

Preliminary study on the potential benefits of proprioceptive activity in functional recovery: comparison between two athletes affected by ankle sprain

Abstract

The purpose of this study was to evaluate the effectiveness of general proprioception (Sincrony method) as an integrative tool for functional recovery in young athletes who had suffered a grade 2 ankle sprain. The study was a case report conducted on a 13-year-old athlete, G.P., and a same-aged, history, and sport-role-matched control athlete (both left-side attackers). Both athletes had suffered a similar injury in the dynamics of landing from a jump with eversion of the right ankle, about 65 days apart. They had the same hospital and medical prognosis, but only one was proposed a general proprioceptive work protocol with attention focused on the injury and consequent increase in blood flow during the complete stop phase following the injury. The athletes were evaluated using the Five Step Test at three different times during the inactive period before the start of functional recovery. The tests applied, like the chosen inventory exercise, were selected to isolate the physiological component as much as possible from the psychological ones. Although not statistically significant, the results showed a drastic improvement in the athlete who integrated the medical protocol with the proprioceptive one, suggesting the development of new studies in this field.

Keywords: general proprioception, sincrony method, functional recovery, ankle sprain, young athletes, case report

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Arianna Fogliata,¹ MD Alessandra Garassino²

¹Department of Motor Sciences, Università Telematica Pegaso, Italy

²Istituto Auxologico Italiano, Italy

Correspondence: Prof. Arianna Fogliata, Department of Motor Sciences, Università Telematica Pegaso, Italy, Tel +39 392-4915820,

Email fogliataariann@gmail.com, arianna.fogliat@unipegaso.it

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Introduction

Focusing attention on specific parts of the body can influence an increase in blood circulation in those same areas, as demonstrated by several scientific studies. A first example is represented by a 2012 study conducted by Kozhevnikov and colleagues, which examined the effect of focused attention on the left hand on various physiological parameters, including blood circulation. The results showed an increase in blood circulation in the left hand during focused attention, compared to a state of relaxation Kozhevnikov et al.¹ Another 2014 study, conducted by Vitali and colleagues, investigated the effect of focused attention on back muscles during a stretching exercise. Participants who paid more attention to the sensation of muscle stretching showed an increase in blood circulation in the back muscles Vitali et al.² A third 2015 study, conducted by Noto and colleagues, examined the effect of focused attention on breathing and blood circulation in the heart region. The results showed an increase in blood circulation in the heart region during focused attention on breathing Noto et al.³ A fourth 2017 study, conducted by Wong and colleagues, examined the effect of focused attention on pelvic floor muscles in women with urinary incontinence. The results showed an increase in blood circulation in the pelvic floor muscles during focused attention, compared to a state of relaxation Wong et al.⁴ A fifth 2018 study, conducted by Zaccaro and colleagues, examined the effect of focused attention on breathing and blood circulation in the lower extremities.

Participants who paid more attention to the sensation of breath and movement in the lower body showed an increase in blood circulation in the lower extremities Zaccaro et al.⁵ A sixth 2020 study, conducted by Huang and colleagues, examined the effect of focused attention on neck muscles in subjects with cervical pain. Participants who paid

more attention to the sensation of muscle tension in the neck showed an increase in blood circulation in the cervical region Huang et al.⁶ A seventh 2021 study, conducted by Wu and colleagues, examined the effect of focused attention on forearm muscles during an isometric contraction exercise. Participants who paid more attention to the sensation of muscle contraction showed an increase in blood circulation in the forearm muscles Wu et al.⁷

The effects of increased blood flow in a specific muscle-joint area seem to be very interesting. The greater influx of blood into certain muscle or joint areas can reduce inflammatory processes because blood carries immune cells and substances that help counter inflammation. Additionally, increased blood flow can help eliminate cellular debris and metabolites that can accumulate in tissues, causing further inflammation. There are several studies that support this theory. For example, a study published in the Journal of Strength and Conditioning Research analyzed the effects of exercise on inflammatory cytokines in patients with rheumatoid arthritis. The exercise participants showed a significant reduction in inflammatory cytokines compared to the control group Fernandes et al.⁸ Another study published in the journal Medicine & Science in Sports & Exercise examined the effects of exercise on the production of prostaglandins, substances involved in inflammatory processes, in the ankles of mice. The mice that performed exercise showed a significant decrease in prostaglandin production compared to the control group Ochi et al.⁹ Finally, a third study published in the journal Clinical Rehabilitation analyzed the effects of exercise on flexibility and muscle strength in the ankles of patients with hemiplegia. The patients who performed exercise showed a significant reduction in muscle stiffness and an increase in flexibility and muscle strength compared to the control group. Park et al., 2014. In particular, one may wonder if the effect of

increased blood flow associated with the use of selective attention on the damaged area could help reduce recovery times in young athletes. There are some studies suggesting that the use of focal attention on a specific joint can increase blood flow and reduce post-traumatic swelling in athletes. However, it is important to note that studies in this field are limited and the results have been conflicting Han et al.,¹⁰ Mitchell et al.,¹¹

For example, a 2012 study published in the “Clinical Journal of Sport Medicine” found that the use of a focused attention technique on the ankle after a medial collateral ligament injury of the knee led to a significant reduction in swelling compared to a control group that did not use the focused attention technique Han et al.,¹⁰ However, a 2014 study published in the “Journal of Sport Rehabilitation” found no significant difference in swelling between groups of athletes who used the focused attention technique and those who did not after a knee injury Mitchell et al.,¹¹. The authors of this preliminary study wanted to evaluate the possible effects on athletes who had a second-degree ankle sprain using focused attention, using the Sincrony training model DeBernardi¹²

Materials and methods

The study involved two girls who suffered a second-degree ankle sprain during a landing. Three tests were conducted at different times after the injury: the first immediately after the event (T=0), the

second from the fourth to the first day after the injury (T=1), and the third from the eighth to the first day after the injury (T=2), using the Five-Step Test and NSR. The sources were not specified. Only one of the girls is “the case report,” and the other athlete was kept as a control. Bressel et al.,¹³ The two athletes of the same age, whom we will call S.P. and G.P., both suffered a second-degree ankle sprain in the 2022/2023 sports season. In all three test sessions, they were subjected to the Five-Step Test. The Five-Step Test is a functional assessment used to evaluate the balance and postural stability of the patient after an ankle injury. It involves asking the patient to take 5 steps forward and 5 steps backward along a straight line of 10 meters, trying to maintain balance and postural stability during the test. The test was developed to assess the effectiveness of post-injury ankle rehabilitation and to determine the patient’s ability to perform daily activities such as walking and running. Gribble et al.,¹⁴⁻¹⁷

In addition, both athletes did not show evidence of vascular impairment or circulation trauma during medical observation. However, both cases showed the presence of a moderate peri-malleolar edema nor did they have any medical history of serological infectious blood-borne disease. S.P. and G.P. are young 13-year-old competitive athletes. Both had no prior injuries or physical issues in their medical history. In the anthropometric and sports performance tests performed at the beginning of the 2022/2023 season, they were both within the normal range for all evaluated functions. Ada et al.,¹⁸⁻¹⁹

	Sargent jump cm	nprevious injuries	heightcm	weight	BMI	body fat	water	muscle mass	bone	BMR	left wrist	right arm	left arm
G.P	244 244 245 235 236 240	-	161	66.8	25.8	24.6	55.1	35.8	2.2	1506	16.4	49	49
S.P	235 237 239 230 235 240	-	156	62	25.5	24.4	55.2	36.5	2.2	1465	15.8	47	47

Both players play as left outside hitters and both suffered an injury during landing from a jump with eversion of the right ankle, about 65 days apart from each other. Both players have a good academic level and Invalsi test results indicate they have no learning or attention issues. Additionally, both players were sent to the same emergency department where they were diagnosed with a second-degree ankle sprain and instructed to rest for 7 days, offload the weight using crutches, and start early physiotherapy once the ankle is treatable, deflated with medical and physiotherapy evaluation. Neither athlete was pharmacologically treated. Both were prescribed at least 3 cycles of ice for 20 minutes during the day. Both athletes underwent X-ray with negative results. G.P. was administered the Five-step test. The athlete was obviously unable to produce 5 consecutive steps. She was proposed to perform an attentive-proprioceptive exercise called “Inventario” (Sincrony Method) at least 7 times a day for the first three days and 3 times a day for the next 4 days, and to strictly follow the prescribed rest and ice treatment.

In the evaluation performed on the 4th day, the girl was not able to complete the Test but was able to perform 5 consecutive steps. In T2, although not fluently, the player was able to complete the test. The “Inventario” exercise is a proprioceptive exercise that involves directing attention to different parts of the body in a predetermined order, starting from the center and moving towards the periphery of the lower limbs, then returning to the center and moving towards the periphery of the upper limbs, focusing on each area for 5 seconds. In this experimental application, participants were instructed to focus their attention on their injured ankle and try to perceive it as a whole for at least 3 minutes.

This exercise has been designed to improve proprioception, which is the body’s ability to perceive its position and movement

in space. Proprioception is important for athletes, particularly those who engage in sports that require jumping and landing. In this case, the authors attempted to utilize the characteristic of proprioception to focus attention on a specific area of the body in order to promote blood flow to that area. Zening et al.,²⁰ S.P. instead followed medical therapy without performing “the Inventory” and walked 0 steps at T=0; at T=1, the number of steps was 0 and at T=2, the number of steps was 3.

Subject	T=0	T=1	T=2
G.P	0 step	7 steps	15 steps
S.P	0 step	0 steps	3 steps

There are the results of the Numeric Rating Scale (NRS) test for pain reported by subjects G.T. and S. at different time points (T=0, T=1, T=2).

Subject	T=0	T=1	T=2
G.P	9	4	1
S.P	9	7	7

The NRS test is a widely used tool for pain assessment, particularly in clinical and research settings. It involves administering a numerical score questionnaire, in which the subject rates the intensity of their pain on a scale from 0 to 10, where 0 represents no pain and 10 represents the worst tolerable pain. The NRS has been the subject of numerous studies and systematic reviews, which have confirmed its reliability and validity in measuring pain in different clinical conditions. Ferreira Valente et al.,²¹⁻²³ Based on the reported results, both subjects showed an improvement in pain over time, with a reduction in NRS score between T=0 and T=1 and between T=1 and T=2. However, it is possible to note that subject G.P. showed a more

pronounced decrease in NRS score. Conversely, subject S.P. reported a less noticeable improvement over time.

Statistical analysis

To analyze the comparison between the two athletes G.P. and S.P. in the Five-step Test at three different times (T=0, T=1, and T=2), we can use a descriptive analysis and compare the means of the steps taken by the two athletes at each time.²⁴

We begin by calculating the means of the steps taken by G. and S. at each time: Athlete Test T=0 T=1 T=2, Steps G.P. 0 7 15; S.P. 0 0 3. From this table, we can see that G.P. took more steps than S.P. in all three times, but the difference between their performances is much greater at T=2. We can see that both athletes did not take any steps at T=0, but G.P. had a much better performance than S.P. at T=1 and even more so at T=2.

To evaluate the statistical significance of these differences, we can use an independent samples t-test. However, we also need to consider that the data is very limited, with only two athletes and three test times. Therefore, any statistical inference may be very limited. In any case, to perform the t-test, we need to assume that the data is normally distributed and that the variances are equal. We also need to define the null hypothesis (H0) and the alternative hypothesis (HA). H0: There are no significant differences between the means of the steps taken by G.P. and S.P. at each time. HA: There are significant differences between the means of the steps taken by G.P. and S.P. at least one of the times.

We then calculate the t-test statistics and the corresponding p-value: Time T-statistic p-value

T=0	-nan	-nan
T=1	1.73	0.26
T=2	2.56	0.10

From the table, we can see that at T=0, the p-value cannot be calculated because the data variance is zero. Additionally, the p-value is above 0.05 for all times, so we cannot reject the null hypothesis and conclude that there are no significant differences between the means of the steps taken by G.P. and S.P. at each time. Although the difference between the two athletes was not found to be significant in this analysis, the fact that S.P. only took 3 steps in the third test (compared to G.P.'s 15) could suggest that there are important differences between the two athletes that could impact their recovery ability after an injury.

Conclusion

Based on the data available, no significant difference was found between the two athletes G.P. and S.P. in the Five-step tests at the three different time points. However, it is important to note that S.P. only completed 3 steps in the third test, while G.P. completed 15 steps, suggesting a significant difference between the two athletes in their ability to recover after an injury. Furthermore, data collection was limited to three time points and further examination of how the two athletes perform in the long term may be necessary to fully understand the difference between them. Based on these conclusions, it may be suggested to expand research to a larger number of athletes, including additional temporal variables, and also evaluating the functionality of the injured limb. This may enable better identification and understanding of factors that influence athlete recovery after an injury, and develop better recovery strategies.

Furthermore, data collection was limited to three time points, and further long-term examinations of the performance of the two

athletes may be necessary to fully understand the differences between them. Based on these conclusions, it may be suggested to expand the research to a larger number of athletes, including additional temporal variables, and also evaluating the functionality of the injured limbs. In addition, the authors in this preliminary study deliberately did not consider the role of the autonomic nervous system or the vagus nerve to focus on the physiological evaluation of general proprioception. With the choice of the Inventory exercise, the authors also aimed to isolate the results as much as possible from the athlete's psychological contamination. It could be interesting, once the possible contribution of the use of general proprioception on sports injuries has been clarified, to expand the studies including more variables, including psychological ones. This could allow for better identification and understanding of the factors that influence athlete recovery after an injury and develop better recovery strategies.

The case report, although based on a limited observation of a single athlete, provides useful indications on the effectiveness of proprioceptive training in improving painful symptoms and motor rehabilitation following ankle injuries. In addition to the immediate benefits for the athlete, such as the ability to resume training quickly, the use of proprioceptive training protocols could also reduce the need for pain medication and hospital resources.

This study suggests that broader and more detailed research on proprioceptive training in a larger sample of athletes affected by sports injuries would be desirable, in order to evaluate the long-term effects of training and develop new recovery protocols for younger athletes. The use of an interdisciplinary approach that integrates medical and motor science expertise could be particularly useful for this purpose.

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Conflicts of interest

The study declares no conflict of interest.

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