

ESTIMATE THE EFFICACY OF TAPING AND SEMIRIGID BRACE ON SUBJECTS WITH UNILATERAL CHRONIC ANKLE INSTABILITY

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ABSTRACT

The ankle joint is one of the most frequently injured anatomical site for individuals who participate in recreational and sports activities. It has been established that one million people encounter acute ankle injuries every year. Acute ankle sprain occurs during dynamic movement particularly in rapidly changing directions.² After initial injury, the rate of reoccurrence of ankle injury may be as high as 80% among individuals.^{3,4} Practice of taping and bracing to injured ankle is used to prevent further injury by restriction of range of motion among sports medicine clinicians.¹²

The purpose of this study was to compare the effect of commercially available semirigid ankle brace with ankle taping on dynamic balance and functional restraint in subjects with unilateral chronic ankle instability.

KEYWORDS: Ankle Injuries, Semirigid Ankle Brace, Ankle Taping, Chronic Ankle Instability

INTRODUCTION

The ankle joint is one of the most frequently injured anatomical site for individuals who participate in recreational and sports activities. It has been established that one million people encounter acute ankle injuries every year. Acute ankle sprain occurs during dynamic movement particularly in rapidly changing directions.² After initial injury, the rate of reoccurrence of ankle injury may be as high as 80% among individuals.^{3,4} Altered mechanical joint stability due to repeated disruption to ankle integrity with resultant perceived and observed deficit in neuromuscular control has been described as chronic ankle instability.⁵ possible cause of chronic ankle instability is a combination of diminished proprioception and evertor muscle weakness. Several other causes have also been suggested including mechanical instability, resulting in motor in-coordination, thereby predisposing the ankle to instability.^{6,7} Long term effects of repetitive ankle trauma leaves an individual more susceptible to degenerative changes and reduction in proprioceptive awareness with a correlation to postural instability. According to researches postural control appeared to be altered in patients with chronic ankle instability.^{7,8,9}

Chronic ankle instability is a condition resulting from inadequate healing of teared ligaments which when subjected to constant motion and stretching, either heal elongated or are replaced with a mass of scar tissue leading to loss of integrity of the ligamentous support and instability of ankle joint which in turn causes recurrent ankle sprains.¹⁰ A number of investigations have provided information about alternative mechanisms by which ankle support may offer protection to the ankle therefore commonly used for prevention and treatment for ankle injury. The objective of these

support systems is to provide mechanical restriction of undesirable ankle joint motion and to relieve ankle joint ligaments of excessive strain while allowing for minimal hindrance to normal joint mechanics.¹¹ These ankle supports are used to control swelling and range of motion in the acute stage, and to provide support or stability to the ligaments and joint in the chronic stage. Practice of taping and bracing to injured ankle is used to prevent further injury by restriction of range of motion among sports medicine clinicians.¹²

Initially only taping was advocated as the means to protect the ankle ligaments from excessive strain,¹³ but in recent time a variety of ankle braces have become commercially available as alternative to ankle taping. Both ankle taping and bracing is suggestive to enhance proprioception,^{14,15} provide proper restriction of the range of motion to ankle^{16,17} and reduce ankle injury and frequency rates.^{18,19,20} It has also been proved that prophylactic use of both taping and bracing is effective at reducing the incidence of ankle sprains.^{2,21,22} This can be principally due to mechanical support offered by these devices, although increased sensorimotor function offered by external support may also be a contributing factor.^{4,17,18}

Comparison of taping and bracing was previously done by many authors. rovere et.al.¹⁷ retrospectively compared effect of laced ankle stabilizers with taping in injury prevention. Metcalfe et.al.²³ compared the effectiveness of tape and brace on ankle subtalar range of motion, Comparison of ankle taping and bracing has also been done on the parameters of motor performance²⁴ and functional performance²⁵. Nevertheless the goal of both taping and bracing is to support the unstable ankle and prevent joint hypermobility without severely handicapping the normal biomechanics of ankle joint, the comparison of their effect on stability and injury prevention was previously done only on athletes.^{1,7,26} It was therefore needed to compare the effect of taping and bracing in patients suffering from instability condition like chronic ankle instability.

The purpose of this study was to compare the effect of commercially available semirigid ankle brace with ankle taping on dynamic balance and functional limitations in patients with unilateral chronic ankle instability.

Study Design

Sample

Thirty subjects with self reported chronic ankle instability from Bansal hospital, New delhi volunteered to participate in the study. All the subjects had unilateral chronic ankle instability who reported of having the history of atleast one unilateral ankle sprain with pain and or limping for greater than one day, chronic ankle weakness, pain or instability attributed to the initial injury and self reported giving way of the involved ankle in the last 6 months.^{49,51} Subjects selected were randomly assigned into three groups.

Group A- Subjects included with mean age 24.00 ± 2.74 , mean height 164.40 ± 5.58 and mean weight 57.80 ± 5.05 .

Group B- Subjects included with mean age 25.30 ± 1.25 , mean height 164.40 ± 3.16 and mean height 59.90 ± 6.73 .

Group C- Subjects included with mean age 23.70 ± 2.62 , mean height 166.10 ± 4.70 and mean weight 58.90 ± 8.04 .

Inclusion Criteria^{49,51}

- Both males and females
- Age 20-30 years
- Weight 50-70kg

- Height 150.0-185.0cm
- History of atleast one unilateral ankle sprain with pain and or limping for greater than one day.
- Chronic ankle weakness, pain or instability attributed to the initial injury.
- Self reported giving way of involved ankle in last six months.

Exclusion Criteria^{15,49,60}

- History of fracture in lower limb
- Impairments of the trunk or central nervous system
- Any ear infection
- Skin allergy or infection over ankle
- Prior balance training
- Bilateral ankle instability

STUDY DESIGN

Comparative study design

Instrumentation

Semirigid Braces

Semirigid braces with medial and lateral plastic uprights lined within covering that could be adjusted by three velco bands to the leg and foot, manufactured by Flamingo, Ascent Health Care, Malad [west], Mumbai, India.

Tape

One and a half inch tape, manufactured by Elastoplast, North Ryde, australia.

Underwrap

Hypoallergic adhesive underwrap, 10m x 5cm.

Star Excursion Balance Test

Star Excursion Balance Test [SEBT] which is a simple, reliable, low cost alternative to more sophisticated instrumented methods that is currently available to assess dynamic postural control. The reliability of SEBT in assessing dynamic balance⁶¹ and its efficacy in detecting reach deficits in subjects with CAI⁶⁰ has previously been established.

Foot and Ankle Disability Index

The foot and ankle disability index [FADI] which is designed to assess functional limitations related to foot and ankle conditions. The reliability and sensitivity of the foot and ankle disability index in subject with CAI is already established.⁵¹

Goniometer

Goniometer was used to measure ROM of ankle.

Protractor

Adhesive Tape

Measuring Tape



Figure 1: Semirigid Brace



Figure 2: Taping material



Figure 3: Underwrap

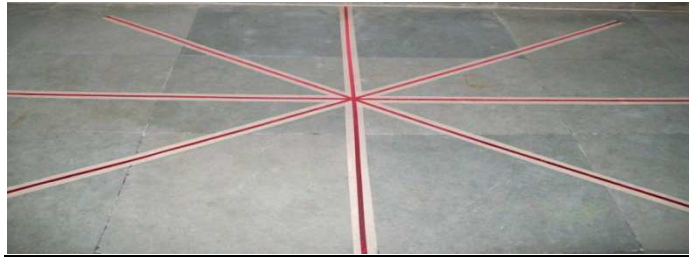


Figure 4: SEBT Grid

Protocol

Subjects with self reported chronic ankle instability^{49,51} were into randomly assigned into these groups. Each group has ten subjects. All the patients were assessed with Star Excursion Balance test [SEBT] and Foot and Ankle Disability Index [FADI] [Appendix D] to measure the dynamic stability and functional limitation respectively. In Group A adhesive tape was applied to the subjects using closed basket weave technique and ankle rehabilitation was given. In Group B patients were given semirigid ankle brace with ankle rehabilitation and in Group C' which was control group where only ankle rehabilitation was given. SEBT and FADI was again performed after seventh day and fourteen day to check the effect of taping and bracing on dynamic stability and functional limitations.

Procedure

Thirty selected subjects with self reported CAI were included and randomly assigned into these groups. On the first day the whole procedure was explained to all the subjects and a consent form was signed by each of them.

All the subjects were prior to treatment assessed with Star Excursion Balance test [SEBT] and Foot and Ankle Disability Index [FADI] for measuring dynamic balance and functional limitations.

Star Excursion Balance Test [SEBT]

The SEBT was performed on a grid of eight lines made with three inch wide adhesive tape extended out at 45 degree from each other, enclosed in area of 6 foot by 6 foot square hard tile floor.^{8,60} The eight lines on the grid were named in relation to the direction of reach with regard to the involved extremity. The grid was constructed using a protractor, tape and tape measure. The directions were named anterior, anteromedial, medial, posteromedial posterior lateral, antero lateral and posterolateral.

To perform the SEBT the subjects were asked to maintain a single leg stance bearing weight on involved extremity while reaching with the contralateral leg [reach leg] as far as possible along the appropriate vector. The foot of the test limbs was positioned in the middle of the grid. The subject was instructed to keep the heel of the stance leg on the ground at all times and keep their hands on the iliac crest. The subject lightly touched the furthest point possible on the line with the most distal part of the reach foot, maintaining stability achieved through adequate neuromuscular control of the stance leg. The subjects then returned to the bilateral stance, maintaining equilibrium. They were asked to perform the reach in a clockwise manner. The examiner manually measures the distance from the center of the grid to touch point with the measure tape in centimeters, Subjects were given 15 seconds of rest in between reaches. Three reaches in each direction was recorded, separated with 10 seconds of rest. Average of 3 reaches was calculated.⁶⁰

Trials were discarded and repeated if the subject⁶⁰ :-

- Did not touch the line with the reach foot while maintaining weight bearing on the stance leg.
- Lifted the stance foot from the center grid.
- Lost balance at any point in the trial, that means is not able to maintain balance while one foot is lifted.
- Did not maintain start and return positions for one full second.
- If the subject touched the reach foot to the ground in a manner that he/she supports body on it or uses it to widen base of support.

Foot and Ankle Disability Index [FADI]

The FADI has 26 items [Appendix D]. Each item is scored from 4 (unable to do), 3 (extreme difficulty), 2 (Moderate difficulty), 1 (Slight difficulty) and 0 (no difficulty at all). The FADI has total point value of 104 points, and was scored in the study as percentages.⁵¹

Group A

Ten subjects assigned in Group 'A' after performing SEBT and FADI performed ankle rehabilitation [Table. 1]. Adhesive tape was applied to these patients using closed basket weave technique.^{55,56,63} The tape was removed after 24 hours^{64,65} and reapplied after new exercise session. The total treatment protocol was for 2 weeks^{52,68} in which treatment was given thrice a week. During the exercises the hold time varied according to the comfort of the patient. At the end of the first and second week SEBT and FADI was repeated to reassess the dynamic stability and functional limitations.

Closed basketweave technique:- Position of the individual sitting on a table or bench with the leg extended off the edge with the foot in 90 dorsiflexion.^{55,56,63}

The following steps were followed:-

- Pre wrap was applied starting at the mid foot and continuing up to the leg approximately 5-6 inches above the medial malleolus.
- An anchor strip at the proximal and the distal ends of the pre wrap with half of the tape covering the pre wrap and the other half adhering to the skin was applied.
- Starting posteromedially on the proximal anchor a stirrup covering the posterior third of the medial malleolus and then under the foot and up the lateral side to the proximal anchor was applied.
- Starting at the distal anchor a horse shoe around the heel (approx. 2 inches) from the plantar surface to either side of the distal anchor was applied.
- Step number 3 and 4 with half the width of tape overlapping were repeated.
- Figure of eight starting medially at the position of the first step pulling the tape at an angle towards the medial longitudinal arch under the foot across the anterior aspect of ankle and around it was applied.
- Close-up the tape was applied by single stirrup of tape around the leg.
- To apply a heel lock tape was started at the anterior aspect of the proximal anchor laterally the tape was pulled at the angle towards posterior aspect of lateral malleolus around posterior aspect under heel up to lateral side of foot

across the anterior aspect of ankle.

At the end of the treatment the tape was removed by pulling it gently back with a smooth motion while the skin was compressed by other hand.⁵⁵ Patients comfort was taken into proper consideration. Water and other lubricants were also used for removal of tape.

Group B

Ten subjects of unilateral CAI assigned in group B after performing SEBT and FADI performed ankle rehabilitation [Table 1]. These patients were given semirigid ankle brace. They were taught how to apply brace themselves at home and adjust it by Velcro straps patients were guided to keep the brace applied throughout the day and were suggested to remove braces at night. They were also instructed to tighten the brace at any point during the day in case of its loosening. In the two weeks of treatment protocol the subjects had six sessions of ankle rehabilitations.^{52,68} During the exercises the hold time varied according to the comfort of the patient. At the end of the first week and second SEBT and FADI was repeated to reassess the dynamic and functional limitations.

Group C

Ten subjects of unilateral chronic ankle instability assigned in this group performed SEBT and FADI and underwent ankle rehabilitation^{49,52} [Table 1] thrice a week and six times in two weeks which was the scheduled time period.^{52,68} During the exercises the hold time varied according to the comfort of the patient. At the end of the first week and second week SEBT and FADI were repeated to reassess the dynamic stability and functional limitations.

Table 1: Exercise Protocol for CAI

Exercise	Sets	Repetitions	Rest Period(min)
Bilateral squat	3	1x3	1
Heel raise	3	1x3	1
Unilateral stance	3	1x3	1
Unilateral squat	3	1x3	1

DATA ANALYSIS

Data was analysed by using SPSS version 11.0 software.

ANOVA was done to calculate significant difference of age, weight and height between groups.

Oneway ANOVA was used to find significant difference for all the variables of Star Excursion Balance Test (SEBT) [posteromedial(PM), posterior(p), posterolateral(PL), lateral(L), anteromedial(AM), medial(M), anterolateral(AL), and anterior(A)].

Post hoc multiple comparisons were applied between Group A, Group B and Group C comparing all the variables of SEBT of Day1, Day7 and Day 14.

Oneway ANOVA was used to find significant difference for Foot and Ankle Disability Index (FADI).

Post hoc multiple comparisons were applied between Group A, Group B and Group C comparing FADI of Day1, Day7 and Day 14.

The level of significance was set at 0.05.

RESULTS

Oneway ANOVA was done to calculate level of significance of age ($p=0.275$), weight ($p=0.849$) and height ($p=0.638$), and the result showed no significant difference [Table 2]

Oneway ANOVA was done to calculate level of significance of FADI between the groups and showed no significant difference for Day 1 ($p=0.542$) and Day7 ($p=0.46$) but showed significant difference for Day 14 ($p=0.045$) [Table 3]

Post hoc multiple comparisons were applied between Group A, B and C of FADI. And the results for Day 1 and Day 7 showed no significant difference between Group A Vs B ($p=0.693$) ($p=0.546$), Group B Vs C ($p=0.983$) ($p=0.986$), Group C Vs A ($p=0.583$) ($p=0.560$) respectively. For Day 14 showed significant difference between Group A Vs B ($p=0.033$), Group B Vs C ($p=0.048$), Group C Vs A ($p=0.043$) [Table 4]

One way ANOVA was done to calculate level of significance of FADI within the groups and showed no significant difference for Group A ($p=0.146$) and Group C ($p=0.536$) and significant difference for Group B ($p=0.025$) [Table 5].

Post hoc multiple comparisons were applied within groups of FADI. The result showed no significant difference for Group A and C between Day 1 Vs Day 7 ($p=0.574$) ($p=0.812$), Day 7Vs Day 14 ($p=0.210$) ($p=0.894$) respectively and Day 14 Vs Day1 ($p=0.541$) for Group C. The result was significant for Group B between Day 1 Vs Day 7 ($p=0.048$), Day 7 Vs Day 14 ($p=0.032$) and Day 14 Vs Day 1 ($p=0.037$) and between Day 14 Vs Day 1 ($p=0.027$) of Group A [Table 6].

One way ANOVA was done to calculate level of significance of SEBT between the groups of Day 1 and was found non significant for P($p=0.275$), PL($p=0.569$), AM($p=0.717$), M($p=0.766$), AL($p=0.678$) and A($p=0.548$) and significant for PM($p=0.045$) [Table 7].

Table 2: ANOVA of Demographic Data

	F Value	p Value
age	1.354	0.275
weight	0.164	0.849
height	0.457	0.638

Table 3 : ANOVA of FADI between the Groups

	F Value	p Value
Day-1	0.626	0.542
Day-7	0.808	0.456
Day-14	0.638	0.045

Table 4: Multiple Comparison of FADI between the Groups

Variables	Group	Mean Diff.	S.E.M.	p-Value
Day-1	A Vs B	3.7000	4.2896	0.693
	B Vs C	0.8000	4.2892	0.983
	C Vs A	4.5000	4.2892	0.583
Day-7	A Vs B	4.5000	4.0435	0.546
	B Vs C	0.1000	1.000	0.986
	C Vs A	4.4000	0.560	0.560
Day 14	A Vs B	4.2000	3.8058	0.033
	B Vs C	2.9000	3.8058	0.048
	C Vs A	1.3000	3.8058	0.043

Table 5: ANOVA of FADI Within the Groups

	F Value	p Value
Group-A	4.256	0.146
Group-B	2.065	0.025
Group-C	0.634	0.536

Table 6: Multiple Comparison of FADI Within the Groups

Variables	Group	Mean Diff.	S.E.M.	p-Value
Group-A	1 Vs 7	3.1000	2.9117	0.574
	7 Vs 14	5.3000	2.9117	0.210
	14 Vs 1	8.4000	2.9117	0.027
Group-B	1 Vs 7	3.9000	4.3907	0.048
	7 Vs 14	5.0000	4.3907	0.032
	14 Vs 1	8.9000	4.3907	0.037
Group-C	1 Vs 7	3.0000	4.6344	0.812
	7 Vs 14	2.2000	4.6344	0.894
	14 Vs 1	5.2000	4.6344	0.541

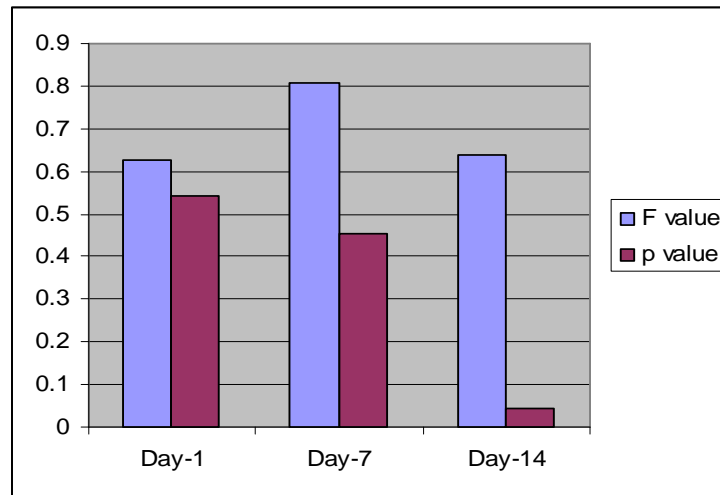


Figure 5

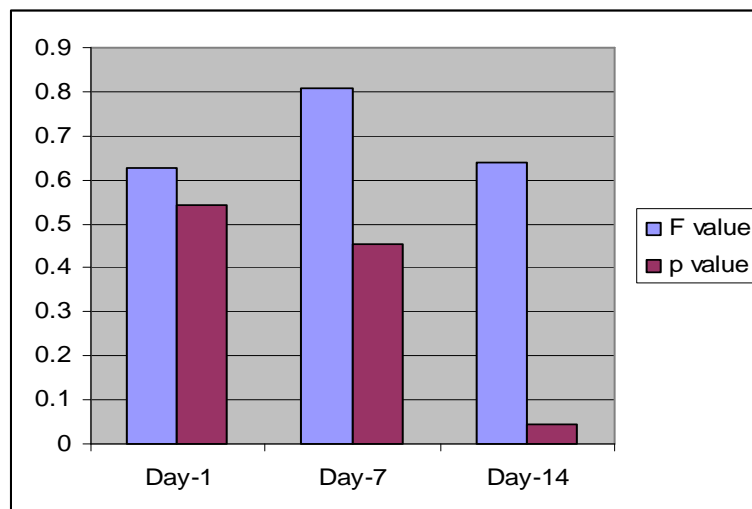


Figure 6

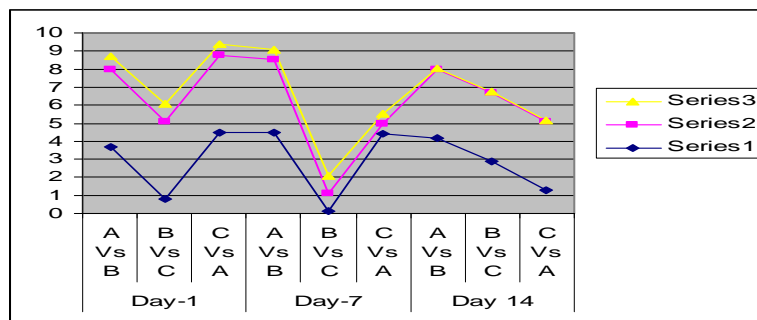


Figure 7

CONCLUSIONS

The results of present study showed that bracing was more effective than taping in improving dynamic balance and functional limitations in patients with CAI. The result showed significant improvement in posteromedial, anteromedial and anterior directions of the SEBT when dynamic balance was checked. The study of Jay Hertel et.al.⁶⁶ supported the result of the present study as they concluded that posteromedial component of SEBT is highly associated with performance defect in subjects with CAI. Further they added that it can be due to some statistically significant difference in muscle activation pattern and lower extremely joint range of motion during execution of 8 different reaches of SEBT.⁶⁶ supporting the present study previously effect of braces on postural control was found significant, where semirigid ankle brace was found to decrease the amplitude and frequency of postural sway, there findings suggested that the semirigid brace acts to provide cutaneous afferent feedback in maintaining postural control.⁴ Further, in the present study bracing was also found more significantly effective as compared to taping in improving functional limitations as measured by foot and ankle disability index (FADI). Mackean et.al.³¹ supported present study and proved prophylactic ankle bracing more effective on functional performance as compared to taping.

In the present study bracing proved to play potential role in treatment of CAI, the reason behind which can be its property of supporting the ligaments and capsule and enhancing proprioceptive feedback as quoted by David persin.⁵⁵ According to Kaminiski et.al.⁷⁰ braces stimulate cutaneous nerve receptors with resultant stimulation of the joint mechanoreceptors (pacinian corpuscles and ruffini endings.), which has been suggested to result enhanced muscular protective reflex mechanism and is the basis for justifying the use of prophylactic ankle taping and bracing from a proprioceptive standpoint. Rosenbaum et.al.²² depicted that semirigid braces are recommended because they are easy to handle and provide the key effect of stability to the joint. A strong semirigid ankle brace was also significantly found to reduce talar and subtalar motions of PF, inversion and adduction in subjects with symptoms of CAI. ¹⁴ Phillip et.al.³⁰ proposed that protective mechanism of ankle bracing include mechanical restriction and increased somatosensation as brace provides an added tactile stimulus that is sensed by the cutaneous receptors at the ankle-foot complex, which may enhance neuromuscular control of ankle.

Additionallym reflex protection of joint via peroneal latency has also been theorized as having a role in protecting ankle from injury and supporting the chronically unstable ankle.^{49,70} According to the study of Hooper et.al.⁶⁷ the decreased EMG activity of peroneal and gastronemius muscle induced by bracing may reflect a decreased in the need for these muscles to provide mechanical stability of ankle which proves the importance of braces on ankle stability.

The results of present study also showed no significant effect of tape on unilateral CAI. One major criticism and

drawback of taping is that it loosens with time and activity.^{24,26,28} It could be suggestive that taping due to the characteristic loosening could not properly in the present stud had to keep the tape applied for 24 hrs which provides a significant time period for the tape to get loosened. The patients were also performing all their daily activities without hinderance which allowed ankle to undergo dynamic loading. The effect of tape on dynamic load was examined by Matin and Harter et.al.⁶⁹ who used 8.5% laterally tilted treadmill test to evaluate inversion angles and concluded that tape is unable to restrict inversion under dynamic loads. Ankle taping was also found ineffective on peroneal muscle latency on subjects with ankle instability.³⁰

Earlier Metcalf et.al.²⁸ depicted that brace had a slight edge over other prophylactic applications. Timonhy et.al.² also concluded that it is justified to use commercially available ankle braces instead of taping to decrease the incidence of ankle injuries as braces proved to be more significant in restricting movements. Supporting their study Grasso et.al.⁷¹ suggested that semirigid ankle support may be more effective than atheltic tape in preventing ligamentous ankle injury. Bracing was also found to enhance functional performance as compared to taping.³¹ Bracing also is found to have an advantage over taping in being slef applied without needing the expertise of qualified personal, convenient to apply and remove, reusable, readjust able and easily washable. There is also less possiblities of skin problem. As compared to taping a properly applied brace will not be significantly loosened during activity. Moreover brace can be quickly and easily be tightened at any point by patients themselves.

FUTURE RESEARCH

- The present study can be repeated to find out the long term effect of taping and bracing on CAI where a time period of 4 weeks or 6 weeks should be considered.
- Future research in needed to compare the effect of semirigid and rigid brace on subjects with CAI.
- Future research is needed to investigate the sensitivity to change of the SEBT for each direction; this may increase utility of this tool in condition like CAI.

Relevance to Clinical Praticce

The result of the present study can be taken into consideration while prescribing prophylactic stabilizing agents to patients with CAI. Semi rigid braces could be more effective and hence should be prescribed for improving dynamic balance and functional limitations inpatients with CAI.

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