Restoration of Balance after lateral Ankle Sprains

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ABSTRACT

Chronic ankle instability after ligamentous injuries has been related to disturbance or loss of proprioception. Proprioceptive training enables injured subjects to reduce proprioceptive deficits and increase postural control. This study investigated the effects of proprioceptive ankle training on balance and postural sway control in patients with chronic lateral ankle sprains. Forty patients were included in the study, and were divided into two groups at random. The first group underwent standard exercise program emphasized progressive resistive exercises, and the second group followed the standard program plus proprioceptive ankle control training. Subjects were pretested and post tested using the Stabil-Ometer infrared stability platform. The mean time on the center was calculated for each subject. The mean time on the center was 8.97 sec. + 5.90 sec. for the first group, and 9.02 sec.+ 4.80 sec. for the second group pre-testing. Post-training the time on center was 9.75 sec. + 6.01 sec., and 23.02 sec. + 4.77 sec. for both groups respectively. The differences were significant. This means that proprioceptive ankle training significantly increased balance control and decreased postural sway in patients with chronic lateral ankle sprains.
Key words: *Posture, Ankle joint, Balance, Ankle rehabilitation, Proprioception.*

INTRODUCTION

Ankle inversion injuries are common among physically active young men and women especially athletes. The majority of ankle sprains occur in persons under the age of 35 years, and most commonly in the 5-year range of 15 to 19 years[29]. Ankle sprains constitute 10% to 28% of all sport related injuries[9,12,26]. Reports indicate that 20% to 50% of individuals with ankle inversion sprains have some kind of subsequent disability[22,25,26].

Impairment of ankle proprioception has been suggested as one of the causes of functional instability of the ankle[1,22]. Mechanoreceptors in human ankle ligaments are classified into four types. Type I receptors provide postural sense to the central nervous system. In contrast, type II receptors, thought to provide the sensation of the beginning of joint motion. Type III receptors are most common, and are activated at the extremes of movement. Type IV receptors are responsible for nociceptive sensation[28].

The ankle joint ligaments provide more than just structural support of the joint. The sensory output from ligaments help in controlling muscle stiffness and coordination to increase stability[19,20]. Proprioceptors are mediating muscle tone, articular reflexes, and kinesthesia[19].

Proprioception deficient ankle joint with altered neuromuscular control have been demonstrated to have less stability and balance especially during a single leg stance, and also to have longer muscular reaction time to a

sudden angular movement[6,7,22,26]; which could lead to further injuries to the ankle joint.

The restoration of ankle joint functional stability was the focus of all rehabilitation programs that include muscular strength, taping, neuromuscular feedback, and balance training[13,15,17].

Balance training effects were investigated in normal subjects[8,16], but not in patients with functional instability of their ankle joints.

The purpose of this study was to use the Stabli-Ometer balance platform, as an objective and reliable tool[10], to investigate the effect of proprioceptive balance training program on patients with inversion ankle sprain.

MATERIALS AND METHODS

Subjects

Forty inversion ankle sprain volunteer patients assigned to two groups at random. The first group (12 males and 8 females) with a mean age of 24.30 years (range 17-38); and the second group (13 males and 7 females) with a mean age of 26.7 years (range 16-40). Subjects were chosen according to the following criteria:

1) unilateral inversion ankle sprain, left or right, male or female; 2) no lower limbs deformity or past history of lower limb injury 12 month prior to the study (except for current injury); 3) no balance related disorders; 4) ability to stand for 30 seconds with no assistant device; 5) ability to understand and follow verbal instructions.

The study protocol and purpose were explained to all subjects, and they all signed an informed consent form.

Instrumentation

a) Stabil-Ometer infrared stability balance platform, model 16020, Lafayette Instrument, Lafayette, IN, USA.
b) Rocker board with two halves of circles situated on the bottom, which allows anterior-posterior movement.
c) Balancing board atop a section of sphere allowing multidirectional movement.

Procedures

A) Balance testing

At the beginning, both groups were tested for balance. Testing was conducted in two consecutive days. The first day was used to acquaint the patient with the balance platform and the test sequence. On the second day subjects performed two tests, each of which lasted 30 seconds, followed by a rest period of 30 seconds.

Subjects step onto the platform so that he/she is facing the control, subject was told to began balancing when the green test light on the top of the control turns on, and end the test when the test light turns off. The area included as on-center was adjusted to 5 degrees on either side of the perpendicular. The total time on center is displayed on the screen of the control. Data from both tests were recorded for each patient; the mean of the two tests was calculated for each subject.

B) Treatment

All patients followed a standard three-phase rehabilitation program that emphasized progressive resistive exercises. The treatment period was 3 months long at a frequency of three treatment sessions per week. In addition the second group performed the following exercises to improve Proprioceptors function and to train the fast twitch fibers of the evertors, invertors, dorsiflexors, and planterflexors to improve ankle joint dynamic control[10,16]:

The patient stood on both legs and made foot fists i.e., made attempts to grasp the

floor or an object with both feet.

The patient sat with the foot of the injured side on a rocker board. The patient tried to control the movement of the board as quickly as possible in both anterior-posterior and medial-lateral directions. The exercise was repeated using both feet on the rocker board. The exercise was then repeated and the therapist moved the board suddenly in a direction that was known to the patient, the patient tried to stop the board s movement as quickly as possible. The exercise was then repeated once more and the therapist moved the board suddenly in unknown direction to the patient, the patient tried to stop the board s movement as quickly as possible.

The patient sat with injured foot on balancing board, and tried to control the movement of the board as quickly as possible. The exercise was repeated using both feet. The exercise was then repeated and the therapist moved the board suddenly in a known direction to the patient, the patient tried to control the board s movement as quickly as possible. The exercise was repeated once more when the therapist moved the board suddenly in unknown direction to the patient, the patient tried to control its equilibrium against the sudden force given by the therapist.

The rocker board and the balancing board exercise sets were then repeated from standing position.

Data analysis

The unpaired t-test was used for comparison between patient two groups, differences were considered significant at $P< .05$.

RESULTS

The balance variability was measured twice, and the pre-treatment and post-treatment mean balance variability was calculated for each subject in both groups. Table (1) shows comparison between the two groups mean time on-center for the pretest. The first group mean time on-center was 8.97 ± 5.90 sec. (range 0-15), and the second group mean time on-center was 9.02 ± 4.80 sec. (range 0-14). The t-value was 0.03 and the 2-tail probability was 1.07. These values indicated that there was no significant difference in the length of time on-center between the two groups before treatment.

Table (1): Comparison between the two inversion ankle sprain groups time on-center before treatment.

	Group 1	Group 2
Range		
Minimum	0.00	0.00
Maximum	15.00	14.00
Mean	8.97	9.02
St. deviation	5.90	4.80
St. error	1.29	1.01
t-value	0.03	
2-tail probability	1.07	

Table (2) shows comparison between the two groups mean time on-center for the post-treatment test. The first group, received only the three-phase rehabilitation program, mean time on-center was 9.75 ± 6.01 sec. (range 3-17), and the second group received the three-

phase rehabilitation program plus ankle proprioceptive dynamic training, mean time on-center was 23.02 ± 4.77 sec. (range 12-30). The t-value was 8.67 and the 2-tail probability was 0.00. These values indicated that there was a significant difference in the length of time on-center between the two groups.

Table (2): Comparison between the two inversion ankle sprain groups time on-center after treatment.

	Group 1	Group 2
Range		
Minimum	3.00	12.00
Maximum	17.00	30.00
Mean	9.75	23.02
St. deviation	6.01	4.77
St. error	1.33	1.12
t-value	- 8.67	
2-tail probability	0.00	

The differences between the tow groups in both pre and post-treatment tests were shown in figure (1).

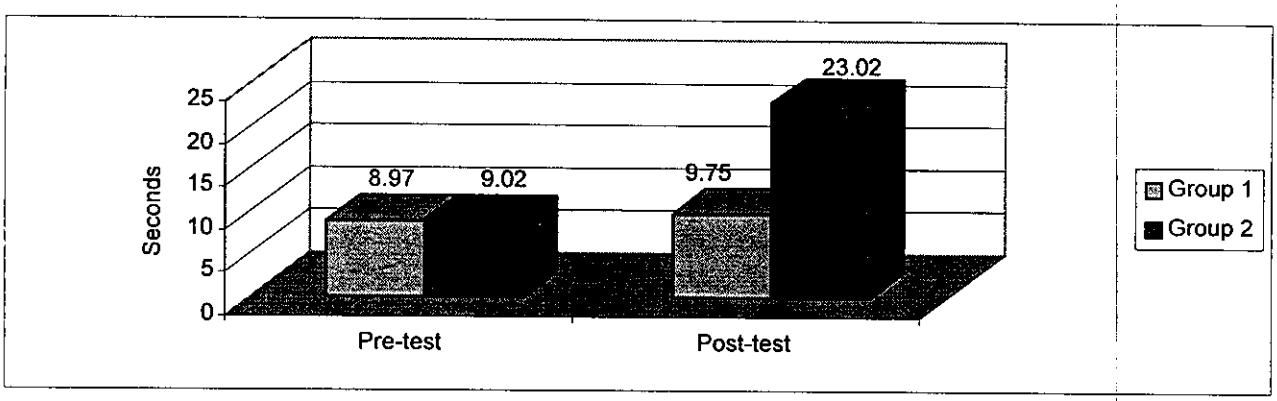

Fig. (1): Mean time on-center for both inversion ankle sprain groups pre. and post-treatment.

DISCUSSION

The major finding of this study was that 12 weeks of dynamic ankle joint proprioceptive retraining had a significant effect on balance after lateral ankle sprains.

Attempts to eliminate tester error were made by using the same tester for all tests, and by giving standardized instructions to the subjects.

The central nervous system uses a dynamic combination of sensory inputs from vestibular, somatosensory, and visual system to control balance[18,23]. It has been suggested that diminished sensory input from damaged mechanoreceptors at the ankle decreased motor control and functional instability[11,24]. The joint receptors regulate muscle tone and posture by influencing the gamma muscle spindle system[21], which regulates the alpha motor neurons sensitivity to stretch. This means that stiffness in the muscles acting on

the ankle joint is guided by the ankle mechanoreceptors[31]. Failure of the affected ankle joint to provide kinesthetic information to central nervous system might contribute to imbalance[26].

Many treatment strategies has been adopted to solve the problem. Many investigators[2,4,27] favored muscle strengthening techniques, while others recommended the use of ankle orthoses[3,14,27]. It was unclear if coordination training can improve joint position sense[5], but was proved to decrease postural sway in healthy subjects[16], and in reducing residual symptoms except edema after partial sprains of the lateral ligaments[30].

The dynamic proprioceptive training was used and was proven to be very effective in restoration of balance in patients after inversion ankle sprains. The effectiveness of the treatment program was directly related to improvement of foot function, equilibrium, reaction to sudden movement or force, and to quick transference of body weight from one leg to another.

It is concluded that the program is effective and could be used as an integral part of inversion ankle sprains rehabilitation programs.

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الملخص العربي

استعادة الاتزان بعد الإلتواءات الوحشية لمفصل الكاحل

يهـدف هذا البحث لدراسة تأثير استخدام برنامج علاجي يقوم على تدريب المستقبلات الحسية العميقة بمفصل الكاحل على استعادة التحكم الديناميكي في المفصل بعد إصابات الأربطة الناتجة عن الإلتواءات الوحشية للمفصل .
تـم اسـتخدام جهاز لقياس الاتزان له درجة ثقة كبيرة ، لقياس الفرق في درجة الاتزان لمجموعتين من المرضى قبل تنفيذ برنامج العلاج . تم تأهيل إحدى المجموعتان باستخدام برنامج العلاج القياسي المبني على تقوية عضلات مفصل الكـاحل واتـبعت المجموعـة الثانية نفس البرنامج بالإضافة إلى برنامج تدريب المستقبلات الحسية العميقة بمفصل الكاحل . اتبعت كل مجموعة برنامج العلاج الخاص بها لمدة اثنا عشر أسبوعاً بواقع ثلاث جلسات أسبوعياً .
بعد استكمال البرنامج تم تقييم الاتزان باستخدام جهاز الاتزان مرة أخرى .
أشـارت نتائج البحث إلى عدم وجود فروق معنوية بين أداء مجموعتي المرضى على جهاز الاتزان قبل تنفيذ برنامج العـلاج . أشـارت نتائج البحث أيضاً إلى وجود فروق معنوية بين أداء مجموعتي المرضى على جهاز الاتزان بعد تـنفيذ بـرنامج العـلاج مما يدل على التأثير الإيجابي لبرنامج تدريب المستقبلات الحسية العميقة لمفصل الكاحل في اسـتعادة الـتحكم الديـناميكي وفي تحسن وظيفة مفصل الكاحل بعد إصابات الأربطة الناتجة من الإلتواءات الوحشية للمفصل .