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EFFECTIVENESS OF AMEDA STEP (ACTIVE MOVEMENT EXTENT DISCRIMINATION APPARATUS) AND AMEDA STAND ON JOINT PROPRIOCEPTION IN FOOTBALLPLAYERS WITH RECURRENT ANKLE INSTABILITY

Imran Ahmed Farooqui[1] (Sports. Med Rehab), J.Uday Raj[2] (Asst. Professor Apollo College of Physiotherapy)

INTRODUCTION

The ankle is one of the most frequently injured parts in sport, especially in soccer / football, which account for 24% to 54% of total injuries. Up to 70% of individuals with a history of ankle injury report ongoing symptoms of ankle instability or pain, of whom 40% report ‘‘giving way’’ as their main problem, resulting in a functional ankle instability (FAI).[1] Athletes are always at a significantly higher risk of sustaining a lateral ankle sprain compared with syndesmotic and medial ankle sprains[24], grade I and II sprains being frequent. Despite extensive clinical and basic science research, the recurrence rate of ankle sprains remains high and the reasons why it tends to recur are unclear; thus, making a successful rehabilitation difficult.

In a review of the potential causes of FAI, recurrent ankle injuries cause muscle-strength deficits, joint position-sense deficits, delayed peroneal muscle-reaction time, balance deficits, altered common peroneal nerve function, and decreased dorsiflexion range of motion[7,10,14,15]. Thus, it remains important to search for the contributory factors of chronic ankle instability (CAI), which is hypothesized to predispose individuals to re-injury after lateral ankle sprains.

It has been proposed that ankle injury may disrupt joint afferents located in the supporting ligaments. After injury to the nervous and musculo-tendinous tissue, proprioceptive deficits are likely to occur and may manifest as reduced joint position sense (JPS). The ability to detect motion in the foot and to make postural adjustments in response to these detected motions is thought to be crucial in the prevention of ankle injury[4,10]. Several authors have suggested that inversion ankle sprains may occur due to improper positioning of the foot just before and at foot contact and this may be due to the loss of proprioceptive input from mechanoreceptors. Studies on joint position sense in the chronically unstable ankle have demonstrated varying results of decrease in active joint-position sense, compared to the uninjured ankle[1]. The evertor muscles are often suggested to play an important role in preventing ligamentous injuries[14]. The strength of the peronei (longus and brevis) muscles is supposed to provide support to the ankle lateral ligaments.[14]

To date, most tests carried out to evaluate proprioception involve isolating movements of the joint that is being examined and are often conducted in sitting or non–weight-bearing positions. Proprioceptive testing in weight bearing results in different levels of proprioceptive acuity [10]. For optimum ecological validity, ankle function assessments should aim to reproduce movement speeds, joint ranges of movement and muscle forces like those experienced during functional activity. The Active Movement Extent Discrimination Apparatus (AMEDA) was developed with this intention.[1] Participants are tested standing, bearing full weight, and with movements through the midrange of active ankle inversion involving the supporting musculature. AMEDA incorporates normal leg alignment for gait, full weight bearing during testing, and active use of involved leg muscles.

Various authors using this apparatus to test JPS have demonstrated measurable differences between insole interventions [12] in clinically different participant groups, and comparing healthy ankle subjects with injured ankle subjects in AMEDA stand and step.[10] These are studies show that AMEDA step or AMEDA stand can assess ankle JPS and can also be used as an intervention to improve JPS. But there are few or no studies comparing both the variants of AMEDA to show which can bring about better improvement in proprioception. This study aims to fill this gap by comparing the use of AMEDA step (ASTP) and AMEDA stand (ASTD) as an intervention in unstable ankles due to grade II ankle sprains in football players.

METHODOLOGY

Thirty-eight football players, between the age group of 20-30 years with a history of repeated ankle sprains were selected by convenient sampling from local football academies of Hyderabad. Players with acute ankle injuries, grade 3 ankle sprains, neurological and vestibular impairments, lower limb deformities, contractures or fractures were excluded. They were assessed with Cumberland Ankle Instability Tool (CAIT) and Kaikkonen Functional Scale (KFS) and 30 players were selected by coin toss method, as they fulfilled the criteria and were divided into two equal groups AMEDA stand (ASTD) and AMEDA step (ASTP). Informed consent was taken from the participants and were explained about what treatment they would be receiving. They were also informed that they would have to come to Apollo College of Physiotherapy for the intervention.

The AMEDA apparatus used consisted of a steel frame with a wooden sheet of 6 x 3 x 1 feet, within which an iron footplate component of 18 x 18 inches was fixed. This plate could be tilted along its central axis when stepped on into plantar flexion, dorsiflexion, inversion or eversion, depending on the direction the player faces ie., across or along the footplate. During testing and treatment, an inclinometer was placed on the plate to explain and make the patient familiar with the different angles of the foot when he or she stood or stepped on to the plate.

AMEDA Stand (ASTD) group: Participants stood on the footplate and the apparatus was randomly set at 4 angles of lateral tilt (10.2°, 13.4°, 15.6°, and 17.8°) causing inversion. Each complete AMEDA-stand test involved a standardized warm-up, in which the participant is shown all 4 stop positions corresponding to the different ankle inversion depths, in sequence from 1 to 4, given 3 times consecutively. Between active inversion movements, they were asked to return the footplate to the starting position and hold it for a standardized interval, while the next stop angle is set. Using table of random numbers, ten repetitions of each inversion angle position were used, pseudo randomized to avoid giving more than 2 consecutive repetitions of any angle. The protocol measures the

participant's ability to differentiate between the angles (Annexure IV). The participant tells the therapist which of the 4 angles he or she thinks the plate is set for each active inversion. The final, overall discrimination score is the average of the scores for the pair wise tests.

AMEDA Step: The participants had to cross the plane component with two steps and the third step is placed on the footplate and then with the fourth step, should cross the plate and step out off the apparatus walks back around to the starting point and repeats the procedure. The footplate was weighted on its lateral edge on a wooden stepper block. This block had adjustments made at 4 different angles (10.2°, 13.4°, 15.6°, and 17.8°) that could hold the plate in the desired inversion angle position before foot contact while stepping. For every repetition, the footplate angle was changed randomly by moving the wooden block. Using table of random numbers, ten repetitions of each inversion angle position were used, pseudo randomized to avoid giving more than 2 consecutive repetitions of any angle.

Because partially or wholly obscuring vision can change biomechanics and result in searching with the landing foot, participants were permitted normal use of vision throughout the trials. They were asked to look and target their step and then to raise their focus of vision and look forward horizontally as they stepped across the footplate, in order to walk with a normal, head-up posture. To reduce visual cues, the surfaces of the AMEDA were painted a homogeneous black color, so that the step across the footplate was as normal as possible, to maintain ecological validity. The same angles, number of trials, data-processing methods, and reporting used in the standing protocol were used.

After the participant was made familiar with the process, treatment was given by randomly calling out numbers from a table of random numbers and the participant must place the plate in that position in ASTD group whereas in the ASTP group, the plate was fixed in different angles and the participant had to inform at which position the plate is in. This was done for 50 times in each session and the treatment time for each participant in a group was approximately 10-20 minutes.

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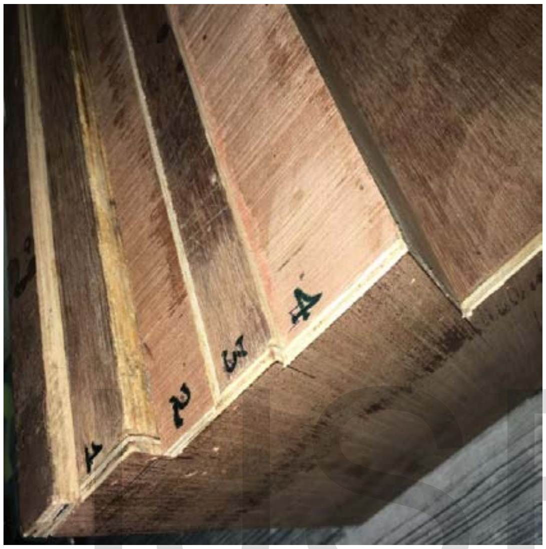
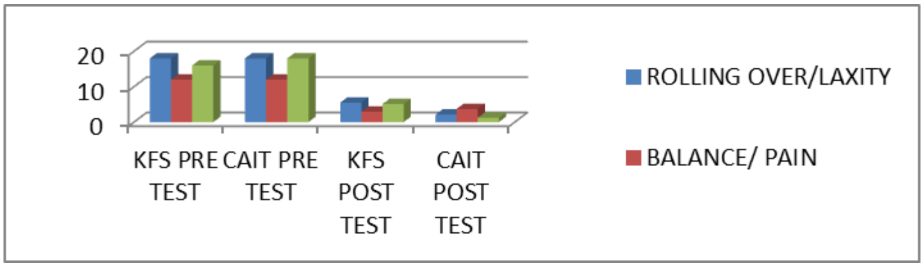


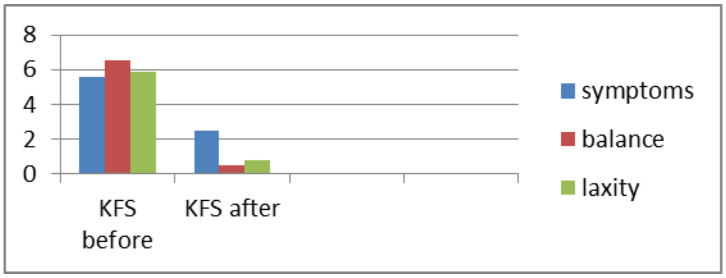
RESULTS

The current study was done of 30 football players with a history of chronic ankle instability (CAI). The male to female ratio was 2:1 (18 males and 12 females), of which 19 subjects had dominant side ankles affected and 11 subjects had non-dominant side ankles affected. AMEDA Stand group (ASTD) consisted of 15 participants (n=15), with a gender distribution of a 10 males (66%) and 5 females (33%) and AMEDA Step also consisted of 15 subjects (n=15), with a gender distribution of 8 males (60%) and 7 females (40%).

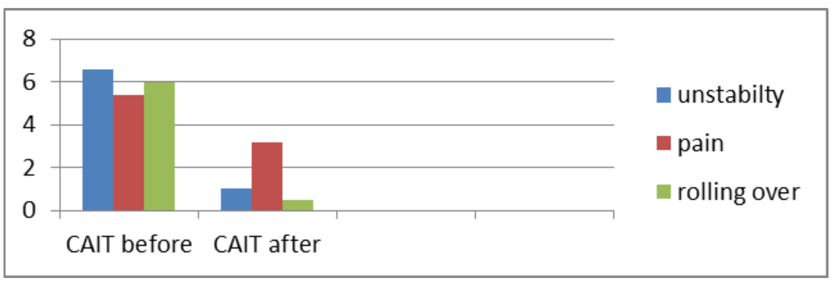
The mean age was calculated, using student t-test (ASTD = 23.2 ± 3.32 and ASTP = 22.66 ± 2.69). The intergroup comparison didn't show any difference between the groups.



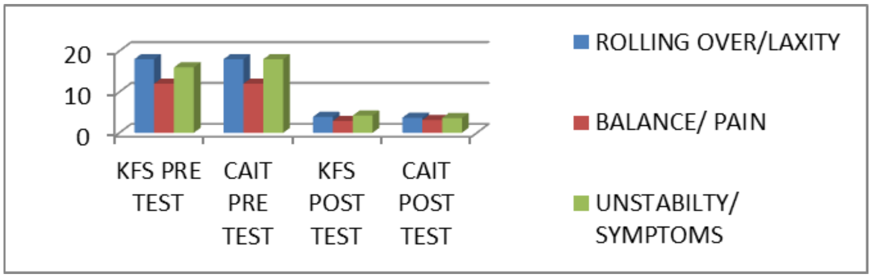
GRAPH 1: within the group both KFS and CAIT have shown positive result with p<0.05 level of significance



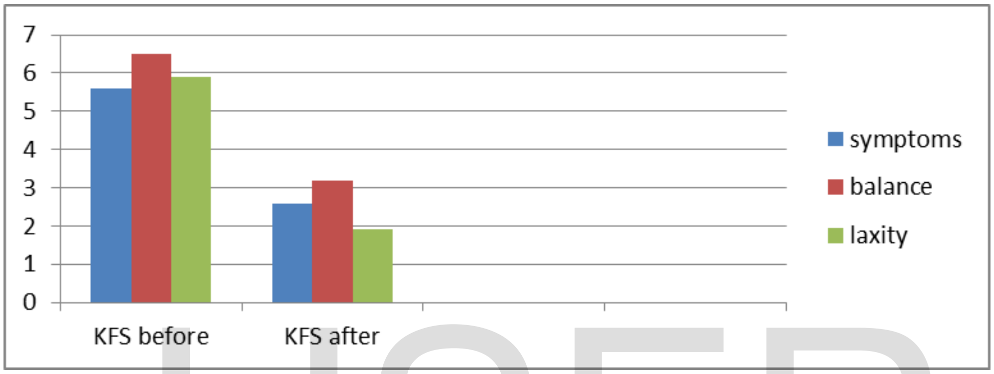
GRAPH 2 : KFS have shown the improvement in the 3rd week of treatment between the group which has increase the balance capacity and reduce the laxity with slight decrease in a symptoms in group B



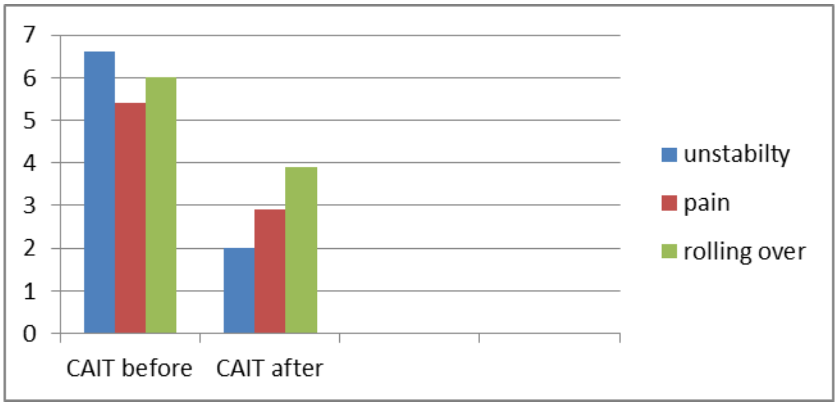
GRAPH 3: CAIT after treatment of 3 weeks improvement in performance of instability, pain and rolling over after 3 weeks of treatment in group B



GRAPH 4: within the group A both KFS and CAIT have shown positive result with $p<0.05$ level of significance



GRAPH 5 : KFS have shown the improvement in the 3rd week of treatment between the group which has increase the balance capacity and reduce the laxity with slight decrease in a symptoms in group A



GRAPH 6: CAIT after treatment of 3 weeks improvement in performance of instability, pain and rolling over after 3 weeks of treatment in group A

The baseline values for Kaikonen functional scale (KFS) and Cumberland ankle instability test (CAIT) were taken in the 1st week for both ASTP and ASTD groups and were compared with the values taken after 3 weeks of intervention. The values obtained from the players before and after treatment were subjected to statistical analysis.

There was no significant difference in the pre-test score values of Kaikkonen functional scale and Cumberland ankle instability test between the groups ($p > 0.05$) but the post-test values showed significant difference ($p \leq 0.05$). Statistical tool used to do the analysis was Wilcoxon signed ranked test.

DISCUSSION

The terms ‘Ankle Ligament Laxity’, ‘Ankle Instability’ and ‘Chronic Ankle Instability’ are often used interchangeably. Laxity is a physical sign that is objectively detected on examination, instability is a symptom which identifies the presence of an unstable ankle resulting from ligament injury and a recurrent ligament injury causes a Chronic Ankle Instability (CAI). After an inversion injury or a lateral ankle sprain, the talus rotates internally within the mortise of the ankle. The injured ligament on the lateral aspect of the ankle, now, will not be able to provide stability at all the positions of the tibio-talar joint movement.[26] An athlete with such an instability may describe a feeling of the ankle giving way during the game.

It has been proposed that ankle injury not only causes injury to the nervous and musculo-tendinous tissue but may also disrupt joint afferents located in the supporting ligaments. Following recurrent injuries, proprioceptive deficits are likely to occur that may manifest as reduced joint position sense[10]. The ability to detect motion in the foot and to make postural [10] adjustments in response to these detected motions is thought to be crucial in the prevention of ankle injury[4]. Similarly, the ability of an individual to detect the position of the foot before foot contact is important.

On further continuing the game, repeated ankle sprains cause chronic ankle instability and each subsequent sprain leads to further weakening (or over stretching) of the ligaments, resulting in greater instability and the likelihood of developing additional problems in the ankle. The ability to balance and maintain the foot arch is often affected because of the damage to the proprioceptors.[18]

AMEDA (Active movement extent discrimination apparatus or Active movement extent discrimination assessment) was developed to assess and improve the joint position sense (JPS) or proprioception at the ankle joint by Gordon Waddington et al. In his study, he used 50 trails on AMEDA, to assess the ability and to discriminate between a set of different small movements at different inversion angles (10.49°, 11.84°, 12.55°, 13.27° and 14.52°). He concluded that individuals with ankle instability improved with repeated test situations causing an implicit learning effect (improved performance, by repeated exposure to the task without any external feedback) [10].

The current study was done on 30 football players with CAI, to check whether AMEDA-step or AMEDA-stand would produce higher Joint Position Sense (JPS) scores, representing greater JPS acuity, or whether both would have the same acuity. 18 male and 12 female participants were recruited by convenient sampling into the study and were streamlined into two groups, AMEDA stand (group A - ASTD) and AMEDA step (group B - ASTP), by coin toss. Both the groups were assessed by the CAIT (Cumberland ankle instability) and KFS (Kekkonen functional scale) questionnaire in the 1st week and 3rd week and were statistically analyzed. The difference in the initial scores (1st week) of CAIT and KFS of ASTD and ASTP was less because of the initial low Joint Position sense (proprioception).

In the current study, for analytical examination, the movement stimuli were given as a signal (voice command), to know the inclination (inversion) values by inclinometer for the stimulus. This nonparametric (by Random Numbers Table) voice command method measures the actual ability of proprioceptive mechanism of the sensorimotor system. AMEDA gave the players an improved capacity to differentiate midrange inversion angles and thus an overall learning effect for each test repetition. Altered neuromuscular biomechanics has been associated with differences in positioning of the foot and ankle leading to episodes of inversion sprain. AMEDA helped to correct the altered biomechanics of the ankle joint by repetition.

The treatment protocol was for 3 weeks, 6 day a week. The duration of the testing sessions was 10 – 20 minutes. On the first day of AMEDA step and AMEDA stand, duration of testing / treatment was nearly 20 minutes. This was due to the lack of confidence of the player on the apparatus. As the treatment period progressed, the time on the table reduced, suggesting an increase in the confidence of the players. On the 18th day, the duration of testing / treatment in AMEDA stand group reduced to 10 minutes and in AMEDA step group to 8 minutes. The 3 weeks of testing / treatment on AMEDA, lead to learning mechanisms of required angles (Implicit Learning) which improved performance. Implicit learning occurs most efficiently when the demands of the task are different.[27].

In the current study out of 30 players, 19 players had unstable ankles in the dominant limb and 11 players in the non-dominant limb. Side specificity has more prominence in achieving proprioceptive skills. Dominant limb on AMEDA-step and stand has shown more confidence and improvement. This might be due to more stabilizing part of the non-dominant limb. Previous studies have shown activity specific nature of motor skills and functional difference between preferred (dominant) and non-preferred (non- dominant) limbs [5].

The non-preferred upper limb is usually used in statically stabilizing objects in a specific position to the preferred upper limb to manipulate in some way, for example removing a jar lid or hammering a nail. Similarly during AMEDA stand (group A) testing protocol the non-dominant legs was used more for statically stabilizing in overcoming pelvic rotations while controlling the AMEDA plate in inversion, and in the AMEDA step (group B) the non-preferred lower limb is usually used in stabilizing the body to the preferred lower limb to swing while stepping across the AMEDA apparatus. Thus, joints in non-preferred limbs are more likely to receive more "positioning" practice, resulting in more accurate discrimination of movement. This finding is also consistent with Sainburg's proposition that the non-preferred arm/hemisphere system is specialized for limb position control [5] and the results of ankle joints in the current study indicate that the non-preferred leg/hemisphere system follows the same rule.

The AMEDA-step tests the participant's ability to distinguish between angles of inversion tilt as he or she actively stepped across the apparatus. The AMEDA-stand test incorporates more movement from other joints of the limb, which has been shown to be important contributors to ankle proprioception, and allows greater feedback from the vestibular and visual systems, as is normal in functional activity. In spite this, the AMEDA-stand group showed a lower joint position sense scores than AMEDA-step group in clinical findings but statistically there was no significant difference observed between the groups scores.

During testing, sometimes, the players used trick movements by confirming the numbers while repositioning the required angle. This gave them time to adjust the given angles. All the participants were tested barefoot. It would have been appropriate to test them in their sport shoes which might help them in their game.

CONCLUSION:

This study has shown the greater improvement in proprioception of treating recurrence ankle sprain patients in both the subjects with AMEDA stand AMEDA step. This study hypothesized alternatively the AMEDA step would be more better in AMEDA stand protocol. And finally conclude the AMEDA step has shown more improvement in joint position score clinically significant.

The improvement shown in this study is assisted by gains in confidence with repetition in AMEDA step compare to AMEDA stand. It may be that the treatment protocol was designed in such a way to overcome functional changes in mobility patterns (like walking) by directly exposing with standing at one place to workloads and tasks involving proprioceptive challenges.

Patients with chronic pain can improve their function and build confidence to overcome fear and avoidance of pain by exposure in their living style by workloads that they normally avoid.

There are some certain limitations in this study where the effect of voice command during proprioceptive ability study and some behavioral changes (eagerly doing) in subjects while testing and treating upon the AMEDA table .and the accurate sensory feedback while performing barefoot.At the same time the non-dominance side behavior of motor control.

It is to be recommended that the study needed on barefoot treatment in AMEDA Step and stand with acute sensory feedback and non-dominance side behavior with the behavioral changes such as imposing our self to get in the accuracy of performance and with clear and accurate voice command mechanisms.

ANNEXURE IV

NAME: AGE: WEIGHT: CAIT: KFS:
AMEDA: STEP/STAND HEIGHT: GROUP: A/B SIDE: L/R DATE:

days		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1																		
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33	1																		
34	3																		
35	4																		
36	2																		
37	1																		
38	4																		
39	3																		
40	2																		
total																			

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