Ankle Proprioception Training Program for Preventing Lateral Ankle Sprains in Adolescent Basketball Players: A Case Validation Study

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ABSTRACT

The purpose of this case validation study was to examine the effects of a previously established proprioception training program on the number of lateral ankle sprains in secondary school basketball players. The patient population consisted of 22 patients (5 females, 17 males, age = 16±1 years old, height = 181.8±8.9 cm, weight = 74.8±12.8 kg) from a small rural high school in Illinois. The team completed the proprioceptive training program as part of a warm-up supervised by the athletic trainer and took approximately five minutes to complete. The program was completed every day for five weeks with one additional week of maintenance exercises. The main outcomes assessed were the number of lateral ankle sprains, anterior reach distance from the Y-Balance Test, and Foot and Ankle Ability Measure (FAAM) Sport Scale scores. Data collection occurred at baseline (prior to starting the program), week 6, week 12, and follow-up. There were a total of 9 lateral ankle sprains and 3 re-injury throughout the course of the previous season without using the proprioceptive training program. There were 6 lateral ankle sprains and only 1 re-injury during this competition season. Anterior reach distances on the Y- Balance test improved from follow-up to week 6; but decreased from week 6 to week 12 and follow-up. FAAM Sport scale scores remained consistent throughout the duration of the season. The proprioceptive training program was effective in reducing the number of lateral ankle sprains in the adolescent population and helped improve anterior reach distance while patients were completing the exercise program. Athletic trainers should incorporate more proprioceptive training programs with their patient population as primary prevention measures.

Key Phrases
Injury risk reduction, clinician-rated outcomes, secondary school patient population

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Full Citation
Rivera MJ, Powden CJ, Games KE. Ankle proprioception training program for preventing lateral ankle sprains in adolescent basketball players: A case validation study. *Clin Pract Athl Train*. 2018;1(1):3-10.
https://doi.org/10.31622/2018/0001.2

Submitted: May 14, 2018 **Accepted**: May 23, 2018

ARTICLE CITATION AND SUMMARY

Schiftan GS, Ross LA, Hahne AJ. The effectiveness of proprioceptive training in preventing ankle sprains in sporting populations: A systematic review and meta- analysis. J Sci Med Sport. 2015;18:238-244

We selected a guiding systematic review[1] that examined the evidence regarding the use of ankle proprioceptive training programs and its influence on ankle sprain rates. The authors completed a comprehensive literature search of MEDLINE, CINAHL, SPORTDiscus, and PEDro through October 2013. Studies were evaluated using the following criteria: (1) study design was a moderate-to-high level randomized controlled trial (4/10 on the PEDro scale), (2) participants were physically active (regardless of previous ankle injury), (3) intervention group received proprioceptive training only compared to a control group (no proprioceptive training), and (4) the rate of ankle sprains was reported as a main outcome. The authors examined the number of participants, interventions, and injury rates. Seven of the initial 345 studies were included in the review totaling 3,726 patients. A comprehensive meta-analysis of all patients from the 7 included studies, regardless of history of injury, revealed a significant reduction in ankle sprain rates for the proprioceptive training group compared to the control group (relative risk = 0.65, 95% CI = 0.51-0.81). Proprioceptive training was statistically significant exclusively as a primary preventative measure (relative risk = 0.57, 95% CI = 0.34-0.97). The review concluded that proprioceptive training programs are effective at reducing the incidence rates of lateral ankle sprains, including those with a history of ankle sprains.

 ISSN Online 2577-8188

OBJECTIVE

The purpose of our validation case study was to examine whether the use of a previously established ankle proprioceptive training program would effectively reduce the number of lateral ankle sprains in secondary school (grades 9-12) patients, which student-athletes were competing in basketball.

Additionally, we investigated the use of the proprioceptive training program on dynamic balance (Y-Balance Test) and perceived function of the ankle (Foot and Ankle Ability Measure Sport).

PATIENT POPULATION

The clinical practice setting was a secondary school in rural Illinois. Both female and male basketball programs from one secondary school were utilized for the project. Twenty-two patients (5 females, 17 males, age = 16±1 years old, height = 181.8±8.9 cm, weight = 74.8±12.8 kg) completed the proprioceptive training program throughout the basketball season. Patients were included regardless of ankle sprain history and were free of injury at the onset of the proprioceptive training program. There were 8 males and 3 females with a history of previous ankle sprains.

INTERVENTION

The proprioceptive training program (Table 1) was developed based on recommendations provided by a study in the guiding review.[2] Each participant completed the proprioceptive training program as a part of a structured, active, group warm-up supervised by the athletic trainer. The program was initiated at the beginning of the competitive season and consisted of 5-week long phases of increasing difficulty based on individual participant performance and concluded at the end of week four with a maintenance week (week 5). The first 4 phases (weeks 1 through 4) required patients to complete 5 training sessions per week for approximately 15 to 20 minutes total per week. The final phase (week 5) consisted of maintenance exercises 3 times for approximately 10 minutes total per week. During each session, 3 to 4 tasks were completed. The patients did not complete the program on game days.

The program (Table 1) consisted of single leg stance on flat surface, dribbling a basketball on a single leg, double leg stance on a balance board, single leg stance on a balance board, and dribbling a basketball in a single leg stance on the balance board (Figure 1).[2] Each task was part of a progression and not every task was completed each day. Each exercise was performed for 30 seconds on each leg with a 30-second rest period between each exercise. Each task was completed with eyes open initially and progressed to eyes closed in the subsequent phases. The balance boards were constructed using a round, precut 16-inch board. A piece of round plastic tubing approximately 5 inches wide was adhered to the middle of the board.

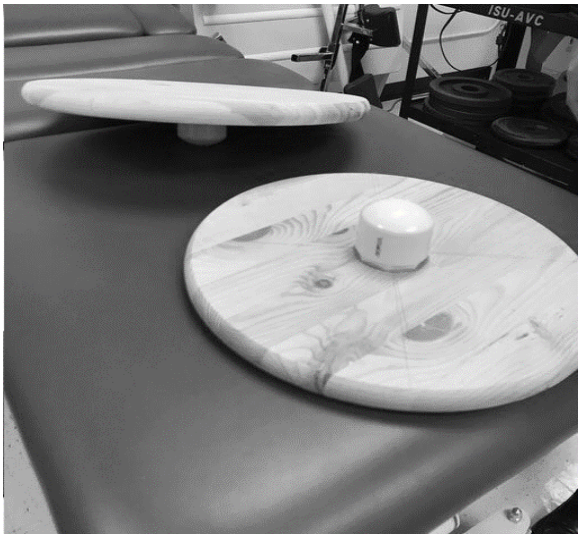

Figure 1. Balance boards created for the proprioceptive training program.

If a participant missed 5 consecutive days or was unable to perform the outcome assessments, the patient's data were not used in the analysis. Patients were excluded from the outcome assessment if they had an injury that prevented

them from bearing weight on a single leg to perform the anterior reach distance at the time of data collection.

Outcomes were assessed before starting the proprioceptive training program (baseline), at the conclusion of the training program (week 6), 6 weeks after conclusion (week 12), and at the end of the season (follow-up). Outcomes data were collected before patients participated in practice. The 3 main outcomes that were assessed throughout the data collection period were number of lateral ankle sprains, anterior reach distances on the star excursion balance test, and the Foot and Ankle Ability Measure (FAAM) Sport Scale.

Table 1. Proprioceptive Training Program.

Week	Surface	Eyes	Exercises
Week 1	Floor	Open	Single leg stance
		Open	Single leg stance with leg swing
		Open	Single leg squat (30°- 45°)
		Open	Single leg stance while dribbling ball
Week 2	Floor	Closed	Single leg stance
		Closed	Single leg stance with leg swing raised
		Closed	Single leg squat (30°- 45°)
Week 3	Board	Open	Single leg stance
		Open	Single leg stance with leg swing raised
		Open	Single leg squat (30°- 45°)
		Open	Double leg stance while rotating the board
Week 4	Board	Closed	Single leg stance
		Open	Single leg stance with leg swing raised
		Open	Single leg squat (30°- 45°)
		Open	Single leg stance while rotating the board
Week 5-6	Board	Closed	Single leg stance
		Open	Single leg squat (30°- 45°)
		Open	Single leg stance while rotating the board
		Open	Single leg stance while dribbling the ball

Table 2. Means (± Standard Deviations) for all Main Outcome Measures.

	Baseline	Week 6	Week 12	Follow-Up
Y-Balance Test (%)				
Anterior Dominant Limb	84.23 ± 7.48	86.82 ± 6.60[a]	83.79 ± 6.44[b]	83.23 ± 6.63[b]
Non-Dominant Limb	84.58 ± 7.82	87.89 ± 8.43[a]	84.09 ± 7.64[b]	83.05 ± 6.19[b]
FAAM Sport scale				
Score	31.32 ± 1.76	30.55 ± 3.99	31.09 ± 3.07	31.36 ± 2.26
Perceived Function (%)	96.91 ± 5.38	99.14 ± 3.23[a]	99.32 ± 2.34	99.09 ± 2.94[b]

[a]=Significantly different from pre-intervention at $p<0.05$, [b]=Significantly different from week 6 (termination of intervention) at $P>0.05$.

 ISSN Online 2577-8188

Ankle sprains were evaluated by the athletic trainer and defined as an injury localized to the lateral ankle (indicated by positive anterior drawer test and inversion stress test), required at least 48 hours of activity modification, and documented in the electronic medical record system (EMR). The number of ankle sprains were compared to the number of ankle sprains in the same population in the previous season that also fit the definition of injury and treatment outlined above.

The anterior reach distance on the Y-Balance Test was utilized to assess any changes in dynamic postural control throughout the duration of the proprioceptive training program.[3,4] The Y-Balance Test has been shown to have good reliability and validity in assessing dynamic postural control as an indicator of LE injury in the adolescent population.[4] The same evaluator collected anterior reach distances using a standard tape measure secured to the floor. Patients were instructed to place their big toe at the 0 indicator on the tape measure and to reach the opposite foot as far as they could straight ahead while maintaining single leg balance.[4] The distance was recorded at the most distal aspect of the reach foot. Each patient completed three practice trials followed by three testing trials. Reach distances were normalized to patient height and classified as dominant limb or non-dominant limb. A trial was void if they could not maintain the single leg stance, stance foot was lifted off the ground, or of the non-stance limb touched the ground.[4]

Perceived ankle function was measured using the FAAM Sport scale. The FAAM has been demonstrated to detect self-reported functional deficits in those with chronic ankle instability and a range of other musculoskeletal conditions in the foot and ankle.[5,6] Patients were given an electronic version of the FAAM Sport scale and instructed to complete the form based on their current symptom score. Each item on the FAAM Sport scale is an 8-item measure scored on a 5-point Likert scale of 0-4.[5,7] Zero indicating the patient could not complete the task and "4" indicating the patient had no difficulty completing the task.[5,7]

A 4x2 repeated measures ANOVA was used to assess differences in anterior reach scores over time (baseline, week 6, week 12, follow-up) and between limbs (dominant, non-dominant). A one-way ANOVA was used to examine FAAM Sport scale differences over time. Post hoc analysis was completed using Fishers LSD test. Significance was set a-priori at $P<0.05$. All statistical analyses were completed using SPSS Version 24 (IBM Corp. Released 2016. IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp.). The number of ankle sprains was extracted from an EMR and compared to data from the year prior to the implementation of the proprioceptive training program.

MAIN FINDINGS

Nine first time lateral ankle sprains were sustained in the competition year prior to the proprioceptive training program. During the proprioceptive training program year, 6 first time lateral ankle sprains were sustained. In the previous year, 3 patients sustained a second lateral ankle sprain to the same ankle in the same competition year. While using the proprioceptive training program, only 1 patient sustained a re-injury in the same competition year. There were no major changes in competition level, number of patients, training schedules, competition schedules, etc.

A significant time main effects was found for anterior reach distance ($P<0.001$). Post hoc analysis indicated that anterior reach distances were significantly greater at ~~six~~ 6 weeks compared to baseline ($P<0.001$), week 12 ($P=0.003$), and follow-up ($P<0.001$). No other significant differences were found between each time point ($P>0.17$). There was no limb main effect for the anterior reach distances ($P=0.58$). There was no time by limb interaction detected (P

 ISSN Online 2577-8188

=0.51). After patients, ceased participation in the proprioception training program anterior reach distances decreased in both dominant and non-dominant limbs.

There was no time main effect for FAAM Sport scale scores throughout data collection (P =0.56). There was no time main effect in the perceived level of function (0-100% scale) on the FAAM Sport scale (P=0.56) (Table 2).

DISCUSSION

No statistical tests were used to compare the rates of ankle sprains due to the small patient population; rather, the number of ankle sprain were reported. Our findings are consistent with other literature investigating the use of proprioceptive training programs to prevent lateral ankle sprains.[1,2,8-10] Specifically, from investigations within the guiding review, both the number of initial injury and re-injury rates decreased for patient populations utilizing the proprioceptive training programs.[1] However, perhaps a greater achievement in the reduction of ankle sprains is time saved treating these injuries. Athletic trainers spend an increased amount of time treating patients with time-loss injuries compared to non-time-loss injuries.[11] Athletic trainers primarily use therapeutic exercise and neuromuscular reeducation as treatments for patients with ankle sprains.[11] This current study suggests that athletic trainers can reduce the amount of ankle sprains they are treating and further reduce the amount of time spent treating ankle sprains by using a primary prevention program targeting proprioception.

The results from the current study suggest that proprioceptive training programs can improve dynamic balance as we identified increases in anterior reach distances from baseline to week 6. Further evidence of the improvements are indicated by the decreases in anterior reach distances at week 12 and follow-up once compliance rates dropped. This reduction in scores highlights the need to assure compliance with proprioceptive training programs to ensure optimal outcomes. A similar investigation looking at balance improvements with the use of neuromuscular training also found comparable improvements in the SEBT.[12] Similar to the current investigation the authors found improvements in the reach distances after a 6 week program targeted at neuromuscular control.[12] However, the previous study utilized a program that also incorporated strength and plyometric exercise with longer training sessions.[12] Furthermore, other investigations examining dynamic balance found an 8-week balance and strength program to increase the anterior reach distances in collegiate female soccer players.[13] The program focused primarily on strength and conditioning for more elite athletes compared to the current investigation. However, the findings of improved dynamic balance with a targeted program are similar. Overall, the use of the proprioceptive training program can help patients improve dynamic balance and thus could reduce the risk of suffering an ankle sprain.

There was no time main effect for FAAM Sport scale scores suggesting that the proprioceptive training program did not change perceived foot and ankle function. There was also no time main effect for perceived level of function ranked from 0-100% function. Other investigations implementing rehabilitative protocols or proprioceptive training programs have found improvements in FAAM scores.[14,15] However, these previous investigations used participants that had chronic ankle instability whereas the current investigation used healthy subjects from baseline. The patients in this study were athletes functioning at a high level with no disability to start. Previous research has shown that participants that are healthy have higher FAAM scores and therefore could have had a ceiling effect on FAAM scores in the current project.[5] Future investigations should focus on the use of a proprioceptive training program and severity of ankle sprains that

patients sustain. Additionally, future studies should investigate the influences of a prophylactic proprioception training program and the amount of time patients take to return to baseline outcome scores.

In order to be more proactive in injury reduction, athletic trainers should attempt to incorporate more preventative measures in their clinical practice. By becoming more proactive, athletic trainers can reduce the amount of time spent treating initial injury and re-injuries for ankle sprains.[11] Neuromuscular reeducation is the second most common intervention used when treating ankle sprains in the secondary school setting.[11] Treating from a reactionary standpoint after a patient is injured may costs athletic trainers more time and limits their focus on other aspects of their duties. By becoming more proactive in using neuromuscular training as a prevention method, athletic trainers can reverse this cycle. Furthermore, by decreasing the amount of injuries sustained athletic trainers can help combat inflating healthcare costs and long-term consequences of injury such as chronic ankle instability and osteoarthritis.

The implementation of a prevention program can be a difficult task to accomplish, especially in settings where no previous effort in injury prevention has been made. There are a variety of variables that should be considered and accounted for to successfully implement a prevention program. First, the time required for patients, coaches, and practitioners to complete the prevention program is considered a limitation of injury prevention.[16] In an investigation looking at a comprehensive prevention program in youth football, investigators found coaches were 87% less likely to not implement a prevention program if they felt the time required was too long.[16] However, through this case validation the investigators implemented a program with a realistic length to track changes in positive outcomes. The overall time required was less than 5 minutes per player, per day, totaling only 25-30 minutes for the entire week. Additionally, the proprioceptive training program was implemented as a component of a team warm up before practice each day to ensure daily compliance for each player. As previously established, compliance rates with injury prevention measures can greatly improve the outcomes seen for participants.[17] Additionally, it has been shown that supervised programs (either by athletic trainer or coaches) are likely to have higher adherence rates than unsupervised programs.[17,18] Athletic trainers need to evaluate their clinical practice, the common injuries they treat, and the time required to implement a prevention program for such injuries to leverage compliance from coaches, patients, and stakeholders.

Data collection, management, and analysis was simple and effective for this clinical practice site. The EMR in the project, which was already in place at the clinical practice site, was utilized to store and protect data. The use of electronic fillable PDFs made data collection for the FAAM Sport score easy. Data collection periods were quick and efficient with 1 athletic training student facilitating the FAAM Sport scale administration and 1 athletic trainer measuring the anterior reach distances. Data were downloaded from the EMR and exported onto a Microsoft Excel 2016 (Microsoft Corp, Richmond WA) sheet for analysis. Athletic trainers should explore the data management capabilities of their record systems in place; additionally, athletic trainers should investigate which clinician and patient reported outcomes would be most appropriate to track based on their patient population, needs, time, and prevention methods being implemented. Resources such as money, equipment, and training are required for the implementation of prevention practices. However, for this project, the only associated costs were those required for the building of the balance boards, which was minimal. The budget for a program used in this project was small and the time required to

complete the exercises was minimal. Athletic trainers should leverage resources and positive relationships with coaches to explore options for prevention program implementation.

CLINICAL BOTTOM LINE

The findings from this case validation study concur with the guiding systematic review and meta-analysis that the use of proprioceptive training programs are effective in the reduction of lateral ankle sprains. Additionally, the use of the proprioceptive training program also improved dynamic stability and postural control of patients as the anterior reach distances of the Y-Balance Test increased. Athletic trainers should begin to examine their own clinical practice to determine the feasibility of implementing a proprioceptive training program with their patient population to reduce the incidence of ankle sprains.

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