ORIGINAL ARTICLE

Rehabilitation protocol with VISS (Vibration Sound System) following ankle sprain

Caudia Barbato ✉ . *Department of Biomolecular Sciences. University of Study of Urbino Carlo Bo. Urbino, Italy.*
Roberto Coppola. *Kore University. Enna, Italy.*
Danilo Bruni. *Department of Medicine and Aging Sciences. University of Study G. d'Annunzio. Chieti/Pescara, Italy.*
Rachele Stradaioli. *Department of Biomolecular Sciences. University of Study of Urbino Carlo Bo. Urbino, Italy.*
Marco Gervasi. *Department of Biomolecular Sciences. University of Study of Urbino Carlo Bo. Urbino, Italy.*
Rosa Grazia Bellomo. *Department of Biomolecular Sciences. University of Study of Urbino Carlo Bo. Urbino, Italy.*

ABSTRACT

Introduction: Ankle sprain is one of the most frequent injuries in physically active people and the most common among lower extremity injuries. Although about 50% of these injuries are minor and resolve within a week, between 32% and 74% of subjects develop persistent symptoms such as pain, swelling, a feeling of sagging and reduced function, and recurrent sprains within 12 months of the first event. This set of symptoms is referred to as chronic ankle instability. Materials and Methods: This study included 30 subjects aged between 20 and 35 years. The subjects were initially divided into two groups: the experimental group followed a 4-week protocol with VISS, while the control group completed a 4-week protocol of proprioceptive and balance exercises. Results: The research protocol demonstrated that the 6-week VISS protocol is effective in improving the pathological condition of Chronic Ankle Instability (CAI), resulting in enhanced muscle tone, reduced pain, and a decreased perception of instability. Conclusions: Although limited by the sample size, the results of this study provide a starting point for future research.
Keywords: Sport medicine, Athletes, Rehabilitation, Extremity injury.

Cite this article as:
Barbato, C., Coppola, R., Bruni, D., Stradaioli, R., Gervasi, M., & Bellomo, R. G. (2025). Rehabilitation protocol with VISS (Vibration Sound System) following ankle sprain. *Journal of Human Sport and Exercise, 20*(2), 479-490. https://doi.org/10.55860/6pth6f95

✉ **Corresponding author.** *Department of Biomolecular Sciences. University of Study of Urbino Carlo Bo. Urbino, Italy.*
E-mail: c.barbato2@campus.uniurb.it
Submitted for publication November 13, 2024.
Accepted for publication December 20, 2024.
Published February 10, 2025.
Journal of Human Sport and Exercise. ISSN 1988-5202.

doi: https://doi.org/10.55860/6pth6f95

INTRODUCTION

The incidence of ankle sprains is notably high (Doherty et al., 2013). In the United Kingdom, ankle sprains account for approximately 3% to 5% of all emergency department visits, translating to around 5,600 ankle sprain cases per day (Cooke et al., 2003 in Doherty et al., 2013).

From an economic perspective, ankle sprains result in significant costs, as roughly one-quarter of individuals who experience a sprain are unable to attend work or school for at least 7 days following the initial injury (RA de Bie et al., 1997 in Doherty et al., 2013).

A 2016 survey involving a sample of 225,000 individuals who presented to emergency departments for ankle sprains highlighted variations in incidence across age groups (Martin et al., 2021). Among those surveyed, 27% were under 18 years old, 40% were aged 18 to 35, 18% were between 36 and 49, and the remaining 15% were over 49 years of age (Martin et al., 2021).

Ankle injuries are highly prevalent in sports. Research found that between 2002 and 2006, approximately 3,140,132 ankle sprains occurred in the United States, with the highest incidence observed in individuals aged 15 to 19 years (Waterman et al., 2010). Among those aged 15 to 24, there was no significant difference in incidence between males and females, though a higher prevalence was found in females over age 30 (Waterman et al., 2010). About half of the ankle sprains in this population occurred during sports activities, such as basketball, soccer, and athletics (Waterman et al., 2010).

Furthermore, as many as 70% of individuals who have experienced an initial ankle sprain may suffer from a subsequent sprain or continue to experience symptoms such as weakness, a sense of instability, and pain. This condition is referred to as chronic ankle instability (CAI) (Sefton J.M., et al., 2011). While ankle sprains are common across the general population, their frequency increases significantly among physically active or sports-engaged individuals. In fact, ankle sprains are the second most frequent injury in athletes, and recurrent sprains often have a history of prior sprains (McKeon P.O., Hertel J., 2008).

Approximately 70% of individuals who sustain an initial ankle sprain are at risk of developing CAI within a short period (Herzog et al., 2019). Recent studies indicate that between 15% and 64% of individuals with an initial ankle sprain continue to experience unresolved symptoms three years post-injury (Jull et al., 2015). This systematic review further noted that roughly 8% of patients in the general population report long-term issues persisting up to ten years (Jull et al., 2015).

In 2016, the International Ankle Consortium released a consensus statement and evidence review addressing the prevalence, impact, and long-term consequences of lateral ankle sprains (Gribble PA., et al., 2016). These publications provide an evidence base regarding lateral ankle sprains, CAI, and the associated direct and indirect costs, setting specific objectives for future research.

CAI affects not only the ankle but can also systematically impair other joints, leading to additional physical complications (Hertel J., et al., 2019). In individuals with CAI, the ankle structure exhibits reduced range of motion, secondary tissue damage, restricted osteokinematics, and post-traumatic osteoarthritis (Hertel J., et al., 2019). CAI adversely impacts proprioception, balance, movement patterns, and results in muscular weakness and bilateral reflex impairment (Hertel J., et al., 2019). Additionally, it can predispose individuals to further injuries, such as recurrent ankle sprains, early onset osteoarthritis, and increased stress on the anterior cruciate ligament (Gribble PA., et al., 2016).

Due to the numerous adverse outcomes associated with CAI, implementing a preventive strategy is essential, with epidemiological data playing a critical role (Bahr R., Krosshaug T., 2005). In a meta-analysis, Doherty C., et al. (2014) reported an incidence rate of 0.93 per 1,000 athlete exposures (AE, where 1 AE is defined as 1 athlete participating in 1 competition or training session). By comparison, the incidence rates for acute medial and high/syndesmotic ankle sprains were lower, at approximately 0.06 and 0.38 per 1,000 AE, respectively (Doherty C., et al., 2014).

Indeed, more than three-quarters of all acute ankle sprains are lateral ankle sprains, with roughly 73% affecting the anterior talofibular ligament (Fong DT., et al., 2007). Of the remaining acute ankle sprains, 25% are medial (involving the deltoid ligament) or high/syndesmotic (affecting the anterior-inferior or posterior-inferior tibiofibular ligaments).

MATERIALS AND METHODS

The research group consisted of 30 subjects aged between 20 and 35 years. Subjects were selected based on the following inclusion criteria:

- Aged between 22 and 30 years;
- Diagnosed with a grade 1 or 2 ankle sprain.

Exclusion criteria included:

- Subjects with multiple injuries;
- Subjects with other conditions limiting mobility;
- Subjects with ankle injuries requiring immobilization;
- Subjects unable to follow the rehabilitation protocol.

Participants were initially divided into two groups: the experimental group followed a 4-week protocol with VISS (Vibration Intervention System for Strength), while the control group followed a 4-week protocol of proprioceptive and balance exercises.

After selection, subjects underwent two physical tests (the talar tilt test and the anterior drawer test) and completed two questionnaires, the SF-36 and Cumberland questionnaires, along with the VAS scale. Following the preliminary assessment, the subjects, grouped into two cohorts, began the respective protocols.

The experimental group underwent a 6-week VISS protocol with two sessions per week. During these sessions, the 15 subjects received VISS treatment. VISS is designed to enhance physical strength, increase muscular endurance, and improve coordination through a high-tech system based on the mechanical and sonic action of vibrations. When applied to localized muscle regions, it optimizes muscle tone, increases resistance to muscular load, and improves coordination.

The first six sessions, each lasting approximately 30 minutes, included:

- The first 10 minutes at 300 Hz to enhance muscle strength;
- The next 10 minutes at 200 Hz to normalize muscle tone;
- The final 10 minutes at 120 Hz to relax, relieve fatigue, and target trigger points.

The final six sessions were 30 minutes each at 300 Hz. For optimal transmission of vibration to the skin, pen-shaped transducers were used to better adhere to smaller areas and target trigger points. This transmission

was safe and controlled, allowing the therapist to adjust the intensity and frequency of vibrations according to each patient's needs.

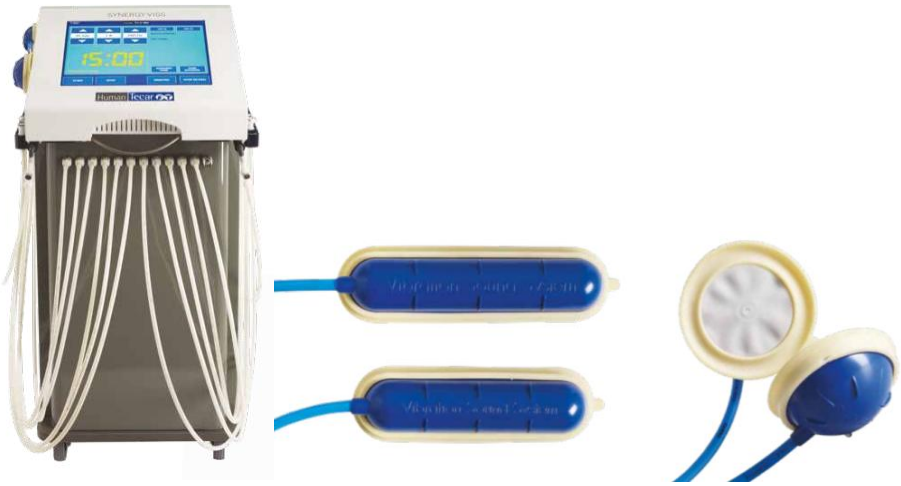

Figure 1. Vibration sound system and transducers.

The control group followed a 6-week protocol, with two sessions per week, where the 15 participants engaged in physical activity sessions that included exercises for stretching, proprioception, balance, and muscle strengthening.

The goal of the protocol was to achieve the full range of motion for the joint and to restore specific pain-free movement, along with coordination recovery and complete body awareness.

Each session lasted approximately 50 minutes, consisting of a 10-minute warm-up, a 30-minute main segment, and a 10-minute cooldown.

During the warm-up, exercises such as walking, high-knee walking, and walking on toes and heels were performed.

The main phase included exercises such as plantar and dorsal flexion, and internal and external rotation using resistance bands.

Perform ground-based heel raises, initially with bilateral support, then progressing to single-leg support, and finally using a Bosu ball to increase the exercise difficulty. Complete 15 repetitions per exercise, for 3 sets.

Proprioceptive exercises in a non-weight-bearing position, using a proprioceptive balance board. The subject is seated and instructed to perform ankle flexion-extension, inversion, and eversion movements.

Balance training on BOSU or balance board

Initially, balance exercises are performed in a bipodal (two-legged) stance, progressing to a unipodal (single-legged) stance. Each stance is maintained for 20 seconds, with 4 sets in total.

Proprioceptive load-bearing exercises

Using a proprioceptive balance board, single-leg balance exercises are performed with the ankle moving through plantar flexion and dorsiflexion, as well as abduction and adduction.

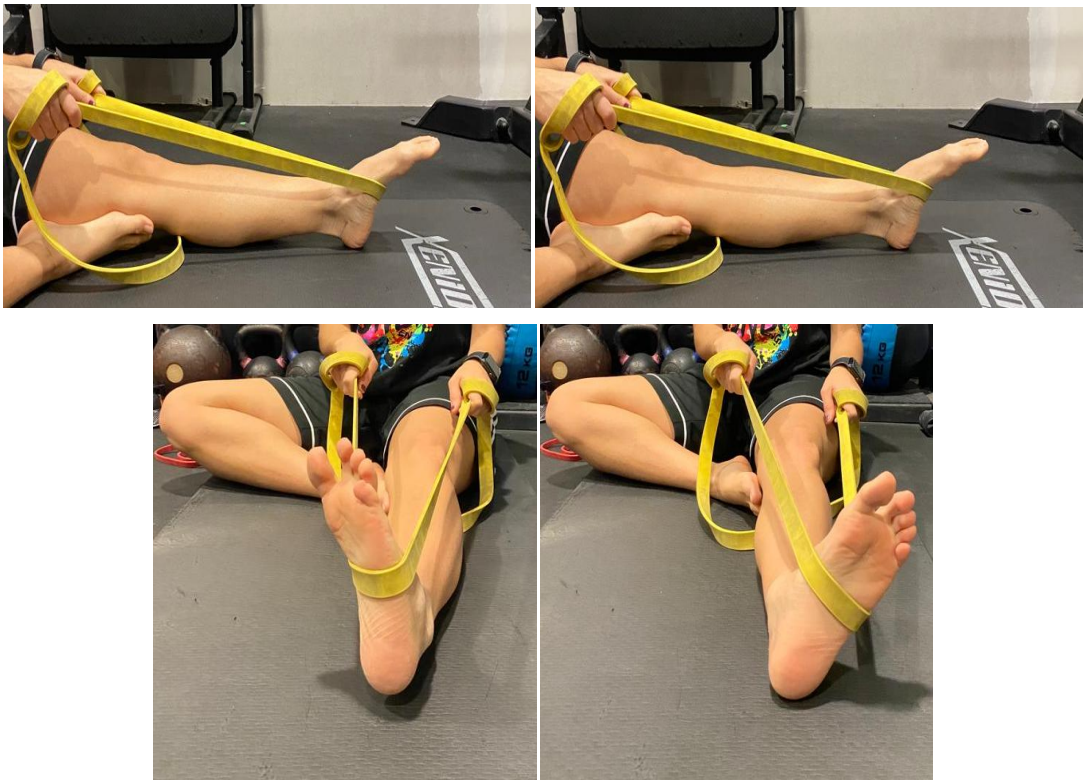

Figure 2. 12 repetitions per exercise, for 3 sets.

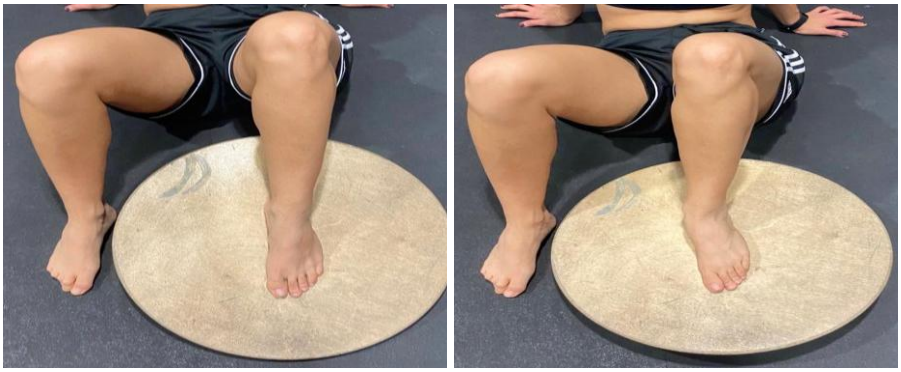

Figure 3. 12 repetitions per exercise, for 3 sets, balance training.

RESULTS

The symmetry and kurtosis analysis tests, along with the Kolmogorov-Smirnov normality test, confirm the normal distribution of the data ($p < .0001$). Therefore, parametric tests are employed to investigate differences between groups as well as the effectiveness of the experimental protocol and motor protocol.

The analysed variables pertain to three measurements:

1. Drawer Test (1 item)
2. Talar Tilt Test (3 items)
    a. Inversion
    b. Neutral
    c. Eversion
3. SF36 Questionnaire (36 items – 8 variables)
    a. Physical functioning
    b. Physical health limitations
    c. Emotional health limitations
    d. Energy and fatigue
    e. Emotional well-being
    f. Social functioning
    g. Pain
    h. General health perception

Table 1 presents the mean, standard deviation, and standard error for all variables, segmented by group (experimental VISS and control) and time (pre- and post-treatment).

Table 1. Descriptive statistics - mean, standard deviation, and standard error of distinct variables, categorized by group (experimental and control) and time (pre- and post-treatment).

		Control Group			Experimental Group (Viss)		
Variable	**Time**	**Mean**	**Std. Deviation**	**Std. Error Mean**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Drawer test	Pre	0.000	0.000	0.000	0.000	0.000	0.000
	Post	0.07	0.067	0.258	1.00	0.000	0.000
Inversion	Pre	0.000	0.000	0.000	0.000	0.000	0.000
	Post	0.000	0.000	0.000	1.00	0.000	0.000
Normal	Pre	0.000	0.000	0.000	0.07	0.07	0.258
	Post	0.13	0.091	0.352	1.00	0.000	0.000
Eversion	Pre	0.000	0.000	0.000	0.000	0.000	0.000
	Post	0.07	0.067	0.258	1.00	0.000	0.000
SF36_ Physical functioning	Pre	10.00	5.35	20.70	3.33	3.33	12.91
	Post	16.67	6.29	24.39	99.67	0.33	1.29
SF36_ Physical health limitation	Pre	0.000	0.000	0.000	0.000	0.000	0.000
	Post	0.000	0.000	0.000	99.17	0.83	3.23
SF36_ limitations emotional problems	Pre	0.000	0.000	0.000	0.000	0.000	0.000
	Post	0.000	0.000	0.000	100.00	0.00	0.00
SF36_ Energy Fatigue	Pre	9.67	2.46	9.54	4.67	1.91	7.43
	Post	6.67	2.52	9.76	97.50	1.34	5.18
SF36_ Emotional well-being	Pre	5.87	2.27	8.79	11.47	2.56	9.89
	Post	5.33	2.36	9.15	100.00	0.00	0.00
SF36_ Social functioning	Pre	6.67	2.95	11.44	13.33	3.10	12.01
	Post	13.33	3.33	12.91	98.33	1.67	6.46
SF36_Pain	Pre	7.50	2.83	10.98	13.50	2.95	11.41
	Post	7.50	2.83	10.98	100.00	0.00	0.00
SF36_ General health	Pre	12.67	2.84	10.99	5.67	2.43	9.42
	Post	7.67	2.83	10.99	99.33	0.67	2.58

First, the differences between the two groups were examined both before and after the treatment, and the results are presented in Table 2.

Table 2. t- t-test; differences between the two groups (Control group and Viss group) before treatment (pre-treatment) and after treatment (post-treatment).

	Pre		Post	
Variable	**t**	**sig.**	**t**	**sig.**
Drawer test	-	-	-14.00	<.001
Inversion	-	-	-	-
Normal	-1.00	>.05	-9.54	<.001
Eversion	-	-	-14.00	<.001
SF36_ Physical functioning	1.059	>.05	-13.16	<.001
SF36_ Physical health limitation	-	-	-119.00	<.001
SF36_ Limitations emotional problems	-	-	-	-
SF36_ Energy Fatigue	1.60	>.05	-31.85	<.001
SF36_ Emotional well-being	-1.64	>.05	-40.05	<.001
SF36_ Social functioning	-1.56	>.05	-22.81	<.001
SF36_Pain	-1.47	>.05	-32.63	<.001
SF36_ General health	1.87	>.05	-31.43	<.001

Note. The variables with no values showed the same results between pre and post, making it impossible to calculate the t-value.

It can be observed that initially the two groups did not show statistically significant differences for all the variables considered. However, after the treatment, statistically significant differences were found for almost all the variables. Since no differences were observed for all the variables, a t-test was performed by dividing the sample into groups to assess the effectiveness of the treatment with Viss (control and Viss).

Table 3. Independent samples t-test. Effects of therapy using Viss on the sample (difference between pre- and post-treatment).

	Control Group		Viss Group	
Variable	**t**	**sig.**	**t**	**sig.**
Drawer test	-1.00	>.05	-	-
Inversion	-	-	-	-
Normal	-1.47	>.05	-14.00	<.001
Eversion	-1.00	>.05	-	-
SF36_ Physical functioning	-0.807	>.05	-28.76	<.001
SF36_ Physical health limitation	-	-	-119.00	<.001
SF36_ Limitations emotional problems	-	-	-	-
SF36_ Energy Fatigue	0.852	>.05	-39.69	<.001
SF36_ Emotional well-being	1.00	>.05	-34.64	<.001
SF36_ Social functioning	0.067	>.05	-24.14	<.001
SF36_Pain	1.00	>.05	-29.36	<.001
SF36_ General health	0.35	>.05	-37.13	<.001

This table highlights the findings presented in the previous one, as the experimental group shows significant results, indicating an improvement in nearly all the analysed variables.

CONCLUSIONS

The objective of this study is to analyse the effectiveness of the VISS protocol in the treatment of chronic ankle instability (CAI). Specifically, pain, the perception of instability, strength, and muscle tone were evaluated. The research protocol revealed that the 6-week VISS protocol is effective in improving the pathological condition of CAI, leading to enhanced muscle tone, reduced pain, and a lower perception of

instability. Although the results of this study are limited by the sample size, they provide a starting point for future research, where the sample size could be expanded and a third group could be included, incorporating a multidisciplinary approach with other specialists (for instance, to address aspects related to the "*Emotional Issues*" variable).

AUTHOR CONTRIBUTIONS

All authors contributed to the study conception and design. All authors read and approved the final manuscript.

SUPPORTING AGENCIES

No funding agencies were reported by the authors.

DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

ETHICS APPROVAL

This study was performed in line with the principles of the Declaration of Helsinki. Written informed consent was obtained from the parents.

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