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Effects of Aircast brace and elastic bandage on physical performance of athletes after ankle injuries

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Objective: The aim of this study was to evaluate the effect of using Aircast® orthosis and elastic bandage application on the physical performance of athletes with ankle injuries.

Methods: The study included 60 elite male football players with ankle injuries. Ankle range of motion on the sagittal and frontal plane was measured. One maximum repetition test for the tibialis anterior, tibialis posterior and peroneal muscles; fingertip rise test, single- and double-feet vertical jump tests and 10-step/sec test for the gastrosoleus were performed. All tests were performed three times; without brace application, wrapped in elastic bandage and fitted with the Aircast® orthosis.

Results: There was no statistically significant difference between the test results of single-foot vertical jump, 10-step/sec and fingertip rise tests ($p>0.05$). Double-feet vertical jump test results with both exterior supports were better than the ankle without any support ($p<0.05$). Vertical jump test results were significantly higher with the Aircast® orthosis than elastic bandage ($p<0.05$). Inversion and eversion movements were restricted significantly more in the Aircast® orthosis than in the elastic bandage ($p<0.05$).

Conclusion: Although external supports restrict the foot-ankle range of motion in specific ratios, these restrictions did not adversely affect the athlete's physical fitness. The Aircast® orthosis was more effective than the elastic bandage in reducing injury risk, preventing repetitive injuries and providing an early return to sports.

Key words: Aircast brace; ankle; elastic bandage; ligament injury; physical performance.

The foot and ankle region is the most common injury area in sports injuries.[1-5] Research has shown that 25% of all sports injuries are ankle-foot injuries, of which external lateral ligament injuries constitute 85%. In foot and ankle injuries, ankle sprains account for 80% of all injuries; 77% are collateral ligament injuries and 73% isolated ruptures or anterior talofibular ligament tears. Problems accompanying injuries are pain in 30.2% of cases, instability in 20.4%, crepitus in 18.3%, muscle weakness in 16.5%, stiffness in 14.6%, and edema in 13.9%.[6-10]

In ligament injuries, the mechanical stability of the foot and ankle is decreased as a result of damages to peripheral tissues, such as the nerve, muscle and tendon.

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Decreased stability in turn increases the risk of repetitive injury. The risk of re-injury is especially increased within the first year of injury in athletes who previously suffered an ankle injury.[3,9,11] Approximately 50% of these repetitive injuries are the cause of chronic pain or instability and require long-term medical treatment. The increase in risk of repetitive injury of the ankle and foot continues even after the completion of treatment.[3]

Treatment of foot and ankle injuries varies according to the severity of the injury. Well-planned workouts increase the effectiveness of treatment as well as the application of various treatment programs. External supports, such as elastic bandage, taping and orthotics can be used to support the treatment and reduce the risk of re-injury, both during and after treatment. A good external support should not adversely affect the physical fitness of the athletes, while restricting the movement of the ankle and improving ankle stability.

The aim of our study was to evaluate the restrictions of Aircast® orthosis and elastic bandage application compared to an ankle without any application, assess its support to the ankle and physical performance, and to determine which external support was more effective.

The hypothesis of this study was that external supports improved the stability of an ankle which had previously suffered an injury.

Materials and methods

This study included 60 elite football players diagnosed with 2nd degree inversion sprain in the right ankle. Average age was 20.00±2.33 years, height 175.95±6.38 cm, and body weight 68.53±7.62 kg. Subjects played football for an average of 5.23±1.73 years. Time from between injury and evaluation was 10.43±3.70 months. All athletes received medical treatment after injury.

Patients who were right-dominant and diagnosed by a specialist with right ankle 2nd degree inversion sprain were included. Patients with history of acute injury, accompanying injuries with inversion or history of injury in both extremities were excluded from the study. Demographic information (age, gender, body weight, height, etc.) of the participants were recorded on the registration form.

Athletes were evaluated physically and functionally. One maximum repetition weight was determined for the tibialis posterior, tibialis anterior and peroneal longus and brevis muscles. The amount of weight the athlete could lift only once in dorsiflexion, inversion and eversion was determined and recorded in kg with the patient in the sitting position with the knees flexed at 90 degrees and stabilized.[12] To test the muscular strength and endurance of the gastro-soleus muscle complex, the number of fingertip rises in one minute with the knees in extension and flexion between 30 and 45 degrees was recorded. Results were recorded as "number of repetitions".[12]

Normal joint movement of the foot and ankle were evaluated with goniometric measurements. Dorsiflexion, plantarflexion, inversion and eversion motions of the ankle joint were measured for all cases. For dorsi- and plantarflexion, the pivot of the goniometer was placed on the lateral malleolus, the fixed arm placed parallel to the fibula and the swinging arm placed on the lateral of the 5th metatarsal, with the patient in the supine position. The position where the angle between the foot and fibula was 90 degrees was accepted as 0 degrees. Results were recorded in degrees with the ankle in dorsiflexion and plantarflexion. For eversion and inversion, with the patient in the sitting position, the pivot point was placed over the lateral of the foot at the metatarsal head level and the fixed arm of the goniometer was kept parallel to the lateral midpoint of the leg to achieve active movement. The results were recorded in degrees. The same procedure was followed for eversion in the medial of the foot.[13]

To evaluate physical performance, single-foot vertical jump, double-feet vertical jump and 10-step/sec tests were performed. BOSCO, an instrument with a recessive or capacitive platform connected via a cable to a digital part, was used for the double-feet and single-foot vertical jump tests.[14,15]

Athletes were asked to jump as high as they could with double feet on BOSCO's platform in the double-feet vertical jump test. In the single-foot vertical jump, athletes were asked to jump as high as they could with a single foot on BOSCO's platform. Results were recorded in cm for these two tests. For the 10-step/sec test, subjects were asked to climb up and down a stairs of ten steps as fast as possible. Time was recorded in seconds using a sensitive chronometer.[16]

All tests were conducted three times; without any application, with the ankle in an 8-shape elastic bandage and with the ankle in an Aircast® orthosis. The highest score was recorded. Subjects were given 15 minute rests after every test. Subjects wore sports shoes during all tests and evaluations were performed by the same physiotherapist.

Data were analyzed using SPSS v11.0 (SPSS Inc., Chicago, IL, USA). Demographic characteristics were recorded as the arithmetic mean and standard deviation.

Table 1. Demographic characteristics of the subjects.

	Mean±SD
Age (year)	20.00±2.33
Height (cm)	175.95±6.38
Body weight (kg)	68.5±7.62
Injury duration (month)	10.43±3.70
Time football played (year)	5.23±1.73

Dependent samples t-test was used to analyze the differences between the groups. P values of less than 0.05 were considered significant.

Results

Demographic characteristics of all subjects are shown in Table 1.

The difference in one maximum repetition weight values between the tibialis anterior and peroneal muscle groups of the injured and uninjured ankles was significant ($p<0.05$). The difference between the tibialis posterior of the injured and healthy sides was insignificant ($p>0.05$) (Table 2). When the results of the 1-minute fingertip rise test of the gastrocnemius and soleus muscles of the athletes were compared, there was a significant difference between the injured and healthy sides ($p<0.05$) (Table 2).

In dorsi/plantarflexion range of motion, the elastic bandage created a restriction. In terms of eversion and inversion range of motion, both the Aircast® orthosis and elastic bandage significantly restricted the range of motion ($p<0.05$). It was also determined that Aircast® orthosis created a statistically significant restriction in joint range of motion, compared to the elastic bandage in terms of eversion and inversion with both supports ($p<0.05$) (Table 3).

When the double-feet vertical jump tests were evaluated, results of the ankle with external support (Aircast® orthosis and elastic bandage) were significantly higher in comparison to the ankles with no application ($p<0.05$). Aircast® orthosis results were significantly higher than those of the elastic bandage ($p<0.05$) (Table 4).

Injured side single-foot vertical jump test results of ankles with external support (Aircast® orthosis and elastic bandage) were significantly higher than ankles without any application ($p<0.05$). There was no significant difference when the two external supports compared to each other ($p>0.05$). Again, there was no significant difference was between the injured and healthy sides ($p>0.05$) (Table 4).

Comparisons of 10-step/sec test results displayed no significant differences between the groups ($p>0.05$) (Table 4).

Discussion

Ankle injuries are the most common injuries in sport activities. Previous studies have displayed high occurrence and repetition rates in both professional and recreational athletes.[17-19] While many cases heal completely following a suitable treatment, repetitive ankle injuries cause seriously unimproved findings and problems due to functional instability.[17]

Following injury, athletes must refrain from sports and exercise programs for certain periods, depending on the degree of injury. These periods adversely affect physical performance and characteristics of the athlete. Treatment aims to minimize these losses and ensure the athlete's return to sports as early as possible. Studies carried out have shown that, in addition to a good treatment program, external supports used during treatment, exercise programs and games are very effective in de-

Table 2. Ankle one maximum repetition and fingertip rise test values.

	Mean±SD	t	p
One maximum repetition test (kg)			
Tibialis anterior (right)	22.00±2.94	4.90	<0.05
Tibialis anterior (left)	21.3±2.88		
Tibialis posterior (right)	21.05±3.78	0.47	>0.05
Tibialis posterior (left)	20.88±2.90		
Peroneal (right)	21.15±3.21	4.68	<0.05
Peroneal (left)	20.60±2.95		
Fingertip rise test			
Gastrocnemius (right)	66.83±14.57	0.08	>0.05
Gastrocnemius (left)	66.78±14.65		
Soleus (right)	66.25±13.42	1.37	>0.05
Soleus (left)	66.95±13.96		

Table 3. Results of normal joint range of movement measurements of the athletes.

	Mean±SD	t	p
Dorsi/plantar flexion movement restriction			
Ankle with no application	0.00±0.00		
Ankle with elastic bandage	9.85±3.74	20.37	<0.05
Ankle with Aircast brace	0.00±0.00		
Ankle with elastic bandage	9.85±3.74	20.37	<0.05
Ankle with no application	0.00±0.00		
Ankle with Aircast brace	0.00±0.00	–	–
Eversion-inversion movement restriction			
Ankle with no application	0.00±0.00		
Ankle with elastic bandage	10.70±4.14	20.01	<0.05
Ankle with no application	0.00±0.00		
Ankle with Aircast brace	21.83±5.49	30.80	<0.05
Ankle with Aircast brace	21.83±5.49		
Ankle with elastic bandage	10.70±4.14	22.14	<0.05

Table 4. Physical fitness test results of the athletes.

	Mean±SD	t	p
Double-feet vertical jump test (cm)			
Ankle with no application	38.78±7.10	2.45	<0.05
Ankle with Aircast brace	39.47±6.89		
Ankle with no application	38.78±7.10	3.19	<0.05
Ankle with elastic bandage	40.04±7.34		
Ankle with Aircast brace	39.47±6.89	2.20	<0.05
Ankle with elastic bandage	40.04±7.34		
Right side single-foot vertical jump test (cm)			
Ankle with no application	22.67±3.85	2.04	<0.05
Ankle with Aircast brace	23.29±3.94		
Ankle with no application	22.67±3.85	1.39	>0.05
Ankle with elastic bandage	23.08±3.80		
Ankle with Aircast brace	23.29±3.94	0.96	>0.05
Ankle with elastic bandage	23.08±3.80		
Left side single-foot vertical jump test (cm)			
Ankle with no application	22.75±3.65	1.01	>0.05
Ankle with Aircast brace	22.96±3.79		
Ankle with no application	22.75±3.65	1.01	>0.05
Ankle with elastic bandage	22.96±3.89		
Ankle with Aircast brace	22.96±3.79	0.19	>0.05
Ankle with elastic bandage	22.96±3.89		
10-steps/second test (sec.)			
Ankle with no application	4.12±0.36	1.25	>0.05
Ankle with Aircast brace	4.08±0.36		
Ankle with no application	4.12±0.36	0.06	>0.05
Ankle with elastic bandage	4.12±0.36		
Ankle with Aircast brace	4.08±0.36	1.38	>0.05
Ankle with elastic bandage	4.12±0.36		

creasing the risk of injury repetitions and in preventing injuries.(20-23) Amongst various applications, the most commonly used are elastic and hard bandaging technics, elastic bandages and orthoses with different designs. Each of these materials has different effects on the ankle joint. However, these external supports should not adversely affect athletes' physical performance. Therefore, in our study, we aimed to determine which application is more effective and whether use of elastic bandage and Aircast® orthosis affects physical performance of athletes with Grade 2 ankle inversion sprain.

In the current study, there was a statistically significant difference in favor of the right against the left side in terms of tibialis anterior, peroneus longus and brevis muscle strengths. No differences were detected among other muscles. It was concluded that the difference between the two sides was due to the subjects being right-dominant.

Ankle injuries depend on size and direction of the force to which the foot is exposed. Most injuries occur with torsional overload. Sprain occurs with either inversion and internal rotation or eversion and external rotation mechanism.[4,9,24,25] Therefore, the external support is expected to allow for ankle dorsi/plantarflexion movement and, at the same time, restrict the movement in eversion-inversion direction in order to increase joint stability. External supports help the recovery of the ankle proprioceptive sense and decrease repetitive ankle injuries.[26] In a study with 8 subjects with Grade 2 ankle sprain and 11 subjects with no previous injuries, Lee et al.[17] compared 3 different external supports. Subjects were evaluated first with the ankle with no application and then with a single orthosis. As a result, they found that orthoses did not restrict plantarflexion movement, and restricted inversion movement when compared with the ankle without orthosis. In the current study, joint range of motion measurements, which are performed to determine the rate at which the external supports restrict the ankle movement, showed that Aircast® orthosis did not cause any restriction in dorsi/plantarflexion and elastic bandage caused a restriction of 9.86 degrees. Additionally, Aircast® orthosis caused a restriction of 21 degrees and elastic bandage caused an average restriction of 10.7 degrees in inversion-eversion movements. According to these results, it was concluded that both external supports increased joint stability due to the restriction caused in ankle movements. However, while Aircast® orthosis did not create any restriction in dorsi/plantarflexion movement, it caused more restriction in inversion and eversion movement compared to the elastic bandage, and therefore was more effective in increasing joint stability.

In a study[27] carried out comparing the effects of 3 different ankle supports, including the Aircast® orthosis, subjects were evaluated in terms of vertical jump, ability and dynamic balance with or without supports. Ankle supports had an effect on performance values such as running, but did not adversely affect other skills such as jump-balance. Ozer et al.[28] investigated the effects of bandaging and protective bracing on functional balance, jump performance, multiple joint coordination and proprioceptive sense in a similar study. Whereas there were no differences between groups in the balance tests, the authors noted that the subjects showed better performances barefoot in the double-feet and dominant side jump tests. In addition, bandaging and bracing groups had better coordination results. Consequently, the authors concluded that, while causing a decrease in vertical jump performance, orthosis and bandaging played an important role in preventing injuries and in treatment through development of eccentric and concentric coordination.

A study[4] investigating the effect of bracings in decreasing the severity and incidence of new and repetitive injuries among college basketball players reported acute ankle injury incidence to be 0.47 in the bracing group and 1.41 in the control group. Similar results were recorded in both groups for moderate ankle injuries. In patients with previous ankle injuries, incidence rate was 0.83 in the bracing group and 1.79 in the control group, and the researchers emphasized that bracing use decreased both acute and repetitive injury rates. Verhagen et al.[29] compared the effects of bandaging, bracing and neuromuscular training in ankle injuries and found that all three methods had protective effects in repetitive ankle injuries. In the present study, functional tests were performed on athletes in order to determine the effect of elastic bandage and Aircast® brace on performance. Significant differences were observed between the groups in the double-feet jump test. While there was no significant difference between the results of healthy side in the single-foot jump test, there was a significant difference between the normal ankle and ankle with Aircast® brace. It was also noted that athletes were better with elastic bandage and Aircast® brace. No significant difference was found between the groups in the 10-step/sec test. According to these results, Aircast® orthosis and elastic bandage do not have any adverse effect on the vertical jump of the athlete and positively affected results as they ensured stability.

The inability to perform certain evaluations (isokinetic system, etc.) or evaluate different physical performance parameters due to limited facilities of the

research center can be considered a limitation of the study.

In conclusion, elastic bandage and Aircast® bracing did not affect the functional performance and functions of the athlete and can both be used as support and protection after injury. However, in terms of maintaining stability, restricting movement in the inversion-eversion direction and not restricting dorsi/plantarflexion during its use, Aircast® orthosis is more effective than elastic bandage.

Conflicts of Interest: No conflicts declared.

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