Effect of Chiropractic Manipulation on Vertical Jump Height in Young Female Athletes with Talocrural Joint Dysfunction: A Single-Blind Randomized Clinical Pilot Trial

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Abstract

Objective: The main objective of this pilot study was to explore the effect of chiropractic high-velocity, low-amplitude (HVLA) manipulation on vertical jump height in young female athletes with talocrural joint dysfunction.

Methods: This was a randomized assessor-blind clinical pilot trial. Twenty-two female handball players with talocrural joint dysfunction were randomized to receive either HVLA manipulation (n = 11) or sham treatment (n = 11) once a week during a 3-week period. The main outcome was change in vertical jump height from baseline to follow-up within and between groups after 3 weeks.

Results: Nineteen athletes completed the study. After 3 weeks, the group receiving HVLA manipulation (n = 11) had a statistically significant mean (SD) improvement in vertical jump height of 1.07 (1.23) cm (P = .017). The sham treatment group (n = 8) improved their vertical jump height by 0.59 (2.03) cm (P = .436). The between groups' change was 0.47 cm (95% confidence interval, −1.31 to 2.26; P = .571) in favor of the group receiving HVLA manipulation. Blinding and sham procedures were feasible, and there were no reported adverse events.

Conclusion: The results of this pilot study show that a larger-scale study is feasible. Preliminary results suggest that chiropractic HVLA manipulation may increase vertical jump height in young female athletes with talocrural joint dysfunction. However, the clinical result in favor of HVLA manipulation compared with sham treatment needs statistical confirmation in a larger randomized clinical trial. (J Manipulative Physiol Ther 2014;37:116-123)

Key Indexing Terms: *Ankle Joint; Manipulation; Chiropractic; Athletes; Randomized Controlled Trial*

Ankle joint injures are very common, costly, and usually associated with physical activity and sports.[1] It has been estimated that 16% to 30% of all sports injuries are related to the foot[2] and that ankle sprains or lateral distortions of the foot and ankle are among the most common injuries in the age group 16 to 64 years.[3] Several joints, collectively known as the *ankle complex* or the *talocrural joint*, are involved in the movement of the foot. Dysfunctions of the talocrural joint may have multiple causes such as anatomical anomalies of the bones, ligaments, and/or muscles affecting the ability of the joints to function effectively. Decreased mobility as a result of immobilization after a previous injury may also be an important factor in dysfunctional ankle joints.[4] It has been estimated that loss of dorsiflexion in the talocrural joint might increase the risk of a lateral ankle sprain up to 5 times.[5]

Chiropractors and other manipulative therapists traditionally use manipulation, often known as *high-velocity, low-amplitude (HVLA) manipulation*, to normalize joint function.[6,7] A traction, or long-axis, HVLA manipulation is an example of a frequently used manipulative technique for treating dysfunctions of the talocrural joint.[6] Manipulative therapists use active and passive ranges of motion, joint play, and pain provocation testing to detect altered joint mobility and biomechanical dysfunction suitable for

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Fig 1. *Active manipulation of the ankle. (Color version of figure is available online.)*

Fig 2. *Sham manipulation of the ankle. (Color version of figure is available online.)*

manual treatment. Research in this area targeting the spine indicates that pain provocation testing may have high intratester and intertester reliability, whereas motion palpation yields higher intratester than intertester reliability.[8] However, the reliability of such tests applied to the foot and ankle is not as well documented. Despite the long-standing popularity of using HVLA manipulation in the lower extremities, there is a general lack of scientific studies examining the effects of such treatment.[9] Thus, perhaps not surprisingly, manipulative therapy was not recommended in a recent evidence-based clinical guideline targeting the diagnosis, prevention, and treatment of ankle sprains.[1]

Previous clinical studies in the area of manipulative treatment of the ankle have yielded various results. Nield et al[10] studied the effect of HVLA manipulation on ankle dorsiflexion in asymptomatic participants. The authors did not find any significant effect and suggested future studies to involve symptomatic participants.[10] Following that route, a study by Pellow and Brantingham concluded that HVLA manipulation of the talocrural joint appeared superior to placebo treatment for reducing pain and increasing ankle range of motion and function in patients with subacute and chronic lateral ankle sprain.[11] In contrast, Andersen et al[12] found no statistically significant changes in ankle dorsiflexion between manipulated ankles and controls in participants with a history of lateral ligament sprain, although the ankles that cavitated displayed greater improvement compared with those that did not gap. Research on HVLA manipulation and ankle proprioception has showed no effect on standing stability in healthy participants,[13] whereas participants with chronic recurrent ankle sprain receiving multiple HVLA manipulations of the talocrural joint have showed an increased range of motion and improved proprioception compared with participants receiving a single HVLA manipulation.[14] Other positive findings of manipulative therapy of the ankle in participants with ankle sprain have indicated biomechanical effects such as redistributing the load supports at foot levels,[15] improving ankle range of motion,[16,17] and creating an initial hypoalgesic effect after treatment.[16] Additional effects include distal tibiofibular joint manipulation producing immediate and significant increase soleus muscle activation.[18] A recent literature review targeting manipulative therapy of lower extremity disorders concluded that there is fair to limited evidence for manipulative therapy in the management of ankle inversion sprain.[19] Taken together, previous research indicates an emerging evidence base with some potential clinical benefits for manipulative therapy of the ankle complex. Nonetheless, there is still a general a lack of studies examining clinical change in functional performance by such treatment for different populations.

The main objective of this pilot study was to evaluate the feasibility of a study that would explore the effect of chiropractic HVLA manipulation on vertical jump height in young female athletes with talocrural joint dysfunction. Specific objectives included quantifying change in vertical jump height from baseline and follow-up after 3 weeks by randomized group assignment to either active or sham HVLA manipulation, to estimate the appropriate sample size for a full-scale clinical trial based on the pilot trial data, to assess the feasibility of sham treatment and blinding, and to identify potential adverse events relating to the assigned intervention treatments.

Methods

Study Design and Setting

The study design was an assessor-blind randomized clinical pilot trial. The study was conducted in the settings

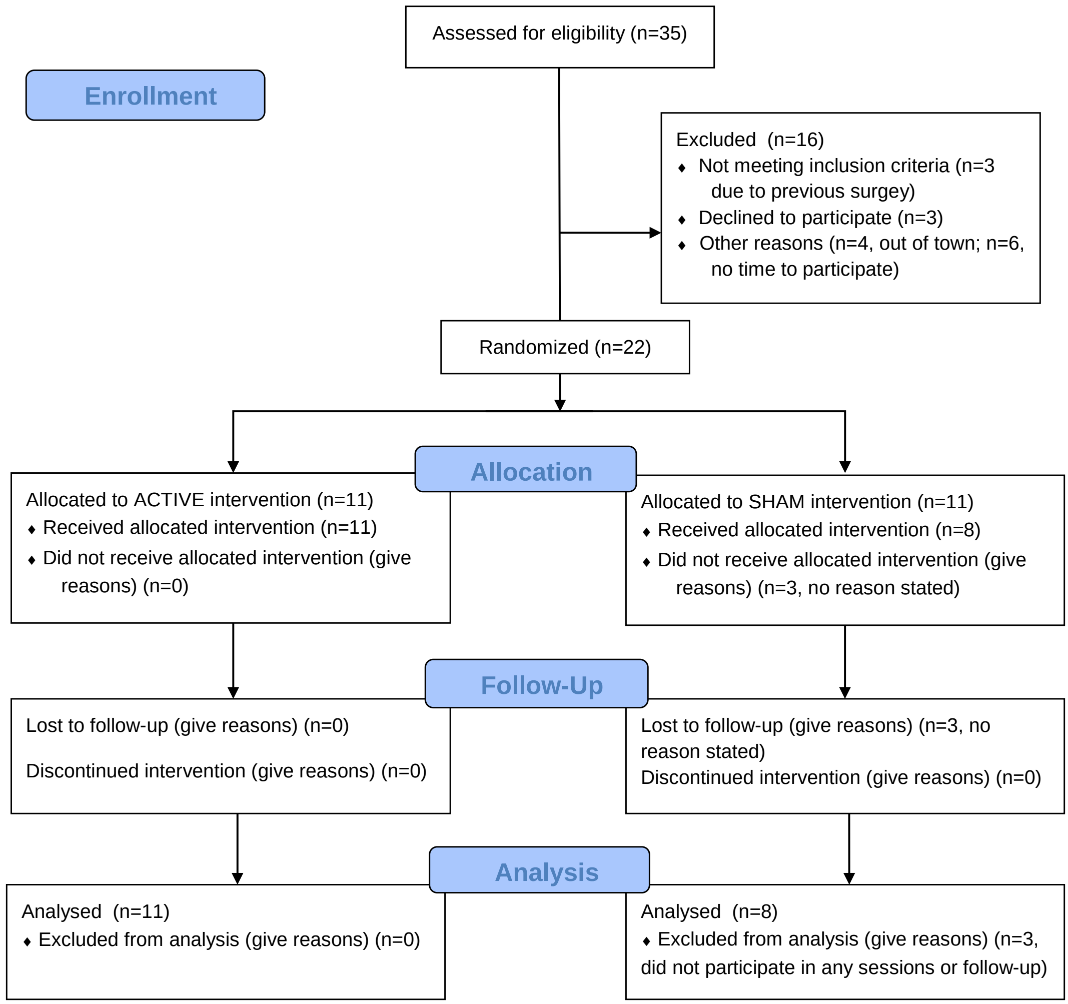

Fig 3. *CONSORT flow diagram. (Color version of figure is available online.)*

of a local handball club and a private chiropractic clinic in primary care in Stockholm, Sweden.

Participants

The study participants constituted of a convenience sample of female athletes recruited from an elite-level handball team. The participants provided oral and written informed consent before inclusion and physical screening procedures. Inclusion criteria were female sex, older than 16 years, elite handball player, and talocrural joint dysfunction. A state-registered chiropractor enrolled the participants by verifying the inclusion criteria and conducting a physical examination to assess the presence of specific talocrural joint dysfunction. The latter was defined by positive findings from manual pain provocation testing and decreased joint mobility by motion palpation of the talocrural joint. If a participant had bilateral ankle dysfunctions, the ankle with the most prominent dysfunction, according to the examining chiropractor, was chosen for subsequent study testing and treatment. Reasons for exclusion were current injury/trauma to the ankle joint, acute inflammatory symptoms such as pain or swelling, and previous surgery including fixation or fusion of the ankle joint.

Randomization

Eligible participants were randomized to 1 of 2 study arms, an active treatment arm receiving active HVLA manipulation (active treatment group) or a sham treatment arm receiving sham HVLA manipulation (sham treatment group). The randomization was conducted by using opaque sealed envelopes without blocking or stratification procedures.

Blinding

The study participants were informed that they would receive 1 of 2 different types of HVLA manipulation to the lower extremity during the trial but not whether it would be corrective or sham treatment. The investigator (S.H.) that coordinated the study and conducted the randomization and inclusion of participants was not blinded. The allocation was blinded to all investigators assessing the outcomes, which were conducted and evaluated separately from the intervention treatments.

Interventions

The study participants were seen once a week during a 3-week period. The participants who had been allocated to the active treatment group received a corrective HVLA manipulation to the talocrural joint dysfunction, that is, long-axis HVLA manipulation of the talocrural joint (Fig 1). The participants allocated to the sham treatment group received HVLA manipulation applied to the distal portion of the tibiae, that is, not affecting the talocrural joint (Fig 2). The first and third sessions included both vertical jump testing and treatment procedures. During the second session, participants received the allocated treatment, but no jump testing was performed. All treatments were provided by the same state-registered chiropractor.

Outcome Assessment, Testing, and Data Collection

The main outcome measure was change in single-leg vertical countermovement jump height in centimeters from baseline (before the first session, February 2010) to follow-up after 3 weeks (after the third session, March 2010). At each data collection session, the participants had to do a warm-up by 5-minute jogging immediately before the vertical jump testing procedure. The warm-up was followed by the conduction of 2 test jumps. After that, the data collection started and each participant performed 3 single-leg vertical countermovement jumps[20] on the leg with the dysfunctional talocrural joint. The athletes were instructed to keep their hands on the hips, squat down, and then jump up vertically as high as possible and then land in the same spot as takeoff to prevent displacement. The performance of single-leg countermovement jumps for assessing vertical jump height in female athletes has been reported with an estimated intraclass correlation coefficient of 0.91 (0.81-0.96).[21]

The vertical jumps were automatically sampled by an optoelectronic infrared system (IVAR IR-Matta; SH Sport & Fitness AB, Mora, Sweden). The infrared system consisted of 2 parallel bars positioned opposite each other on the floor. The athlete was positioned between the bars, and each time the infrared light between the bars was interrupted, that is, at the takeoff and landing, the system was triggered to record the flight time with a precision of 0.001 second. Once 3 jumps had been performed, the output was converted to a result in centimeters displayed as the average value from the sampled flight times.[22]

Poststudy, once all treatments and testing procedures had been finished, an assessor verbally asked the participants in the sham group whether they believed they had received active or passive, that is, sham, treatment. The potential occurrence of adverse events in relation to the intervention treatments was explored by examining the medical records used in the study.

Table 1. *Baseline characteristics of randomized participants*

Intervention arm	Active (n = 11)	Sham (n = 8)
Women (n)	11	8
Age (y), mean ± SD	22.0 ± 1.6	17.9 ± 0.5
Elite handball player (n)	11	8
Positive complaint of ankle pain (n)	11	8
Positive test for talocrural joint dysfunction with decreased joint mobility (n)	11	8
Vertical jump height (cm), mean ± SD	9.4 ± 1.6	10.6 ± 2.9

Statistical Analysis and Data Handling

The collected data were analyzed within and between groups at each measurement point and over time using standard descriptive statistics and paired- and unpaired-samples t tests corrected for unequal variances. P value calculations were 2 tailed, and the level of significance was set at 5%. The minimum sample size required to detect statistically significant between-group differences over time was calculated by using 80% power and the SDs derived from the clinical trial data. Statistical software included STATA 12 (StataCorp, College Station, TX).

All participant data were labeled with serial and patient identity number during the data collection and subsequently made anonymous before data analysis. All examinations, treatments, consent forms, and health claims were documented in a medical record. These were archived with full confidentiality. The list of participants was terminated at the end of the study.

Ethics and Funding

The study was approved by the institutional review board at the Scandinavian College of Chiropractic, which also funded the study, and by the Regional ethics committee in Stockholm. The study was registered at ClinicalTrials.-gov (NCT01121952).

Results

Twenty-two athletes were eligible to participate in the study; however, 3 participants dropped out with no reason stated. The analysis and results were based on the 19

Table 2. *Change in vertical jump height from baseline to follow-up by randomized groups*

Group	Baseline, mean ± SD	Follow-up after 3 wk, mean ± SD	Pre-post change, mean (95% CI); *P*
Active (n = 11)	9.43 ± 1.63	10.50 ± 2.31	1.07 (0.24 to 1.90); *P* = .017
Sham (n = 8)	10.60 ± 2.86	11.19 ± 2.94	0.59 (−1.11 to 2.29); *P* = .436

Abbreviation: *CI*, confidence interval.

participants who completed all testing and treatment procedures in the active treatment group (n = 11) and in the sham treatment group (n = 8). The flow of patients in the trial is shown in the CONSORT flow diagram (Fig 3). Baseline characteristics by randomized groups are detailed in Table 1.

After 3 weeks, the athletes who had received active HVLA manipulation had a statistically significant improvement in vertical jump height (Table 2). The athletes that had received sham HVLA treatment had an improved vertical jump height that was not statistically significant (Table 2). The between groups' change in vertical jump height over the 3-week period was 0.47 cm (95% confidence interval, −1.31 to 2.26; *P* = .571) in favor of the group receiving HVLA manipulation.

The sample size required to detect statistically significant differences between groups in a full-scale trial, using 80% power and the application of the clinical data from the trial, was estimated to 199 patients per arm.

The poststudy inquiry of participants in the sham group, about whether they perceived they had received active or passive, that is, sham, treatment, showed that 6 of 8 participants were not aware what treatment they had received.

The use of blinded assessors and procedures were feasible, and there were no reported adverse events after the active or sham interventions.

Discussion

The results from this pilot study indicate that a study evaluating HVLA manipulation is feasible. Preliminary results suggest that treatment may increase single-leg countermovement vertical jump height in young female athletes with talocrural joint dysfunction. The results of improved functional performance after manipulative therapy of dysfunctional ankle joints might be interesting from several perspectives. Previous research has pointed to a range of potentially beneficial areas for implementing manipulative therapy for ankle disorders. Such reported findings include improved biomechanics and ankle range of motion,[14–17] which may indeed support our current result having positive effects on functional performance in athletes involved in sports requiring adequate ankle joint function to accomplish certain movements, such as jump shots in handball. Indication that manipulative therapy may also increase lower extremity muscle activation,[18] although on short term after treatment, additionally supports our results and the value of implementing manipulative therapy to increase functional or rehabilitation performance. However, future studies are needed to evaluate and confirm the relevance of such effects over longer-term periods than the 3 weeks used in the present study. Nonetheless, even short-term effects may be important to acknowledge for chiropractors and other manipulative therapists working with athletes preparing for competitive events or similar preparations where short time frames are common. Reduced pain and tenderness after manipulative treatment of the ankle[11,16] are additional aspects that may contribute toward improved functional performance, as was seen in the current study.

The current pilot study used repeated treatment sessions over a period of 3 weeks. Previous research has similarly reported that multiple sessions of manipulative therapy for 4 weeks was superior to a single session for improving proprioception and ankle range of motion.[14] Thus, to gain most from treatments, it may be of importance to plan for multiple sessions when implementing chiropractic health services in the rehabilitation of athletes.

The pilot study results suggest that the use of blinded assessors and sham HVLA manipulation may be feasible to integrate in a future clinical trial. However, the larger variance observed in the sham group is an indication that future studies targeting this group of athletes may indeed need larger sample sizes to achieve balanced groups and facilitate the detection of statistically significant differences between groups. Additional research questions that can be valuable to address in future investigations may include the following: What is the minimal clinical important difference in vertical jump height obtained with active HVLA manipulation? What is the degree of change in vertical jump height obtained with HVLA manipulation for talocrural joint dysfunction compared with healthy athletes? What is the optimal frequency, duration, and treatment period of active HVLA manipulation to increase functional performance of athletes with talocrural joint dysfunction. Future research questions may also involve whether the integration of chiropractic and conventional care together has more impact on foot and ankle function and performance compared with either intervention alone.

Limitations

This clinical pilot trial had several limitations that need to be considered in future studies before any firm conclusions can be made. The current testing procedure involved the use of the IVAR optoelectronic test system, which is a system for measuring vertical jump height based on infrared measurements of flight time with an accuracy of

0.001 second. To our knowledge, the IVAR system used has not been validated against criterion standard measures such as force plates or 3-dimensional analysis systems, although it is commonly used in Swedish elite sports testing and medical rehabilitation settings,[23] and despite that it has previously been used in research targeting clinical rehabilitation of lower limb pain in Swedish competitive and recreational athletes.[24] Nonetheless, the use of validated optoelectronic test systems building on the same technical principles as the IVAR system, with the same target precision of 0.001 second, has been recommended in place of using mechanical contact mats for estimating vertical jump height from flight time.[25] In addition, some of the advantages of using optoelectronic test systems such as IVAR to assess vertical jump height in athletes are that it is easily applicable in field settings and commercially available to clinical professions such as chiropractors, physical therapists, and sports and conditioning coaches working with athletes. This should be compared with more advanced and expensive analysis systems such as force plates and video analysis systems that are almost exclusively found in biomechanics laboratories, universities, or hospitals.

The reliability of the vertical jump height measurements from the 3 jumps was not addressed in this pilot study. However, previous research targeting single-leg countermovement jumps for vertical jump height assessment in female athletes, similarly assessed with a contact mat, has reported an intraclass correlation coefficient of 0.91.[21] Future investigations are recommended to ensure the use of validated technical equipment and provide estimates of reliability for the testing procedures used, to make the assessment of study outcomes as accurate as possible.

The treatment arm that received active HVLA manipulation increased their vertical jump height more than the arm receiving sham treatment. Nonetheless, both study groups increased their average vertical jump height, which may question the potential superiority of implementing active HVLA manipulation alone compared with, for example, a pragmatic approach using additional manipulative therapy techniques to manage talocrural joint dysfunction. The latter approach would likely be more in resemblance to clinical management patterns found in real-world chiropractic practice. A potential challenge with implementing a pragmatic approach in a clinical trial could be that the control or sham procedures would appear more obvious to the participants. The observed improvements in vertical jump height may also have been due to the process of learning, whereby the jump height increased as the jumping technique improved, or due to the fact that the participants simply felt eager to perform. Increasing prestudy testing procedures or providing defined training and activity protocols for participants before and during study participation may help standardize some aspects that may influence participants vertical jump performance over time.

The current study did not include a control arm with healthy participants. This may limit the possibilities to interpret the clinical impact and relevance of HVLA manipulation in the management of talocrural joint dysfunction for increasing vertical jump height. For example, it may be of interest to quantify how much the improved vertical jump height obtained with HVLA manipulation relates to the vertical jump heights of athletes without talocrural joint dysfunction. We are not aware of any previous studies that have specifically targeted single-leg vertical jump comparisons between handball players with and without talocrural joint dysfunction, nor determined the minimal meaningful difference for jump height performance. However, there are some reference data in the literature regarding single-leg vertical jump height involving healthy female athletes,[21] which has been estimated to be 16.9 (2.9) cm. Consequently, based on at least some research-based data, the single-leg vertical jump height obtained with active HVLA manipulation in our current study seems to be markedly lower (about 10.5 cm vs 16.9 cm). This difference may be due to multiple factors including different study populations, different equipment used, and, last but not the least, the previously mentioned talocrural joint dysfunction in our participants. Future studies may want to confirm both clinically and statistically significant differences between active, sham, and healthy control groups before any specific treatment recommendations can be made.

Lastly, although active HVLA manipulation may increase the vertical jump height in female athletes with talocrural joint dysfunction, the transferability of such improvement into increased performance in clinical sports and competitive settings are is still to be investigated. Clinical long-term benefits and cost-effectiveness of HVLA manipulation compared with other forms of passive and active treatments or even self-administered procedures to increase functional performance are also still to be explored.

Conclusion

The results of this pilot study show that a larger-scale study is feasible. Preliminary results suggest that chiropractic HVLA manipulation may increase vertical jump height in young female athletes with talocrural joint dysfunction. However, the clinical result in favor of HVLA manipulation compared with sham treatment needs statistical confirmation in a larger randomized clinical trial. Blinded outcome assessment and the use of sham treatment appear feasible.

Future trials should ensure the use of validated technical equipment and reliability-assessed testing procedures. The inclusion of healthy control participants may be warranted in future studies to further appreciate the clinical impact and the relevance of managing athletes with talocrural joint dysfunction with HVLA manipulation.

Practical Applications

- Blinded outcome assessment and the use of sham treatment appear feasible.
- A larger trial is needed to confirm statistical significance.
- Future trials should ensure the use of validated technical equipment and reliability-assessed testing procedures.
- The inclusion of healthy control participants may be warranted to additionally appreciate the clinical impact and relevance of managing athletes with talocrural joint dysfunction with HVLA manipulation.
- Pilot results suggest that active talocrural joint manipulation was more effective than sham manipulation to increase vertical jump height performance.

Funding Sources and Potential Conflicts of Interest

The study was funded by the Scandinavian College of Chiropractic. No conflicts of interest were reported for this study.

Contributorship Information

Concept development (provided idea for the research): SH, HN, ML, TS.

Design (planned the methods to generate the results): SH, HN, ML, TS.

Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): SH, HN, ML, TS.

Data collection/processing (responsible for experiments, patient management, organization, or reporting data): SH, HN, ML, TS.

Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results): SH, HN, ML, TS.

Literature search (performed the literature search): SH, HN, ML, TS.

Writing (responsible for writing a substantive part of the manuscript): SH, HN, ML, TS.

Critical review (revised manuscript for intellectual content, this does not relate to spelling and grammar checking): SH, HN, ML, TS.

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