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EDITORIAL

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Prof. Sami AlAbdulwahab PT PhD
Editorial-in-chief,
International Journal of Physiotherapy Research & Practice

DYNAMIC BALANCE DEFICIT AND RECOVERY TIME AFTER AEROBIC AND ANAEROBIC FATIGUE PROTOCOLS

Kumar S.*, Nuhmani S.**, Anand P.***

ABSTRACT

Introduction:. Impaired dynamic balance is more critical then static balance in sports. There appear to be relationship between altered postural control and deficit in static postural control related to different fatigue exercise and its recovery time have been investigated, but there is little evidence to link aerobic and anaerobic fatigue to measures of dynamic postural control. **Purpose:** The purpose of this study was to evaluate the effect of aerobic and anaerobic fatigue protocols on dynamic balance and to investigate recovery time from each exercise protocol in which dynamic balance returns to baseline. **Method:** 30 college level healthy athletes participated in the study. Each subject participates in aerobic and anaerobic fatigue protocols on different days. Dynamic balance and exertion level was checked by 3 reaching directions of star excursion balance test (SEBT) and Borg's 15 point scale immediately after each fatigue protocols and after fatigue at 4, 8, 12, and 20 min. **Result:** Decrease in dynamic balance after each fatigue protocol as measured by decrease in3 reach directions of star excursion balance test (SEBT). Dynamic balance comes to baseline in 12 minute after anaerobic fatigue protocol and in 16 minute after aerobic fatigue protocol. Exertion scores is increased after each fatigue protocol and recovered in same time as their respective dynamic balance recovered. **Conclusion:** Aerobic and anaerobic fatigue protocols have negative effect on dynamic balance. Dynamic balance is impaired after each type of exercise as evident by SEBT reading. Recovery of dynamic balance was faster after anaerobic fatigue protocol (12 min) as compared to aerobic fatigue protocol (16 min.).

Key words: Dynamic balance, fatigue, recovery, SEBT, RPE.

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INTRODUCTION

Balance can be defined as ability to maintain body's center of gravity over its base of support with minimal sway or maximal steadiness[14] .Balance can also be defined as ability of body to maintain equilibrium and orientation within base of support[1]. Maintaining an upright posture involves controlling an inherently unstable system and this task is performed by postural control system (PCS)[2].

Balance or postural control can describe as either static or dynamic[3]. Dynamic postural control involves the completion of a functional task with purposeful movements without compromising an established base of support[4]. Dynamic postural control is important in many functional tasks as it requires integration of appropriate level of proprioception, range of motion and strength[5].

Maintenance of the state of dynamic equilibrium needs systematic involvement with feedback from the ocular, vestibular, kinesthetic and auditory systems[6]. Dynamic balance is

important for an athlete because falls will result if the athlete's strategies are unsuccessful and inefficient balance strategies will result in poor athletic performance[7].

Significance of balance to joint function, stability, injury prevention has been well documented. In sports, an athlete is usually attentive to game and activity is dynamic in nature at the time of injury[8]. Fatigue is one of the most important factor which limits sustained exercise in sports. Fatigue is often associated with increased clumsiness[9]. Immediate effect of fatigue is reduction in ability to apply muscular force. Reduced ability can impair efficiency of muscular skills and performance[21]. Studies have shown relationship between performance under fatigue and increase incidence of injury[10-12].

Fatigue has been shown negatively affect static and dynamic balance. Litrature[13], demonstrate moderate fatigue induced by fast walking in treadmill decrease dynamic balance. A study[14], demonstrate chronic ankle instability and fatigue disrupted dynamic balance. Similarly, another study[15], found a decrease in postural stability as a result of a 7-station, 20 min exercise protocol as measured by BESS total error score. Although they investigated fatigue as a combined function, of aerobic and anaerobic activity, they did not clearly delineate between fatigue effects related to one versus other.

Few authors have investigated the immediate recovery time after fatigue for postural control measures return to baseline. They use the protocol lasting 20 minute or longer and they shows that balance recovers within 20 minute after fatigue protocol$_{16}$. More importantly, they combined aerobic and anaerobic exercise into protocol and they study only static balance by using BESS scores system. In sports, impaired dynamic balance is mire critical then static balance. .

The purpose of this study is to evaluate what is the effect of aerobic and anaerobic fatigue protocols on dynamic balance and to investigate its recovery time.

Material & Method: 30 college athletes which were healthy and asymptomatic, without any neuromuscular, orthopaedic, cardiovascular conditions were recruited from Indira Gandhi Institute of physical science. Subjects were recruited from those who voluntarily come forward to participate in the study.

All the subjects were made aware of the purpose and procedure of the study.

Each subject was asked to participate in two fatigue groups (aerobic and anaerobic group). In aerobic group aerobic fatigue protocol is applied on each subject for 1 time. In anaerobic group anaerobic fatigue protocol is applied on each subject for 1 time.

The independent variables were aerobic and anaerobic fatigue protocol. Aerobic fatigue protocol was yo-yo intermittent recovery test level 1 and anaerobic fatigue protocol was yo-yo intermittent recovery test level 2.

Dependent variables were dynamic balance and perceived exertion. Dynamic balance was measured by star excursion test (in 3 directions out of 8 directions) and perceived exertion by Borg's 15 point scale.

Procedure: The potential volunteered candidates were explained nature and purpose of study and those agreed to participate were given the screening questionnaire to judge their suitability for the study. Eligible candidates underwent consent taking.

Descriptive variables of all subjects, such as age, height, sex and limb length were recorded. Each subjects attended 1 practice session and 2 testing sessions. Subjects perform1 practice session familiarize themselves with SEBT, RPE scores and fatigue protocols.

Each subject reported for 2 testing sessions. Each testing session included 1 exercise protocols. To allow for an adequate physical recovery, testing sessions were 7 days apart.

On the test day, subjects were asked to self stretch as needed before testing to prevent injuries during balance testing and exertion protocol. Out of eight directions only three directions (anteromedial, medial, posteromedial)[17] was used in this star excursion balance test (SEBT) [18]. Subjects were allowed to practice SEBT reaching in each direction six times to minimize the learning effect[19].

The baseline measures of SEBT was taken by performing 3 trials in each of the 3 directions(anteromedial,medial, posteromedial) and perceived exertion noted through borg's 15 point scale (scale of rating of perceived exertion)[4].

The subjects in each of the test group were tested once before the exertion protocol (pre-test) and then specific fatigue protocol was given depending upon the group in which they were on that particular day.

The subjects in the aerobic and anaerobic test group were monitored for their exertion level and told to continue the test until they feel exhausted and cannot continue further. When subject failed to reach finish line before audible

beep on 2 runs he or she considered fatigued and exertion protocol was terminated.

After completion of test protocol these test groups were tested immediately for the dynamic balance and perceived exertion then again at 4 min, 8min 12min, 16min, and 20 min.

Exercise protocol[20,21]

The protocol was performed on running lines with a width of 2m and length of 20m. Another 5m distance behind the finishing line marked the walking distance during active recovery period.

Before exercise protocol all participants carried out worm-up and stretching period consisting of first 2 running internal followed by back and lower extremity stretching. The Yo-Yo Intermittent Recovery Test is both reliable and valid in relation to Stressing Aerobic and Anaerobic metabolic pathway[22].

Aerobic Exercise Protocol[23]– We used yo-yo intermittent recovery test, level 1 to elicit the fatigue. This test consist of repeated 20-m shuttle run from starting line to turning point and then finishing line at progressively increased speed controlled by audible tapes delivered at known frequency. The protocol began with 4 running bout 10 to 13 km/hr over the first 160m, followed by 7 running bout at 13.5 to 14 km/hr. (160 to 440m) it continued with stepwise 0.5 km/hr. speed increments after every 8 running bouts (i.e. after 760, 1080, 1400, 1720 m etc.) until the participant become fatigued. Between running bouts, the subject have 10 sec. active rest period consisting of 5m walk / jog at his or her own pace. When subject failed to reach finish line before audible beep on 2 runs he or she considered fatigued and exertion protocol was terminated. The missed runs did not have to occur in consecutive order for the participant to be deemed fatigued.

Anaerobic Exercise Protocol[24] - This test starts at 13km/hr speed. In Second running bout speed is 15km/hr. then in next two bouts speed is 16km/hr (total accumulated distances is 160 meters).Then it continued with stepwise 0.5 km/hr. speed increments after every running bout until the participant become fatigued. If subject failed to reach the finish line twice during the test, subject is considered fatigue. Borg 15 point (16 to 20) category rating scale was used to measure each participant's RPE to ensure exertion is adequate.

Data analysis: Data analysis was done using SPSS (version 13) software system. Demographic data of subjects including age, height, weight, and leg length were descriptively summarized. The General linear model of repeated

measures analysis of variance (ANOVA) was used to examine all the conditions separately for balance and perceived exertion. Paired t-test was applied within each fatigue group to compare base line value of dynamic balance and RPE with post test value to calculate recovery time. Bonferroni post hoc analysis was done in each condition to know if there was significant difference. The significance level set for the study was $p<0.05$.

RESULTS: For our study 30 subjects with a mean age of 30±8.8 yaers were selected. The mean high, weight & leg length were 172±7.2, 69±5.4 & 95±4.5 respectively.

Table 2. Total SEBT and RPE scores in aerobic group.

	SEBT	RPE
Pre test	267.2±3.7	6.7±0.36
Post-test 1	233.9±4.6	17.5±0.5
Post test 2	242.9±3.8	14.9±0.7
Post test 3	255.1±3.6	12±0.6
Post test 4	262.7±3.4	7.72±.69
Post test 5	267.9±3.6	6.32±.36
Post test 6	267.3±3.9	6.28±.34
F	1563	3182
P	0.0001	0.0001

Table 2 shows that exertion level and dynamic balance is significantly affected in aerobic fatigue exercise.

SEBT	Mean±S.D	t	p
PRE – POST 1	33.4 ± 3.9	46.7	0
PRE – POST 2	24.4 ± 3.2	42.13	0
PRE – POST 3	12.2 ± 1.8	37.33	0
PRE – POST 4	4.5 ± 1	24.94	0
PRE – POST 5	0.1 ± 0.5	0.48	0.634
PRE – POST 6	0.1 ± .9	0.29	0.77

Table 3.Comparison of SEBT scores in aerobic group

RPE	Mean±S.D	t	p
PRE – POST 1	11.20 ± 00.61	-100.52	0.000
PRE – POST 2	08.61 ± 00.76	-61.93	0.001
PRE – POST 3	05.66 ± 00.62	-50.01	0.001
PRE – POST 4	01.41 ± 00.79	-09.70	0.001
PRE – POST 5	00.01 ± 00.56	-00.16	0.873
PRE – POST 6	00.01 ± 00.56	00.16	0.873

Table 4. Comparison of RPE scores in aerobic group

Table 3 and 4 shows dynamic balance and perceived exertion come to baseline in 16 min after aerobic fatigue protocol.

	SEBT	RPE
Pre test	267.21±3.55	6.28±.34
Post test 1	233.43±4.38	17.62±.52
Post test 2	245.84±4.31	12.57±1.92
Post test 3	263.03±3.96	7.9±.62
Post test 4	267.28±3.50	6.37±.37
Post test 5	267.27±3.56	6.25±.34
Post test 6	267.26±3.67	6.27±.34
F	1599.279	828.975
P	.0001	.0001

Table 5. Total SEBT and RPE scores in anaerobic group.

Table 5. Shows that and dynamic balance and exertion level is significantly affected in anaerobic fatigue exercise.

SEBT	Mean ± S.D.	T Value	P Value
PRE – PT 1	33.77 ± 03.97	46.54	0.000
PRE – PT 2	21.37 ± 02.96	39.42	0.000
PRE – PT 3	04.17 ± 01.14	19.95	0.000

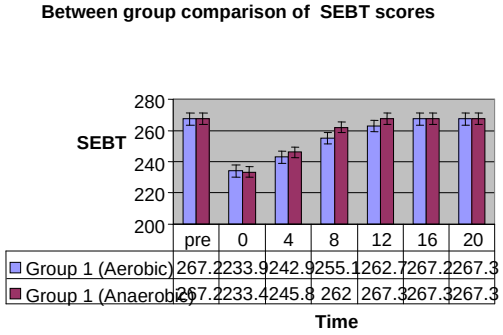
PRE – PT 4	00.07 ± 00.51	00.76	0.449
PRE – PT 5	00.06 ± 00.63	00.54	0.589
PRE – PT 6	00.05 ± 00.73	00.41	0.678

Table 6.comparison of SEBT scores in anaerobic group

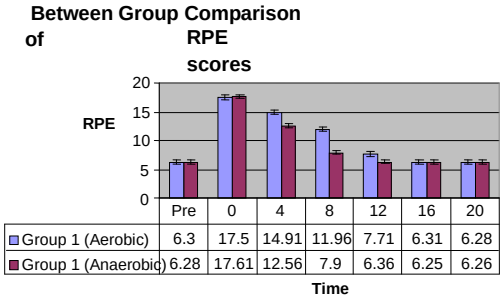
RPE	Mean ± S.D.	T Value	P Value
PRE – PT 1	11.33 ± 00.63	-97.86	0.000
PRE – PT 2	06.28 ± 01.88	-18.27	0.000
PRE – PT 3	01.61 ± 00.72	-12.17	0.000
PRE – PT 4	00.08 ± 00.57	-00.79	0.433
PRE – PT 5	00.03 ± 00.57	00.32	0.752
PRE – PT 6	00.01 ± 00.56	00.16	0.873

Table 7.comparison of RPE scores in anaerobic group

Table 6 and 7 shows dynamic balance and perceived exertion come to baseline in 12 min after anaerobic fatigue protocol.



Between group comparison of SEBT scores



Between group comparison of RPE scores

Discussion: The primary purpose of the present study was to evaluate the effect of fatigue on dynamic balance after aerobic and anaerobic fatigue protocols. Secondary purpose was to establish an immediate recovery time from each fatigue protocol over which the effect of fatigue lessened and dynamic postural control measures returned to baseline.

The result of this study shows that both aerobic and anaerobic exercise protocols adversely affects dynamic balance as measured through the star excursion balance test (SEBT). Zachary G Fox et al[33] (2008) evaluate the effects of fatigue on postural control in healthy college-aged athletes performing anaerobic and aerobic exercise protocols, they concluded that postural control was negatively affected after anaerobic and aerobic exercise protocols as measured by total BESS score, elliptical sway area, and sway velocity.

Wilkins et al (2004)[29] studied the effect of fatigue protocol consisting of sprinting, jogging, step ups, and found that fatigue group scored more errors than control groups on posttest than on pretest. They measured balance by balance error scoring system (BESS) and concluded that factors that could potentially cause a decrease in balance performance after fatigue could focus on both central and peripheral means of fatigue. The factors that could potentially cause a decrease in balance

performance after fatigue focus on both central and local means of fatigue.

Philip A gribble et al (2004)[11] investigates the effect of fatigue and chronic ankle instability on performance measures of dynamic postural control task. They concluded that chronic ankle instability and fatigue disrupted dynamic balance postural control.

Ludin et al (1993)[21] examined the effects of plantar flexor and dorsiflexor fatigue on postural control. The fatigue protocol resulted in significant increase in mediolateral postural sway amplitude and increase in anteroposterior postural sway.

Localized muscle fatigue is influenced by decrease in metabolic substrates available for muscle contraction , as well as increase in metabolites including lactic acid in muscle, resulting in inability to maintain desired muscular force output. Contraction mechanism and neuromuscular junction impairments constitute peripheral fatigue[27].

Localized muscle fatigue impairs proprioceptive (position perception) inputs, by adversely affecting muscle spindle activity and disrupting mechanoreceptor (somatosensory) feedback (Johnstan et al., 1996)[17]. Impairment of the somatosensory system by localized muscle fatigue (LMF) might perturb the sensory inputs to the CNS. In addition to this, fatigue also affects the efferent pathway (by affecting motor performance) of the postural control system directly (Enoka and Stuart, 1992)[8].

The present findings that balance decrease after fatigue has been demonstrated in investigations using various methods of causing central fatigue. Martin Simoneau (2006)[22] examined how moderate fatigue induced by fast walking in treadmill challenge dynamic balance control and attention demand. Concluded that the fatigue induced by fast walking had an initial negative impact on control of centre of pressure.

Alejandro et al (2009)[1] Study the immediate effect of an upper body fatigue protocol on the performance of star excursion balance test (SEBT). Their results demonstrate that SEBT reach distance decrease immediately after the fatigue protocol, demonstrate that balance ability diminished.

During prolonged aerobic exercise CNS mechanisms have been implicated in the fatigue process[5]. Reduction in CNS drive to the muscle may be mediated by afferent feedback from muscle or reduction on corticospinal impulses reaching the motorneurones. A

reduction in corticospinal impulses reaching motoneurones could be result of alterations in neurotransmitter function in brain[5].

Meeusen et al (2006)[23] showed that serotonin levels in brain increase after aerobic exercise when plasma concentration of free tryptophan (TRP) also increased. This caused fatigue because of its role in arousal, sleepiness and mood.

Thus mainly CNS as well as some component of peripheral mechanisms influence fatigue during aerobic exercise. Thus its can be said that fatigue can result from combination of peripheral and central factors and fatigue caused by these resulted in impaired balance ability.

Another finding was that SEBT scores increased with time. This was because as the effect of fatigue weaned off dynamic balance started to recover. Rate of recovery was different in both protocols. The dynamic balance had recovered in 16 minutes in aerobic protocol and 12 minutes in anaerobic protocol.

Yaggie and Armstrong (2004)[31] observed transiently degraded postural control after fatigue from bouts of exercise performed on a cycle ergometer as measured by postural sway. Changes in balance indices were observed immediately after fatigue and returned to baseline values within 10 minutes of recovery. Susco et al[28] showed that balance recovered within 20 minutes after fatigue protocol because both the central and peripheral fatigue mechanisms were involved in fatigue process and central fatigue mechanisms require much more time for recovery as compared to peripheral.

Baker et al (1993)[2] demonstrated that most of the anterior tibialis muscle force is recovered within 15 minutes after long duration fatigue protocol and after short duration fatigue protocol recovery occurred in 5 minutes. They said that during short duration activities metabolic processes come into play and this causes early recovery whereas during long duration it is the non-metabolic factors that delay the recovery.

Emma et al (2007)[7] showed that peripheral and central fatigue after a marathon (42.2 km) on a treadmill lead to maximal voluntary contraction decrease and remained significantly decreased after 4 hrs.

Researchers have used different methods and fatigue protocols as well as different variables to measure fatigue effects. So, the recovery time from fatigue have varied results, high intensity short duration exercise

protocol which target mainly the peripheral mechanism has more rapid recovery as compared to medium intensity exercises protocol for long duration which target mainly the central mechanism

The Borg's 15-point scale was used to measure each participant's RPE as the criterion to confirm fatigue after each exercise protocol[4]. Using the 15-point Borg scale, Seliga et al. (1991)[26] showed perceived exertion scores increased significantly with increase in work load. The result of our study also demonstrates that immediate post test RPE readings were increased as compared to pre test in both the protocols. The RPE value ranged from 13 to 14.2 at 70% VO_2max across the exercise modes to 15.4 to 16 at 80% and 18 to 18.2 at 90% . Immediately after the aerobic exercise protocol, mean RPE was 17.5, whereas the anaerobic exercise protocol produced a mean RPE of 17.62. Both values suggest that participants' levels of exertion reached very, very hard.

Therefore, we feel confident that, during our protocol, subjects were working at a level greater than 80% VO2max at the end of protocol, and the decrease in SEBT performance noted during the posttest was a result of their fatigue

Recovery rate of RPE values in both the protocols were different. This can be related to rate of recovery will be different according to duration and intensity of exercise. RPE value in aerobic protocol returned to base line in 16 minutes and 12 minutes in anaerobic protocol.

When comparing the two fatigue protocols for SEBT scores and rating of perceived exertion scores it showed that there was insignificant difference for the pretest readings in both the fatigue protocols. Decrease in reach distance in SEBT and increased perceived exertion immediately after both fatigue protocols demonstrate that due to fatigue dynamic balance ability diminished. Recovery was different for aerobic and anaerobic fatigue protocols.

Conclusion: Aerobic and anaerobic fatigue exercises have negative effect on dynamic balance. Dynamic balance is impaired after each type of exercise as evident by SEBT reading. Recovery of dynamic balance was faster after anaerobic fatigue exercise (12 min) as compared to aerobic fatigue exercise (16 min).

References

1. Alejandro camps olmedo, Juan rojo rodriguez. Effect of upper body exercise on dynamic postural

control. Buenos Aires. 2009 ;14-135.

2. Baker A.J. Kostov K.G. Miller R.G. Weiner M.W. Slow force recovery after long duration exercise: metabolic and activation factor in muscles fatigue. J. Appl. Physiol. 1993; 74(5); 2294-2300.
3. Blackburn T, Guskiewicz KM, Petschaur MA, Prentice WE. Balance and joint stability:the relative contributions of proprioception and muscular strength. *J Sport Rehabil*.2000;9:315-328.
4. Borg GA. Psychophysical bases of perceived exertion. Med Sci Sports Exerc. 1982;14(5):377–381.
5. Davis J.M., Bailey S.P. Possible mechanisms of central nervous system fatigue during exercise. Med Sci Sports Exercise. 1996; 29(1): 45-57
6. Derave W., Clerco D.D. The influence of exercise and dehydration on postural stability. Ergonomics.1998; 41(6): 782-789
7. Emma Z. Ross, Natalie middleton, Rob shave,Keith george. Corticomotor excitability contributes to neuromuscular fatigue following marathon running in man. Exp Physiol. 2006; 92.2; 417-426.
8. Enoka, R.M. and Stuart, D.G. (1992). Neurobiology of muscle fatigue. *J Appl Physiol* **72**(5): 1631-48.
9. Gambetta V. Everything in balance. *Train Cond*. 1996;1:15-21.
10. Gerlach K.E., White S.C. Kinetic changes with fatigue and relationship to injury in female runners. Med. Sci. Sports Exercise. 2005; 37(4): 657-663.
11. Gribble PA, Hertel J, Denegar CR, Buckley WE (2004). The effects of fatigue and chronic ankle instability on dynamic postural control. *J Athl Train* 39(4):321-329.
12. Hertel J, Miller SJ, Denegar CR. Intratester and intertester reliability during the star excursion balance tests. *J Sport Rehabil*. 2000;9:104-116.
13. Hertel J, Braham R, Hale S, Olmsted-Kramer L. Simplifying the star excursion balance test: analyses of subjects with and without chronic ankle instability. *JOrthop Sport Phys Ther*. 2006;36(3):131-137.
14. Horak Fay B. Clinical measurement of postural control in adults. Physical Therapy. 1987; 67 (12): 1881-1885
15. Irrgang JJ, Whitney SL, Cox ED. Balance and proprioception training for rehabilitation of the lower

extremity. *J Sport Rehabil*. 1994;3:68-83.

16. Jens Bangsbo F. Marcello Iaia and Peter Krustrup,. The Yo-Yo Intermittent Recovery Test A Useful Tool for Evaluation of Physical Performance in Intermittent Sports", Sports Med 2008; 38 (1): 37-51
17. Johnston, R.B., Howard, M.E., Cawley, P.W., & Losse, G.M. (1996). Effect of lower extremity muscular fatigue on motor control performance. *Medicine & Science in Sports & Exercise*. 30(12): 1703-07.
18. Kinzey SJ, Armstrong CW. The reliability of the star-excursion test in assessing dynamic balance. *J Orthop Sports Phys Ther*. 1998;27:356-360
19. Krustrup P. Mohar M. Amstrup T. Rysgaard T. Jonhansen. The yo-yo intermittent recovery test; physiological response, reliability and validity. Med sci sprts exer. 2003 apr 35(4): 679-705.
20. Lephart, S.M., Pincivero, D.M., Rozzi, S.L. (1998). Proprioception of the ankle and knee. *Sports Medicine*. 25(3): 149-155.
21. Lundin, T.M., Feuerbach, J.W., & Grabiner, MD. (1993). Effect of plantar flexor and dorsiflexor fatigue on unilateral postural control. *Journal of Applied Biomechanics*. 9:191-201.
22. Martin Simoneau, Francois begin, Normal Teasdole. The effect of moderate fatigue on dynamic balance with attentional demands. Journal lf neuroengineering and rehabilitation . 2006; 3; 22.
23. Meeusen, R., Watson, P., Hasegawa, H., Roelands, B. and Piacentini, M.F. Central fatigue: the serotonin hypothesis and beyond. *Sports Med.2006;* **36**(10): 881-909.
24. Riemann BL, Caggian NA, Lephart SM. Examinations of clinical method of assessing postural control during functional performance task. J of sports rehab. 1999. 8;171-183 .
25. Sharpe M.H., Miles T.S. Position sense at the elbow after fatiguing contractions. Exp. Brain Res. 1993; 94: 179-182
26. Seliga R, Bhattacharya A, Succop P, Wixhstrom R, Smith D, Willeke K (1991). Effect of work load and respirator wear on postural stability, heart rate, and perceived exertion. *Am Ind Hyg Assoc* J 52:417-422.
27. St Clair Gibson, A. and Noakes, T.D. (2004). Evidence for complex system integration and dynamic neural regulation of skeletal muscle recruitment during exercise in

humans. *Br J Sports Med* **38**: 797-806.

28. Susco TM, Valovich McLeod TC, Gansneder BM, Shultz SJ. Balance recovers within 20 minutes after exertion as measured by the Balance Error Scoring System. J Athl Train. 2004;39(3):241–246.
29. Wilkins JC, Valovich McLeod TC, Perrin DH, Gansneder BM.Performance on the Balance Error Scoring System decreases after fatigue. J Athl Train. 2004;39(2):156–161.
30. Winter D, Patla A, Frank J. Assessment of balance control in humans. *Med Progress Through Tech.* 1990;16(1):31-51.
31. Yaggie J, Armstrong WJ. Effects of lower extremity fatigue on indices of balance. J Sport Rehabil. 2004;13(4):312–322.
32. Yaggie, J.A., & McGregor, S.J. (2002). Effects of isokinetic ankle fatigue on the maintenance of balance and postural limits. *Archives of Physical Medicine Rehabilitation*. 83: 224-8.
33. Zachary G Fox, Mihalik JP, Blackburn JT, Battaglini CL, Guskiewicz km. Return of Postural Control to baseline after anaerobic and Aerobic

EFFECT OF SENSORY RETRAINING, ON LOWER LIMB MOTOR RECOVERY & FUNCTIONAL OUTCOMES IN ACUTE STROKE.

Mayank B. Gupta*, Mona P. Maurya**, Anjali Syal***

ABSTRACT

Introduction: Several studies have shown promising results in the treatment of rehab upper limb sensations after stroke using sensory retraining. Majority of studies have been done in patients with chronic stroke but little has been done in the initial period **Methods:**30 ischemic stroke patients with sensory impairments (NIHSS stroke scale) were selected and were divided into experimental group receiving sensory retraining of foot along with conventional rehab protocol and control group receiving only conventional rehab on basis of MRP the motor recovey and functional outcomes of patients were analysed for within and between group improvements at day 0, 2 weeks and 4 weeks. **Results**: Significant improvement occurred within each group at both 2 and 4 weeks although no significant difference was found between the experimental and control group after 2 weeks of retraining protocol but after 4 weeks significant difference was found between the experimental and control group in both the variables: motor recovery(STREAM) and functional outcomes(Barthel Index).**Conclusion:** The use of sensory retraining in functional weight bearing positions for the lower extremity leads to better levels of motor recovery and functional profile of patients by activating the normal sensory motor and neuromuscular pathways required for motor activities and minimizing the detrimental effects of learned non use phenomenon than providing them conventional rehabilitation alone.

Key words: Stroke, sensory retraining, motor recovery, functional outcomes

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Stroke is a major cause of disability worldwide. Incidence of dependency in ADL's is highest in the phase immediately after stroke and decreases thereafter[2]. The ultimate stroke outcome are not at impairment level but rather at functional and disability level[1].

Sensory impairments common after stroke occurring in almost 60% of stroke patients and have received less attention although its effect on functional outcome is known. Bobath stated that the patient with severe and persistent sensory deficit has poor prognosis for functional recovery [3].Impaired discriminative sensations such as texture discrimination, two point discrimination and point localization are frequently observed in patients with unilateral stroke [4] and these subtle sensory changes may contribute to patient's neurological disabilities and functional outcomes of stroke patients [5].

The learned nonuse phenomenon occurring with sensory loss leads to further deterioration of motor abilities[7]. Plasticity of somatosensory system has also been highlighted in studies on

intact animals [8].Damaged brain is considered to be more plastic and sensory afferents have been found to have an influence over motor efferents as well[9].

If left untreated sensation tends to improve in the first three months following stroke[10].Several studies have shown promising results in the treatment of rehab upper limb sensations after stroke using sensory retraining. Majority of studies have been done in patients with chronic stroke but little has been done in the initial period [3,11,12].

Sensory retraining uses concentration and exposure to different sensory inputs education about sensory loss[3]to enhance sensory awareness

Although there is some evidence that sensory retraining for stroke patients with sensory dysfunction of feet is effective more research was required particularly in acute period after stroke to measure its effectiveness and to analyze the benefits of sensory retraining Vs spontaneous recovery of sensory system that usually occurs around 3 months.

Methods: A sample of 30 subjects was selected from All India Institute of Medical Sciences, New Delhi .The subjects were randomly allocated to either the experimental or the control group of equal sample size. The subjects underwent neurological assessment and were screened to meet the inclusion/exclusion criteria. Inclusion criteria:1)Patients receiving in-patient rehabilitation following first ever ischemic stroke.2)Age group of 40-65 yrs3)Sensory dysfunction. (Grade 1 on sensory examination using NIHSS scale) 4) Stage 2 and 3 of Brunnstorm stages of recovery for lower extremity. 5) Medically stable.6)Gave informed consent7)Patients with normal cognition and attention levels with MMSE score of 24 or above.8) Able to stand and walk 10 m with no more than 1 person assisting.

Exclusion criteria:1)Patients with communication deficits and perceptual deficits assessed by standard tests like line bisection test.

2) Pre existing sensory deficits from any other neurological deficit or peripheral neuropathies.

3) Used a walking aid prior to stroke.

4) Patients with orthopedic manifestations such as arthritis, PTS, fractures etc

Study design:The study was designed as a two group pre test post test study. Experimental design included a pre test measure of dependent variables STREAM and Barthel Index and a measure on completion of treatment protocol of 2 weeks and a follow up reading at 4 weeks.

Experimental group received :Exercise therapy protocol based on the principles of MRP.The protocol was patient specific and was followed according to recovery of the patient. Along with exercise therapy protocol the subjects received ten 30 minute sensory retraining sessions of 5 days a week for a period of 2 weeks. The sensory retraining protocol included training the subjects for texture discrimination; proprioception and two point discrimination .Subjects were also given education regarding sensory impairment along with sensory retraining.

30 minute treatment sessions were equally divided into training for modalities interposed with rest intervals. Instructions given to subjects were simple and concise. Appropriate feedback in form of KP or KR was provided.

The 2 days of the week when subjects did not be attended for treatment, they were asked to perform the tasks involving the same principles at home like recognizing different floor surfaces etc.

Control group received the exercise therapy protocol only and not the sensory retraining protocol. Exercise therapy protocol was based on the principles of MRP. The protocol was patient specific and was followed according to recovery of the patient.

Data analysis

30 subjects were recruited with 15 in the experimental group (Group A) and 15 in the control group (Group B). None of the included subjects withdrew during the course of study. Demographic data of subjects including age and sex of the subjects were descriptively summarized. All the values were recorded as means and standard deviation. The statistical analysis was performed using the SPSS/STATA 9.0 software.

Result: The study recruited 30 patients (M= 18, F=12, Aged 51.36 ± 6.78) while none of the subjects withdrew. The baseline characteristics of the patients are summarized in Tables 5.1

Table 5.1: Baseline Characteristics of the Patients

Variable	Mean ± Std. Deviation
STREAM	24.26 ± 1.57
Barthel Index	6.33 ± 2.24

Between group comparisons were made using chi square test, a non parametric test between the two groups for sex and age and no significant difference was found between the 2 groups(p value for age- 0.157 , p value for sex – 0.456)[Table 5.2] .

Table 5.2. : Age and sex distribution between the 2 groups

	Group 1*	Group 2*	p value
Age (yrs)	49.6±6.5	53.1± .84	0.157
Male: Female	10 : 5	8 : 7	0.456

* group 1 – experimental group,group2-control group

Within group analysis was done using repeated MANOVA. The subjects within the experimental group showed significant improvement for variable STREAM (p value- 0.001) and Barthel index (p value- 0.001).The subjects within the control group also showed significant levels of improvement for variable STREAM (p value – 0.001) and Barthel index (p value – 0.04).[Table 5.3]

Table 5.3 showing within group analysis for STREAM and Barthel Index

	Baseline	Week2	Week4	p
SEG	24.5±1.6	26.5±1.4	27.7±1.4	0.001*
SCG	24± 1.6	25.4±1.5	26.3±1.5	0.001*
BIEG	7 ± 2.5	10±3.8	13.3±3.6	0.001*
BICG	5.7±1.8	7±2.5	10.4±2.3	0.04*

*significant at .05 level

STREAM-experimental group, STREAM-control group, Barthel index experimental group, Barthel index control group

Between group analysis was done for both the variables using student t-test. Baseline assessments showed no significant difference between the 2 groups for STREAM (p value- 0.36) and Barthel index (p value – 0.10).No significant difference was seen between the 2 groups for STREAM (p value – 0.05) and Barthel index (0.06) at 2 weeks but a significant difference was there between the 2 groups for STREAM (p value – 0.009) and Barthel index (p value – 0.011) [Table – 5.4]

Table 5.4 showing between group analysis for STREAM and Barthel Index

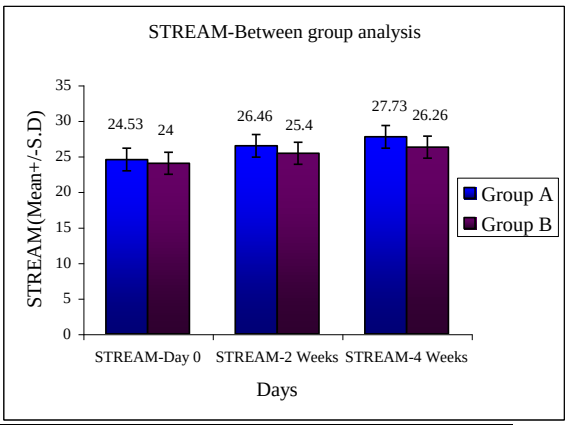
Variable	Group 1	Group 2	p value
STREAM 1	24.53 ± 1.59	24 ± 1.55	0.36
STREAM 2	26.46 ± 1.35	25.4± 1.45	0.05
STREAM 3	27.73 ± 1.38	26.26 ± 1.48	0.009*
Barthel 1	7 ± 2.53	5.66 ± 1.75	0.10
Barthel 2	10 ± 3.77	7 ± 2.53	0.06
Barthel 3	13.33 ± 3.61	10.33 ± 2.28	0.011*

*significant at .05 level;

STREAM 1- Day 0; STREAM 2- 2 Weeks; STREAM 3- 4 Weeks.

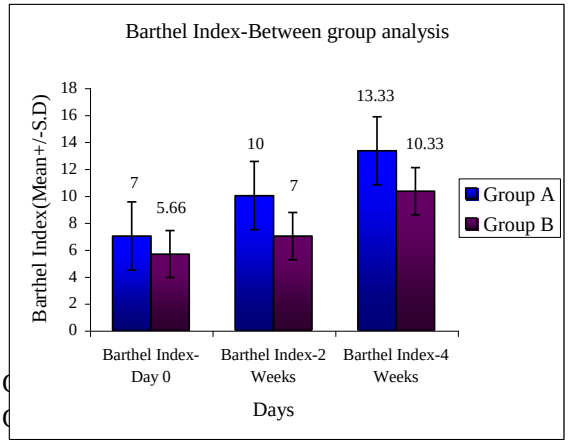
Barthel 1- Day 0; Barthel 2- 2 Weeks; Barthel 3- 4 Weeks.

Fig:1-STREAM-Between group analysis



Group A- Experimental group, Group B- Control group

Fig2: Barthel Index-Between group analysis



Discussion: The objective of the study was to determine the effect of sensory retraining of lower extremity on motor recovery and functional outcomes in acute stroke. Although there is evidence that sensory retraining for stroke patients with sensory dysfunction of the feet is effective[20], more research was required particularly in the acute phase to measure its effectiveness. Subjects during the acute phase after stroke were specifically selected because the intention of the study was to investigate the theory that 'earlier is better' with regard to sensory retraining. Our study hypothesized that sensory retraining protocol would lead to better motor recovery and functional outcomes as compared to conventional exercise therapy protocol alone as it has been proved that patients with well preserved sensations achieve a greater improvement in motor functions than patients with gross sensory deficits[24].

The subjects suffering from ischemic stroke were included because perceptual differences have been found between ischemic and hemorrhagic stroke[26].The improvement in individual sensations was not taken into consideration for statistical significance but only the effect of sensory retraining on dependent variables was taken into account.

Studies have shown that somatosensory deficit has a negative effect on functional outcome of stroke patients and prolongs rehabilitative treatment[22,23]. It has been proved that the therapist must recognize that cutaneous sensory inputs are usually a part of an integrated motor act which also supplies sensory information as feedback signals from muscles and joints before and during movement[21] and without training a "learned nonuse phenomenon" occurs that leads to further deterioration[7].

It has been shown patients with pure sensory stroke can achieve significant improvement in somatic sensation and in related deficits of motor control after experimental rehabilitative training as somatosensory structures in

brain have been shown possess high level of plasticity[19] and that rehabilitative training specifically aimed at restoring somatosensory deficit and related disabilities can lead to significant functional improvements[3,6].

The statistical analysis showed significant improvement occurred within each group at both 2 and 4 weeks although no significant difference was found between the experimental and control group after 2 weeks of retraining protocol but after 4 weeks significant difference was found between the experimental and control group in both the variables: motor recovery and functional outcomes.

The improvement noticed within each group at both 2 and 4 weeks was in accordance with previous studies that have shown that maximal functional improvement generally occurs during the first month and then may continue upto a period of 2 years[15].

The within group improvement can be attributed to both: the effects of spontaneous recovery and to the effects of rehabilitation protocol leading to recovery in by enhancing the plasticity of the nervous system. Also it is known that another factor which can influence hemiplegic rehabilitation is flaccidity which is usually accompanied by severe motor disability[24], thus with rehabilitation and in accordance with the natural recovery patterns of stroke flaccidity might have reduced leading to better motor abilities.

The possible explanation for no significant difference between the experimental and control groups at 2 weeks, but significant difference at 4 weeks is that for the first two weeks the subjects in the experimental group participated in the rehabilitation protocol but could not incorporate the principles of sensory retraining in their activities of daily living and functional activities but after 2 weeks of rehabilitation the subjects used the principles of sensory retraining in functional activities and their activities of daily living therefore leading to better performance due to sensory-motor coordination which is an integral part of functional activities.

In previous studies it has been proved that relay of cutaneous messages from the skin to the cortex is modified during movements including active touch thus it is important to design a sensory rehabilitation program to include the active participation of the patient in a series of volitional motor acts[21].

A possible explanation for no significant difference between the experimental and control group at 2 weeks is that for the first 2 weeks the subjects of the experimental group were retrained for sensory deficits in non weight bearing positions except for texture discrimination which was trained in weight bearing position but after 2 weeks of retraining the subjects used the same principles of sensory retraining in activities of daily living and functional activities which are performed in weight bearing positions which has been proved to be a more functional position for lower extremity[27] ,thereby leading to better motor recovery and functional outcomes at 4 weeks.

It has been said earlier that training program is characterized not only by exercise of somatic sensation but also by exercises aimed at rehabilitation of sensory related deficits of motor control[11]. Also it has been said that wide number of activities is another important feature of training programs and there is generalization of relearned abilities to activities that were not the specific training objectives[11] although there is poor generalization between different somatosensory sub modalities[6].

Gowers in 1888 said that recovery is better in an environment which will encourage the patient to make the best use of the functional recovery. There is evidence that a period at home provided the patients with the opportunity to directly experience how stroke affected their daily lives and they had renewed interest in improving their skills and level of independence. Therapy at home is often appropriately used after the acute inpatient rehabilitation as it allows the patients to orient themselves to a familiar environment[17].

It has also been stated that the patient initially is noticeably insecure in dealing with the cues on the impaired side because the cues may be ambiguous or misleading but with practice they can begin to trust visual cues as a way of making sense for guiding action[13].

Another possible explanation is that we were interested in patient's actual functioning rather than his potential and this method concentrates on observed function. We were measuring functional recovery which must include a large element of adaptation by the patient to his disability and this does not necessarily reflect neuronal recovery[16]. Also since the activities performed by he patient are patient

specific, the patients might have undermined or overmined their capabilities.

Another possible explanation for no significant difference at 2 weeks is the poor attention and motivation levels during the initial days after stroke which tend to improve when the patient receives home environment and support of care givers. Motivation towards treatment was found very significantly related to outcome at all stages. It has been stated that the patient's attitude towards and ability to co operate with the treatment is as important as the actual amount if treatment provided[14].

Significant difference was observed between the experimental and control groups at 4 weeks and improvement in functional recovery can also lead to improvements in motor recovery as both are inter-related[25].

The limitations of study were that the study was conducted on a small sample size. The sample collection was limited to one hospital. The effect of other factors which have prognostic significance such as motivation levels, environment, level of education, premorbid status, vocational factors, initial ADL level of patient etc were not taken into account. A major limitation of study was the absence of a reliable and valid tool to assess and measure proprioception prognosis of great toe and due to cost limitations of the study we could not use the laboratory set ups having sensitive and reliable instruments.

On the basis of results obtained in our study, future researches incorporating principles of sensory retraining with functional exercises (in weight bearing position for lower extremity) is advised.

Conclusion: The sensory retraining protocol of foot used along with the conventional rehabilitation protocol did not lead to any significant improvement at 2 weeks but led to statistically significant improvement at 4 weeks thus it can be concluded that the use of sensory retraining in functional weight bearing positions for the lower extremity leads to better levels of motor recovery and functional profile of patients by activating the normal sensory motor and neuromuscular pathways required for motor activities and minimizing the detrimental effects of learned non use phenomenon than providing them conventional rehabilitation alone.

References:

1. Pamela w duncan: Stroke disability; Phys. Ther.;1994(74)399-406

2. Kojimas s et al: Prognosis and disability of stroke patients after 5 years in Akita,Japan:Stroke :1990:(21);72-77
3. Yekutial ;E.gutman : A controlled trial of the retraining of the sensory function of the hand in stroke patients : J Neurol Neurosurg Psychiatry;1993(56)241-44
4. Jong s kim; Smi choi kwan :Discriminative sensory dysfunction after unilateral stroke: Sroke;1996(27);677-682
5. Rose L ,Bakal DA:Tactile extinction and functional status after stroke:Stroke ;1994(25);1973-1976
6. Carey LM et al: Sesnory loss in stroke patients : effective training of tactile and proprioceptive discrimination :Arch Phys Med Rehabil;1993(74);602-611
7. Dannenbaum RM:Sensory loss in the hand after sensory stroke : Therapeutic Rationale :Arch of Phys Med and Rehab.;1988(69);833-39
8. Jenkins WM: Functional reorganization of primary somatosensory cortex in adult owl monkeys after behaviorally controlled tactile stimulation:Journal of Neurophysiology;1990(63)82-104
9. Ward N:Mechanisms underlying recovery of motor function after stroke:Post graduate medical journal :2005(81); 510-514
10. Julkenen L etal : Recovery of somatosensory deficits : Acta neurologica Scandinivica :1995
11. Smania . N etal : Rehabilitation of somatic sensation and related motor control in patients with pure sensory stroke. : Arch. of Phys Med and Rehab : 2003 (84) ;1692-1702.
12. Carey LM :Sensory loss in stroke patients: Effective training of tactile and proprioceptive discrimination: Arch of Phys Med and Rehab ; 1993 (74) ; 602-611
13. Gresham et al : Epidemiologoc profile of long term stroke disability : Arch Phys Med Rehabil : 1979 (60) ; 487-91
14. Henley S et al: Predictive factors in stroke recovery: Journal of Neurology, Neuro surgery and Psychiatry: 1985(48); 1-6.
15. Amasa B Ford et al : Prognosis after strokes : Medicine:1966 ;(45) : 223-245.
16. Wade etal : Recovery after stroke – the first 3 months : Journal of neurology, neurosurgery and psychiatry : 1985 : 48 : 7-13.

17. Pat t Tangeman etal : Rehabilitation of chronic stroke patients : changes in functional performance : Archives of physical medicine and rehabilitation : 1990:71:876-880.
18. Dickstein etal : Stroke rehabilitation : three exercise therapy approaches ; physical therapy : 1986 : 66 : 8 : 1233-1238.
19. Xerri etal : plasticity of primary somatosensory cortex paralleling senosrimotor skill recovery from stroke in adult monkeys : Journal of Neurophysiol : 1998 ;(79) : 2119-2148.
20. Morioka S yagi etal : Effcets of perceptual learning exercises on standing balance using hardness discrimination task in hemiplegic patients following stroke : a randomized controlled pilot trial:Clin Rehabil ; 2003 ; (17) : 600-607
21. Asanuma etal : Experiments on functional role of peripheral input to motor cortex during voluntary movements in monkey : Journal of neurophysiology : 1984 : 52: 212-227
22. Anderson EK : Sensory impairments in hemiplegia : Arch Phys Med Reahbil : 1971;(52):293-297.
23. Stern PH et al: Factors influencing stroke rehabilitation : Stroke ;1971;(2) : 213-218.
24. Buskirk CV et al : Prognostic value of sensory defect in rehabilitation of hemiplegics : Neurology ; 1955 : 407-411.
25. Gresham GE et al : The relationship of neurological deficit and co morbid disease to dependence in ADL and mobility among survivors of Framingham study : Arch Phys Med Rehabil : 1975 : (54) :540
26. Chwen-Yng Su et al : Perceptual differences between stroke patients with cerebral infarction and intracerebral hemorrhage: Arch Phys Med Rehabil :2000; 81(6);706-714
27. Kusoffsky A et al:The relationship between sensory imapirement and motor recovery in patients with hemiplegia:Scan J Rehab Med:1982: (14);27-32

EFFECT OF FOOT PLATE ON FOOT POSTURE IN CHILDREN WITH CEREBRAL PALSY: AN EXPERIMENTAL STUDY

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ABSTRACT

Abstract

Introduction: To find the immediate effects of foot posture by using the foot plate in children with cerebral palsy. **Methods:** 19 children with cerebral palsy were selected by purposive sampling. A custom-made footplate was prepared for each child and pre post measurement was done. Study was conducted in Manipal University, India in 2011. **Results:** Foot Posture Index 6.0 was used as an outcome measure. There were significant changes after the application of foot plate. ($p<0.05$). **Conclusion:** Custom made foot plate with medial arch support had an excellent immediate corrective effect on FPI 6.0 in children with cerebral palsy.

Key words: Cerebral palsy, foot deformity, foot plate, foot posture index.

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Introduction: Cerebral palsy is one of the most common causes of childhood disability and 90% of children with cerebral palsy have foot deformity which significantly affects their walking[1-4]. Hip adductors, internal rotators and plantar flexors are the muscles most commonly affected in lower limbs[5]. Due to improper activity of these muscles, children usually adapt medial weight bearing which in turn leads to low arch while standing and walking[5-7].

Conservatively Physical Therapists manage this medial weight bearing by foot muscle exercises, various varieties of ankle foot orthosis and medial arch supports. By providing medial arch support or ankle foot orthosis it is intended to transfer a portion of the load to lateral structures of the foot. Literature has revealed that commercial readymade plastic arch support, rigid ankle foot orthosis is not successful in correcting spastic valgus deformity[8]. By the tailor-made arch support, we can correct this deficiency and various other associated deformities of fore foot and hind foot by extending the support front or back[9, 10].

Foot plate is a type of arch support, which is tailor-made for specific foot deformity for the patients. Therapist

measures the height, length, width of the arch support required to correct the foot deformity and maintain the talus in neutral position at the ankle. Thereafter by using resilient Ethaflex® the therapist marks the arch support and attaches it to the inner sole of the footwear.

Even though foot plate among the most common, affordable, convenient method to correct the foot deformity, there is a dearth of literature supporting the effectiveness of it on foot posture[11]. Our study is intended to find the immediate effects of foot posture by using the foot plate in children with cerebral palsy.

Methodology: This experimental study design took 19 children with cerebral palsy. Purposive sampling from the tertiary care hospital was done. 19 children of age ranging from 2 to 10 years of both genders were included (Table-1).

Children with cerebral palsy who could stand with GMFCS – ER level[12, 13](1 to 4) without any fixed deformity at hip, knee and ankle were included in the study. Those children with CP who underwent serial casting, botulinum toxin injection in the last six months, and recent orthopaedic surgery within 12 months were excluded from the study.

The main outcome major is Foot posture index 6.0, which has already been validated in cerebral palsy population. It has six components, which are mainly consisted of talar head position (THP), curves above and below malleoli (CABM), calcaneal inversion or eversion (CIE), medial arch height (MAH), talo calcaneal joint congruence (TNC), forefoot adduction/abduction (FAA)[14, 15].

Procedure: Children were selected as per inclusion and exclusion criteria. Written consent from each parent/ guardian was collected.

For making foot plate children were made to stand on the Ethaflex® sheet and their foot outline was drawn. Foot was corrected to normal position keeping the talus in neutral position. Once this position has been achieved the therapist took the length and width measurement of the arch support required according to the need of the child. The child was made to sit and therapist cuts out the line on Ethaflex®, 3–4 layers of semi lunar shaped Ethaflex® were stacked one upon the other by pasting with Fevicol® SR998. Once the arch support is ready the child was made to stand and checked for talar position. The FPI 6.0 was measured before and after the foot plate was administered.

Data analysis: For analysing data SPSS 13.0 was used. The pre and post differences of six components and total scale of FPI was calculated by using Wilcoxon signed- rank test. In pre and post values on total FPI paired t- test was used. p value <0.05 is significant with 95% confidence interval.

Results: Most of the children had pronated foot with a minimum to maximum score ranging from 6 – 12 out of a total score of 12. There was significant change seen in all the components of the foot posture index after the application of the foot plate arch support.

Table-2: Pre and post values of components of the FPI 6.0

	Mean	SD	Z	p
RT THP1	1.68	0.47	3.58	0.001*
RT THP2	0.68	0.58		
LT THP1	1.74	0.56	3.52	0.001*
LT THP2	0.63	0.59		
RTCABM1	1.05	0.70	3.55	0.001*
RTCABM2	0.11	0.31		
LTCABM1	0.95	0.78	3.23	0.001*
LTCABM2	0.11	0.31		
RT CIE1	1.42	0.60	3.23	0.001*
RT CIE2	.26	0.56		
LT CIE1	1.42	0.76	3.39	0.001*
LT CIE2	0.16	0.68		
RT MAH1	1.89	0.31	3.16	0.001*
RTMAH2	0.0	0.00		
LT MAH1	1.84	0.375	4.12	0.001*
LT MAH2	0.00	0.00		
RT TNC1	1.47	0.513	3.00	0.001*
RT TNC2	1.00	.471		
LT TNC1	1.42	.607	3.16	0.001*
LT TNC2	0.89	0.567		
RT FAA1	1.42	0.607	3.13	0.001*
RT FAA2	0.74	0.452		
LT FAA1	1.47	0.612	3.36	0.001*
LT FAA2	0.79	0.419		

(*) – Significant

Keys: THP- Talar Head Position, CABM – Curve Above and Below Malleoli, CIE- Calcaneum Inversion or Eversion, MAH – Medial Arch Height, TNC- Talo Navicular Joint Congruence, FAA – Forefoot Adduction or Abduction. RT- Right, LT- Left.

There were significant changes in the total score between both the legs. The total values of foot posture index after the foot plate application are RT 2.63±1.16, LT 2.60±1.30. The pre and post values of right and left foot mean, standard deviation, mean differences, standard deviation of mean differences, z value, p- values in each component of FPI 6.0 are given in table-2.

Table-3: Pre and post value of FPI 6.0 total scores

	Mean	SD	p value
Rt foot pre	8.78	2.57	<0.001*
Rt foot post	2.63	1.16	
Lt foot pre	8.94	2.52	<0.001*
Lt foot post	2.68	1.33	

(*) –Significant

The pre and post of right and left foot mean, standard deviation, mean differences, standard deviation of mean differences is given in table-3.

Discussion: The main aim of this study was to investigate the function of foot plate as an arch support to correct foot deformities in children with cerebral palsy. Results have shown that a highly statistical significance on the

score obtained from ankle foot posture index.

Plano valgus foot deformity is characterized by valgus of the hind foot and pronated at mid foot resulting flattened longitudinal arch. Due to the hind foot valgus, the distal talus lies medial to substance of the calcaneum. In the mid foot, the naviculum slides laterally with respect to the talar head with a corresponding shift of the calcaneo cuboid joint. The talar head become pronated both plantar and medially[16, 17].

When the talus was corrected to neutral by the custom-made foot plate arch support. We expect the talus to attain the subtalar neutral thereby gaining hind foot, mid foot in neutral position with gaining subsequent longitudinal arch. That is why it was found to have an excellent result of foot correction in FPI 6.0.

There were an insufficient number of samples representing individual subtypes of cerebral palsy for generalization of the result. Immediate improvement in foot alignment will sustain or not is questionable.

The study can be performed with larger sample size in a longitudinal basis. A variety of pediatric conditions where foot is involved can be included.

Conclusion: Custom made foot plate with medial arch support had an excellent immediate corrective effect on FPI 6.0 in children with cerebral palsy.

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References:

1. Jhonson A. Prevalence of cerebral palsy in Europe. Dev Med Child Neurol 2002; 44: p.633-40
2. Gaston M, Rutz E, Dreher T, Brunner. R. Transverse plane rotation of the foot and transverse plane hip and pelvic kinematics in diplegic cerebral palsy. Gait Posture 2011; 34:p.218-221
3. Czerniecki JM. Foot and ankle biomechanics in walking and running. A review. Am J Phys Med Rehabil 1988; 67:p.246–52.
4. Knutson LM, Clark DE. Orthotic devices for ambulation in children with cerebral palsy and Myelomeningocele. Phys Ther 1991;71:p.947–60
5. Hylton N. Postural and functional impact of dynamic ankle-foot

orthosis and foot orthosis in a paediatric population. Journal of Prosthetics and Orthotics 1989; 2:p.40-53

6. Hylton N. Dynamic casting and orthotics. In: The Practical management of Spasticity in Children and Adults ed by Glenn M, Whyte J. Pa Lea & Febiger; Philadelphia, 1990:p.167-200
7. Stebbin J, Theologis T, Thompson N, Harrington ME, Zavatsky AB. Gait compensation caused by foot deformity in cerebral palsy. Gait Posture 2005; 32:p.226-30
8. Bleck E. Orthopaedic management in cerebral palsy. Oxford Blackwell s cientific publications. Phildelphia 1987; p.179-80
9. Ball KA, Afheldt MJ. Evolution of foot orthotics – part I: coherent theory or coherent practice? J Manipulative Physiol Ther 2002; 25(2) : p.116-24
10. Riley PO, Kerrigan DC. Kinetics of stiff-legged gait: induced acceleration analysis. IEEE Transac Rehabil Eng 1999; p.420–26
11. Klein P, Mattys S, Rooze M. Moment arm length variations of selected muscles acting on talocrural and subtalar joints during movement: an in vitro study. J Biomech 1996;29:p.21–30
12. Morrison SC, Ferrari J. Inter-rater reliability of the foot posture index (FPI-6) in the assessment of the paediatric foot. J Foot Ankle Res. 2009;2:p.26
13. Palisano R, Rosenbaum P, Walter S, Russell D, Wood E, Galuppi B. Development and reliability of a system to classify gross motor function in children with cerebral palsy. Dev Med Child Neurol 1997; 39: 214–23
14. Rosenbaum P, Paneth N, Leviton A, Goldstein M, Bax M. Definition and Classification Document, in the Definition and Classification of Cerebral Palsy. Dev Med Child Neurol2007; 49 (S): p 8–14.
15. Redmond AC. The foot posture index: easy quantification of standing foot posture: six item version: FPI-6: user guide and manual. United Kingdom. 2005
16. Keenan AM, Redmond AC, Horton M, Conaghan PG, Tennant A. The Foot Posture Index: Rasch analysis of a novel, foot-specific outcome measure. Arch Phys Med Rehabil 2007;88:p.88-93
17. An Approach to Foot Orthopedics: Journal of the American Podiatry Association, February 1964 J. Am. Podiatr. Med. Assoc. 2007; 97: p.299-303

COMPARISON OF ACTIVE CYCLE OF BREATHING TECHNIQUE AND PURSED LIP BREATHING WITH THERA PEP® IN PATIENTS WITH ACUTE EXACERBATION OF COPD.

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ABSTRACT

Introduction: The effect of short term treatment of two techniques i.e. active cycle of breathing technique and pursed lip breathing with TheraPEP were evaluated in patients with acute exacerbation of chronic obstructive pulmonary disease. **Material and Methods:** COPD patients with acute exacerbation were acquainted and randomly assigned into two groups and patients performed each technique on successive days in a within subject randomized crossover design. The study was conducted in wards at AIIMS hospital, Delhi; following dependent variables were measured before treatment, immediately after treatment, 30 mins. After treatment. BP, HR, RR, SPO2, PEFR, VAS, BCSS, SV and patient preference. **Results:** Data was analyzed using SPSS package for windows version "15", between the treatment, groups means analyzed for difference using student "t" test. Repeated measure of variance (ANOVA) was used to examine the changes in dependent variables. Level of significance was set at($p<0.05$).there was statistically significant difference between the treatments in SPO2 ,SV,BCSS between the techniques and between the group showed a statistically significant difference for SV,BCSS.the result suggests TheraPEP was as effective as ACBT+PLB rather in context of sputum volume and BCSS it showed better results. Both the treatments were effective in removing secretion, improving oxygenation, decreasing dyspnea and do not cause any hemodynamic instability, and TheraPEP found more preference among patients. **Conclusions:** the results of the study indicates TheraPEP® is as effective as ACBT+PLB in acutely clearing secretions and improving oxygen saturation without causing any undesirable effects on heart rate, BP and RR and also decreases dyspnea ,rather in terms of secretion clearance and day to day prognosis.TheraPEP proved to be better .As also more patients preferred TheraPEP,introduction of TheraPEP can be a step forward to introduce technology in airway clearance in patients with acute exacerbations of COPD.

Keywords: ACBT, TheraPEP, acute exacerbation of COPD, airway clearance technique.

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Introduction: Chronic obstructive pulmonary disease (COPD) is a major cause of chronic morbidity and mortality thus represents a substantial economic and social burden throughout the world[1].it is the fifth leading cause of death worldwide and further increase in its prevalence and mortality are expected in the coming Decades. GOLD Describes COPD as "a disease state that is characterized by airflow limitation that is not fully reversible. This airflow limitation is usually associated with an abnormal inflammatory response of the lungs to noxious particle gases (most frequently cigarette smoke) and is usually progressive[2,3]."This progression produces progressively disability symptoms that eventually impact on every aspect of a patient's Life and hence it can be rightly said that COPD

represents a serious public health problem with many social And economic ramification. Several factors may place a person at risk for COPD including smoking, environmental exposures (e.g.: chemicals or dust in the workplace), and genetic abnormalities (eg: α-1-Antitrypsin deficiency, susceptibility to cigarette smoke). symptoms associated with COPD (Egg: cough, shortness of breath, sputum production, wheezing, reduced exercise capability) are often overlooked By patients and healthcare providers.3the burden of COPD on individuals, the health and society as a whole Is great[4,5],compared to angina there are at least twice as many general physicians' consultations for COPD and of the total cost of managing of COPD. About 18 million Indians (5.1%men and 2.7%women) above the Age of 30 years are already suffering from the disease[5].The vast majorities of patients with COPD is or have been smokers, there is smaller percentage who have never smoked. It is also true to say that not all smokers will develop COPD. However for those who do smoke: stopping is the only thing that reduces progression of COPD.A study published by the WHO reported that COPD is likely to rise from being the 12th most Burdensome disease in 1990s to 5th in 2020[7].In the past COPD has been viewed primarily as a disease Occurring in men, yet beginning in 2002, more women died from this disease than men[2].In addition to the Chronic disease patients with COPD experience regular acute exacerbation that increases in frequency with increase disease severity[8].Exacerbation is defined as an event in natural course of the disease, characterized by Change in patients baseline dyspnea, cough or sputum that is beyond normal day to day variation, which is acute in onset and may warrant change in regular medication in patients with underlying COPD[8, 9]. Exacerbation Are caused or triggered by a variety of factors including viruses, bacteria and air pollution and are associated with acutely increased worsening of existing airway inflammation, odema, mucus hyper secretion and Bronchoconstriction contribute to greater narrowing of airways and change in distribution of ventilation[10,11]. Frequent exacerbation increase disease progression and leads to significant loss of quality of life[5].Airway mucus hyper secretion is a cardinal feature of COPD[12].The increased mucus is associated with Goblet cell and sub mucosal gland hyper trophy. The number of ciliate cells and ciliary length

is decreased in Patient with chronic bronchitis[13].These abnormalities coupled with mucus hyper secretion are associated with reduced mucus clearance and airway obstruction[14].Retained airway secretion can form mucus plugs and bronchial casts that cannot be expelled by coughing, airway plugging causes impaired ventilation, resulting in Lower ventilation to perfusion ratio[15,16],in disease, the increased secretion viscosity and volume, dyskinesia of the cilia, and ineffective cough combine to reduce the ability to clear secretions, and may increase infections[17].Cephalad airflow bias is a factor in mucus movement in small airways during normal ventilator pattern. Narrowing of the airways of exhalation increases the[17, 18] linear velocity and shearing force in the airway Creating a cephalad airflow bias. Above mentioned process is lost in COPD.

Need for bronchial hygiene: In a patient with unstable airways[18,19], the high pressure and flow during a normal cough maneuver combine in the dynamic compression of airways, which trap gas and secretions, rendering the cough ineffective. Moreover cough can aid secretion clearance only uptil 6 generations. For these patients a variety of Breathing techniques have been developed that enhance cephalad airflow bias. Directed cough has been redefined to include techniques such as FET and ACBT. Hence a variety of breathing maneuvers have been developed, redefined and used to assist patients in mobilizing secretions from the lower respiratory secretions from the lower respiratory tract. Bronchial hygiene therapy a.k.a"chest physiotherapy" is effective in clearing secretion from the lung of the patient with copious secretion. The conventional treatment for many years was postural drainage with percussions[21, 22, 23]. Deleterious effects have been associated with manual techniques namely arterial desaturation, bronchospasm, atelactasis, haemodynamic disturbances. In recent years new methods have been Adopted among which are ACBT (active cycle of breathing technique),PEP terapy[20].

Forced expiration technique (FET): FET was first described[18] in 1968 by Thomson, a Newzealand physician and therapist team working with Patients with asthma. They described the use of 1 or 2 huffs from middle to low lung volumes, with the glottis open, preceded and followed by a period of relaxed, controlled diaphragmatic breathing, with slow deep Breaths. Secretions mobilized from the lower to

upper airways were expectorated, and the process is repeated.

Drawback in clinical application of FET: As so often happens[18]; many clinicians adopted parts of FET and concluded that huff is the most important component, which caused concern among the primary proponents of FET. Because of the misinterpretation that huff is the most important part of FET researchers emphasized the integral importance of relaxed Breathing control and thoracic expansion exercise.FET was redefined as one of 3 primary components of ACBT (Webber and Pryor, 1993)

Active cycle of breathing technique: The ACBT[18,20] is combination of breathing control, thoracic expansion control and FET. Wherein; Breathing control is comprised of PLB. The period of breathing control is essential between the other Phases to prevent bronchospasm (Lapin, 1990). The thoracic expansion exercise are simply active inspirations with larger than normal breaths Followed by relaxed expiration. This larger lung volume increases airflow through collateral ventilation Channels which increase the gas volume available to mobilize secretion during expiration. FET-as already explained involves 1or2 huffs combined with breathing control. Pursed lip breathing(PLB)the breathing retraining pattern often employed by patients[24,25], it added a measure Of comfort to their struggle to breathe[26]. PLB works to improve expiration, both by requiring active and prolonged expiration [29]and by preventing airway collapse.

The subject performs a moderately active expiration, through the half-opened lips, including expiratory mouth pressures of about 5cm water[27, 28].Theories and insightful description appeared in the literature and respiratory pioneer Alvan Barach in the late 1930 deduced that breathing against an external resistance helped to keep bronchiolar passage open to make way for alveolar emptying. Schmidt and colleagues determined that the effect of the back pressure of PLB is to slow exhalation so as to minimize small airway collapse. The major difficulty presented by PLB studies is that there is no standard method of training.[26] A more contemporary but less explored in India bronchial hygiene therapy technique is PEP therapy. It was developed in 1970[30].PEP technique was developed in Denmark in the1970.PEP pushes air into the lungs behind mucus, holds the airways open and keeps them from closing. The person breathes in normally but breaths out against

resistance at an expiratory pressure of 10-20cms water[30, 20, 17]. PEP therapy employs mechanism which reminiscent to pursed lip breathing[21,31]. PEP has also been shown to enhance collateral ventilation, the positive back pressure generated during PEP allows airflows to enter these channels behind areas of mucus obstruction keeping the airways open during exhalation[17,20,32].During PEP therapy the resistance imposed at the mouth is transmitted upstream the resulting back pressure succeeds in splinting the airways open. The so called choke point has been defined as the point in the respiratory tract where intrinsic compression causes collapse of distensible airways[21,33]. The addition of positive pressure at the lips tends to move the choke point away from the periphery and towards the central airways are automatically more rigid and thus less likely to collapse in the absence of premature airway collapse expiratory airflow is able to mobilize mucus towards the larger airway from which it can be Coughed up and expectorated[31, 21].

Equal pressure point: Presence of equal pressure points and its ability to be manipulated is physiological factor for airway clearance[34].PEP device are considered class2 medical devices and are regulated by FDA[17], eg.of this type of design is Thera PEP. The influence of PEP applied during[35] inhalation of beta agonist in treatment of bronchial asthma was investigated and was found that PEP alone showed a uniform pattern of significant bronchodilator. Till date the literature throws light on the fact that it is widely explored in western countries for treatment of Cystic fibrosis and makes the patient much more independent in self administration of bronchial hygiene therapy. Although indicated for secretion removal in COPD[19] has yet to be explored, no study to date has determined the efficacy of PEP therapy in acute exacerbation of COPD. Airway clearance with PEP Therapy has been emphasized as a daily and integral part of disease management in CF patient. Several Studies have shown favorable results as applied to the CF population. It is this reason the investigators of this Study has transplanted typical protocols in the cystic fibrosis studies into the COPD population. This study is hence designed to compare the short term effect of PEP therapy and ACBT in acute exacerbation of COPD. Based on the findings, appropriate airway clearance technique could be used in these patients.

Methodology: Thirty (30) COPD patients with age above 40 years with

mean ± standard deviation age 56.20 ±5.361 were taken for the study. The patients were admitted in hospital due to acute exacerbation of COPD. The acute exacerbation of COPD was defined as one of three symptoms i.e. dyspnea increase in sputum purulence increase in sputum volume as well as one of the following upper respiratory tract infection fever without apparent cause increased wheezing increased cough or increased respiratory rate or heart rate above baseline .Subjects with coexistent medical problems i.e. angina, neurological deficits, indication for ventillatory support ,severe hemodynamic instability eg.cardiac arrhythmias ,cor pulmonale ,pneumothorax, Pulmonary embolism, GOLD stage IV :very severe COPD, congestive heart failure were excluded from the study.

On the day PEP therapy via TheraPEP was performed, patients were made to sit comfortably and then they were instructed to keep dental cotton swabs[36] between the cheek and the gum and then under the tongue to absorb saliva to ensure that collected sputum is protected from salivary contamination. Then the diameter of the orifice was set such that the inhalation is to exhalation ratio be 1:4 then place mouthpiece lightly in mouth, But a tight seal was maintained during exhalation ,patient was directed to take in a larger than a normal breath ,but not filling lungs to capacity ,then to exhale actively but not forcefully, maintaining a pressure of 10-20cm H_2O (keeping the top of the blue indicator between the lines on the Thera PEP pressure indicator) exhalation should last approximately 3 times longer than inhalation. Then patient performed 10 such PEP breaths, then mouthpiece was removed and patient performed 2-3 “huff” coughs as per the directions of the physiotherapist. Cough to raise secretions as needed. Patient was made to do the treatment for about 30 mins i.e. 3 sessions comprising of 10 breaths each. On the day ACBT was performed patient was made to sit comfortably and then were instructed to keep dental cotton swabs between the cheek and the gum and then under the tongue to absorb saliva to ensure that collected sputum is protected from salivary contamination. Then patient was directed to perform breathing control i.e. PLB at normal tidal volume(for aprox. 6 breaths),followed by 3-4 deep inspirations with relaxed exhalation (thoracic expansion exercise) and then again a period of breathing control i.e. PLB then patient was asked to perform 3-4 thoracic expansion exercises again followed a breathing

control and then followed FET i.e. a deep breath in and to do huff cough and then a medium breath in and again a huff cough then again a breathing control this session continued for about 30 mins.

Subjects meeting the inclusion and exclusion criterion were acquainted with both the techniques i.e. ACBT+PLB and PEP therapy to be administered via TheraPEP this was followed by randomized assignment of subjects to groups i.e. A or B, and subjects were provided with breathlessness sputum cough scale to be filled while going to bed .Subjects in group A were treated with ACBT+PLB on first day and PEP therapy via TheraPEP on second day and subjects in group B were given PEP therapy on first day and ACBT+PLB on second day, on the third day patients of both the groups were asked to give their preference regarding which technique they found better ,then all the treatment sessions were performed under supervision and at the same time of the day all the usual medications were administered during the study days. Dependent variables were collected before the treatment, immediately after treatment and 30 mins after treatment, however sputum breathlessness cough scale (one of the variable) was given to the patients to be filled on the day0 when no intervention was given, then to be filled at the end of the first day of the treatment and then at the end of the second day of treatment (to be filled before going to the bed) and the preference for the treatment was asked from the patients on the third day . Dependent variables in the study were heart rate, blood pressure, respiratory rate, peak expiratory flow rate, arterial oxygen saturation, sputum volume, Visual analog scale, Breathlessness cough sputum scale, patient preference.

Data analysis was performed using software package SPSS for windows version “15”.statistical test applied were student “t” test for comparisons for group statistics i.e. between two techniques in a group and technique effect in contest of groups, repeated measure analysis of variance (ANOVA) was used to examine changes in all dependent variables, the within subject factor was time which was measured at 3 intervals: Before treatment, Immediately after treatment, 30 mins, after treatment. Between subjects analysis was conducted by repeated measure analysis, variables which were showing a statistically significant result were further explored in a crossover. Crossover was carried out for period effect, treatment period effect and

treatment effect and were statistically Analyzed using two sample T test Significance level set for this study was set at ($p<0.05$).

Results: Blood pressure remained stable with the application of both the techniques rather it decreased in comparison to baseline ,group statistics for both the group showed did not show any statistically significant results with($p>.05$),and results were not affected by the order in which the treatment were given. The crossover i.e. between groups also showed statistically non-significant difference.

Heart rate decreased as compared to baseline immediately after treatment and 30 mins., after treatment with administration of both the techniques group statistics for both groups did not show any statistically significant difference with ($p>.05$) and results were not affected by the order in which the treatment were given. Between groups also showed statistically nonsignificant difference.

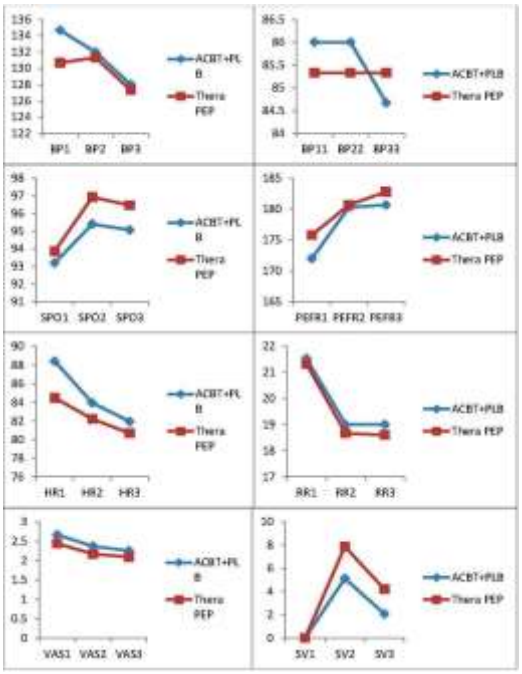
Respiratory rate decreased immediately after treatment as compared to baseline but remained same 30 mins, after treatment as was immediately after with both the techniques i.e. ACBT+PLB and TheraPEP group statistics suggest nonsignificant difference between the two techniques with ($p>.05$) the results was not affected by order in which treatment was given.

Arterial oxygen saturation increased immediately after treatment but remained same 30 mins, after treatment as was immediately after treatment with both the techniques. Summary statistics suggest that increase with administration of TheraPEP was more in comparison to ACBT+PLB. Group statistics shows a statistically significant difference between the two techniques with ($p=0.001$) immediately after treatment and ($p=0.006$)30 mins, after treatment in group A. Group B did not show statistically significant difference 30 mins. Later with both the treatment i.e. ACBT+PLB and TheraPEP but immediately after treatment showed statistically significant difference. Between group analysis also showed clinically significant results.

Visual Analog Scale summary statistics suggest decrease in VAS at both time periods however administration of TheraPEP showed more decrease as compared to ACBT+PLB.There did not exist statistically significant difference between the two techniques and between the groups.

Peak Expiratory Flow Rate summary statistics suggest increase in PEFR

immediately after administration of ACBT+PLB but administration of PEP therapy via TheraPEP shows increase in both the time periods. However there did not exist statistically significant difference between the technique and between the groups.



Sputum Volume sputum volume increased immediately after administration of both the techniques i.e. ACBT+PLB and TheraPEP .30 mins after, the sputum volume expectorated decreased but remained high as compared to baseline. Individual difference suggest increase with TheraPEP was more as compared to ACBT+PLB between technique showed a significant difference with (p=0.00).Between group also showed statistically significant difference with(p=0.00).

Breathlessness cough sputum scale summary statistics showed a decrease in BCSS mean with more decrease after administration of TheraPEP. Between technique showed significant statistical difference with (p=0.006) and also there existed a statistically significant difference between baseline and each technique (p=0.00).Between group analysis showed a statistically significant difference (p=0.000).

Discussion:

This study was a randomized crossover study designed to compare a newer technique pep therapy administered via Thera pep with a more established technique of airway clearance ie:ACBT+PLB in acute exacerbation of COPD. Results of this study suggests that both the treatments were found effective in sputum clearance, the difference between two techniques was statistically significant, rather summary statistics suggested administration of PEP therapy with TheraPEP showed expectoration of more sputum volume as compared to ACBT+PLB. Increased sputum expectoration with Thera PEP has been reported by Richard et al[24] and Falk et al [25],P Tonneson et al [26].But ACBT+PLB was also effective in sputum clearance as is supported by Jenkins et al[28].The difference found can be attributable to the fact that under

ordinary conditions, the collateral flow resistance is large when the bronchi are obstructed or narrowed by mucus or sputum plugs, the resistance by the ordinary bronchial route is increased, and thereby the resistance in the collateral channels distal to the obstruction is relatively reduced. The positive pressure created by PEP during expiration may cause build up of positive pressure behind the obstruction. This pressure gradient across the sputum plug will force the secretions centrally towards the large airways, where it can be cleared more easily ,by huffing which is achieved by manipulation of equal pressure points, as is also supported by J L Hofmeyer,Karen Ann[17],B.Oberwaldner[29],D.Selsby[19].Further airway obstruction can also cause airway to close during expiration as a result ,causing an increase pressure gradient, administration of positive pressure creates positive intraluminal pressure which prevents airway collapse and allows expiratory airflow to move the secretions centrally. Forced expiration are then used to mobilize secretions to where they may be effectively expectorated.[31]

However a substantial improvement in sputum expectoration is also seen during ACBT+PLB,as ACBT is well documented technique in clearing lung secretion and improving lung function in stable[32] COPD and cystic fibrosis patients, which also produces collateral ventilation and followed by FET aids in sputum expectoration . PLB in combination to ACBT is used to splint airway open as PLB creates a back pressure which also creates a positive intraluminal pressure, and as it is proposed that PLB is a kind of PEP and induces positive pressure during expiration. However despite both the techniques working on same mechanism ie:ACBT+PLB and pep therapy administered via Thera PEP, the present difference found with Thera PEP, producing more sputum expectoration could be attributed to the possibility that although PLB splints the airway open, but only when patient performs it correctly as it cannot be ascertained if back pressure is created or not as there is no objectivity to its performance[26],but Thera PEP provides with visual feedback[33] which ensures that a back pressure is created in airways as same can be seen on the equipment.In the study sputum volume is measured because it is a simple non-invasive short term clinical outcome measure of the effectiveness of airway clearance technique[17]. It has been ensured in this study that sputum does

not get contaminated by saliva to this effect preliminary precaution was taken by using dental swabs by patients under the tongue and between the gums before beginning the treatment. Subjects in this study did not show any swallowing of sputum as they were warned against it and treatment sessions were supervised by physiotherapist and this practice was discouraged. As the results of the present study suggests that both the techniques did not show any significant changes in BP and HR, within the groups, and also between the groups. The techniques applied were irrespective of the groups, showed no significant changes in BP and HR. As BP and HR remained stable throughout the administration of both the techniques rather summary statistics for both the techniques i.e.: ACBT+PLB and Thera PEP showed a slight decrease in blood pressure and HR more with administration of Thera PEP in comparison with ACBT+PLB, hence it can be safely predicted that patient did not show any abnormal deviation in both systolic as well as diastolic BP. The BP was measured in this study as a measure to assure that patient remained haemodianamically stable

because the brochure of TheraPEP device used the administer PEP therapy ,gave it as a point that hypotension can be an uncontrolled effect of the PEP therapy, however the same was not seen, and hence is safe as far as BP deviation is concerned. Same is supported by study which posed a question that what is the clinical relevance of the observed reduction in systemic blood pressure and heart rate in association with increased parasympathetic modulation of heart rate in patients with COPD? Abnormalities in autonomic nervous function with sympathetic activation are well described phenomenon accompanying COPD. In addition, several lines of evidence indicate that sympathetic activation and parasympathetic withdrawal are associated with a worse prognosis in patients suffering from COPD. But results of the present study suggests parasympathetic activation hence it can be predicted that application of both techniques results in improvement and in accordance with summary statistics Thera PEP showed more decrease in blood pressure than administration of ACBT+PLB. However the physiologic basis by which parasympathetic modulation of blood pressure along with heart rate may increase with treatment is not directly approached in our study as many factors might would have come into play come into play as

increase in spo2 might lead to proportional decrease in blood pressure and heart rate, cited by[32].Further increase in PEFR might lead to decrease in blood pressure and heart rate supported by study done citing this proportional decrease with FEV1 and a study by [34] supporting a good correlation between PEFR and FEV1.Decrease in heart rate in association with administration of Thera PEP was cited by Richard[24]

RR showed a trend of decrease in value immediately after treatment and remained so even 30 mins post treatment. This trend was observed after administration of both the techniques that is ACBT+PLB and PEP Therapy via Thera PEP. However no significant difference persisted between both the techniques in the respective groups. Both the techniques irrespective of administration in whichever group showed a trend of decreasing

Between group analysis did not show any significant difference for treatment effect but there did not existed any period effect or treatment period effect between the groups Summary statistics reflects that both the techniques did not cause increase in respiratory rate rather a decrease after administration therefore may be safely practiced in patients of acute exacerbation of COPD.

This could be attributed to the fact that both techniques increases the tidal volume in part due to the collateral ventilation , and as tidal volume[23] increases respiratory rate should decrease because it is established that in the start of exercise body responds to it by an immediate increase in ventilation, nerves from the central as well as peripheral nervous system respond to stimuli to cause increase in respiratory rate to cause increase in ventilation, but as both the techniques induce collateral ventilation respiratory rate decreases. .Decrease in respiratory rate was in accordance with case citation by Richard Wilson[24].Patients demonstrated an increase in oxygen saturation (SPO2) from baseline post administration of both the techniques and remained similar thirty minutes post treatment. However tendency towards higher oxygen

Saturation was administration of PEP Therapy via Thera PEP and hence the difference found statistically significant. Increase in oxygen saturation might have been the results of removal of retained mucus plugs from the airways, lead to improved alveolar ventilation, optimized ventilation-perfusion mismatch and finally improved oxygen transport to the tissue. Elisabeth Dean, and as in accordance with Karen and

abnormal clearance leads to in homogeneity of ventilation, which can affect gas exchange. This increase in oxygen saturation was in accordance with case citation by Richard Wilson[25], and also reported by Groth et al.

Breathlessness(Dyspnea) as depicted by Visual Analog Scale(VAS) scores decreased from baseline after administration of both the techniques that is ACBT with Pursed Lip Breathing and pep therapy via Thera PEP and further decreased thirty mins post treatment ,although statistical summary showed decreased breathlessness with pep therapy than after administration of ACBT with pursed lip breathing but between the techniques difference was statistically insignificant in both the groups and same trend was found with between the groups analysis. Decrease in breathlessness can be attributed to the fact that both the techniques lead to improvement of aeration of alveoli similar decrease of breathlessness assessed by Visual Analogue Scale was reported by Jenkins[28].

In airway clearance techniques PEFR is a useful outcome measure of any change in airway Obstruction following short term intervention. PEFR increased after the administration of both the techniques, statistical summary showed more improvement with pep therapy, but however there was no statistically significant difference between the two techniques. Similar results was reported by Savci et al[31] in study comparing ACBT and AD in stable COPD patients This change can be attributed to a larger airflow, without an airway collapse. Also a continuous visual feedback was provided during the application of PEP therapy via TheraPEP, as patient could see that while exhaling. Blue spring moves towards the point indicating the 10-20 cm H_2O pressure, this could contribute to boost the morale of the patient and could aid patient to give their best expiratory effort without apprehensions, and also study by Erika Christensen reporting that PEP therapy showed a uniform pattern of significant increase in PEFR,indicating that Pep therapy alone dilates airways, pep therapy seem to distend bronchi and bronchioles, in this way opening of the airways might enhance mobilization of airway secretions which could contribute to the increase in PEFR and similar effects are seen with various forms of PEP including pursed lip breathing.

Breathlessness Cough Sputum scale (BCSS) depicts day to day prognosis in symptoms of acute exacerbation of COPD although the mean BCSS scores do not show any statistically

significance within the group i.e. between two techniques i.e. ACBT+PLB and Thera PEP or between the group. However the individual changes which can be seen with both techniques as put in summary statistics show a clinically significant result, and in this content PEP therapy via Thera PEP outcomes ACBT+PLB.

Patient preference is an important subjective outcome variable which poses as an important deciding factor for which airway clearance technique to be administered. The results of present study suggested majority of the patients preferred PEP therapy via Thera PEP This is in accordance with results reported by elkins and study by Costantini and by Mcllawaine and Steen et alThis trend could be due to the fact, that Thera PEP makes it easy for administration of PEP therapy and easy to follow, because not much instructions are needed and also it gives 360˚ feedback[32] hence a satisfaction of improvement, and also it was seen during the course of study, that patient who did not prefer PEP therapy, were because they could not buy the equipment and were ready to use it more often if same is made available by hospital.

Conclusion: This study supports the importance of physiotherapy in aiding secretion clearance in acute exacerbation of COPD and hence providing relief to patients. The results of the study indicate that Pep therapy administered via Thera PEP is as effective as ACBT with Pursed Lip Breathing in aiding secretion clearance and reducing dyspnea and improving lung function and arterial oxygen saturation rather in terms of sputum clearance pep therapy proves to be better than Active cycle of breathing technique along with pursed lip breathing. Both the techniques are capable of producing day to day improvement in symptoms of acute exacerbation of COPD as is recorded on BCS Scale maintained as diary entry, and both the techniques are safe for the patients as hemodynamic stability is maintained as blood pressure remains stable and at the same time heart rate and breathlessness decreases after administration .Majority of the patients preferred pep therapy administered by Thera PEP as is easy to administer and also provides a visual feedback hence boosts patients morale as patient can actually see the effort made could raise the blue line. Also it was seen that few patients non preference for Thera PEP was not based on their liking but on the no availability of equipment as they found pep therapy better but did not

have equipment, hence may be if made freely available at least in government hospitals will gain more patient compliance and independence in easy to administer airway clearance technique that is pep therapy via Thera PEP. Introduction of pep therapy via Thera PEP as an airway clearance technique will be step forward to bring technology and accuracy (as visual feedback ensures that a pressure of 10-20cm h20 is created in airways) in practice of airway clearance respiratory therapy for patients of acute exacerbations of COPD and will also make the patients more independent as it is easy to administer hence will gain more compliance.

Future research

Due to unavailability of resource this study could not use radio aerosol tracing, future research could include this variable. Due to paucity of time and resources long term follow-up of patients to see adherence to which technique that is pep therapy via Thera PEP or Active Cycle Of Breathing Technique along with Pursed Lip Breathing is favoured, and also to access the frequency of exacerbations and hospital admissions with each techniques was not done same can be an aspect for future research.

REFERENCES

1. Romain A Pauwels, MD, Klaus F Rabe. Burden and clinical features of chronic obstructive pulmonary disease (COPD) The Lancet:2005;(364):613-620
2. Gold workshop report (2006 update), Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Pulmonary Disease.
3. BrianW.Carlin, MD . Chronic Obstructive Pulmonary Disease"Learn More Breathe Better".Journal of Cardiopulmonary Rehabilitation and Prevention:2007;(27):311-313.
4. From Seminars in Respiratory and Critical Care Medicine (2007) Cost and Quality Issues Related to the Management of COPD.www.ptjournal.org.
5. World health organization, world health report 2002.Geneva.WHO2002.www.who/.int/whr/2002/en/Gold Workshop.www.gold.copd.org.
6. Rodriguez-Roisin R. Towards a consensus definition for COPD exacerbations. Chest: 2000; 117 (suppl2): 398s-401s
7. Jadwiga A Wedzicha MD and Gavin C. Exacerbations of Chronic Obstructive Pulmonary

Disease. Respiratory Care: 2003; (48):1204-1211.

8. Voynow, Judith A, Rubin, Bruce K, MD. Mucins, Mucus and Sputum. Chest:2009;135(2):505-512
9. Seemugal TAR, Donalson GC, Paul Jeffries. Time course and Recovery of exacerbation in patient with COPD. Am J Res Crit Car Med:2000;(161):1608-1613
10. Balowin, Hardy. What is acute exacerbation of COPD? Eur Respir J :2004;(88):6-13
11. M. Rubin. Mechanism of worsening gas exchange during acute exacerbations of COPD. Eur Respir J:1997;(106):1285-1296
12. Roosman m,WaldesR,Sampson D.Effect of chest physical therapy on the removal of mucus in patients with cystic fibrosis. Am Respir Dis:1982;(126):131-135
13. Bradford, Wilson. Relation of sputum inflammatory markers to symptoms and lung function changes in COPD exacerbations.Thorax:2000;(55):114-120
14. Karen Ann Hardy. A Review of Airway Clearance: New Techniques, Indications, and Recommendations. Respiratory Care: 1994;(39):440-452
15. James B Fink. Forced Expiratory Technique. Directed Cough, and Autogenic Drainage. Respiratory Care: 2007;52(9):1210-1221.
16. D. Selsby & J.G Jones. Some physiologic and clinical aspects of chest physiotherapy. British Journal of Anaesthesia:1990;(64):621-631
17. Meridian. Bronchial Hygiene Therapy. American Journal of Nursing: 2002; (102), Number1 Bronchial Hygiene Therapy Smiths magazine.
18. Connors A, Hammon W, Martin. Chest physical therapy, immediate effect on oxygen in acutely ill patients.Chest:1980;(78):559-64
19. Reins HD, Sade RM, Bradford. Chest physiotherapy fails to prevent post operative atelactasis in children after cardiac surgery. Ann Surg:1982;451-55
20. Gail Dechma Wilson. Evidence underlying Breathing Retraining in People With stable chronic obstructive pulmonary Disease. Physical Therapy: 2004; (84)1189-97.
21. Richard Wilson (1990) PEP Therapy: The key to effective, low cost removal of bronchial creation. www.rtmagazine.com

22. Falk et al, From Cochrane Database of Systematic Reviews 2006, Issue 2.Art No:CD003147.
23. Tonnesen Pet al. PEP as lung physiotherapy in cystic fibrosis in cystic fibrosis. Eur J Respir Dis:1984;(65):419-22
24. Cencins NM, Jenkins SC, Ryan The Active Cycle Of Breathing Technique-to tip or not to tip? Respiratory Care: 1999; (93):660-665.
25. B. Oberwaldner. Physiotherapy for airway clearance in paediatrics. Eur Respir J: 2000; (15):196-204.
26. Sandra Truesdell. Helping patients with COPD manage episode of acute shortness of breath. Med Surg. Nursing:2000;(1):1-4
27. Savci, Sema, Ince Deniz. A comparison of autogenic drainage and active cycle of breathing technique in patients with chronic obstructive pulmonary disease. Journal of cardiopulmonary Rehab:2000;(20):36-43
28. P.Skyba,P. Joppa,M. Oroion, RTkalova. Blood pressure and heart rate variability response to noninvasive ventilation in patient with exacerbation of chronic obstructive pulmonary disease. Physiol Res:2007;(56):527-533
29. Puchelle E, Tournier J M, Zahm JM. Rheology of sputum collection by a simple technique limiting salivary contamination. J Lab Clin Med: 1984;103(3):347-53

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IMPACT OF SPORTING ACTIVITIES ON BONE MINERAL DENSITY.

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ABSTRACT

Introduction:. It is known that participating in sports can have a beneficial effect on bone mass. However, it is not well established which type of sporting activity is more beneficial for increased bone mineral density. The objective of the study was to determine the relationship between impact of sporting activities and bone mineral density. As a part of study, bone mineral density of sportspersons was compared with age-matched non-sportspersons. **Method**: Research design for present study was a cross-sectional design. A total of 70 subjects in the age group of 25-75 years participated in the study. They were divided into two groups: (1) sportspersons group (n=35, mean age=48.05 years, mean BMI=25.99 kg/m^2) and (2) non-sportspersons group (n=35, mean age=48.14 years, mean BMI=26.29 kg/m^2). Bone mineral density was measured by using Ostepro - ultrasound bone mineral density system. **Results**: The results revealed statistically significant difference with t value of 4.2061 (**p<0.05**), indicating that sportspersons had higher bone mineral density than their non-sports cohort. A statistically significant positive relationship was exhibited (r = 0.463) between impact of sporting activities and bone mineral density which implies that sportspersons involved in high impact sports (basketball, football, and athletics) have greater bone mineral density as compared to athletes involved in moderate impact sports (table tennis and cycling). **Conclusions**: Bone mineral density is higher in sportspersons than their non- sports cohort and sportspersons involved in high impact sports have substantially higher bone mineral density than sportspersons involved in moderate impact sports.

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Introduction: Bone mineral density is used in clinical medicine as an indirect indicator of osteoporosis and fracture risk. There is a statistical association between poor bone density and higher probability of fracture. Fragility fractures, which result from a fall from no greater than standing height, are a significant public health problem leading to much medical cost, inability to live independently, and even risk of death. Bone density measurements are used to screen people for osteoporosis risk and to identify those who might benefit from measures to improve bone strength.

It is estimated that around 40% of US white women and 13% of US white men aged 50 years will experience at least one clinically apparent fragility fracture in their lifetime. At age 50, a white woman has a 17% chance of sustaining a hip fracture, 15% chance of vertebral fracture and 16% chance for forearm fracture, with comparable figures of 6%, 5% and 2.5% respectively, for fractures in white males[1]. The 1st year total direct cost of osteoporotic fractures is estimated to be

25 billion Euros in Europe[2]. The report of the European Commission (1998) estimates an increase in the incidence of hip fractures in Germany from 117,000 in the year 2000 to 240,000 in the year 2040[3]. Thus, osteoporosis and osteoporotic fractures have become one of the major health problems in western countries[4].

Nevertheless, in Asia, Osteoporosis is greatly under-diagnosed and undertreated even in the most high risk patients who have already fractured. The problem is particularly acute in rural areas. In the most populous countries like China and India, the majority of the population lives in rural areas, where hip fractures are often treated conservatively at home instead of by surgical treatment in hospitals.

In India, osteoporosis is highly prevalent, with an estimated 30 million women diagnosed to have osteoporosis[5]. Expert groups peg the number of osteoporosis patients at approximately 26 million with the numbers projected to increase to 36 million by 2013. In a study among Indian women aged 30-60 years from low income groups, BMD at all the skeletal sites were much lower than values reported from developed countries with a high prevalence of osteopenia (52%) and osteoporosis (29%) thought to be due to inadequate nutrition[6].

Thus, it is critically important to diagnose osteoporosis at the earliest. Currently, bone mineral density testing is the most objective method to diagnose osteoporosis in asymptomatic individuals. Because bone mineral density accounts for 70% of bone strength, low bone mineral density is the greatest predictor of risk for bone fractures[7]. Consequently, a better understanding of mechanisms leading to low bone mineral density is a crucial step in the identification of patients at risk of osteoporosis and for designing therapeutic and prevention programs.

Bone mineral density peaks at 20-30 years of age in both women and men. Remodelling maintains bone mass and mechanical competence in the adult skeleton by replacing the damaged and degraded bone tissue with new tissue. With ageing and osteoporosis, however, the remodelling tends to remain uncoupled in that packets of bone removed during resorption are not completely replaced during bone formation, resulting in a net loss of bone[8].

Thus, bone is metabolically active tissue with continuous remodelling occurring throughout life. Accordingly, it is reasonable to believe that

mechanical force exerted on skeleton is of critical importance to maintain and improve bone mineral density. Animal studies have demonstrated a significant relationship between mechanical loading and bone formation. In humans, physical exercise, especially weight bearing activity has been reported to have beneficial effects on the skeleton in both adolescent and the elderly[9]. Bone mineral density has been demonstrated to be higher in male athletes than in less active individuals[10]. Additionally, athletes especially those who are strength trained, generally have greater bone mineral density than non-athletes, and that maximum strength levels and muscle mass correlates with bone mineral density[11]. A number of studies have demonstrated a beneficial effect of physical exercise and sport training on bone mineral density[12-17].

Overall, these studies provide evidence that there is a protective effect of sporting activity on bone mineral density. However, whether there is a direct relationship between the impact of various sporting activities and bone mineral density is less clear. To examine this issue further, the present study has investigated the relationship between sporting activity and bone mineral density. As a part of study bone mineral density of sportspersons was compared with age-matched non-sportspersons.

Material and Methods: This was a cross-sectional study, which was performed in the Department of Physiotherapy, Punjabi university, Patiala in accordance with ethical considerations of the Institute. A total of 70 subjects in the age group of 25-75 years participated in the study. Informed consent was taken from all the participants prior to the study. They were divided into two groups: (1) sportspersons group (n=35, mean age=48.05 years, mean BMI=25.99 kg/m^2) and (2) non-sportspersons group (n=35, mean age=48.14 years, mean BMI=26.29 kg/m^2). Males and females engaged in any sport were included in sportspersons group. Males and females less than 25 years and more than 75 years were excluded. Subjects with a previous history of bone disease, illness or drug use that could affect bone mass were excluded.

All the subjects underwent anthropometric measurement. The subject's vitals were examined and the detailed physical examination was done. The sportspersons were ranked from 1- 10 for moderate to high impact sports including table tennis, cycling, throwing, wrestling, badminton,

gymnastics, athletics, handball, football and basketball respectively.

Bone mineral density: The subjects were then made to undergo, bone mineral density test. Bone mineral density was measured by using Ostepro - ultrasound bone mineral density system.The bone mineral density was measured in the form of T- score. The subjects were classified as normal if T-scores were ≥ -1, osteopenic if the lowest T-score was between -1 and -2.5 and osteoporotic if either T-score was ≤ -2.5.

Results: The data was analyzed with the help of SPSS 13 software. Initially mean and standard deviation were calculated of both sportspersons and non- sportspersons. Later on, unpaired t test was used to analyze the significant difference of variables between sportspersons and non- sportspersons. Pearson correlation was applied to establish the relationship between the impact of various sporting activities and bone mineral density. Significance level was set at 0.05.

Table 1: Comparison of mean value for Age, BMI and Bone mineral density (BMD) between sportspersons and non-sportspersons

	Sports Persons	Non-Sports Persons	t	p
	Mean±SD	Mean±SD		
Age	48+ 15	48.2+ 15	0.02	P>0.05
BMI	26+3.2	26.3+4.8	0.3	P>0.05
BMD	-1+1.8	-2.6+4.2	4.21 *	P<0.05

Table 1 describes, the Mean values and T values of Age, BMI and Bone mineral density (BMD) for the sportspersons and non- sportspersons. The t value of Age, BMI and BMD is 0.24, 0.30 and 4.21 respectively, which is statistically significant for bone mineral density (BMD) and non-significant for Age and BMI indicating that two groups are homogenous and bone mineral density of sportspersons is more than non-sportspersons.

Figure 1: Comparison of mean value for Age, BMI and Bone mineral density (BMD) between sportspersons and non-sportspersons

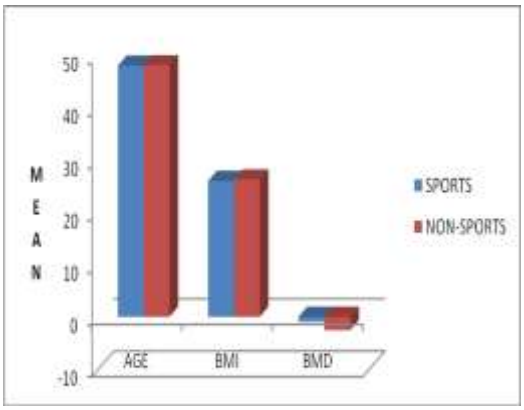


Table 2: Description of the Mean and SD of bone mineral density for different sporting activities.

Sporting Activity	Bone Mineral Density (T-Score)	
	MEAN	SD
Table tennis	-2.373	0.546
Cycling	-2.473	1.67

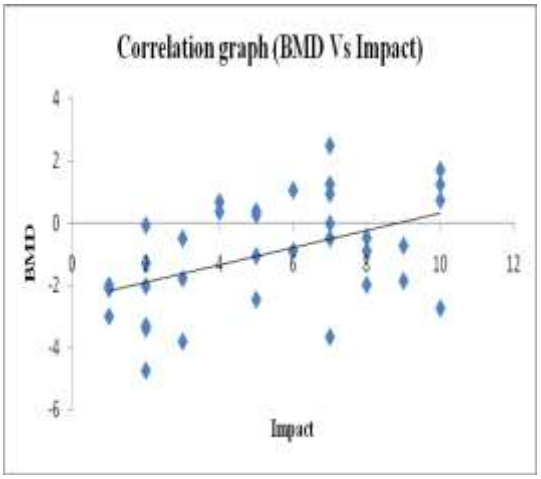
Throwing	-2.03	1.668
Wrestling	0.515	0.219
Badminton	-0.72	1.33
Gymnastics	0.075	1.378
Athletics	0.078	2.105
Handball	-1.123	0.779
Football	-1.295	0.799
Basketball	0.232	2.014

Table 3: Correlation of Bone mineral density (BMD) with impact of sporting activites

	Pearson Correlation	N	Sig.
BMD Vs Impact of sporting activities	0.463	35	P < 0.05

Table 3 describes, about the correlation of impact of sporting activities with BMD. The correlation (r) of impact of sports with BMD is 0.463 which is statistically significant indicating that with an increase in impact of sporting activities, there is an increase in bone mineral density.

Figure 2: Correlation graph of Bone mineral density (BMD) Vs impact of sport



Discussion and Conclusion: Bone mineral density is the amount of mineral per square centimetre of bones, used in clinical medicine as an indirect indicator of osteoporosis and fracture risk. The primary intent of the present study was to evaluate the impact of sporting activities on bone mineral density. To achieve this objective, the research work was carried out in two phases:

Phase I: Comparative study in which, bone mineral density of sportspersons was compared with that of non-sportspersons and

Phase II: Correlational study in which the relationship between the impact of different sporting activities and bone mineral density was investigated amongst sportspersons.

The results of the comparative study revealed statistically significant difference in the mean values of bone mineral density between sportspersons and non- sportspersons with t value 4.2061, indicating that sportspersons had higher bone mineral density than their non-sports cohort. It is imperative here to mention that the difference in Mean values of age and body mass index between sportspersons and non-sportspersons was found to be statistically non- significant (t value=0.0240 and 0.3043 respectively),

suggesting that the two groups in the present study, were homogenous in terms of age and body mass. These findings further suggest that sporting activity is a reasonable indicator of bone mineral density and may exert its effects independently of age and body mass.

Thus, findings of present study were suggestive of higher bone mineral density and therefore better bone strength in sportspersons when compared with age matched non-sportspersons. This is well in line with the study done by Andreoli[18] who stated that the athletes had significantly greater bone mineral density than the non-athletes of similar age. It appears that mechanical stress in the form of sporting activity may be a major factor in bone mineralization, though the physiological mechanisms involved in the response of bone cells to mechanical stress are still unclear. A possible explanation may be that osteocytes, acting as mechanoreceptors, respond and release chemical factor capable for promoting osteoblast proliferation at the local bone site.

Thus, increased mechanical load is a contributory mechanism in sportspersons. However, it is possible that these beneficial effects of sporting activities on bone mineral density are impact reliant. Because the present study has demonstrated a significant relationship (r = 0.463) between impact of sporting activity and bone mineral density, indicating that with an increase in impact of sport, there is an increase in bone mineral density. The sportspersons included in the present study were Athletes, throwers, wrestlers, gymnasts, cyclists, basketball, football, handball, badminton and table tennis players. With all of them being the national level players, it was observed that athletes involved in high impact sports (basketball, football, and athletics) had greater bone mineral density as compared to athletes involved in moderate impact sports (table tennis and cycling). These findings suggest that sporting activities having higher impact produce greater effects on bone remodelling than sporting activities with lower or moderate impact. This may be because of the application of strain magnitudes and rates of force development closer to the optimum for stimulating bone remodelling.

These findings of the present study support the previous reports of the positive effects of high impact activities on bone mineral density. The study done by Block[19] has reported that weight bearing forms of vigorous

exercise are associated with greater levels of bone mineral density. Another study done by Lanyon[20] stated that physical activity involving high impact or weight bearing movements provides an osteogenic stimulus that may enhances bone mass at any age. Heinonen[21] reported that the form of exercise has been shown to affect bone mineral density since weight bearing activities are associated with higher BMD while non-weight bearing exercises such as cycling and swimming do not seem to increase bone mineral density in young adults. Barlet[22] have demonstrated the importance of weight bearing physical activity as well as mechanical loading for maintaining skeletal integrity. Fehling[23] also demonstrated that a group of athletes who is engaged in a sport that loads the skeletal system with high magnitude, short duration stimuli had greater BMD than athletes who participated in a sport that actively taxes their muscular system, but does not evoke ground reaction forces, suggesting that the type of mechanical loading regimen plays an integral part in influencing bone mineral density. Klesges[24] has also shown that training using loaded weight bearing exercises causes significant higher bone mineral density. Regular exercise, especially resistance and high impact activities, contributes to development of high peak bone mass and may reduce risk of falls and osteoporotic fracture in later life[25]. It has been widely accepted that engaging in weight bearing activity can elicit significant positive bone mass adaptation[17].

On the whole, these studies, done over the period of last three decades, suggest that impact of physical exercise and sport training is an important factor in the acceleration and maintenance of bone mineral density. The present study has demonstrated a significant correlation between the impact of sporting activity and bone mineral density. Furthermore, the study has revealed an osteogenic effect of sporting activity that is independent of age and body mass of an individual. In conclusion, present study analysis reveals that sporting activity has a positive effect on bone status and such a positive effect is increased by the higher impact of sporting activity that involves weight bearing loading. This implies that age-related loss in bone mineral density is preventable by the appropriate exercise program that includes increased mechanical loading with sporting activity of higher impact. Clinically, this information is important, as it can be utilized while designing

preventive and treatment plans for osteopenic and osteoporotic individuals respectively.

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References

1. Cummings S R, Melton L J. Epidemiology and outcomes of osteoporotic fractures. Lancet 2002; 359: 1761.
2. Melton L J, Chrischilles E A, Couper C, Lane A W, Riggs B L. Perspective. How many women have osteoporosis? *Journal of bone and metabolic research* 1992;9: 1005-10.
3. Haussler B, Gothe H, Gol D. Epidemiology, treatment and costs of osteoporosis in Germany-the Bone EVA Study. Osteoporos Int 2007; 18:77.
4. Kannus P, Niemi S, Parkkari J, Palvanen M, Vuori I, Jarvinen M. Hip fractures in Finland between 1970 and 1997 and predictions for the future. *Journal of bone and mineral research* 1999; 353:802–805
5. Shah R S, Savardekar L S. Post menopausal osteoporosis in India: Growing public Health concern. Symposium, Forum 9, Mumbai India 2005; 12-6
6. Shatrugna V, Kulkarni B, Kumar P A. Bone status of Indian women from a low-income group and its relationship to the nutritional status. Osteoporos Int 2005; 16: 1827.
7. Follin S L, Hansen L B. Current approaches to the prevention and treatment of postmenopausal osteoporosis. Am J Health Syst Pharm 2003; 60(9):883-901; quiz 903-4
8. Suominen H. Strength training for osteoporosis. Book of abstracts, 4th international conference on strength training. Aristotle University of Thessaloniki 2004; 23-26
9. Scerpella T A, Davenport M, Morganti C M. Dose related association of impact activity and bone mineral density in pre-pubertal girls. *Calcification Tissue International* 2003; 72(1):24–31.
10. Petterson U, Nordstrom P, Lorentzon R. A Comparison of Bone Mineral Density And Muscle Strength In Young Male Adults With Different Exercise Level. *Calcif. Tissue Inernational* 1999; 64:490–498.

11. Chilibeck P D, Sale J T, Webber J C. Exercise and bone mineral density. *Journal of sports medicine* 1999; 19:103
12. Dalen N, Olsson K E. Bone mineral content and physical activity. *Acta Orthop Scand* 1971; 45:170-174.
13. Cooper C, Barker D P, Wickham C. Physical activity, muscle strength and calcium intake in fracture of the proximal femur in Britain. *British medical journal* 1988; 297: 1433-46.
14. Snow H C, Whalen R, Myburgh K L, Arnaud S, Marcu R. Bone mineral density, muscle strength, and recreational exercise in men. *Journal of bone and mineral research* 1992; 1291-1296
15. Yung P S, Lai Y M, Tung P M, Tsui H T, Wong C K, Hung K L, Qin L. Effects of weight bearing and non-weight bearing exercises on bone properties using calcaneal quantitative ultrasound. *British Journal Sports Med* 2005; 39:547–551
16. Bennell K L, Malcolm S A, Kham K M. Bone mass and bone turnover in power athletes, endurance athletes, and controls: a 12-month longitudinal study. *Journal of Bone* 1997; 20:477– 484
17. Blanchet C, Turcot-Lemay L, Dumont M. Leisure physical activity is associated with quantitative ultrasound measurements independently of bone mineral density in postmenopausal women. *Calcification Tissue International* 2003; 73:339–49.
18. Andreoli A, Monteleone M, Loan M V, Promenzio L, Tarantino U, Lorenzo A. Effects of different sports on BMD and muscle mass in highly trained athletes. *Official Journal of the American College of Sports Medicine* 2001; 33:507-511.
19. Block, Friedlander A, Brooks G A, Steiger P, Stubbs H A, Genant H K. Determinants Of Bone Density Among Athletes Engaged In Weight-Bearing And Non-Weight-Bearing Activity. *Journal of Applied Physiology* 1989; 67:1100 – 1105.
20. Lanyon L E. The success and failure of the adaptive response to functional load-bearing in averting bone fracture. *Journal of Bone* 1989; 13:17-21
21. Heinonen A, Oja P, Kannus P, SievPnen H, MHnttlti A, Vuoti. Bone mineral density of female athletes in different sports. *Journal*

of Bone Mineralisation 1993; 23:1-14

22. Barlet J P, Coxam V, Davicco M J. Physical Exercise and the Skeleton. *Arch. Physiology Biochem* 1995; 103:681– 698.
23. Fehling P C, Alekel L, Clasey J, Rector A, Stillman R. A Comparison of Bone Mineral Densities Among Female. Athletes in Impact Loading and Active Loading Sports. *Journal of bone* 1995; 17:205-210
24. Klesges R C, Ward K D, Shelton M L. Changes in bone mineral density in male athletes. Mechanism of action and intervention effects. *JAMA* 1996; 17:226-30.
25. Wallace L S, Ballard J E. Osteoporosis coverage in selected women's magazines and newspapers,. *J Bone Miner Research 2000*; 17:359-364.

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