A Comparison of Two Thera-Band Training Rehabilitation Protocols on Postural Control

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Context: Thera-Band™ (TB) exercises are commonly utilized in ankle rehabilitation, but previous studies have shown inconsistent results. Objective: To compare two TB protocols among healthy subjects in improving postural control. Design: Mixed model design. Setting: Research laboratory. Participants: Thirty healthy subjects divided into a control (CON), three times/week (TB3) or five times/week (TB5) group. Intervention: Training groups completed TB quick-kick protocols for six weeks either three (TB3) or five times (TB5) per week. Main Outcome Measure: Center of pressure velocity in the anterior/posterior (COPVX) and medial/lateral (COPVY) directions. Results: There were no differences related to Group or Side. COPVX in the eyes open (EO) condition increased pre-post. COPVY decreased pre-post. Conclusion: The lack of differences between Groups and Side indicates these specific TB training protocols did not impact static postural control differently among healthy subjects. Key Words: therapeutic exercise, balance, ankle.

The inversion sprain is the most common ankle injury seen in the athletic population. Rehabilitation and prevention of an ankle sprain demands sport specific exercises and activities to challenge the injured tendons, ligaments, muscle, and bone. Clinicians often implement rehabilitation for weeks to months after injury. The Thera-Band™ is a commonly utilized exercise device by clinicians in the rehabilitation of ankle sprains. One proposed benefit of TB training is promotion of improvements in neuromuscular control about the ankle joint. This inexpensive rehabilitation device has been tested in many studies investigating strength, proprioception, and muscle reaction times.

Although the TB is a commonly used exercise technique, there does not seem to be a consensus number of training weeks and sessions per week for TB rehabilitation programs needed to achieve the desired outcomes of improvements in postural control and other measures of neuromuscular control. Both Baker et al. and Kaminski et al. had subjects perform quick-kick exercises using TB resistance during a six week protocol, training three times per week. However, neither study reported significant improvements in postural control or strength. Both studies attributed this to a lack of intensity and duration of the imposed exercises. Eils
and Rosenbaum\textsuperscript{6} also trained subjects with a six-week TB protocol with only one session per week and reported significant improvements in postural sway as well as joint position sense and joint reaction time. However, they combined TB with other proprioceptive exercises, and the improvements in the neuromuscular control measures may be attributed to the combination of exercises.\textsuperscript{6}

Improvement in postural control associated with ankle rehabilitation using TB training protocols may be influenced by the number of weeks of training as well as the number of training sessions per week. It appears that TB training three times per week may not be enough to elicit significant improvements in postural control\textsuperscript{5}; however, it is unknown if more than three times per week would elicit improvements. Therefore, the purpose of this study was to investigate the efficacy of a TB training protocols on single-leg static postural control as well as the effect of variability in the number of weekly training sessions. Additionally, this study attempted to examine the influence that the Thera-Band training protocols would have on postural control with and without vision as well as between trained and untrained limbs. By comparing different frequencies per week for this intervention strategy, it may be possible for clinicians to develop more efficient rehabilitation strategies for using this rehabilitation tool.

**Methods**

**Participants**

Thirty healthy subjects were recruited for participation in this study from the university community. Subjects reviewed and signed an informed consent form approved by the Human Subjects Research and Review Committee before participation in this study. All subjects were healthy recreational athletes, defined as individuals who exercised at least three times per week for 30 minutes, but who did not take part in organized competition. Exclusion criteria were a history of fracture or dislocation to the testing ankle or leg, neurological disorders, a history of concussions within the last two years, a significant injury to the lower extremity in the previous two years, chronic ankle instability, or previous experience with TB training. The subjects were randomly allocated to three groups (Table 1). The control group (CON: \( n = 10 \)) did no training for the duration of the study. One TB group trained three times per week (TB3: \( n = 10 \)) and the other TB group (TB5: \( n = 10 \)) trained for five times per week.

**Table 1 Subject Demographics**

<table>
<thead>
<tr>
<th></th>
<th>Gender</th>
<th>Age (yr)</th>
<th>Height (cm)</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (control)</td>
<td>M = 3</td>
<td>24.22 ± 2.59</td>
<td>167.64 ± 4.92</td>
<td>71.06 ± 10.49</td>
</tr>
<tr>
<td></td>
<td>F = 6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 (3 times/week)</td>
<td>M = 1</td>
<td>21.11 ± 2.09</td>
<td>164.25 ± 4.92</td>
<td>61.49 ± 7.74</td>
</tr>
<tr>
<td></td>
<td>F = 8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 (5 times/week)</td>
<td>M = 3</td>
<td>19.9 ± .88</td>
<td>172.72 ± 8.12</td>
<td>67.09 ± 8.13</td>
</tr>
<tr>
<td></td>
<td>F = 7</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Procedures

**Instrumentation.** Six feet of green, blue, and black Thera-Bands were used for TB training exercises. A metronome was used to set the pace for the quick kicks. Watches with second hands were used to keep track of time for each exercise set and for breaks between sets. A Bertec NC4060 force plate (Bertec Inc., Columbus, OH) and MotionMonitor™ software (IST Inc., Chicago, IL) were used to measure center of pressure (COP) data of each test leg pre and post-training.

**Postural Control Assessment.** Before and after the six-week training period, subjects in all groups underwent single-leg postural control testing on a force plate in the laboratory (Figure 1). Subjects balanced on both the left and right legs separately. During the pre- and post testing sessions, on both legs, subjects performed three 30-second trials with eyes open and three 30-second trials with eyes closed, for a total of 12 trials per session. The order of testing the stance legs was randomized for both testing sessions. Each leg was assigned as either the training or nontraining leg. The training leg, which served as the stance limb during the training sessions, was assigned to the dominant leg, determined as the leg with which they would prefer to kick a ball. In the TB groups, the training leg received the designated training protocol. The Control group was assigned limbs in the same manner for between group comparisons.

*Figure 1 — Single limb postural control testing.*
Thera-Band (TB) Training. Six feet of TB was doubled together and knotted around the leg of a table. The subjects were not wearing shoes and placed the non-testing foot through the doubled end of the TB while balancing on the training leg (Figure 2). The subjects balanced on the stable surface of the concrete floor with eyes open and eyes closed depending on the week of the training program (Table 2). Resistance was determined by the color of the TB, either green, blue, or black (Table 1). The subjects stood at a starting distance from the table equal to 50% of the resting length of the TB in order to standardize the training sessions for all subjects (Figure 3).

Subjects performed quick kicks in eight directions (anterior, anterior lateral, lateral, posterior lateral, posterior, posterior medial, medial, anterior medial; Figure 4). Kicks were synchronized with a beat of a metronome (Seiko DM50L, Seiko Inc.)

**Figure 2** — Thera-Band™ kicking protocol using right limb as testing limb. Kicks in the Anterior (2a) and Anterior-medial (2b).

**Table 2** TB Exercise Training Protocol

<table>
<thead>
<tr>
<th>Week</th>
<th>Eye Condition</th>
<th>TB Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>EO</td>
<td>Green</td>
</tr>
<tr>
<td>2</td>
<td>EC</td>
<td>Green</td>
</tr>
<tr>
<td>3</td>
<td>EO</td>
<td>Blue</td>
</tr>
<tr>
<td>4</td>
<td>EC</td>
<td>Blue</td>
</tr>
<tr>
<td>5</td>
<td>EO</td>
<td>Black</td>
</tr>
<tr>
<td>6</td>
<td>EC</td>
<td>Black</td>
</tr>
</tbody>
</table>
Thera-Band Training and Static Protocol Control

The order of directions followed the same pattern starting with the medial direction. The first four directions (medial, anterior medial, anterior, anterior lateral) were executed for 20 seconds each with a 10 second rest between each direction, followed by a 30-second rest. Then the subjects turned around and kicked in the same pattern in the opposite direction for 20 seconds each with a 10-second rest between each direction, also followed by another 30-second rest. This process was repeated three times for a combined rest and exercise time of 14 minutes.

**Data Reduction**

Center of pressure data (COP) were sampled at 60Hz. During the pre- and post testing sessions, on both legs, subjects performed three 30-second trials with eyes open and three 30-second trials with eyes closed, for a total of 12 trials per
session. During each trial, MATLAB™ software (The MathWorks, Inc.; Natick, MA) was used to calculate the dependant variables of average COP velocity in the A/P (COPVX) and M/L (COPVY) directions. These dependant variables were calculated for the eyes open and eyes closed conditions on each stance leg during the pre- and post-testing sessions. The means and standard errors were utilized for each condition and were utilized for the statistical analysis.

**Statistical Analysis**

Two separate mixed-model ANOVAs with a 1-between (group: CON, TB3, TB5), 3-within (Time: pre, post; Eyes: EO, EC; Side: dominant, nondominant) factor analysis were performed for the dependant variables of COPVX and COPVY. The statistical level was set a priori at $P < 0.05$. Tukey’s post-hoc testing was applied in the event of significant interactions. The Statistical Package for the Social Sciences 12.0 (SPSS Inc, Chicago, IL) was used for data analysis.

**Results**

Twenty-eight of thirty subjects completed this study. Two subjects were eliminated from the study due to ankle injuries unrelated to the study suffered during the training period.

**COPVX**

There was a statistically significant Time by Eye interaction for COPVX ($F_{2,25} = 6.185, P = .020$). Tukey’s post-hoc revealed that under the EO condition, COPVX significantly increased from pre ($0.068 \pm 0.003$m/s) to post ($0.076 \pm 0.004$m/s), indicating an increase in postural sway (Figure 5). This relationship was associated with an effect size of $d = 0.44$. Additionally, as part of this interaction, a main
effect for Eye ($F_{2,25} = 194.01, P < .001$) demonstrated that the EC condition (0.140 ± 0.006m/s) had significantly higher COPVX compared to the EO condition (0.072 ± 0.003m/s; Figure 5).

**COPVY**

No statistically significant interactions existed for COPVY. A statistically significant main effect was observed for Time ($F_{2,25} = 7.21, P = .013$) demonstrating a significant decrease in COPVY from pre (0.115 ± 0.005m/s) to post-testing (0.102 ± 0.005m/s), indicating a decrease in postural sway (Figure 6). Additionally, there was a significant main effect for Eye ($F_{2,25} = 210.78, P < .001$). COPVY was significantly larger for EC (.142 ± 0.006m/s) compared to EO (.075 ± 0.003m/s) condition (Figure 7).

![Figure 6](image1.png) — Time ($F_{2,25} = 7.208, P = .013$), *$P < .05$.

![Figure 7](image2.png) — Eye ($F_{2,25} = 210.782, P < .001$), *$P < .05$. 
Comments

The purpose of this investigation was to compare the effects of a Thera-Band quick kick training protocol performed three times per week and five times per week for six weeks on static postural control of healthy subjects. Although this study was designed to examine training differences related to Group and Side groups, postural control was not influenced by TB training after six weeks, suggesting that the TB protocol used in this study had no significant effect on static postural control among healthy subjects. The lack of training effect on postural control could be explained by the fact that healthy, recreationally active subjects were recruited. Similar to the study by Baker et al., the absence of existing ankle pathology may have meant that the subjects already possessed highly efficient levels of balance and stability before training, in which case the TB training would create no improvements in this measure.

One of the purposes of this study was to determine if a more demanding TB protocol could influence postural control by increasing the number of weekly training sessions from three, which had been utilized previously, to five times per week. However, it appears that the training programs still may have not been challenging enough and that six weeks was not enough time to create significant changes in static postural control in healthy, recreationally active individuals. The number of weekly sessions (three and five) and the actual time spent each day performing the exercises (14 min per day) may also have not been long enough to influence postural control in already stable ankles. Consistent with the present study, previous authors also failed to find improvements in postural control or strength in healthy subjects.

Kaminski et al. found no significant differences in average torque or peak torque strength ratios of ankle inversion and eversion in any of the groups utilizing a TB training protocol of three times per week for six weeks. While subjects were pre and post-tested isokinetically in a seated position, but were trained with elastic bands sitting on the floor with legs extended, no significant strength gains were experienced by these healthy subjects. Baker et al. also utilized a TB training program of three times per week for six weeks and reported no significant training effects on postural control. As in our current study, Baker et al. used healthy athletes that may have already had high levels of balance and stability.

In our study, healthy subjects were used for the TB protocols to determine if differences existed in group and training leg variables. The lack of training effect in the two studies mentioned above led us to expand the number of sessions of TB training to five times per weeks to determine if an increased frequency of TB training would influence the outcome measurement. As in the Kaminski et al. and Baker et al. studies, a protocol of 3 times per week was not effective at influencing static postural control across the group and training leg conditions in our study, but neither was the expanded protocol of five times per week. Docherty et al. used TB exercises only and found improvements in strength as well as inversion, DF and PF joint position sense in subjects with functionally unstable ankles. Our study did not measure JPS or strength gains, only static postural control. However, it appears from our results and those of Kaminski and Baker, all utilizing only healthy subjects, that it may be necessary to apply these TB protocols to those with ankle pathology to determine the clinical importance of this rehabilitation tool.
There have been previously reported improvements in function with TB protocols, but these studies have combined TB exercises with other rehabilitation tools. Blackburn et al. reported that rehabilitation protocols utilizing TB for strengthening and improving proprioception of the ankle in conjunction with other activities (free weights, calf raises, four-square hopping, BAPS, and foam blocks) improved performance on semi-dynamic and dynamic balance tasks. However, no improvements were observed in single-leg static balance with EC on a force plate. The suggested improvements were seen in semi-dynamic and dynamic balance possibly because the training protocols were similar to the balance assessment, but the lack of static postural control improvement was attributed to single leg standing being an easily learned task that is used on a regular basis and can be stored in the nervous system for future use.

In our results, TB kicking protocols were not able to influence static postural control tested with eyes open and closed. Even with the addition of other exercises designed to improve the strength and proprioception of the ankle, Blackburn et al. also were not able to show any significant influence on static postural control among healthy subjects. It appears that static postural control assessment may not be challenging to non-injured subjects, and efforts to improve this portion of neuromuscular control with TB and other rehabilitation methods is difficult to do in the absence of ankle pathology. Future investigations should also consider utilizing a larger sample size that would include a comparison of subjects with and without ankle pathology.

Eils et al. also combined the TB with other exercises in a multi-station proprioceptive exercise program on CAI subjects, measuring postural sway, muscle reaction times, and joint position sense. There were significant improvements in joint position sense while muscle reaction times had no improvements. These measures were not taken in our present study, but they do measure components of the neuromuscular control system that contribute to postural control. For the postural control measures, Eils et al. reported that the control group had significant improvements in the A/P direction, and the exercise group had improvements in the M/L direction. The authors suggested that the decreases in postural sway following the exercise programs could be attributed to short term adaptations that created a learning response for the postural control task.

**Future Research**

In the results of our study, there was a statistically significant pre-post increase in A/P postural sway for the EO condition and a statistically significant pre-post decrease in M/L postural sway. While these statistical differences existed, clinicians should consider the clinical importance of these findings. What we feel may be of greater interest is that the therapeutic intervention selected for this study did not create differences between groups or within limbs that received the training among healthy subjects. Future research should continue to use injured and non-injured subject extremities with ankle pathologies when examining the efficacy of TB rehabilitation protocols. Previous reports suggest that additional exercises could be combined with TB training to create a battery of exercises to improve postural control. Additional investigation should examine what combination of these exercises will address the postural and neuromuscular deficits related to ankle
instability. Finally, the TB kicks used in this study could be found to have greater influence on dynamic postural control rather then the static assessment we used and should be included in future studies.

**Conclusion**

While there was a statistically significant improvement in frontal plane postural control, the present study found no significant improvements in static postural control among healthy individuals related to a specific Thera-Band training regiment after six weeks of training regardless if the exercises were performed three or five times per week. Therefore, increasing the number of training sessions per week may not be as influential as previously suggested. However, this rehabilitation tool and application may still have important clinical benefit, which could be determined by comparing this regiment between those with and without ankle pathology and utilizing additional assessments besides static postural control.

**References**