pain relief because similarly another study that was done on carpal tunnel syndrome several years ago also showed at least 3 hours of pain relief, but the study wasn't long enough to show the actual length of relief. I think it was great that you were able to show this.

In terms of that study, were there any other limitations you saw in terms of applying it into daily practice?

DR. MICHAEL ROGERS

Firstly, one limitation was that this study delimited to delayed onset muscle soreness, so we haven't looked at chronic pain or disability. In this case, we have just inflicted pain acutely and looked at relief there. So the question still is relatively unanswered in long term pain, how much it may reduce. Pain sensation is another area that we can explore in the future. One of the limitations is that there is another 8 hours assessment of pain perception, so it was just not feasible to keep individuals in the laboratory for those 8 hours. We sent them off on their own to do the questionnaires and were asked to do an unweighted squat right before they completed the survey every half hour. Again, it is subjective to pain scale so it is hard to get a truly objective measure of pain, but we are able to show that subjectively related pain was able to decrease at 20-30%. This happened as quickly as 60 minutes after application and was maintained for up to 5 hours.

Why is TRAC important to you and what impact do you think it may have not just on you but on other clinicians or practitioners?

DR. MICHAEL ROGERS

Well like I said I have been with TRAC for 15 years now. It's been a great experience and I think as I look back on all those experiences, I really believe that TRAC provides me with opportunities to develop and conduct studies with a group of incredibly knowledgeable and experienced international scholars. Through the sharing of ideas and the pulling of our resources in our laboratories and our clinics, we are able to complete a wide range of projects that focus on innovative exercise programming and really clinically relevant outcomes. I truly believe these collaborative efforts would be incredibly difficult to perform without Performance Health as a catalyst for this. And I just want to disclose that I do appreciate Performance Health sponsoring these programs and studies and look forward to publishing them in the near future, as well as presenting them at other conferences on a national and international stage.

DR. PHIL PAGE

Thank you, Dr. Rogers. We appreciate your 15 years of being around not just as a researcher and on TRAC, but also as a good friend of mine, a good partner, and I really enjoy working with you. I know that we have a lot more years together so thank you.

DR. MICHAEL ROGERS

Thank you, Phil, I really appreciate it. It has been a pleasure doing this today.

Clinical Research **Digest**

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Hand, Wrist & Elbow

Kinesiology tape applied over the wrist extensors significantly increased grip strength in healthy subjects, while rigid strapping tape did not increase strength.

Kim JY, et al. Effects of kinesio tape compared with non-elastic tape on hand grip strength. 2016. J Phys Ther Sci. 28(5):1565-68.

Direction of kinesiology tape application doesn't influence muscle force in healthy subjects. Although statistically significant increases in muscle force were seen with 'placebo' tape placed horizontally, it was a mere 3% increase.

Vered et al. Influence of kinesio tape application direction on peak force of biceps brachii muscle: A repeated measurement study. 2016 J Bodyw Mov Ther. Jan;20(1):203-7

This systematic review concluded that eccentric exercise (including the Tyler Twist with the TheraBand Flexbar) could reduce pain and improve strength, although comparison with other tendinopathy interventions is needed.

Ortega-Catillo M et al. Effectiveness of the eccentric exercise therapy in physically active adults with symptomatic shoulder impingement or lateral epicondylar tendinopathy: A systematic review. J Sci Med Sport. 2016 Jun;19(6):438-53.

Neck

A 4-week exercise program including elastic bands for patients with chronic neck pain reduced pain and disability, but did not change posture; however, biofeedback exercise targeted to deep neck flexors was more effective.

Kim JY et al. Clinical effects of deep cervical flexor muscle activation in patients with chronic neck pain. J Phys Ther Sci. 2016. 28:269-73.

This systematic Cochrane review found specific strengthening exercises (Including TheraBand exercises) are beneficial for chronic neck pain and cervicogenic headaches.

Gross AR et al. Exercises for mechanical neck disorders: A Cochrane review update. Man Ther. 2016 Aug;24:25-45.

Patients with mechanical neck pain receiving stabilization exercises using TheraBand resistance and exercise balls had significantly better improvements in disability, pain, range of motion, and quality of life compared to those receiving manual therapy alone.

Delenay ST et al. A Comparison of the Effects of Stabilization Exercises Plus Manual Therapy to Those of Stabilization Exercises Alone in Patients With Nonspecific Mechanical Neck Pain: A Randomized Clinical Trial. J Orthop Sports Phys Ther. 2016 Feb;46(2):44-55.

An exercise program for patients with dizziness and chronic whiplash that included elastic resistance at home can improve dizziness symptoms and balance.

Treleaven J et al. Balance, dizziness and proprioception in patients with chronic whiplash associated disorders complaining of dizziness: A prospective randomized study comparing three exercise programs. Man Ther. 2016 Apr;22:122-30

This case report includes the use of elastic resistance for isometric cervical exercise and the Bruegger exercise.

Niethamer L, Myers R. Manual Therapy and Exercise for a Patient With Neck-Tongue Syndrome: A Case Report. J Orthop Sports Phys Ther. 2016 Mar;46(3):217-24.

Kinesiology tape reduced upper trapezius trigger point pain and strength compared to a 'sham' taping application in patients with myofascial pain syndrome over 3 days.

Ozturk et al. 2016. Efficacy of kinesio tape application on pain and muscle strength in patients with myofascial pain syndrome: a placebo-controlled trial. J Phys Ther Sci. 28:1074-79.

This is a study protocol examining the effects of exercise including neck strengthening using TheraBand resistance on frequency, intensity, and duration of chronic headaches and migraines in working women.

Rinne M et al. Therapeutic Exercise Training to Reduce Chronic Headache in Working Women: Design of a Randomized Controlled Trial. Phys Ther. 2016 May;96(5):631-40.

Shoulder

Prone plyometric shoulder exercises with the TheraBand Soft Weight preferentially activate the lower trapezius over the upper trapezius and provide very high (88-97% MVIC) activation of the middle and lower trapezius muscles.

Maenhout A et al. Scapular muscle activity in a variety of plyometric exercises. J Electromyogr Kinesiol. 2016 28;27:39-45.

A 6-week strengthening program with TheraBand resistance in subjects with poor scapular position can significantly improve scapular strength and shoulder posture.

Ha SM et al. Effects of scapular upward rotation exercises on alignment of scapula and clavicle and strength of scapular upward rotators in subjects with scapular downward rotation syndrome. J Electromyogr Kinesiol. 2016 Feb;26:130-6.

This article reviews 3 previously published studies on shoulder impingement, suggesting eccentric exercises can be beneficial, but the specific dosage remains unknown.

Valier AR et al. The Impact of Adding an Eccentric-Exercise Component to the Rehabilitation Program of Patients With Shoulder Impingement: A Critically Appraised Topic. J Sport Rehabil. 2016 May;25(2):195-201.

The authors completed a systematic review of exercises that provide optimal activation ratios of scapular stabilizer muscles, and provided recommendations for optimal exercise prescription.

Schory A et al. A systematic review of the exercises that produce optimal muscle ratios of the scapular stabilizers in normal shoulders. Int J Sports Phys Ther. 2016 Jun;11(3):321-36.

Researchers compared scapulothoracic muscle activity during several shoulder elevation exercises (including one with TheraBand resistance), noting higher pectoralis minor activation in patients with shoulder impingement compared to healthy subjects.

Castelein B et al. Scapulothoracic muscle activity during elevation exercises measured with surface and fine wire EMG: A comparative study between patients with subacromial impingement syndrome and healthy controls. Man Ther. 2016 Jun;23:33-9.

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Shoulder continued

This review of rotator cuff-related shoulder pain provides examples of exercises using elastic band loops and exercise balls, as well as a clinical model for managing pain from rotator cuff dysfunction.

Lewis J. Rotator cuff related shoulder pain: Assessment, management and uncertainties. Man Ther. 2016 Jun;23:57-68.

A 4-week exercise program with elastic bands and stretching reduced pain in patients with scapular muscle pain

Buttagat V et al. Effects of scapular stabilization exercise on pain related parameters in patients with scapulocostal syndrome: A randomized controlled trial. 2016 J Bodyw Mov Ther. Jan;20(1):115-22.

This article reviews the evidence for conservative management of rotator cuff tears and provides a rehab protocol including elastic resistance.

Edwards P et al. Exercise rehabilitation in the non-operative management of rotator cuff tears: a review of the literature. 2016. Int J Sports Phys Ther. Apr;11(2):279-301.

Active-assisted shoulder pulley exercises activate rotator cuff muscles approximately 20% of maximum. Rotator cuff patients undergoing physical therapy after surgery should use pulleys in the sagittal plane before the frontal plane.

Gurney AB et al. Shoulder Electromyography Measurements During Activities of Daily Living and Routine Rehabilitation Exercises. J Orthop Sports Phys Ther. 2016 May;46(5):375-83.

Performing a bilateral shoulder elevation with resisted external rotation using TheraBand resistance increases activation of the middle and lower trapezius compared to a scaption exercise, while reducing upper trapezius activation.

Castelein B et al. Superficial and Deep Scapulothoracic Muscle Electromyographic Activity During Elevation Exercises in the Scapular Plane. J Orthop Sports Phys Ther. 2016 Mar;46(3):184-93.

This is the recommended protocol for rehabilitation after arthroscopic rotator cuff repairs including guidelines for using elastic resistance exercise.

Thigpen CA et al. The American Society of Shoulder and Elbow Therapists' consensus statement on rehabilitation following arthroscopic rotator cuff repair. J Shoulder Elbow Surg. 2016 Apr;25(4):521-35.

This case study describes the use of elastic bands worn on the chest to improve scapular dyskinesis.

Yoo WG. Effects of the dual chest banding using elastic bands on the shoulder pain of scapular dyskinesis patient with winging and elevated scapular. J Phys Ther Sci. 2016. 28:711-13.

Patients will full thickness tears of their rotator cuff (supraspinatus muscle, specifically) underwent a 12 week exercise program including elastic resistance. Patients showed improvements in patient-reported outcomes and shoulder strength.

Effects of exercise therapy for the treatment of symptomatic full-thickness supraspinatus tears on in vivo glenohumeral kinematics. Miller RM et al. 2016. J Shoulder Elbow Surg. 25(4):641-9.

An exercise program with TheraBand combined with phonophoresis was better than ex alone for shoulder impingement.

Comparative effectiveness of ultrasonophoresis and iontophoresis in impingement syndrome: a double-blind, randomized, placebo controlled trial. García I, et al. Clin Rehabil. 2016 Apr;30(4):347-58.

TheraBand could be a valid and reliable instrument to measure shoulder strength in healthy adults.

Andersen LL, et al. Validity and reliability of elastic resistance bands for measuring shoulder muscle strength. Scand J Med Sci Sports. 2016 May 17. (Ahead of print)

Shoulder impingement patients wearing kinesiology tape for 4 weeks had similar improvements in pain, range of motion, and function, compared to those receiving a corticosteroid injection.

Sahin-Onat S et al. 2016. Effectiveness of Kinesiotaping and Subacromial Corticosteroid Injection in Shoulder Impingement Syndrome. Am J Phys Med Rehabil. Apr 15. [Epub ahead of print]

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Hip

Structured exercise programs including TheraBand resistance are beneficial to improve mobility after hip fracture.

Diong J et al. Structured exercise improves mobility after hip fracture: a meta-analysis with meta-regression. Br J Sports Med. 2016 Mar;50(6):346-55.

A specific exercise targeting the gluteus maximus with an elastic looped band performed over 6 days changes motor patterns in the brain.

Fisher BE et al. Evidence of altered corticomotor excitability following targeted activation of gluteus maximus training in healthy individuals. Neuroreport. 2016 Apr 13;27(6):415-21.

In a randomized controlled trial of hip osteoarthritis patients, Nordic walking was found to be better than strength training (including bands) over 12 months in function, physical activity, and mental health.

Bieler T, et al. In hip osteoarthritis, Nordic Walking is superior to strength training and home-based exercise for improving function. Scand J Med Sci Sports. 2016 Apr 30. [Epub ahead of print]

Kinesiology tape does not provide additional benefit to exercise to improve hip range of motion in healthy subjects.

Choi JH et al. The effects of taping, stretching, and joint exercise on hip joint flexibility and range of motion. 2016. J Phys Ther Sci. 28(5):1665-68.

Knee

Combining exercise (including elastic resistance bands) with manual therapy for knee osteoarthritis is more effective than exercise alone. In addition, spreading 12 monthly physical therapy visits over the course of one year was more effective than 12 consecutive visits.

Abbott JH, et al. The Incremental Effects of Manual Therapy or Booster Sessions in Addition to Exercise Therapy for Knee Osteoarthritis: A Randomized Clinical Trial. 2015. J Orthop Sports Phys Ther. 2015 Dec;45(12):975-83.

Adding elastic resistance or a ball between the knees during a squat does not increase vastii muscle activation.

Lee TK, et al. Analysis of vastus lateralis and vastus medialis oblique muscle activation during squat exercise with and without a variety of tools in normal adults. 2016. J Phys Ther Sci. 28(3):1071-3.

Adding hip strengthening exercises with TheraBand to knee exercises results in significantly better pain reduction and functional improvement in females with anterior knee pain after 12 weeks.

Sahin M et al. The effect of hip and knee exercises on pain, function, and strength in patients with patellofemoral pain syndrome: a randomized controlled trial. 2016. Turk J Med Sci. 46:265-277.

An 8 week exercise program including exercise balls and elastic resistance results in significant reduction in pain and flare-ups in patients with hip or knee pain.

Sandal LF et al. Pain trajectory and exercise-induced pain flares during 8 weeks of neuromuscular exercise in individuals with knee and hip pain. Osteoarthritis Cartilage. 2016 Apr;24(4):589-92.

The authors describe the clinical management of proximal hamstring tendinopathy, including several exercises with elastic tubing.

Goom TSH et al. Proximal Hamstring Tendinopathy: Clinical Aspects of Assessment and Management. J Orthop Sports Phys Ther. 2016 Jun;46(6):483-93.

Knee osteoarthritis patients can improve pain and function after either group-based or individual physical therapy including progressive elastic resistance strengthening.

Allen KD et al. Group Versus Individual Physical Therapy for Veterans With Knee Osteoarthritis: Randomized Clinical Trial. Phys Ther. 2016 May;96(5):597-608.

Adolescent females with anterior knee pain had more improvement with exercise, patellar taping and patient education compared to education alone.

Rathleff et al. Effect of exercise therapy on neuromuscular activity and knee strength in female adolescents with patellofemoral pain-An ancillary analysis of a cluster randomized trial. Clin Biomech (Bristol, Avon). 2016 May;34:22-9.

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Knee continued

Healthy females performed a squat protocol to induce quadriceps soreness (DOMS) without and with kinesiology tape applied. There was no difference in soreness or sprint performance with the tape, but their quadriceps flexibility was maintained with the tape.

Ozman et al. The Effect of Kinesio Taping on Muscle Pain, Sprint Performance, and Flexibility in Recovery From Squat Exercise in Young Adult Women. J Sport Rehabil. 2016 Feb;25(1):7-12.

Applying kinesiology tape to quadriceps of knee osteoarthritis patients can significantly reduce pain and improve flexion range of motion over a month compared to a placebo tape, but there is no improvement in strength.

Kaya Mutlu E et al. Does Kinesio Taping of the Knee Improve Pain and Functionality in Patients with Knee Osteoarthritis?: A Randomized Controlled Clinical Trial. Am J Phys Med Rehabil. 2016 May 4. [Epub ahead of print]

Kinesiology tape to lower extremity muscles significantly improved pain and disability outcomes in patients with knee osteoarthritis when combined with traditional "physical therapy."

Lee K, et al. The effects of kinesiology taping therapy on degenerative knee arthritis patients' pain, function, and joint range of motion. J Phys Ther Sci. 2016. 28:63-66.

Kinesiology tape applied to the quadriceps muscle of ACL reconstruction patients does not improve muscle strength or activation, or improve balance.

Oliviera et al. Immediate effects of Kinesio Taping® on neuromuscular performance of quadriceps and balance in individuals submitted to anterior cruciate ligament reconstruction: A randomized clinical trial. J Sci Med Sport. 2016 Jan;19(1):2-6.

Kinesiology tape does not improve quadriceps strength or function in healthy individuals after 5 day application, or at 72 hours after removal.

De Jesus et al. Kinesio taping effect on quadriceps strength and lower limb function of healthy individuals: A blinded, controlled, randomized, clinical trial.2016. Phys Ther Sport. 2016 Mar;18:27-31.

Kinesiology tape in healthy individuals does not improve quadriceps strength, muscle activation, hop, or postural stability.

Lins CA et al. Delayed effect of Kinesio Taping on neuromuscular performance, balance, and lower limb function in healthy individuals: a randomized controlled trial.Braz J Phys Ther. 2016 Mar 22 (Epub ahead of print)

Researchers found no increase in quadriceps strength in healthy subjects after applying kinesiology tape.

Guedes R et al. The effects of Kinesiotaping on quadriceps muscle performance at different velocities: A randomized controlled trial. 2016. Isokinetic Ex Sci. 24:149-56.

A randomized controlled trial found that 48 hours of kinesiology tape application to rectus femoris does not enhance joint proprioception or functional performance in healthy subjects.

Magalhaes I et al. Prolonged use of Kinesiotaping does not enhance functional performance and joint proprioception in healthy young males: Randomized controlled trial2016. March. Epub ahead of print. http://dx.doi.org/10.1590/bjpt-rbf.2014.0151

Foot & Ankle

A 12-week exercise program including elastic bands improved pain, range of motion, strength and function in soccer players with chronic ankle sprain. (Note: There was no control or randomization in this study)

Kim K, Jeon K. Development of an efficient rehabilitation exercise program for functional recovery in chronic ankle instability. 2016. J Phys Ther Sci. 28(5):1443-7.

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This study examined the kinematics and muscle activation while balancing on a wobble board compared to a firm surface, finding activation of muscles in the thigh and ankles.

Silva P et al. Strategies for equilibrium maintenance during single leg standing on a wobble board. Gait Posture. 2016 Feb;44:149-54.

Brazilian researchers compared 3 groups of patients with plantar fasciitis performing either stretching, foot & ankle strengthening with elastic resistance, or hip & foot strengthening with elastic resistance; they found each group improved equally in pain relief, function, and balance.

Kamonseki et al. Effect of stretching with and without muscle strengthening exercises for the foot and hip in patients with plantar fasciitis: A randomized controlled single-blind clinical trial. Man Ther. 2016 Jun;23:76-82.

A randomized controlled trial of patients with Achilles tendinopathy showed that adding instrument assisted soft tissue mobilization therapy to an eccentric exercise program led to significantly better outcomes in pain.

McCormack JR et al. Eccentric Exercise Versus Eccentric Exercise and Soft Tissue Treatment (Astym) in the Management of Insertional Achilles Tendinopathy: A Randomized Controlled Trial. 2016. Sports Health. 8:230-37.

During a jump landing, rigid taping stabilizes the rearfoot and midfoot (reducing frontal plane motion) in patients with chronic ankle instability, while kinesiology taping does not influence foot kinematics; both tapes reduce plantar flexion range of motion.

Kuni B et al. Effect of kinesiotaping, non-elastic taping and bracing on segmental foot kinematics during drop landing in healthy subjects and subjects with chronic ankle instability. Physiotherapy. 2015 [Epub ahead of print]

Kinesiology tape applied to the peroneus longus did not significantly change the muscle activation during downhill running in subjects with functional ankle instability, although there was a small effect on reducing the feeling of instability in some subjects.

Juchler et al. The effect of kinesio tape on neuromuscular activity of peroneus longus. Physiother Theory Pract. 2016 Feb;32(2):124-9.

This case series reported that 5 patients with plantar fasciitis experienced improvements in pain and function within 2 weeks of applying kinesiology tape and performing daily stretches.

Doshi et al. Short term effects of kinesiotaping on pain and function in patients with plantar fasciitis. Orthop Phys Ther Practice. 2016. 28(1):40-46.

Kinesiology tape applied to the lateral gastrocnemius for 72 hours results in reduced duration of activation during gait in healthy adults, but no change in amplitude.

Martinez-Gramage J et al. Effect of Kinesio Taping on gastrocnemius activity and ankle range of movement during gait in healthy adults: A randomized controlled trial.Phys Ther Sport. 2016 Mar;18:56-61.

Kinesiology tape applied to gastroc with 50% tension has no effect on balance or functional performance in healthy individuals compared to 'sham' tape applied without tension.

Wilson V et al. The immediate and long-term effects of kinesiotape® on balance and functional performance. 2016. Int J Sports Phys Ther. Apr;11(2):247-53.

Kinesiology tape applied to lower leg reduced plantar pressure during gait in subjects with 'flexible flat feet.'

Wang JS et al. Immediate effects of kinematic taping on lower extremity muscle tone and stiffness in flexible flat feet. 2016. J Phys Ther Sci. 28:1339-42.

Kinesiology tape improved joint position sense (proprioception) in patients with a history of ankle sprains.

Seo HD et al. Effects of Kinesio taping on joint position sense of the ankle. 2016. J Phys Ther Sci. 28:1158-60.

Kinesiology tape on the fibularis longus muscle does not change balance or muscle onset timing in healthy subjects, regardless of the direction of application.

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Foot & Ankle continued

Correia C et al. Kinesiology taping does not change fibularis longus latency time and postural sway. 2016. J Bodyw Mov Ther. Jan;20(1):132-8.

Wearing ankle compression garments increases skin temperature, but does not enhance performance, strength, or blood lactate clearance while being worn. This is consistent with other research finding no performance benefit to wearing compression garments during activity; rather, evidence suggests wearing compression garments after strenuous activity may enhance recovery.

Samaher N, et al. Effect of an Ankle Compression Garment on Fatigue and Performance.J Strength Cond Res. 2016 Feb;30(2):326-35

Sports Rehab & Performance

This practical article provides examples of exercises for mobility using elastic resistance bands for female athletes to reduce injury risk and improve performance.

Knapp KA. Self-Care Modalities: Improved Performance and Decreased Injury for Female Athletes. 2016. Strength Cond J. 38(2):70-78.

This EMG study found a "hip thrust" exercise with an elastic band has comparable muscle activation of the thigh as barbell-resisted weights, although the barbell thrust had higher activation of the upper gluteus maximus.

Contreras B et al. A Comparison of Gluteus Maximus, Biceps Femoris, and Vastus Lateralis Electromyography Amplitude for the Barbell, Band, and American Hip Thrust Variations. J Appl Biomech. 2016 Jun;32(3):254-60.

A 9-week core strengthening program added to regular in-season training that included TheraBand Stability Trainers and exercise balls improved strength, speed, and performance in young soccer players compared to players not performing the program.

Prieske O et al. Neuromuscular and athletic performance following core strength training in elite youth soccer: Role of instability. Scand J Med Sci Sports. 2016 Jan;26(1):48-56.

In a secondary analysis of a randomized controlled trial comparing bracing, neuromuscular exercise (balance board training) and a combination, the authors found that history of previous injury and participation in high-risk sports were predictors of compliance in the prevention program.

Janssen KW et al. Interventions preventing ankle sprains; previous injury and high-risk sport participation as predictors of compliance. J Sci Med Sport. 2016 Jun;19(6):465-9.

A semi-rigid ankle brace provides better dynamic control than a soft ankle brace during a 1-leg landing task.

Maeda N et al. Effect of Semi-Rigid and Soft Ankle Braces on Static and Dynamic Postural Stability in Young Male Adults. J Sports Sci Med. 2016 May 23;15(2):352-7.

In a meta-analysis, the authors reported that prophylactic ankle braces that limit inversion while maximizing sagittal plane motion (such as the Active Ankle) protect ankle ligaments.

Effects of Prophylactic Ankle Supports on Vertical Ground Reaction Force During Landing: A Meta-Analysis. Niu W et al. J Sports Sci Med. 2016. 15:1-10.

The authors compared the biomechanics of jump landing in female netballers with and without lace-up ankle braces.

Mason-Mackay AR et al. The effect of ankle bracing on landing biomechanics in female netballers. Phys Ther Sport. 2016 Jul;20:13-8.

This case report used an elastic band to unload chronic Achilles tendinopathy in a mountaineer.

Yoo WG. Effects of heel support banding using an elastic band on chronic pain at the achilles tendon in a mountaineer. J Phys Ther Sci. 2016. 28:314-15.

Adding elastic resistance to heavy squat did not increase muscle activation (EMG)

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Saeterbakken AH et al. Comparison of Kinematics and Muscle Activation in Free-Weight Back Squat With and Without Elastic Bands. J Strength Cond Res. 2016 Apr;30(4):945-52.

A 12-week neuromuscular training program with stability trainers and balance boards may provide protection against ACL injuries in adolescent female handball and soccer players.

Zebis MK et al. Effects of evidence-based prevention training on neuromuscular and biomechanical risk factors for ACL injury in adolescent female athletes: a randomised controlled trial. Br J Sports Med. 2016 May;50(9):552-7.

Runners with anterior knee pain significantly reduced their pain and increased their function after an 8-week exercise program including elastic bands.

Esculier JF et al. The Effects of a Multimodal Rehabilitation Program on Symptoms and Ground-Reaction Forces in Runners With Patellofemoral Pain Syndrome. J Sport Rehabil. 2016 Feb;25(1):23-30.

This study compared the ability of white athletic tape to self-adherent stretch tape in reducing ankle range of motion after 30 minutes of exercise. They found both were effective at similar costs.

Stanek JM et al. No Difference in Prophylactic Support Provided by Either Cloth or Self-adherent Tape. Athl Train Sports Health Care. 2016. 8(1):8-16.

Kinesiology tape can improve a pronated foot in runners, but has no effect on foot pressure. In contrast, "sham" kinesiology tape (applied without tension) significantly increased plantar pressure time during gait.

Aguilar MB, et al. Effectiveness of neuromuscular taping on pronated foot posture and walking plantar pressures in amateur runners. J Sci Med Sport. 2016 Apr;19(4):348-53.

In a pre-post test observational model, the authors found that kinesiology tape improved muscle performance of quadriceps and thigh muscles in soccer players with knee injuries.

Hong SK et al. Effect of kinesio taping on the isokinetic muscle function in football athletes with a knee injury. J Phys Ther Sci. 2016. 28:218-22.

Kinesiology tape applied to the gastrocnemius of healthy subjects for 48 hours slightly increased rate of force development, but not strength. In addition, there was no difference between applying tape in opposite directions.

Magalhaes I et al. Kinesiotaping enhances the rate of force development but not the neuromuscular efficiency of physically active young men. J Electromyogr Kinesiol. 2016 Jun;28:123-9.

Kinesiology tape applied to both flexors and extensors on the forearm of healthy tennis players reduced muscular fatigue, but did not change strength tested within 2 hours of taping.

Zhang et al. Acute effects of Kinesio taping on muscle strength and fatigue in the forearm of tennis players. J Sci Med Sport. 2016 Jun;19(6):459-64.

Kinesiology tape applied to the quadriceps improved anaerobic (but not aerobic) exercise performance and athletic performance capacity in healthy subjects.

Duruturk N et al. The Effects of Quadriceps Kinesio Taping on Aerobic and Anaerobic Exercise Performance in Healthy Participants: A Randomized Controlled Study. 2016. Int J Athl Ther Train. 21(2):32-38.

Ice applied to shoulder and forearm of pitchers between innings pitched during a simulated game attenuated velocity lost without cooling, reduced perceived exertion, and facilitated subjective recovery.

Bishop SH et al. The Effect of Intermittent Arm and Shoulder Cooling on Baseball Pitching Velocity.2016. J Strength Cond Res. Apr;30(4):1027-32.

These papers surveyed sports physical therapists and athletic trainers on the types of cryotherapy they use clinically (particularly for an ankle sprain), finding great variability.

Hawkins S, Hawkins J. Clinical applications of cryotherapy among sports physical therapists. Int J Sports Phys Ther. 2016 Feb;11(1):141-8.

Hawkins J, Hawkins S. Clinical applications of therapeutic modalities among collegiate athletic trainers, Part I: Cryotherapy. 2016. Int J Athl Ther Train. 21(1):62-67.

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Geriatrics

This is a study protocol using TheraBand resistance, foam rollers and stretch strap in patients with increased thoracic kyphosis.

Katzman WB et al. Study of Hyperkyphosis, Exercise and Function (SHEAF) Protocol of a Randomized Controlled Trial of Multimodal Spine-Strengthening Exercise in Older Adults With Hyperkyphosis. Phys Ther. 2016 Mar;96(3):371-81.

A group resistance training program with TheraBand in very old institutionalized females resulted in improvements in muscle strength and physical performance after 6 months.

Hofmann M et al. Effects of elastic band resistance training and nutritional supplementation on muscle quality and circulating muscle growth and degradation factors of institutionalized elderly women: the Vienna Active Ageing Study (VAAS). Eur J Appl Physiol. 2016 Mar 1. [Epub ahead of print]

The Strong for Life program was developed in the 1990s as an exercise program for older adults exclusively using TheraBand resistance bands. This study showed that home care attendants could successfully facilitate the Strong for Life program for homebound clients.

Danilovich MK et al. Translating Strong for Life Into the Community Care Program. J Appl Gerontol. Online ahead of print. Jan 20, 2016.

Combining massage with eccentric contraction using TheraBand resistance improves balance and ankle flexibility in older adults.

Forman J et al. Effects of massage combined with eccentric resistance on ankle flexiblity and balance in adults aged 50-60 years (Abstract). 2016. J Bodywork Movement Ther 20(1):147

An exercise program for Parkinson's patients including elastic resistance increases physical activity after the program ends.

Ridgel AL et al. Enhanced Exercise Therapy in Parkinson's disease: A comparative effectiveness trial.2016. J Sci Med Sport. Jan;19(1):12-7.

Danish researchers found that TheraBand resistance exercises in stroke survivors produce lower muscle activation (EMG) than similar exercise performed on a weight machine; however, their perceived exertion was similar.

Vinstrup J et al. Electromyographic Comparison of Elastic Resistance and Machine Exercises for High-Intensity Strength Training in Patients With Chronic Stroke. Arch Phys Med Rehabil. 2016 Mar;97(3):429-36

This meta-analysis including studies using TheraBand resistance concluded that moderate intensity progressive resistance training can improve strength, balance, and motor symptoms in early to moderate PD.

Chung CLH et al. Effectiveness of resistance training on muscle strength and physical function in people with Parkinson's disease: a systematic review and meta-analysis. Clin Rehabil. 2016 Jan;30(1):11-23.

In a randomized, controlled trial, a 12-month exercise program including elastic bands improved functional fitness in wheelchair-bound nursing home residents

Chen KM et al. Feasible modalities and long-term effects of elastic band exercises in nursing home older adults in wheelchairs: A cluster randomized controlled trial. Int J Nurs Stud. 2016 Mar;55:4-14.

Older adults performing 12 weeks of balance and strength training including TheraBand Stability Trainers and exercise balls improved balance and strength; furthermore, a supervised program was more effective than unsupervised.

Lacroix A et al. Effects of a Supervised versus an Unsupervised Combined Balance and Strength Training Program on Balance and Muscle Power in Healthy Older Adults: A Randomized Controlled Trial. Gerontology. 2016;62(3):275-88.

A 5-week balance training program for older adults improved function, balance and strength.

Maritz & Silbernagel. A Prospective Cohort Study on the Effect of a Balance Training Program, Including Calf Muscle Strengthening, in Community-Dwelling Older Adults. J Geriatr Phys Ther. 2016 Jul-Sep;39(3):125-31.

Research articles added to the Performance Health Academy Research Database between January and June 2016. To see the abstract or articles, visit www.Thera-BandAcademy.com/research.

Subscribe to the Performance Health Academy blog at performancehealthacademy.com to receive these monthly updates.

A 12-week low-intensity TheraBand resistance-training program with blood flow restriction significantly increased quadriceps muscle size and strength more than those training at higher resistances without blood flow restriction.

Yasuda T et al. Thigh muscle size and vascular function after blood flow-restricted elastic band training in older women. Oncotarget. 2016 May 23.

Knee extension strength in older adults can be validly measured using TheraBand elastic resistance, serving as an alterative to strength assessment using expensive and bulky isokinetic machines.

Nyberg A et al. Validity of using elastic bands to measure knee extension strength in older adults. J Nov Physiother Phys Rehabil 3(1):16-21.

In a randomized, controlled trial, a 6-month exercise program including elastic bands improved ADL and functional fitness in wheelchair-bound nursing home residents with dementia.

Chen MC, et al. Elastic Band Exercises Improved Activities of Daily Living and Functional Fitness of Wheelchair-bound Older Adults with Cognitive Impairment: A Cluster Randomized Controlled Trial. Am J Phys Med Rehabil. 2016 May 4. [Epub ahead of print]

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Martin F et al. Tool for measuring intensity between training sessions in elderly. J Strength Cond Res. 2016. 30(1):S52-53 (Abstract)

Stroke survivors with lower extremity hemiplegia performed PNF exercises with kinesiology tape, rigid Mcconnell tape, or no tape for 8 weeks. Kinesiology tape had more beneficial effect compared to rigid tape and control on gait and balance.

Choi YK et al. Effects of Kinesio taping and Mcconnell taping on balance and walking speed of hemiplegia patients. 2016. J Phys Ther Sci. 2016. 28:1166-9.

Stroke survivors with hemiplegic shoulder pain had kinesiology tape applied for 24 hours; there was no significant change in pain, range of motion, or function.

Kalichman L et al. Effect of kinesio tape application on hemiplegic shoulder pain and motor ability: a pilot study. 2016. Int J Rehabil Res. Apr 12. [Epub ahead of print]

Acute Care

Inpatient pneumonia patients performing an exercise program with TheraBand resistance significantly improved their ADL, functional performance, strength, and quality of life compared to pneumonia patients receiving traditional therapy.

Jose A, Corso SD. Inpatient rehabilitation improves functional capacity, peripheral muscle strength and quality of life in patients with community-acquired pneumonia: a randomised trial. J Physiother. 2016 Mar 17. (Epub ahead of print).

Chronic Diseases

A novel manual approach using a stretch strap helped reduce symptoms of peripheral diabetic neuropathy.

Alshahrani A et al. Effects of a Novel Therapeutic Intervention in Patients With Diabetic Peripheral Neuropathy. 2016. Arch Phys Med Rehabil. May;97(5):733-8.

A 12-week TheraBand resistance training program for Korean women with Type 2 diabetes significantly improved glucose control, body composition, and physical function, regardless of the length of diagnosis (Short or long-standing disease)

Park BS et al. Effects of Elastic Band Resistance Training on Glucose Control, Body Composition, and Physical Function in Women With Short- vs. Long-Duration Type-2 Diabetes. J Strength Cond Res. 2016 Jun;30(6):1688-99

A 5-week core strengthening program including an exercise ball was feasible in multiple sclerosis patients, and resulted in improved gait and balance.

Normann B et al. Group-based individualized core stability and balance training in ambulant people with multiple sclerosis: a pilot feasibility test–retest study. 2016. Eur J Physiother. 18(3):173-8.

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Clinical Research **101**

By Phil Page, PhD, PT, ATC, CSCS, FACSM

Clinical Research 101

In this first "Journal Club" contribution of the *Journal of Performance Health*, we will look at the basics of research design and the research process, focusing on clinical aspects of research. This is the first step in being able to interpret and translate research into clinical practice. In coming issues, the Journal Club will feature in-depth reviews of published articles in an effort to educate readers in the critical review, analysis, and interpretation of a variety of research designs, from meta-analysis to randomized controlled trials, to case reports.

Research Question > Hypothesis > Research Design > Methods > Stats > Interpretation

The Research Process

First, let's look at the research process. In general, clinical research follows the scientific method: a research question generates a hypothesis, which leads to an experiment to determine if the hypothesis is correct. Typically, statistical analysis is used with logic to either verify or refute the hypothesis.

It's important for all components of this process to be appropriate. For example, the research design must adequately address the research question, and the statistics must satisfy the design. Therefore, these components of the research process are all interrelated in order to answer the research question.

Anatomy of a Research Paper

This research process often sets the outline of a research paper:

- **Introduction**
- **Methods**
- **Analysis**
- **Results**
- **Discussion**
- **Conclusion**

Research papers often have abstracts at the beginning of the paper, which are summaries of each of these sections, providing the reader with a summary of the entire study. However, simply reading the abstract is not enough to analyze and critically review a research project. The full article is needed to assess the validity of the results. (Note: some research projects presented at conferences are only published as abstracts, which should be noted in the reference).

The type of publication may reflect the validity of the study as well. A peer-reviewed journal with a high "impact factor" is better regarded for scientific validity than an online trade magazine. Readers should also be aware of a recent increase in less credible 'journals' providing online publication simply to generate revenue.

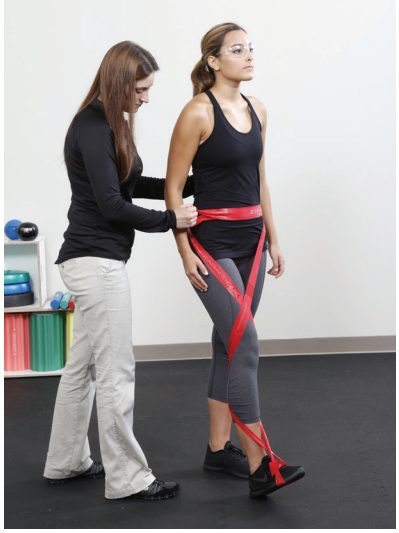
Research Designs

The research question and hypothesis guide the research design. Generally, there are 2 types of research design: experimental (clinical) and descriptive (analytic). Each design type has certain characteristics and different "levels" of evidence.

Traditional "Levels of Evidence" have been provided by the Oxford Center for Evidence-Based medicine (OCEBM) and have been based on research design. For example, Systematic Reviews are "Level 1," while Case Series are "Level 4." One of the disadvantages of the OCEBM Levels is that they combine descriptive and experimental methods without clearly providing levels for various rehabilitation research designs. Table 1 is based on the current OCEBM levels, but provides more rehab-specific designs.

Level	Descriptive (Analytical)	Experimental (Clinical)
1	Meta-analysis or systemic review	RCT of patients
2	Patient Cohorts*	RCT of healthy subjects
3	Healthy Cohorts*	Repeated Measure non-randomized
4	Literature review qualitative / case study	Case Series case control
5	Mechanistic based based reasoning / opinion	Animal / in-vitro bench

*Cohorts include epidemiological, diagnostic, preventive, or observational studies



Consistent with the OCEBM, the level may be graded up or down based on the quality of the study; however, in contrast, the level should not be based on effect size. A small effect size from a well-designed study may be clinically meaningful.

Research Methods

Obviously the research design will drive the methods. The most important component of a research report is the methods section. A detailed explanation of the research methods provides important information in several areas:

- Determine if the methods were appropriate to answer the research question
- Provides the ability to review, critique and analyze methods
- Allows others to replicate the study to validate and collect additional data
- Translate methods into clinical practice such as a clinical intervention
- Determine if the study is relevant to specific populations

CONTINUED

Clinical research designs should provide detail on 4 key topics (PICO)

- **Population**: inclusion and exclusion criteria, as well as sample size
- **Intervention:** specific details that support replication
- **Comparison:** identify what the intervention is being compared to (or control)
- **Outcomes:** specify the outcome measures, including validity & reliability, as well as clinically important differences

Depending on the research design, there are specific reporting guidelines:

- **CONSORT:** Randomized clinical trials
- **STROBE:** Observational studies
- **STARD:** Diagnostic studies
- **PRISMA:** Systematic review or meta-analysis

Relevant Statistics

Assuming the study is properly designed and executed, proper statistical analysis is essential to answer the research question. However, traditional statistics don't always provide important clinical interpretation. Statistical significance only indicates if the researcher made the correct statistical decision regarding a hypothesis. More clinically relevant and useful analysis should be included.

Effect Sizes. Effect sizes provide an idea of how large the difference is between groups, thus providing a standardized estimate that can be compared between studies. This standardized difference is also used in meta-analysis to pool data of multiple studies. Effect sizes can be classified as trivial (<.2), small (.2-.5), moderate (.5-.8), or large (>.8).

Confidence Intervals. Confidence intervals are also helpful clinically by providing a range of estimates containing the true value within a population. Because of the variability within a clinical population, the CI provides clinicians with potential values beyond the average.

Minimal Clinically Important Differences (MCID). To be clinically meaningful, differences between groups or after an intervention should reach a minimum threshold. For example, to drop 2 points on a pain scale of 0-10 would be clinically meaningful, whereas a drop of 1 is not.

Traditionally, statistical significance has been used by researchers and clinicians to determine if an intervention is effective; however, it does not provide us with enough clinically relevant information to make evidence-based decisions.

In addition to relevant statistics, researchers should indicate if the study is adequately powered for statistical analysis. Statistical power enhances the researchers ability to make the correct decision about a hypothesis. A power analysis provides a minimal number of subjects to detect a difference between groups. Underpowered studies generally do not reach statistical significance.

Interpretation

Clinical relevance is the most meaningful interpretation of a research paper. Clinically relevant statistics noted above should be provided. Proper interpretation of the statistical analysis is also critical, and is generally based on the research design. A well-designed randomized controlled trial can determine 'cause-and-effect', whereas an observational study (correlational, repeated measure) may only suggest association.

Obviously the quality of research is the basis for interpretation. One of the most important factors in determining the quality of the evidence is bias, which can be present in several forms. Researchers and readers should be able to identify sources of bias. The PEDro Scale is commonly used to assess bias and quality of clinical studies. All aspects of the study should be assessed for validity and reliability, especially the outcome measures. Finally, disclosure of financial relationships or other interests should always be made to identify potential bias.

Always remember: in clinical practice, there are:

Levels of Proof

1 **Proven**

2 **Proven Not**

3 **Not Proven**

Key points

Here are the key points in analyzing research for clinical translation:

- Is the research question relevant to your practice in terms of population and intervention?
- Do the design and statistical analysis answer the research question?
- Are the methods (procedures/intervention) specified to reproduce and analyze for relevance and quality?
- Are clinically relevant statistics and power analysis provided?
- Were statistics properly interpreted?
- Are sources of bias recognized?

Continued from page 17

from 1 (extremely dissatisfied) to 7 (extremely satisfied) and included characteristics of appearance, ease of application, fit, comfort, stability, interference with ability to move, ability of brace to prevent ankle injury, and overall satisfaction. Repeated measures ANOVA was employed to determine the main effect of bracing conditions on the outcome variables of ROM, functional performance and satisfaction. Tukey's LSD post hoc comparisons were conducted on significant main effects ($p<.05$) to determine the specific differences between the condition means.

Results: All 30 participants completed the study. The single upright ankle brace ROM was similar to the no brace condition in regards to ROM. The double upright brace limited ankle ROM more than the no brace or the single upright braced condition, and this effect was observed to be greatest in PF (R: $p\leq 0.04$). Regarding functional testing, there was no difference between the conditions on the square hop, figure 8 and 6 m crossover hop tests. There were differences between the no brace and double upright brace conditions on the side hop ($p\leq 0.01$) and the vertical hop ($p< 0.02$) tests. Questionnaire results indicated the single upright brace was more comfortable and easier to apply, and was rated as providing less stability than the double upright. There were no differences between the braces in appearance, fit, belief of injury prevention, and overall satisfaction.

Conclusions and Clinical Relevance: The ankle braces used in this study had minimal effects on limiting active ROM, however the double upright brace limited PF more than the single upright brace. Functional performance was not negatively impacted by the ankle braces with the exception of the side hop and vertical hop tests, but these differences were deemed negligible. Overall satisfaction of the brace characteristics was comparable between the two braces.

Addition of roller massage to static stretching does not augment hamstrings flexibility or counterbalance stretch-induced deficits

Hodgson D, Quigley P, Behm DG

Roller massage (RM) of limb muscles has been shown to increase range of motion (ROM) without incurring subsequent performance deficits. On the contrary, prolonged static stretching (SS) has been shown to induce force and power impairments. It is not known if adding RM to a stretching routine would augment stretch-induced ROM improvements. Furthermore, it is not known whether performing RM at intervals after the stretching routine would prolong the ROM increases. Hence the objective of this study was to examine the effects of combining SS and RM with and without subsequent RM at 10-minute intervals on ROM, countermovement jump (CMJ) height and maximal voluntary isometric contraction (MVIC) force. Subjects participated in 5 sessions that included 1) SS, 2) SS+RM, 3) SS with subsequent RM at 10, 20 30 min post-stretch (SS_RM), 4) SS+RM with subsequent RM at 10, 20 30 min post-stretch (SS+RM_RM) and 5) Control. For the SS and SS_RM conditions, the quadriceps and hamstrings received passive SS for two repetitions of 30s each. RM was performed for 1 repetition of 30s per muscle group to a cadence of 60-BPM and 7/10 perceived pain (Visual Analogue Scale-10). The SS+RM session involved one set of SS and RM, while the SS+RM_RM condition received an additional set of 30s RM at 10, 20, and 30 minutes post-stretching. Testing measures included quadriceps and hamstrings active and passive ROM, CMJ height and MVIC force. Results demonstrated significant main effects for time for hamstrings ($p<0.0001$: ~5%▲) and quadriceps ($p=0.013$: ~13%▼) passive ROM as well as quadriceps active ROM ($p=0.008$: ~5%▲) increases respectively. Main effects for condition demonstrated that SS and SS_RM exhibited greater quadriceps active ($p=0.05$; 10-12%▲) and passive ($p=0.019$: 19%▲) ROM increases than SS and SS_RM (active) and SS_RM respectively. Main effects for time were evident with deficits in CMJ height ($p<0.0001$: 3-5%▼), knee extension ($p=0.005$: ~5%▼) and knee flexion ($p=0.06$: 4-5%▼) MVIC forces. In conclusion, ROM increases with SS were not augmented by RM and SS-induced performance impairments were not counterbalanced by RM.

The effect of varied force applications with self-manual therapy on range of motion and voluntary contractile properties

Grabow L, Young JD, Alcock LR, Behm DG

Background: Self-manual therapy (SMT) has shown to increase range-of-motion (ROM) in the majority of investigations. However, the degree of ROM increase varies highly. While differences in the tool used, muscle group tested and the overall volume of SMT could explain the variability, differences in the applied pressure may confound results. Additionally, while multiple studies found no impairments in maximal voluntary contractions (MVCs), one recent study has shown SMT to reduce antagonist muscle activation. Therefore, the objectives of this study were to determine the impact of varied force application with SMT on active (aROM) and passive (pROM) ROM and on muscle activation during MVC.

Methods: A within-subject design was used to investigate the effects of high (SMTh), moderate (SMTm) and sham (SMTsham) pressure SMT on ROM and MVC. SMT consisted of three 60-second bouts applied to the anterior thigh with the TheraBand roller-massager. Active and passive ROM was assessed in a modified kneeling lunge position. Muscle activation was collected from the dominant vastus lateralis (VL), vastus medialis (VM) and biceps femoris (BF) muscles with surface electrodes prior to, immediately after and ten minutes after the intervention during knee extension (KE) and knee flexion (KF) MVC measurements.

Results: (aROM): All aROM measurements significantly improved by an average of 5.9% (p=0.009) from prior to immediately after intervention. Trends show best aROM results for SMTm with an improvement of 10.4% whereas SMTsham caused 4.4% and SMTh 5.9% greater aROM. (pROM): SMT caused highly significant greater pROM results (p=0.000) averaging an 11.3% increase. Comparing the different intensities, significant changes (p=0.04) were found after the first bout of RM between SMTsham with an increasing ROM of 8.0% and SMTm with a pROM decrease of 4.8%. Although not significant, trends showed that SMTh is more effective with a ROM increase of 12.9% than SMTsham (p=0.12) and SMTm (p=0.07). Comparing the pre and post SMT test results, a trend showed that SMTh caused greater pROM (increase of 25.4%) than SMT sham (increase of 12.25%) (p=0.09). (KE): There was a significant decrease in KE MVC force in SMTh compared to SMTm immediately after the intervention (p= 0.012). However, the loss in MVC force in SMTh was not evident 10 minutes after the Intervention of (p=0.037). The rate of force development within the first 100 ms (p=0.0794) and 200 ms (p=0.0853) was significantly higher in SMTm than in SMTh 10 min after the rolling application. No significant muscle activation impairment was caused by the treatment. (KF): There were no significant changes in KF MVC force or EMG activation after SMTh, SMTm and SMTsham. A trend (p= 0.0794) towards less force development after 200 ms in SMTh compared to the SMTm condition was detected at measurements 10 minutes after the intervention in KF.

Conclusion: SMT treatment with different pressures seems to cause differences in aROM and pROM test results. So far, SMTm demonstrated the greatest increases for aROM and SMTh induced the greatest pROM outcomes. No long lasting impairments in MVC measurements were found.

The effect of using roller massager on excitability of the corticospinal pathway

Aboodarda SJ, Philpott DT, Greene RM, Button DC, Behm DG

Roller massager has been used in rehabilitation and athletic settings to promote soft-tissue extensibility and optimal skeletal muscle functioning. It is though that applying mechanical pressure over a muscle, using a rolling massager, can modulate activation of mechanical, pain and position receptors. The afferent feedback responses induced from activation of these receptors to the cortical and subcortical neural circuitries may alter the responsiveness of central motor pathway during voluntary activations. The aim of the present study was to investigate the alteration of corticospinal pathway excitability following rolling massage on quadriceps muscle. Transcranial magnetic and femoral nerve electrical stimuli were used to elicit motor evoked potentials (MEP) and compound muscle action potential (Mmax) in the Vastus lateralis (VL) of six participants before and after i) 4 sets of 45 s rolling massage or ii) rest. The measurements included six MEPs and two Mmax elicited every 5 s during submaximal contractions at 10% of MVC. The MEP/Mmax amplitude show a trend for a significant main effect for time (p = 0.057; effect size between 4th set of rolling massage vs. pretest = 0.75) whereas no change was observed for the conditions (p = 0.931) and interaction of condition * time (p = 0.689). In the present study it is possible that i) the magnitude of pressure applied on the muscle during 45 s rolling massage was not adequate to modulate afferent feedback responses of mechanoreceptors, nociceptors and proprioceptors, ii) the afferent feedback discharge did not cause any excitatory or inhibitory responses in neuronal circuitries of the corticospinal pathway, iii) the measurements were performed at a low contraction intensity (10% of MVC) therefore no modulation in voluntary central drive was necessary to accomplish a low intensity task after rolling massage. Further studies with a greater sample size are required to investigate the effect of massage-like mechanical pressure, using rolling massager, on responsiveness of corticospinal pathway innervating the corresponding muscle.

CONTINUED

An acute session of roller massage prolongs voluntary and tetanic force development and diminishes evoked pain

Cavanaugh MT, Döweling A, Young JD, Quigley PJ, Whitten J, Reid JC, Aboodarda SJ, Behm DG

Roller massage (RM) has been reported to reduce pain associated with exercise-induced muscle soreness and increase range of motion without voluntary performance impairments. The objective was to examine RM effects on evoked pain and contractile properties. Twelve men received 3 sets of 30s RM at a perceived discomfort level of 7/10 on a visual analogue scale on the ipsilateral stimulated plantar flexors (PF), contralateral PF, sham (light rolling on stimulated PF) or control. At pre-test, post-test and 5min post-test, they performed a maximal voluntary isometric contraction (MVIC) and received evoked maximal twitch and tetanic forces as well as 70% maximal tetanic stimulation. Data analysis included perceived pain and contractile properties. There were no main effects or interactions for most contractile properties. The 70% tetanus illustrated 6.5% ($p=0.1$) and 7.3% ($p=0.05$) increases in pain perception with the sham condition. Control exhibited 8.5% ($p=0.02$) and 9.9% ($p=0.08$) increases in pain perception. Furthermore, pain perception with evoked twitches increased 58.7% ($p=0.01$) and 28.8% ($p=0.04$) post- and 5 min post-test with the control condition. There was no pain augmentation with the ipsilateral and contralateral RM post-testing. There were main effects with the ipsilateral condition demonstrating prolonged maximal (3.2% and 2.7%; $p=0.048$) and 70% maximal (2.7% and 2.5% $p=0.033$) time to peak tetanic forces compared to control and contralateral respectively. Data suggest that a RM bout affected tetanic time to peak force and nullified the testing-induced increase in evoked pain.

Foam rolling of quadriceps decreases biceps femoris activation

Cavanaugh MT, Aboodarda SJ, Hodgson D, Behm DG

Foam rolling has been shown to increase range of motion without subsequent performance impairments of the rolled muscle, however there are no studies examining rolling effects on antagonist muscles. The objective of this study was to determine whether foam rolling either the hamstrings or quadriceps would affect antagonist muscle activation and co-activation. Additionally co-contraction ratios were examined to determine the magnitude of muscular co-activation following foam roller application. Gender-based differences were also considered. Surface electromyography was analyzed in the dominant vastus lateralis (VL), vastus medialis (VM), and biceps femoris (BF) muscles. BF activation significantly decreased following quadriceps foam rolling ($F(1,16) = 7.45$, $p = 0.015$, -8.9%). There were no significant changes in quadriceps activation following hamstrings foam rolling. This might be attributed to the significantly greater levels of perceived pain with quadriceps rolling applications ($F(1,17) = 39.067$, $p < 0.001$, 98.2%). There were no gender-based changes in activation following foam rolling for VL ($F(6,30) = 1.31$, $p = 0.283$) VM ($F(6,30) = 1.203$, $p = 0.332$) or BF ($F(6,36) = 1.703$, $p = 0.199$). Antagonist muscle activation may be altered following agonist foam rolling however it can be suggested that any changes in activation are likely a result of reciprocal inhibition due to increased agonist pain perception.

Roller massage inhibits Hoffman reflex excitability of the soleus muscle

Young JD, Grabow L, Behm DG

Roller massage has shown acute increases in range of motion (ROM). It is unclear whether the roller massage-induced increases in ROM can be attributed to changes in neural or muscle responses. The purpose of this study was to evaluate the effect of altered afferent input via application of roller massage on spinal excitability. A randomized repeated measures design was used. Three 30s bouts of plantar flexors roller massage were implemented with 30s of rest between bouts. The researcher applied the roller massage with pain perception at an intensity of 7/10, 4/10, or 0/10 (sham) on a visual analogue pain scale. Measures included full H-reflex/M-wave recruitment curve, maximal and submaximal soleus H-reflex/M-wave (H/M) ratio, as well as H-reflex and M-wave peak-to-peak amplitudes. Roller massage resulted in significant decreases in soleus H-reflex amplitudes ($p = .003$). No significant changes in soleus M-wave amplitude or H/M ratios were observed. High intensity, moderate intensity, and sham conditions resulted in decreased soleus H-reflex amplitudes by 36, 41 and 15 percent, respectively. While

no significant difference between moderate and high intensity pain was observed, both conditions were significantly different relative to sham (p = .009). This is the first study to demonstrate that roller massage application increases afferent input to the spinal cord, thus altering overall spinal excitability as measured with the Hoffman (H)-reflex. These findings suggest that roller massage increases afferent input to the spinal cord, thus inhibiting overall spinal excitability. Pain perception appears to play a role in modulation of this inhibition, with high and low intensity stimuli resulting in smaller percent changes than a moderate stimulus. Roller massage-induced neural modulation of spinal excitability may explain increases in ROM previously reported in the literature.

Effects of Roller Massager on Muscle Recovery After Exercise Induced Muscle Damage

Casanova N, Reis J, Vaz JR, Machado R, Button DC, Pezarat-Correia P, Freitas SR

Introduction: This study determined the effects of roller massager (RM) on ankle plantar flexors recovery after an exercise-induced muscle damage (EIMD) stimulus.

Methods: Two experiments were conducted. Experiment 1 (n=10) examined both functional [i.e., ankle plantar flexion maximal isometric voluntary contraction (MVIC) and submaximal (30% of MVIC) sustained force; ankle dorsiflexion maximal range of motion and resistance to stretch; and pain pressure threshold] and morphological [medial gastrocnemius (MG) cross sectional area, thickness, fascicle length, and fascicle angle] variables, before and immediately, 1h, 24h, 48h, and 72 after an EIMD stimulus. Experiment 2 (n=10) examined MG deoxyhemoglobin concentration kinetics (velocity and amplitude) during a submaximal sustained force test before and 48h after EIMD. Participants performed both experiments twice, with and without (NRM) the application of a RM (6Ð45s, with 20s rest between sets).

Results: RM intervention did not alter the strength and flexibility impairment after EIMD, as well as the MG morphology and oxygenation kinetics (p>0.05). On the other hand, a strong tendency was observed for an acute (within 1h) change of ipsilateral (post-effects: RM=+19%, NRM=-5%, p=0.032) and contralateral (p=0.095) MG pain pressure threshold.

Discussion: In conclusion, the present results suggest that a roller massager has no effect on plantar flexor performance, MG morphology, and MG oxygenation recovery after EIMD, except for muscle pain pressure threshold (i.e. a soreness). Thus, RM may have potential application in recovery of population with increased muscle soreness, if performed immediately before a physical task.

The usability and satisfaction rating of the THERA-PEARL for home treatment

Tyler T, Schmitt B, Squitieri S, Hobson T, Page P

Pain and discomfort can be difficult to manage outside of the clinic. A method commonly used to control pain, swelling and bruising away from the clinic are hot and cold packs. A unique invention on the market that allows the patient to achieve both in one product is called the THERA°PEARL. This product can be put in the microwave for hot use or the freezer for cold usage.

Purpose: The purpose of this study is to analyze the usability and satisfaction rating of the THERA°PEARL by patients whom purchased this item for home treatment.

Methods: Single blinded random survey design. Subjects n=40 (20 males, 20 females) random outpatient orthopedic physical therapy patients, average age 45.9 ± 19.5 years (18 to 71 years old) purchased the THERA°PEARL for individualized unsupervised usage.

Protocol: Based on need, patients purchased a THERA°PEARL. After 5 uses the patients were asked to fill out a questionnaire.

Analysis: Descriptive statistics were used to analyze the usability questionnaires after using the THERA°PEARL.

Results: Of the 40 patients who purchased the THERA°PEARL 22 used it for cold, 12 used it for hot, and 6 used it for both. Of the 22 who used it for cold 20 used it in the freezer while 2 used it in the refrigerator. Not a single patient noticed any condensation on the pack once removed from the cold source. 10 patients used the pack on acute injuries while 30 patients used it for chronic pain. The average pain rating before the pack was 7.2 and after the usage of the pack it decreased to 3.2 (P<0.01). 28 patients applied it directly to their skin with no adverse effects.

CONTINUED

	Ease of use	Comfort	Conformability	Temp Hold Desired	Pain Relief	Versatility	Reusibilty	Ease of Storage
Mean	**1.5**	**1.8**	**2.05**	**3.0**	**2.6**	**2.0**	**1.85**	**1.83**
Range	**(1-7)**	**(1-8)**	**(1-4)**	**(1-10)**	**(1-7)**	**(1-7)**	**(1-8)**	**(1-10)**

(1=Best-10=Worst on numeric scale)

Based on the validated modified usability scale patients rated the THERA°PEARL questions as 1 being strongly disagree and 5 strongly agree. The average for each question is reported.

1. I think that I would like to use this product frequently if I needed to: 4.61
2. I found the product unnecessarily complex: 1.25
3. I thought the product was easy to use: 4.83
4. I think that I would need the support of a technical person to be able to use this product: 1.08
5. I found the various uses in this product were well integrated: 4.60
6. I thought there was too much unpredictability in this product: 1.28
7. I would imagine that most people would learn to use this product very quickly: 4.70
8. I found the product very cumbersome to use: 1.28
9. I felt very confident using the product: 4.73
10. Need to learn a lot of things before I could get going with this product: 1.35

Conclusion: Based on the surveys that were filled out all patients found using the THERA°PEARL as beneficial and decreased their pain. Everyone except one patient said they would purchase more and one patient purchased 5 more packs.

Time course of menthol's effects on the cutaneous microvasculature

Craighead D, Alexander L

Background: *Biofreeze® gel is clinically utilized as a topical analgesic to relieve pain through the gate-control theory mechanism. Menthol is the primary active ingredient in Biofreeze which activates TRPM8 receptors in nerve and vascular tissue and increases blood flow to the cutaneous microvasculature. The effects of menthol on the cutaneous microvasculature are dependent upon the delivery of menthol to the tissue.*

Purpose: The aim of this study was to concurrently measure (1) the perceptual and vasomotor responses to topical menthol, and (2) the concentration of menthol delivered to the cutaneous tissue. This has utility in calculating pharmacodyanamics and kinetics as a first step towards developing longer-lasting/higher potency topical analgesics.

Methods: Two intradermal microdialysis fibers (70kDa cutoff CMA) were placed in the ventral forearm of 10 healthy young men and women. One milliliter of Biofreeze gel was applied over 60cm^2 of skin containing the microdialysis fibers. Menthol was covered with a plastic covering to prevent evaporation. Subjective rating of menthol sensation and pain threshold (dolorimeter) were obtained 5, 10, 15, and 30 minutes post menthol application. After 30 minutes, the plastic covering and the excess Biofreeze were removed. Dialysate from both microdialysis fibers was collected (5 QL•min^{-1}, 5 min) immediately upon menthol removal. Ratings of menthol sensation, pain threshold, and dialysate samples were continually collected every 30 minutes for another four hours post menthol removal. Skin blood flow, expressed as red cell flux, was continuously measured via laser speckle contrast imaging throughout the duration of the protocol. Flux was normalized to cutaneous vascular conductance (CVC: flux•MAP^{-1}). Dialysate samples were analyzed with high-performance gas-chromatography to determine the presence of menthol.

Results: Subjects reported a significant sensation from the applied BioFreeze from minute 5 to minute 60 (all $p<0.05$). However, by minute 90, the menthol sensation was no greater than baseline ($p=0.3$). Menthol had no effect on pain threshold ($p=0.99$). CVC was increased compared to baseline starting by minute 15 and remaining elevated until minute 45 (all $p<0.0001$). By minute 60 CVC was no longer a difference from baseline ($p=0.08$). Menthol was detectable at all time points throughout the experiment (30 minutes-270 minutes post application) at concentrations ≥1ng/QL.

Conclusion: The subjective sensation from topically applied Biofreeze occurred sooner and lasted longer than the menthol-mediated rise in skin blood flow (minute 5 to 60 vs minute 15 to 45, respectively). However, even after the resolution of menthol's sensory and vasoactive effects, menthol was detectable in tissue samples through the duration of the experiment. This suggests that menthol remains in cutaneous tissue long after the effects of the topical analgesic have worn off, indicating potential TRPM8 receptor desensitization.

Lasting effects of Biofreeze on pain relief in sedentary young men and women with delayed-onset muscle soreness (DOMS)

Rogers ME, Jimoh JM, Chekuri SV

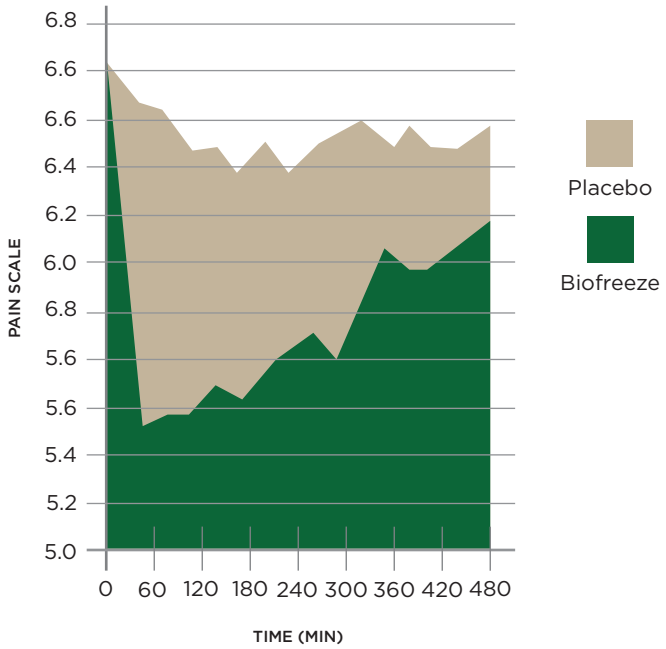
Pain and discomfort in muscle is very common 24 hr after engaging in resistance training. This condition is known as Delayed-Onset Muscle Soreness (DOMS) and is related to an inflammatory response to microtrauma inflicted upon the muscle when producing high levels of force. This inflammatory response produces swelling within the muscle cells that contributes to the soreness. Purpose: To establish how long Biofreeze may reduce pain associated with DOMS.

Method: Sedentary young males (n=3) and females (n=6) (age = 23.9 yr; wt = 70.1 kg; ht = 156 cm) were recruited from undergraduate Human Performance Studies classes at Wichita State University. Participants were instructed to refrain from heavy exercise and consuming or applying any type of anti-inflammatory medication 24 hr before the 1-RM test and throughout duration of the study. After determining 1-RM, participants performed 10 sets of 10 repetitions of barbell back squats at 60% of their 1RM to elicit DOMS. Squats were performed to a predetermined depth using stacked 5-cm spacers so that the femurs were parallel to the floor at the end phase of the eccentric portion. Participants were required to touch the top of the stack during each squat repetition. At 24 hr after the exercise session, Biofreeze was applied (1ml of gel for every 200 cm2 of surface area) to one quadriceps muscle group and the same dose of Biofreeze placebo was applied to the other quadriceps. Application was randomized to each leg and participants were blinded to the identity of the application. Prior to gel application, participants rated the level of pain in each leg using a scale ranging from 0 (no pain) to 10 (pain as bad as it could be). Following application, participants completed this rating scale every 30 min for 8 hr. Results: Pain was reported to be exactly the same for both legs at 24 hr (6.67 - severe pain). After application of Biofreeze, pain declined ($p<0.05$) to a minimum at 60 min (pain rating = 5.28; 21% decline) that was classified as moderate pain. Although pain tended to increase with Biofreeze after 1 hr, pain remained less ($p<0.05$) than placebo for 5 hr.

Conclusions: Biofreeze reduces DOMS-related pain by ~ 20% 60 min after application in sedentary adults and then a lower plateau of pain perception is achieved for 5 hr following application. Our previous study with recreational athletes who had lower ($p<0.05$) initial levels of pain (4.65) 24 hr after exercise also reported maximum pain relief at 1 hr after Biofreeze application. Although they demonstrated a 31% relative decline in pain 1 hr, their absolute scores on the pain scale declined similarly (1.4 points) compared to the current study. Further research is needed to determine whether declines in pain can be attained in less time and/or if a greater decline can be achieved. This could lead to the development of a longer lasting, faster acting, and more effective product.

Application: These results provide an understanding regarding the efficacy of Biofreeze to reduce pain associated with DOMS that will benefit those who work with athletes, athletes themselves, whether recreational, amateur, or professional, as well as the general population, many of who suffer from DOMS following physical activity that is unfamiliar (e.g., raking, digging, construction work).

Table 1. Pain perception following Biofreeze application



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DAY THREE

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Duane Button	Kinesiology Tape Inhibits Hoffman Reflex Excitability of the Soleus Muscle
Jay Greenstein	A comparison of adhesion properties and skin sensation between TheraBand Kinesiology Tape combined with Biofreeze and RockTape combined with RockSauce Chill
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College athlete's perceptions and use of elastic therapeutic tape

Brosky T, Topp R, Neitzke H

Introduction: Use of elastic therapeutic tape (ETT) has gained popularity among professional and amateur athletes. Multiple benefits of ETT have been proposed by the inventor of ETT, Kenzo Kase and others including joint stabilization, increased lymph drainage and blood flow, pain relief, and facilitation of healing of soft tissue injuries. Although a recent meta-analysis of the literature in this area found that ETT provided significantly more pain relief than no treatment at all, it was no better than other interventions. These investigators did not find any other benefits in ETT. To date no study has asked athletes who use ETT what they perceive as the primary benefits of this adjunctive therapy. The purpose of this study was to describe the perceptions of athletes who use ETT.

The following research questions were addressed:

RQ1: What are the indications that college-level athlete would use ETT?

RQ2: What are the perceived benefits of using ETT among college-level athletes?

RQ3: Are there any perceived advantages of ETT over other treatments among college-level athletes?

Methods: A descriptive study recruited 24 varsity-level college athletes (mean age=20.42 years) between the months of December '15 and March '16 from a division II university who participated in seven different sports. Subjects were recruited while they visited the team's athletic trainer for a number of common athletic injuries including tendinitis, muscle strains, and joint sprains. Following providing informed consent subjects were asked to complete a paper and pencil questionnaire regarding their use of ETT.

Results: The sample consisted of a similar number of males (54%) and females (46%) who reported participation in practice or competition an average of 18.67 hours per week (range 10-30 hours) and had been using ETT during practice or competition for an average of 20 weeks. Only one subject reported "Always" wearing ETT during practice while 3 subjects reported "Always" wearing ETT during competition. A majority of the sample (85%) responded to the question "Why do you use ETT?" by indicating "to manage pain". In addition, 75% of the sample indicated that the ETT reduced their pain. Ninety-five percent of the sample indicated the team's athletic trainer recommended the use of ETT. The sample indicated they clearly preferred ETT over wearing a joint brace because the ETT provided greater mobility, ease of movement, better comfort and/or was "less bulky." Only 4 athletes reported ever needing to re-apply tape during practice or competition, which indicated effective and durable adhesive characteristics of the ETT. Fifty percent of the sample indicated a preference for using ETT in their official team colors, and none of the athletes indicated a particular brand preference.

Conclusion and Clinical Implications: Although empirical evidence for the efficacy of ETT is limited, many college athletes use this therapy and are often introduced to this intervention by the team's athletic trainer. The college athletes in this sample overwhelmingly preferred taping over bracing and reported using ETT primarily for the purpose of managing pain. A majority of these individuals found this intervention to be effective. ETT can be considered a viable intervention strategy for reducing pain associated with common sports-related musculoskeletal injuries.

Kinesiology tape inhibits Hoffman Reflex excitability of the soleus muscle

Young JD, Spense AJ, Behm DG, Button DC

Introduction: Kinesiology taping has been shown to increase force, electrical activity of the muscle and range of motion (ROM) and reduce pain in clinical (i.e. increased pain around various joints and in muscle) populations. One potential mechanism that may underlie these changes following application of Kinesiology tape is altered spinal excitability. Since changes in cutaneous input have been shown to modulate spinal excitability, it is plausible that the application of Kinesiology tape may alter spinal excitability.

Purpose: The purpose of this study was to evaluate the effect of altered cutaneous input via application of Kinesiology tape at different tensions on spinal excitability.

Methods: A randomized repeated measures experimental design was used. TheraBand® kinesiology tape was applied to the plantar flexors for 3 minutes at three different tensions: 50%, 25%, and no tension (sham). Electromyograpy (EMG) electrodes were placed on the soleus muscle. During each Kinesiology tape tension, electrical stimulation of the tibial nerve was used to induce muscle compound action potentials (m-waves) and Hoffman (h) reflexes of the soleus muscle. Measures included full H-reflex/M-wave recruitment curve, maximal and submaximal soleus H-reflex/M-wave (H/M) ratio, as well as H-reflex and M-wave peak-to-peak amplitudes.

Results: Kinesiology tape resulted in near significant decreases in soleus H-reflex peak-to-peak amplitude during sham and 25% tension conditions ($p = .051$); however, no significant changes in soleus M-wave peak-to-peak amplitude or H/M ratios were observed. Though not significant, 50% tension resulted in a 4% increase in H-reflex peak-to-peak amplitudes. The small h-reflex facilitation following 50% tension lead to a significant difference between 50% tension and the sham and 25% tension conditions ($p = .041$).

Conclusions: These findings suggest that altered afferent input to the central nervous system via application of Kinesiology tape over the plantar flexors inhibits spinal excitability. The significant decreases in soleus H-reflex peak-to-peak amplitude during the sham and 25% tensions indicate that cutaneous input is a key mechanism for modulating the spinal excitability. The lack of change in spinal excitability following 50% tension illustrates that the effect of Kinesiology tape on overall spinal excitability is tension specific. Clinical uses for Kinesiology tape may be indicated when overall spinal inhibition is desired.

The effect of Biofreeze® on the adhesion and performance of TheraBand® Kinesiology Tape

Bishop BN, Greenstein J, Slaski JE, Page P, Topp R

Globally, low back pain (LBP) has been found to be the 6th highest burden of disease, causing more disability than any other condition. Kinesiology Tape is often used in the clinic setting to aid in rehabilitation, however evidence is minimal as to specific brand characteristics. Biofreeze® is a commonly used topical analgesic. In most situations, Biofreeze® is used in the office or given to the patient for home use as a way to mitigate pain during the course of treatment. Historically, clinicians have applied Biofreeze® and kinesiology tape together and have reported positive anecdotal reports. The purpose of this study was to compare the cooling sensation of Biofreeze on skin versus over TheraBand® Kinesiology Tape (TB-KT) and the adhesion

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properties of TB-KT with Biofreeze, over three days among healthy adults.

Methods: A convenience sample of 20 healthy adults with no low back pain underwent the application of TB-KT applied to the left side of their low back. The tape was applied at L5 and run superior up the lateral erector spinae and 2 inches lateral to the spinous process at 25% tension. Biofreeze® was then be applied to both sides of the low back, including on top of the TB-KT. Subjects were instructed to apply Biofreeze® to both sides of their low back every 6 hours, or 4 times a day, over the next 72 hours. Data were collected a 24 hours and 72 hours after the initial application. Subjects were given a one-page instruction sheet outlining home care instructions.

Outcome Measures: Subjective and objective adhesion properties were collected at all data collection points regarding the adhesion and irritation of the tape as well as the amount of cooling sensation felt on both sides. Objective properties of the tape were operationalized by the average score of 3 clinicians and scientists observing photographs of the lower back where the treatments were applied and providing a score of the percentage of tape adhesion and the presence and degree any skin irritation. Subjects at both data collection points reported on a Likert scale the degree of cooling, satisfaction and irritation they experienced on both sides of their back at both data collection points.

Analysis: Twenty healthy subjects with no lower back pain were recruited for the study. Paired t-test were calculated to determine if objective measures of tape adhesion or subjective measures of cooling, satisfaction and irritation were different at the two data collection points. The sample consisted of young (27.40±4.76 years) healthy (24.40±3.42 BMI) mostly female (80%) diverse (50% white) subjects who reported a high degree of compliance with applying the Biofreeze® at T1 (95%) and at T2 (85%). In order to detect a 25% difference between or with the two sides of Biofreeze® over 2 measurement points with Ð=05, Ð=.20, a within individual correlation of .50 over time, a sample size of 20 subjects is required to complete the entire protocol. The activity level of the sample was lower ($p<.05$) at T1 (78.00+51.64 minutes) compared with T2 (97.50+59.31 minutes) and the observed percentage to the TB-KT adhered to the subjects significantly ($p<.05$) declined from 97.25% measured at T1 to 76.67% at T2. The combination of tape and Biofreeze® did not result in any different subject reporting of cooling, satisfaction or irritation compared to the Biofreeze® alone.

Clinical Relevance: The use of kinesiology tape and Biofreeze® simultaneously has been widely accepted by clinicians but remains an area with limited evidence of its effectiveness and duration of adhesion. It was found that the addition of Biofreeze® to TB-KT did not significantly change the cooling and satisfaction of the products. Additionally, there was no difference in irritation between Biofreeze® and TB-KT compared to Biofreeze® alone. Therefore, the results of this study will allow clinicians to better use TB-KT in conjunction with Biofreeze® for the treatment of musculoskeletal pain.

A comparison of adhesion properties and skin sensation between TheraBand® Kinesiology Tape combined with Biofreeze® and RockTape combined with RockSauce Chill

Greenstein J, Bishop B, Slaski JE, Page P, Topp R

Kinesiology tape is often used in the clinic setting to aid in rehabilitation, however evidence is minimal as to specific brand characteristics. In most situations, topical analgesics are used in the office or given to the patient for home use as a way to mitigate pain during the course of therapy. Historically, clinicians have applied topical analgesics and kinesiology tape together and have reported positive anecdotal reports with no negative affect on skin sensation. The purpose of this study was to compare the percent of adhesion and intensity of sensation of TheraBand® Kinesiology Tape with the addition of Biofreeze® (TBKT/BF) versus Rock Tape® with the addition of Rock Sauce® (RT/RS), among healthy adults.

Methods: A convenience sample of twenty healthy adults underwent two trials, two weeks apart, that involved the application of two brands of kinesiology tape and corresponding topical analgesic. Each trial lasted 3 days separated by a 2-week 'washout' period. The first application trial involved a 20cm strip of the Tape 1 applied to both sides of the low back. Topical Analgesic 1 was then applied directly on top of Tape 1, on both sides of the low back. Following a 2 week 'washout' period, the second application trial involved the same procedures for Tape 2 and Topical Analgesic 2. Subjects were instructed to apply the topical analgesic on top of the tape 4 times a day, for a total of 3 days. In order to blind the reviewers and subjects, a non-screen printed black roll of tape was used for both brands of tape and both product bottles were unlabeled. Subjective data included adhesion, intensity of sensation, and satisfaction of the two brands of tape (1hr, 24hrs, 72hrs) as well as

the intensity of sensation, description of sensation, and satisfaction of the topical analgesic (15min, 30min, 1hr, 24hrs, 72hrs). Objective adhesion properties of the tape were operationalized through three blinded clinicians and scientists who observed 3 photographs of the lower back and provided a judgment of the percentage of tape adhesion and the degree and skin irritation.

Statistical Analysis: Twenty healthy (BMI mean=24.00), young (mean age=25.05) subjects completed the study. One-way repeated measures ANOVA with Tukey's LSD post hoc comparisons indicated the sample exhibited similar ($p>.05$) shower duration and compliance (89.5 – 95.8%) with both protocols over the duration of the study. Measures of Tape-Sensation & Tape-Satisfaction were all the same within both treatment groups over the duration of the study. Topical-Satisfaction was consistently higher at all data collection points under the TBKT/BF condition compared to the RT/RS condition ($p<.05$). Adhesion regardless of treatment was higher at T1 (96-98%) compared with T2 (74-79%). Intensity of sensation 15 min following application of TBKT/BF was higher than the sensation rating all other treatment/times. Sensation at 30 and 60 min following TBKT/BF was higher than the sensation of RT/RS following 30 and 60 minutes of application. The sensation of the RT/RS 15 minutes following application was higher than the sensation reported with this treatment 30 and 60 minutes following application.

Clinical Relevance: The TBKT/BF and RT/RS exhibited similar compliance, adhesion, Tape-Sensation and Tape-Satisfaction. The TBKT/BF condition exhibited higher Topical-Satisfaction and greater sensation at 15, 30 and 60 min following application compared with RT/RS. Future studies may wish to examine the clinical impact of these differences between TBKT/BF and RT/RS.

Tension of Theraband® Kinesiology Tape on Shoulder Pain

Bishop BN, Greenstein J, Slaski JE, Topp R

Introduction: Rehabilitative exercises are considered an important component of care for shoulder pain patient, although pain can be a limiting factor in the advancement of rehabilitation. Thus, it is critical for a patient who may present with pain during activity to be able to perform a rehabilitation program. A new approach to treating musculoskeletal conditions is a kinesiology taping technique designed to target muscles and lymphatic system. The purpose of this study was to determine the effectiveness of standard tension of TheraBand® Kinesiology Tape (TB-KT) application versus varied tension on shoulder pain, disability, and recovery speed during an in-office rehabilitative program.

Methods: A convenience sample size of 36 new patients with current shoulder pain were recruited for this study. Patients were tested within the first 2 to 3 therapy visits, had a diagnosis of shoulder pain, been 18-64 years old, no corticosteroid treatment within the last two weeks, post-surgical cases were excluded, and pregnancy was excluded. Upon agreeing to the study, patients signed an informed consent, completed a demographics questionnaire, and completed specific outcome measure assessments. The outcome measures included the Numeric Pain Rating Scale (NPRS) and the Penn Shoulder Score (PENN). After completing the initial paperwork, patients were randomized into two groups, control and intervention. The Control group received standard FUNHAB® in-office care in addition to standard TB-KT taping technique. The Intervention group received standard FUNHAB® in-office care plus varying tension application of TB-KT. The TB-KT was applied to the shoulder complex to influence proper activation of the rotator cuff muscles, specifically the supraspinatus and infraspinatus. The new TheraBand® Kinesiology Tape has a proprietary design that they call Xact Stretch Technology. This design features a screen printed top of the tape containing irregular hexagons (small and large). When the tape is stretched, the hexagons move to become regular. At 25% tension, the small hexagon looks like all sides and thus internal angles are equal. At 50% tension, the large hexagon takes the shape of a regular hexagon. Thus, clinicians and study personnel will be able to know the tension at 0% (just lay it on), 25% tension (small hexagon becomes regular), 50% tension (large hexagon becomes regular), and 75% (the large hexagon become wider than it is tall. The TB-KT was applied to the shoulder complex to influence proper activation of the rotator cuff muscles, specifically the supraspinatus and infraspinatus. The clinician applied the tape in an "I" strip from the vertebral border of the scapula to the greater tuberosity of the humerus. Over the course of the 4 weeks, the tension of the tape was systemically increased. At the beginning of each week the tape was reapplied, and pain rating was recorded. At the conclusion of 4 weeks patients completed the PENN.

Results: A total of 36 subjects were recruited for the study with 25 completing the entire data collection period (Experimental=13; Control=12). This resulted in a 31% drop out. There were no between group differences. For the PENN, the experimental group did not significantly change from baseline while the control was significantly different ($p=0.000$) at all times from baseline ($x=52.53$). Neither group changed their pain values between baseline and T1 but both groups declined significantly between baseline and T3. Only the control group was able to maintain a decline in pain from baseline ($x=5.115$) at T4 ($x=2.923$) and T5 ($x=2.269$).

Conclusion: The results indicate that tension may not influence improvement of shoulder pain and function over the course of 4 weeks. Although there were significant declines for the control group over time for the PENN and pain the difference between groups may not be clinically significant as values were similar and both groups showed improvement over the course of the study. Future studies need to continue to investigate the effect of varying tape tension.

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The effect of kinesiology tape following rotator cuff stress

Labbe A, Topp R

Most rotator cuff problems are due to over-use syndromes when the rotator cuff is not allowed to fully recover after it has been stressed. Rotator over use syndromes result from inflammation of the cuff presenting as pain, diminished performance and reduced shoulder range of motion (ROM). Kinesiology tape has been used in the clinical environment to functionally "unload" a joint, which is believed to minimize inflammation of the treated area. Overhead throwing sports, particularly baseball, have been demonstrated to invoke rotator cuff stress and is hypothesized to be minimized by the application of TheraBand Kinesiology Tape immediately following the rotator cuff stress. Thus, the purpose of this study is to determine the effective of kinesiology taping the dominant shoulder on shoulder pain, functioning (pitching velocity & throwing distance), and range of motion, 48 hours following stressing the rotator cuff.

Research Hypotheses: RH1: Shoulder pain will be less 48 hours following stressing the rotator cuff among young adults when kinesiology tape is applied to the dominant shoulder compared to when tape is not applied.

RH2: Shoulder functioning (maximum throwing velocity and maximum throwing distance) will be greater 48 hours following stressing the rotator cuff among young adults when kinesiology tape is applied to the dominant shoulder compared to when tape is not applied.

RH3: Shoulder range of motion (ROM) will be different from baseline compared to 48 hours following stressing the rotator cuff among young adults when kinesiology tape is and is not applied to the dominant shoulder.

Methodology: These hypotheses were addressed using a repeated measures cross over design in which all subjects completed the same protocol twice separated by at least 2 weeks. Only measures of ROM were measured at baseline($_B$) prior to the subjects engaging in any rotator cuff stress. Each of the two times the protocol was completed involved initially stressing the subject's rotator cuff by requesting they throw a baseball "as hard as they could" 30 times to induce rotator cuff stress. 48 hours following this rotator cuff stress the subject's pain rating, maximum pitching velocity, maximum throwing distance and four measures of shoulder ROM were collected. The only difference between these two protocols was that TheraBand kinesiology tape ($_T$) was and was not ($_{NT}$) randomly applied to the dominant (throwing) shoulder for 48 hours following one of the pitching sessions and removed just prior to data collection. This resulted in every subject completing the two data collection protocols, each 48 hours after being exposed to the rotator cuff stress with and without the application of TheraBand Kinesiology Tape.

Results: A sample of 12 volunteers completed the study (Age=21.11$\pm$1.97, BMI=26.31$\pm$4.09) a majority (92%) of whom were former baseball players. Paired t-tests indicated that the average velocity of the 30 baseball throws to induce rotator stress was similar ($p>.05$) prior to the kinesiology taping (Mph=59.77$\pm$5.05) and no taping (Mph= Mph=59.92$\pm$5.05) conditions. This same statistical approach indicated that shoulder pain was significantly lower following kinesiology taping versus the no tape condition (1.42_T vs 2.08_{NT}, $p<.02$). Paired t-test also indicated that shoulder functioning including maximum pitching velocity (67.41_T vs. 66.25_{NT} Mph) and maximum throwing distance (68.53_T vs. 76.50_{NT} Ft) 48 hours following rotator cuff stress was similar ($p>.05$) following kinesiology taping versus the no tape condition. Repeated measures ANOVA with LSD post hoc comparisons indicated that shoulder extension (65.50_B vs. 50.33_T vs. 48.08_{NT} degrees) and medial rotation (75.42_B vs. 62.83_T vs.63.33_{NT} degrees) following kinesiology taping and the no tape condition will similar ($p>.05$) although both measures of flexibility were significantly less than baseline measures ($p>.05$). Shoulder lateral rotation (78.42_B vs. 95.83_T vs. 81.33_{NT}) and flexion (183.33_B vs.171.96_T vs. 166.50_{NT} degrees) were significantly greater ($p<.05$) after kinesiology taping compared with these values measured following the no tape condition.

Conclusion: The hypotheses were partially supported. The application of kinesiology tape following rotator cuff stress appears to result in less pain and greater lateral rotation and flexion with no effect on shoulder functioning. These benefits of applying kinesiology tape following rotator cuff stress support the proposed mechanism of action that kinesiology tape "unloads" the affected joint resulting in less inflammation.

Effects of massage and Kinesiology Tape on neck pain, range of motion, and forward head posture in individuals with non-specific neck and shoulder pain

Forman J, Siruvuri D, Eshghi S, Anderson C, Haden L, Rogers M

Neck/shoulder pain and forward head posture are common musculoskeletal disorders experienced by the adult population. Various interventions such as muscle strengthening, endurance exercise, stretching, massage, massage combined with resistance and movement, chiropractic, topical analgesics, and biofeedback have been researched as to their efficacy in helping reduce the impact of this problem. However, little is known about the effect of massage combined with the application of Kinesiology Tape (KT) on neck and shoulder pain, neck range of motion (ROM), and forward head posture (FHP).

Objective: To compare the effects of a brief neck and upper shoulder massage on neck ROM, pain, and FHP to the same treatment supplemented with the application of KT following massage in individuals with non-specific neck and shoulder pain.

Methods: 24 adults with mild to moderate non-specific neck and shoulder pain ($\geq$3 on a 0 (min) to 10 (max) pain scale) were divided into a Massage Group (MG; n=12; 11 women, 1 man; age=44.3$\pm$10.4yr; wt=73.4$\pm$13.5kg; ht=164.9$\pm$8.7cm) and a Massage plus TheraBand® Kinesiology Tape Group (MKTG; n=12; 11 women, 1 man; age=47.3$\pm$12.1; wt=80.5$\pm$18.5kg; ht=164.3$\pm$7.5cm). Neck ROM (neck flexion, right and left lateral flexion, right and left rotation) and FHP were measured using a CROM 3 (Cervical Range of Motion Instrument). Pain was measured with a numerical pain scale and a digital algometer was used to measure pain threshold for the right and left mastoid, upper trapezius, and levator scapulae tender points. After initial assessments were completed, all participants underwent an 8 min massage to the neck and upper shoulders. Assessment measures were then repeated. MKTG then had KT applied to the neck and shoulder region with 25% tension over the marked tender points. At 24 hr post intervention, the tape was removed and all assessments were repeated in both groups.

Results: Compared to baseline (MG=3.75$\pm$2.1; MKTG=4.67$\pm$1.4), self-reported pain levels were reduced ($p<0.05$) immediately following (MG=1.88$\pm$1.7; MKTG=3.00$\pm$2.2) and 24hr-post (MG=2.63$\pm$2.3; MKTG=2.58$\pm$1.4) massage in both groups. There were no differences between groups. No measurement of pain threshold, neck ROM, or FHP changed in either group immediately following massage or 24hr after treatment in either group. Conclusions: A short neck massage significantly reduced self -reported neck pain immediately after intervention and 24hr-post, however no objective measures of pain, neck ROM and FHP were affected by the massage or KT.

Implications: Future research should include individuals with more severe neck pain than the mild to moderate group that volunteered for this study. In addition, a longer massage protocol that targets additional musculature that influences the neck and shoulders, different taping procedures and the effects of adding eccentric resistance to the massage stokes, should be examined.

The effect of TheraBand® Kinesiology Tape on post-manipulation pain and range of motion

Greenstein J, Bishop B, Slaski JE, Page P, Topp R

Introduction: Annually, 30-50% of adults will experience some form of debilitating neck pain. A common treatment option for neck pain is cervical manipulation. This intervention has been found to be effective in reducing pain and increasing short term cervical range of motion, however the long term effects of this intervention on range of motion are still unclear. One approach to treating musculoskeletal conditions is a therapeutic elastic taping technique designed to target muscles and lymphatic system. Limited research on the efficacy of elastic therapeutic taping (ETT) is available for specific patient populations, including neck pain. The purpose of this study was to determine if post-manipulation ETT with TheraBand® Kinesiology Tape to neck pain patients can impact neck range of motion (ROM) and post-manipulation pain.

Methods: A convenience sample of 50 patients, between the ages of 18-64, who presented with acute non-complicated neck pain were recruited from an outpatient chiropractic clinic. Inclusionary criteria included the onset of pain less than 18 days, and indications for cervical manipulation, including pain, decreased range of motion, and hypertonicity. Exclusionary criteria were pregnancy, discogenic pain or radicular symptoms, contraindications to manipulation, and previous neck surgery. Subjects were recruited immediately following their first clinic visit to ensure no therapeutic exercises had been performed. Upon providing consent to participate, patients were randomly assigned into 2 groups; Control Group (n=23) and Tape Group (n=27). Pain and neck ROM were recorded at 3 different intervals: (1) pre-cervical manipulation, (2) within 5 minutes of cervical manipulation, (3) within 48 hours after manipulation. The control group received manipulation only, while the Tape Group had TET TheraBand® Kinesiology Tape applied immediately following cervical manipulation prior to T2 data collection. The taping protocol was applied by the investigator and consisted of a "Y" strip applied at 25% tension running superior to inferior from the hair line to T1-2 and a horizontal "I" strip applied at 50% tension at the C5-C7 level. Six cervical ranges of motion values were recorded utilizing the Acumar DataCapture hand-held dual inclinometer. Range of motion was measured at

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maximum (max) degrees of 6 trials and included: flexion (F), extension (E), left side-bending (LSB), right side-bending (RSB), left rotation (LR), and right rotation (RR). Pain was measured by asking of each patient to rate their neck pain using the Numeric Pain Rating Scale (NPRS) from 0-10.

Statistical Analysis: Repeated measures ANOVA were conducted to determine if the subjects' pain rating of any of the measures of ROM changed within or between the groups over the duration of the study. Significant main effects of Time, Group or Interaction were further explored by calculating Bonferroni post hoc comparisons to detect difference between group/time means at the $p<.05$ level of significance.

Results: The Tape Group demonstrated a significant decline ($p=0.000$) in pain between T1 ($x=6.148$) and T2 ($x=5.370$) and T1 ($x=6.148$) and T3 ($x=4.889$). The control group did not significantly change their pain over the duration of the study. Neither study group exhibited any changes in F, LR, or RR. A significant interaction ($p=0.036$) by groups and time for E was detected with post hoc analysis indicating that both groups increased on this measure between T1 (E=34.296;C=32.391) to T3 (E=41.741;C=36.870), although the Control Group realizing these gains after T2 ($x=38.696$) while the Tape Group had gains between T1 to T3 ($x=41.741$) to a level at T3 that was greater than the Control Group. For LSB, both groups realized gains between T1 (E=27.889;C=27.957) to T3 (E=36.704;C=32.217) although the Control Group realized these gains at T2 ($x=33.696$) and stabilized between T2 and T3 while the Tape Group realized the gains only after T3. For RSB, only the Experimental group exhibited gains ($p=0.002$) between T1 ($x=31.556$) to T3 (38.963) the control group did not change on this variable.

Clinical Relevance: Mechanical neck pain is one of the most commonly treated conditions in outpatient rehabilitation clinics. The use of kinesiology tape has been widely accepted and used by clinicians but remains an area with limited evidence of its effectiveness in specific conditions including mechanical neck pain. Results from this study support the clinical use of TheraBand® Kinesiology Tape in maintaining proper joint alignment and decreasing post-manipulation pain for acute non-complicated neck pain.

Effects of Kinesiology Tape on Static Balance in Older Women at Risk for Falls

Rogers M

Poor balance has been associated with frequent falls in older adults. Balance is affected by sensory and motor systems, as well as higher-level systems, including perceptual systems that integrate sensory information. Exercise programs that specifically target the physiological systems involved in the control of balance have been show to improve balance and reduce the incidence of falls. The application of Kinesiology Tape (KT) has previously been shown to improve anterior-posterior (AP) stability under certain unstable conditions in healthy young adults. However, its efficacy is unknown in older adults, particularly those who have recently suffered a fall.

To determine if the application of Kinesiology Tape affects static postural control in older women at risk for falls.

Method: 14 women aged 75-88 (age = 83.8 3 3.2 yr) who had reported a fall in the past 6 months participated in the study. Medial-lateral stability index (MLSI), anterior-posterior stability index (APSI), and overall stability index (OSI) were measured using a Biodex Balance System SD under two bare-footed conditions in random order: 1) control (no KT) and 2) TheraBand® KT applied in a ML stirrup under the heel, extending 12" above the medial malleolus to 12" above the lateral malleolus, and KT applied in an AP direction under the heel and extending proximally on the posterior calf in a Y-pattern on each side of the gastrocnemius. KT was applied bilaterally with 50% tension. For each condition, bilateral, semi-tandem, and full-tandem stance held for 10s each with eyes open was assessed on a firm surface, and bilateral and semi-tandem stance with eyes open was assessed on a foam surface.

Results: In a bilateral stance, KT did not have an effect on any measure of balance while standing on a firm surface but did improve ($p<0.05$) MLSI on a foam surface. KT improved APSI and OSI for all other conditions: semi-tandem and full-tandem stance on a firm surface, and semi-tandem stance on a foam surface.

Conclusions: KT appears to improve static balance in older women who are at risk for falls, particularly with a reduced base of support and on unstable surfaces. Further research is needed to understand the effects of KT not only in static positions but also during dynamic movements, and if improvements in balance actually result in a reduction of fall incidence. In addition, research is needed to evaluate the effects of long-term application of KT on balance as well as the use of KT combined with physical activity programs designed to improve balance.

		MLSI	APSI	OSI
Firm:	Control	0.99 (0.3)	2.38 (0.8)	2.78 (1.0)
Bilateral	KT	0.97 (0.3)	2.11 (0.8)	2.75 (0.9)
Firm:	Control	2.45 (0.8)	4.11 (1.5)	4.98 (1.4)
Semi-tandem	KT	2.21 (0.8)	3.52 (1.4)*	4.27 (1.3)*
Firm:	Control	2.99 (0.7)	4.96 (1.5)	5.45 (1.4)
Bilateral	KT	2.75 (0.6)	4.36 (1.6)*	4.84 (1.6)*
Firm:	Control	2.75 (0.8)	3.51 (1.6)	4.12 (1.6)
Semi-tandem	KT	2.30 (0.7)*	3.61 (1.5)	4.05 (1.7)
Firm:	Control	3.25 (0.9)	5.02 (1.7)	5.62 (1.8)
Semi-tandem	KT	3.15 (1.0)	4.42 (1.9)*	5.06 (1.6)*

*P<0.05 compared to control under same condition

Clinical Applications: The application of KT on older adults may improve balance and, in turn, reduce the risk of falls. This simple intervention could potentially reduce personal injury and healthcare costs associated with falls in the older population.

Effects of Kinesiology Taping on Post-stroke Patients with Type 1 Complex Regional Pain Syndrome: A Randomized Control Trial

Wang L, Tao Zhou T, Wang X, Ye Z, Feng B, Zhu X

Introduction/Background: Post-stroke Type 1 Complex Regional Pain Syndrome (CRPS-1) is also known as shoulder hand syndrome, or reflex sympathetic dystrophy. The aim of the current study is to investigate the effects of Kinesiology Taping (TheraBandÒ) applied in patients suffered from post-stroke CPRS-1.

Methods: 16 eligible participants with post-stroke CRPS-1 have been recruited from inpatient department of The Sixth Affiliated Hospital of Sun Yat-sen University and The Second Affiliated Hospital of Guangzhou Medical University, Guangzhou, China. Followed by the inclusion criteria include and exclusion criteria include, all participants were randomly allocated into two groups, Kinesiology Taping group (n=10) and control group (n=6). Kinesiology Taping group applied on both shoulder region and forearm/hand of affected limb. The tape was maintained for 24 hours and will be removed before next treatment session. Two groups participants performed the regular PT and OT intervention which combined with transcutaneous electric nerve stimulation (TENS) to the affected shoulder, passive movement of the affected upper limb (shoulder complex, elbow, wrist, and hand), and ADL instructions. The outcome measures included visual analogue scale (VAS) to evaluate the pain level and the level of abnormal sensation of affected limb, hand volumeter measurement, Fugl-Meyer Assessment (FMA, upper limb portion), and pain-free lateral rotation range of shoulder. A trained research physical therapist conducted the assessments at baseline and 1, 2 weeks and 4 weeks after randomization. Each participant or their caregiver has signed the informed consent and ethic was approved by The Ethic Committee of The Sixth Affiliated Hospital of Sun Yat-sen University.

Results: There are significant differences for VAS of effected shoulder after four weeks ($F_{(2, 15)}$=32.46, P<0.001). An apparent decreased trend in Kinesiology Taping compared the control group. There are significant differences for hand edema of effected hand after four weeks ($F_{(2, 15)}$=110.32, P<0.001). Comparison between two groups for hand volume, the results indicate significant reducing edema of hand (P<0.05). Fugl-Meyer Assessment of upper limb and pain-free lateral rotation range of shoulder are also increased during two groups.

Conclusion: Kinesiology Taping could reduce edema, decrease pain level and reduce the level of local abnormal sensation for the patients with CRPS-1 after stroke.

Clinical Relevance: Current research in rehabilitation treatments of post-stroke CRPS-1 is limited. Kinesiology Taping combined with other physical and/or occupational intervention may be an effective way for patients with stroke CRPS-1.

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Physiological interventions for sport concussion management

Stewart G

Introduction: Sport related concussion has received increase attention over the past decade with Congress holding hearings on the issue, retired players suing sports leagues for alleged damage they've suffered, and new research pointing to degeneration in injured athletes' brains over time. The presenter examines current best-practice guidelines for concussion management established by various medical and sport organizations. Furthermore, he clarifies clinical relevance and limitations of the guidelines.

Methods: Data have been collected from case studies and review of the literature.

Results: Best-practice guidelines are comparable across organizations with reported inconsistent adherence. Furthermore, evidence of the effectiveness of specific physiological interventions to improve injury recovery and patient-centered outcomes is sparse.

Conclusion: Additional evidenced based research specific to evaluative and therapeutic intervention for sport concussion is necessary to guide the advancement of best- practices.

Clinical Relevance: Outcome research investigating physiological assessment and interventions of balance dysfunction, headache, fatigue, and pain management will likely impact the refinement of clinical practice guidelines for athletic trainers and physical therapists. Findings may be useful in treating concussions among athletes but also among military personnel.

EMG Activation of Cervical Musculature during a Series of Neck Strengthening Exercises in a Girls Soccer Population

Etnoyer-Slaski JL, Greenstein J, Bishop B

Introduction: Research has shown the large rate of concussions, with football, girls' soccer, and girls' basketball among the greatest at incidences.[1] The focus has recently shifted to understanding why these populations are at risk, including individuals biomechanics. In soccer, a significant negative correlation between neck strength and header acceleration was found, indicating weaker necks sustained greater impacts.[2] It has also been suggested that symmetrical strength in neck flexors and extensors reduces head acceleration during low-velocity heading.[3] Collins et al. found smaller mean neck to head circumference ratio and weaker mean overall neck strength were associated with concussion incidence and that for every one pound increase in neck strength, the odds of a concussion decreased 5%.[4] Although not significant, neck strength, range of motion and susceptibility of neck muscles to fatigue were found to be positively influenced using focused neck training regime in under-19 male rugby players.[5] The purpose of this study will be to identify exercises that provide the greatest activation of the cervical muscles among female high school soccer players.

Methods: A sample of 20 healthy girls' soccer players, between the ages of 16 and 18, will be recruited for a single 1 hour testing session. Informed consent will be obtained from the minor and the parent/guardian and demographic information such as history of concussions, level of activity, height, weight, and sport participation. Exclusionary criteria will include current concussion, neck injury within the past year, history of neck surgery, and under the age of 16 and over the age of 18. Initial data collection will include, range of motion using a dual-inclinometer, head-to-neck ratio measurements, and deep neck flexor endurance. Following these initial measures, Surface electromyography will be used to quantify the activity level of the bilateral 4 prime movers muscles of the cervical region (Sternocleidomastoid (SCM), Anterior Scalenes (AS), Cervical Paraspinal (CP), and the Upper Trapezius (UT)) muscles while performing a series of rehab exercises. The neck area will be prepped and surface electrodes placed on the corresponding muscles. Prior to beginning the testing battery, strength measures will be obtained utilizing standard manual muscle test positions using a hand-held dynamometer. This measure will also serve as the maximal voluntary isometric contraction (MVIC) for each muscle group. The motions to be tested will be flexion, extension, left/right side-bending, and left/right rotation. The testing battery has not been finalized but may include any of the following types of exercises: reactive isometric, dynamic isometric, plyometric, and proprioceptive or unstable surface. Each exercise will involve 5 repetitions. The men will use the green and women will use the red TheraBand® Resistance Band. The order of exercises will be randomized to minimize the effect of fatigue.

Statistical Analysis:
The EMG signals will be smoothed, rectified and analyzed using a root-mean-square algorithm. We will use visual onset and offset of the EMG signal amplitude to select the middle 3 trials. Average activation and peak activation will be determined and compared to the PA for each muscle group, and expressed as a %PA. This will allow %PA to be compared and rank order among groups and muscles.