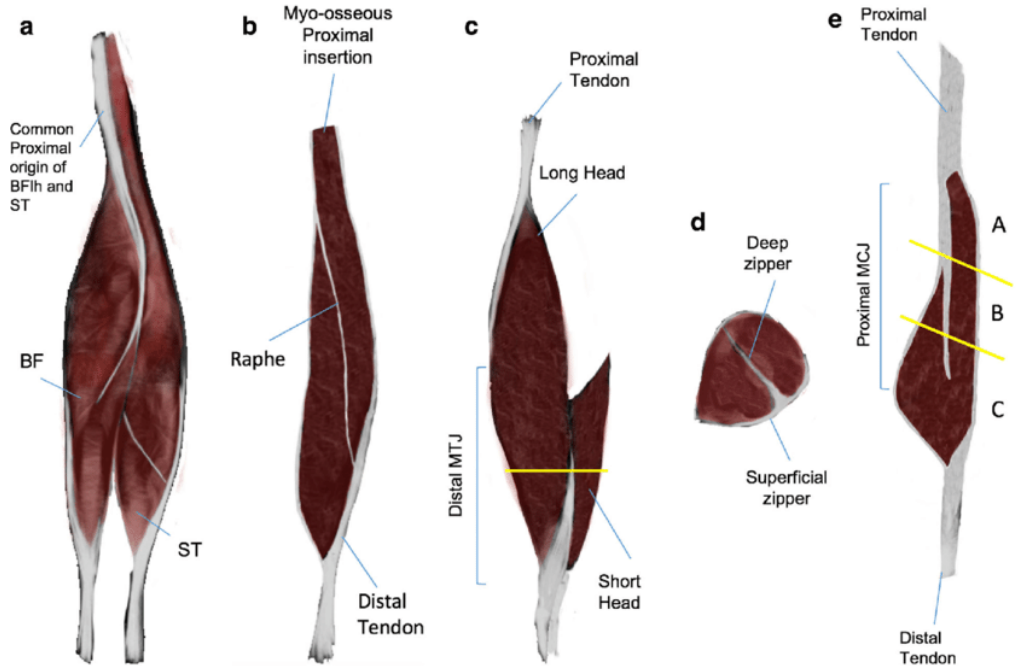
To compare the effectiveness between Kinesio Taping versus Ballistic Stretching for improving hamstring flexibility in collegiate athletes

Dr. Manash Kanti Chakraborty (PT), Shashi Kumar

INTRODUCTION

Hamstring muscles are reported to be the most commonly injured multi-joint muscle group in the body.[1]Sprain, most common muscle injury can occur due to hamstring tightness.Tight hamstrings can cause postural problems and back problems such as sacroiliac joint pain, lower back pain. It is the main contributing factor leading to the risk of pathological conditions of the knee and spine. Tight hamstrings can cause the hips and pelvis to rotate back which leads to flattening the lower back muscle and increased patellofemoral compressive force, which may eventually, lead to patellofemoral pain syndrome [2].



hamstring tightness is often an indicator of muscle weakness elsewhere.[3]People who assume prolonged sitting position are prone to tight hip flexors, hamstrings and calves. Thus, sedentary individuals are susceptible to inflexible or reconditioned hamstrings, while athletes and very physically active individuals have healthy, well-conditioned hamstrings.[4]

Maintaining normal muscle length requires regular stretching to prevent muscle stiffness and benefit from the decreased risk of musculoskeletal injuries and enhanced physical performance[36]. Stretching techniques are the treatments used to improve muscular extensibility to improve ROM, and can help prevent damage in daily life or sports, reduce muscle pain, and improve muscle capability, and athletic performance[5]

Hamstring extensibility is frequently analyzed in the clinical setting and sport training, and it is considered a basic component of physical fitness. hamstring muscle shortness has been related with lower limb injuries [36,37,38], low back pain and changes in lumbopelvic rhythm[39]. Decreased hamstring extensibility has been associated to increased thoracic kyphosis and more posterior pelvic tilt when maximal trunk flexion with knees extended is performed [35]. Short hamstring muscle is common in physically active people, sedentary subjects and athletes[10].

Studies that have analyzed hamstring extensibility in athletes of different sport disciplines have found a high percentage with low extensibility, except in those sports where hamstring extensibility plays a very important role in the performance and posture, such as rhythmic gymnastics and dancing[10].

In an attempt to improve hamstring extensibility,several studies have analyzed and compared the effectiveness of different techniques. The effects of several stretching techniques in hamstring extensibility have been extensively analyzed[1,11-14]. Hamstring stretching is considered an appropriate intervention in both the prevention and treatment of hamstring injuries.

A few studies have also analyzed other techniques. The effects of the Bowen technique [15], dynamic soft tissue mobilizations[16], suboccipital muscle inhibition technique [17], muscle energy tecnnique [18]and neurodynamic sliding technique [19] have shown their effectiveness in increasing hamstring muscle extensibility. In recent years, kinesio tape [20, 21] and electrical muscle elongation[22] have been proposed as alternatives to improve muscle extensibility.

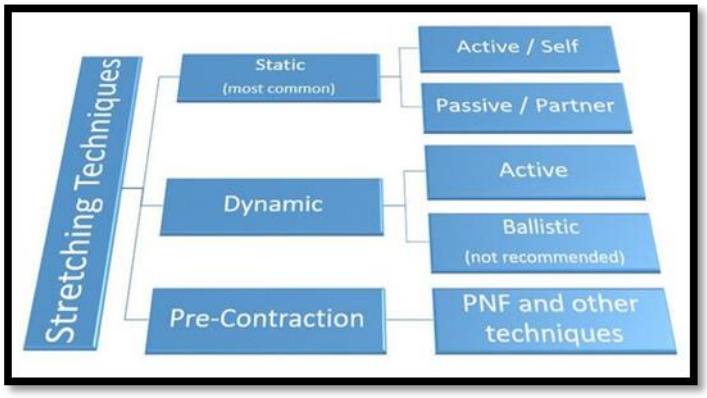
Kinesio tape (KT) is being widely used to prevent injuries to athletes, for rehabilitation and also to treat several musculoskeletal disorders [28,29]. Kinesio tape was developed in 1970s by Dr.

Kenzo Kase. This alternative taping technique, theorized by Kase, had been suggested to introduce the beneficial effects of the tapes including effects on strength, control and performance, as well as reduction in pain, prevention of injury, inhabitation and facilitation of motor activity, improvement of a variety of physiological problems, including the range of motion, based on the functions of the tape [24,25,27] KT mechanism, by which KT exerts its hypothesized effects, has not clearly demonstrated the effectiveness of its methodology yet.

KT has been show to support muscle movement, relieve abnormal feeling or pain on the skin. Mori et al suggested that KT normalizes muscle function [26]. Kase et al believed that the stretch rate and width of the KT affected the facia and flow of lymph fluid[25]. Kinesio taping reduced cervical pain and increased range of motion (ROM) 24 hours following whiplash injury [23]. Slupik et al showed a preliminary effect on quadriceps peak torque and electromyographic activity in healthy subjects[28].

Some authors advocate that ballistic stretching is more functional than other stretching techniques for individuals who participate in activities that require high velocity movements[31,32,35]. However, there are differing opinions about the safety of ballistic stretching with some authors expressing concern over the risk of musculoskeletal injury, particularly as it relates to muscle strain[32,33,34].

The most frequently cited reason for this belief is that ballistic stretching involves repeated rapid stretching of the muscle [34,39]. This rapid stretch may activate the muscle spindle, thus preventing adequate muscle relaxation before the subsequent stretch. Some have hypothesized that this may cause microtrauma to the muscle[35,34]. No literature have found to Compare the kinesio taping versus ballistic stretching for improving hamstring flexibility in collegiate athletes So this study is designed.



METHODOLOGY

STUDY DESIGN : Comparative study .

SAMPLING DESIGN: Randomized

SAMPLE SIZE :40 Collegiate athletes were taken for improving hamstring flexibility.

STUDY CENTRE:PMCH UDAIPUR

DURATION OF THE STUDY: 30 minutes per day, 4days in a week,Total 12 Weeks.

OUTCOME MEASURES

1. SIT AND REACH TEST.
2. ACTIVE KNEE BENDING TEST

STUDY MATERIALS

1. Written consent form.
2. General assessment form.
3. Treatment couch.

3. Paper and Pencil.
4. Chair.

5. Goniometer

6. Kinesio Tape

7. Table

8. Examination couch

INCLUSION CRITERIA

1. Both male and female.
2. Collegiate athletes.
3. Age between 18-28Years.

EXCLUSION CRITERIA:

1. Neurological disorders.
2. Cardiovascular disorders.
3. Any skin allergy
4. Open wounds.
5. Presence of any malignancy.
6. Recent fracture of lower limb.
7. Any surgery in lower limb.
8. Mentally retard persons.
9. Presence of any malignancy

PROCEDURE

After collecting the written consent form patients were selected by inclusion and exclusion criteria and equally divided into 2 groups - Group A and Group B

Group A: Kinesio Tape applied on this group.

5 cm wide kinesio tape was applied to the hamstrings using the X-shapedtaping technique The base of the tape was placed unstrechedwith the patient in a neutral body position, just distal to the insertion of the muscle in order to achieve a relaxingeffect. Then,functional strips were applied on the stretched muscle belly, maintaining the original 10% tape prestretching. Afterward, the anchorage was applied without stretching, just proximal to the insertion of muscle in neutral body position.

First step. Application of the midpoint "X" in the neutral position just above the popliteal fosse and placing theshort strips both medially and laterally to the popliteal fosse.

Second step. Hip flexion and knee extension and then application of the medial strip on semimembranosus andsemitendinosus muscles and the lateral strip on the biceps femoris.

Third step: Joining the anchorages in a neutral position on the ischial tuberosity.To use the correct length of the tape for each person, they were measured in a stretched position fromthe medial or lateral condyle of the tibia to the ischial tuberosity.

Fig: Kinesio taping

Fig: application of kinesio tapping

Group B :Ballistic Stretching given on this group.

Patient position- Supine lying position.

Therapist position - Stand by the side of the patient Flexion extension movements of the hip with knee kept in full extension, with the fastest speed as possible, respecting the limit, 5 cycles of 20 repetitions with 30 seconds interval between them.

Fig: ballistic stretching (Modified straddle stretch)

Fig: Ballistic stretching

Fig: Ballistic stretching

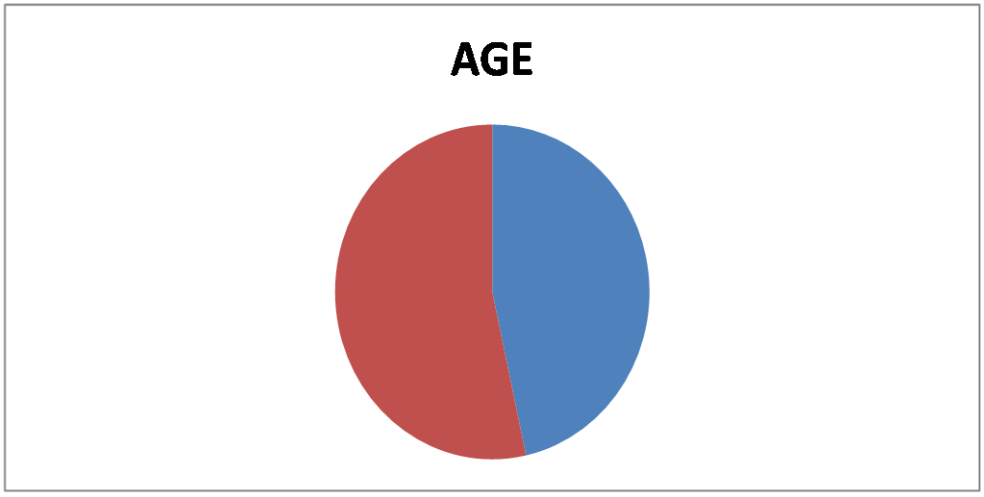
ESULTS & DATA INTERPRETATION

Analyses of pre and post test scores within and between the groups are tabulated with intervention of the result of the study.

TABLE:1

Group	Number	Mean	S.D
GroupA	20	20.9	2.48
GroupB	20	24	2.31
Total	40	44.9	4.80

CHART 1



Interpretation:

Demographic data of mean value of age of participants

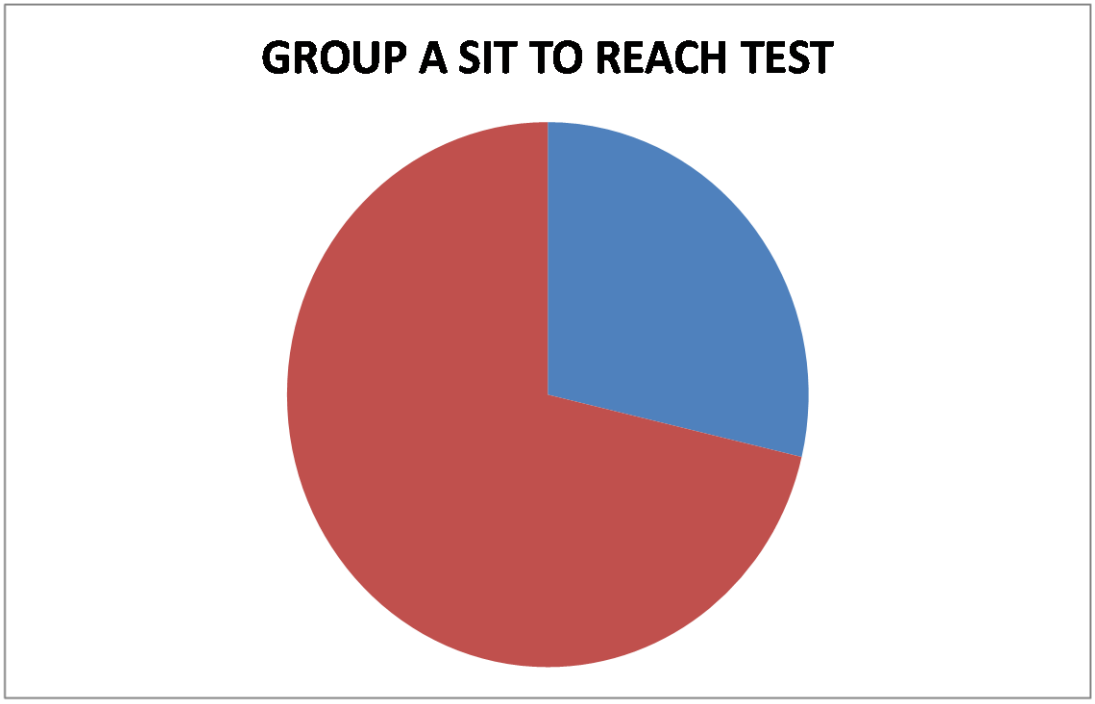
TABLE 2

A. WITHIN GROUPS:

GROUP A SIT TO REACH TEST

SIT TO REACH	N	Mean	SD	Std. Error Mean	Mean Diff	df	t	P
Pre-test	20	4.1	0.78	0.17	6.1	29	4.75	<0.0001**
Post-test	20	10.2	1.43	0.32				

CHART 2



Interpretation:

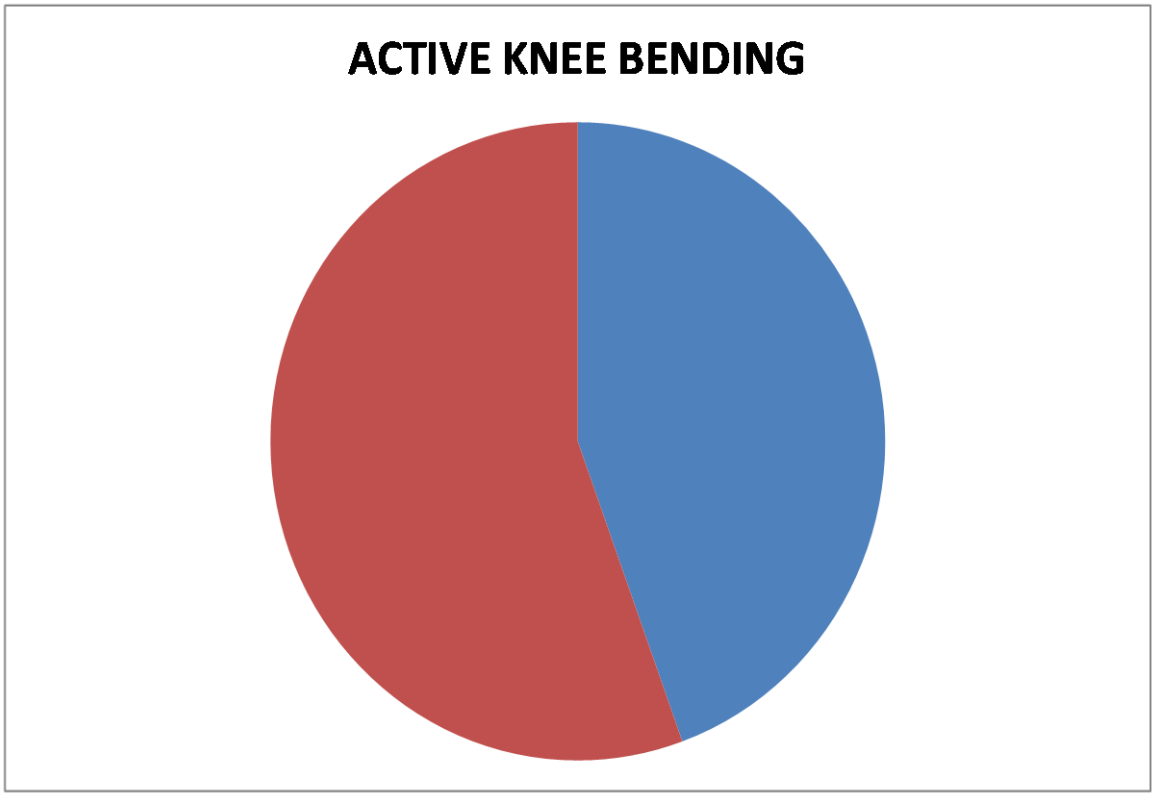
The above table and chart shows the mean value, mean difference, t value and p value of sit and reach test for group A. $p < 0.0001$ was significant.

TABLE 3

GROUP A Active Knee Bending Test

Active knee bending test	N	Mean	SD	Std. Error Mean	Mean Diff	Df	t	P
Pre-test	20	84.5	5.59	1.25	21	19	6.29	<0.0001**
Post-test	20	105.5	5.10	1.14				

CHART 3



Interpretation:

The above table and chart shows the mean value, mean difference, t value and p value of active knee bending for group A. p< 0.0001 was significant.

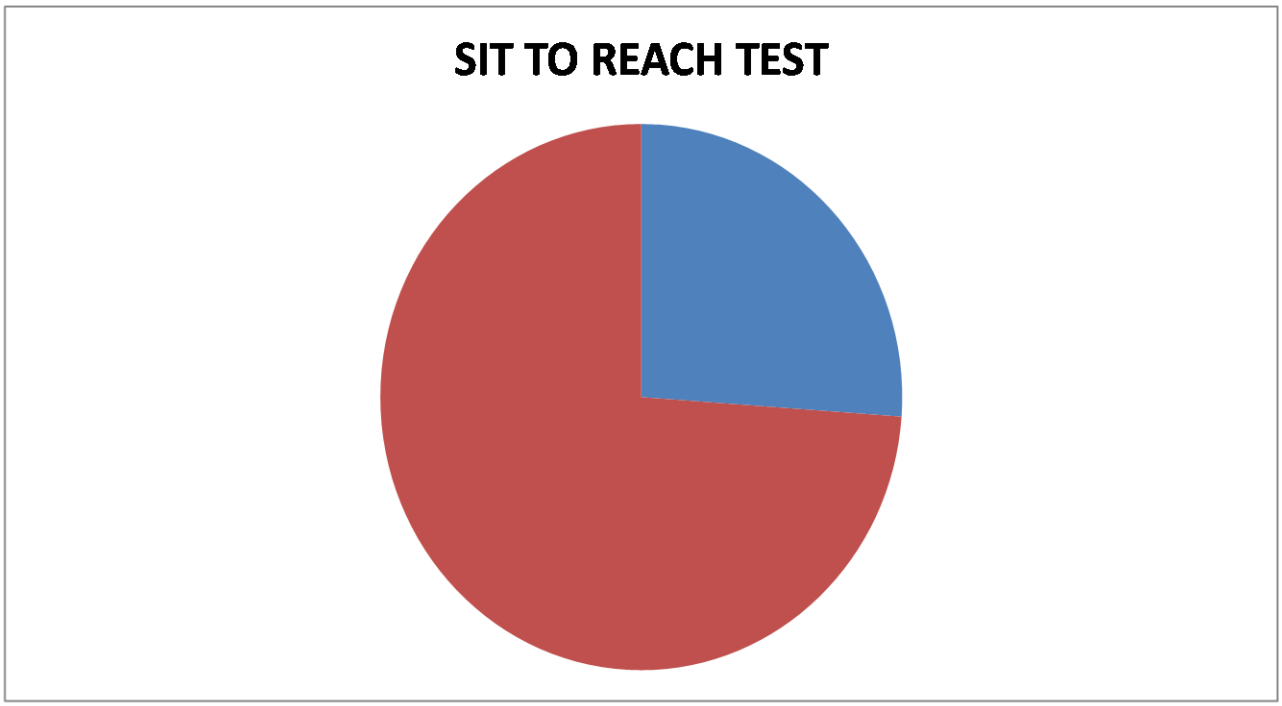
TABLE 4

GROUP B Sit To Reach Test

SIT TO REACH TEST	N	Mean	SD	Std. Error Mean	Mean Diff	df	t	P
Pre-test	20	4	0.79	0.17	7.3	19	9.54	<0.0001**
Post-test	20	11.3	0.97	0.21				

**Significant

CHART 4



Interpretation:

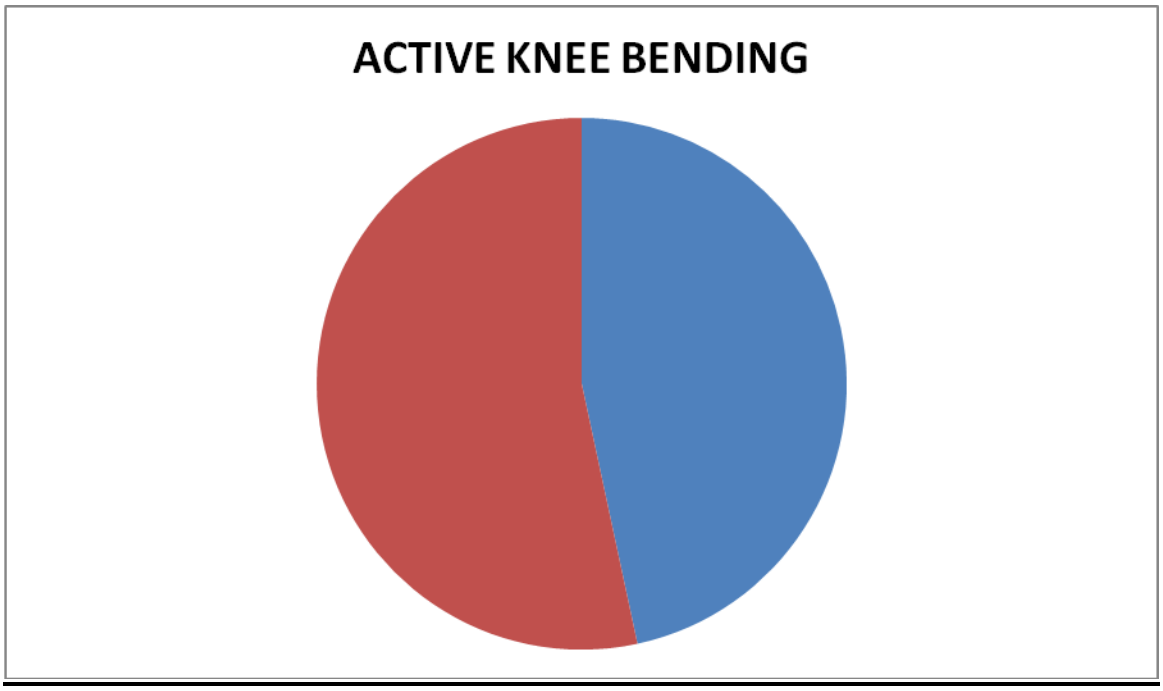
The above table and chart shows the mean value, mean difference, t value and p value of sit and reach test within group B. $p < 0.0001$ was significant.

TABLE 5

GROUP B Active Knee Bending Test

ACTIVE KNEE BENDING	N	Mean	SD	Std. Error Mean	Mean Diff	df	t	P
Pre-test	20	83.9	6.52	1.45	12.1	19	2.56	<0.0001**
Post-test	20	96	4.16	0.93				

CHART 5



Interpretation: The above table and chart shows the mean value, mean difference, t value and p value of active knee bending within group B. p< 0.0001 was significant.

BETWEEN GROUP

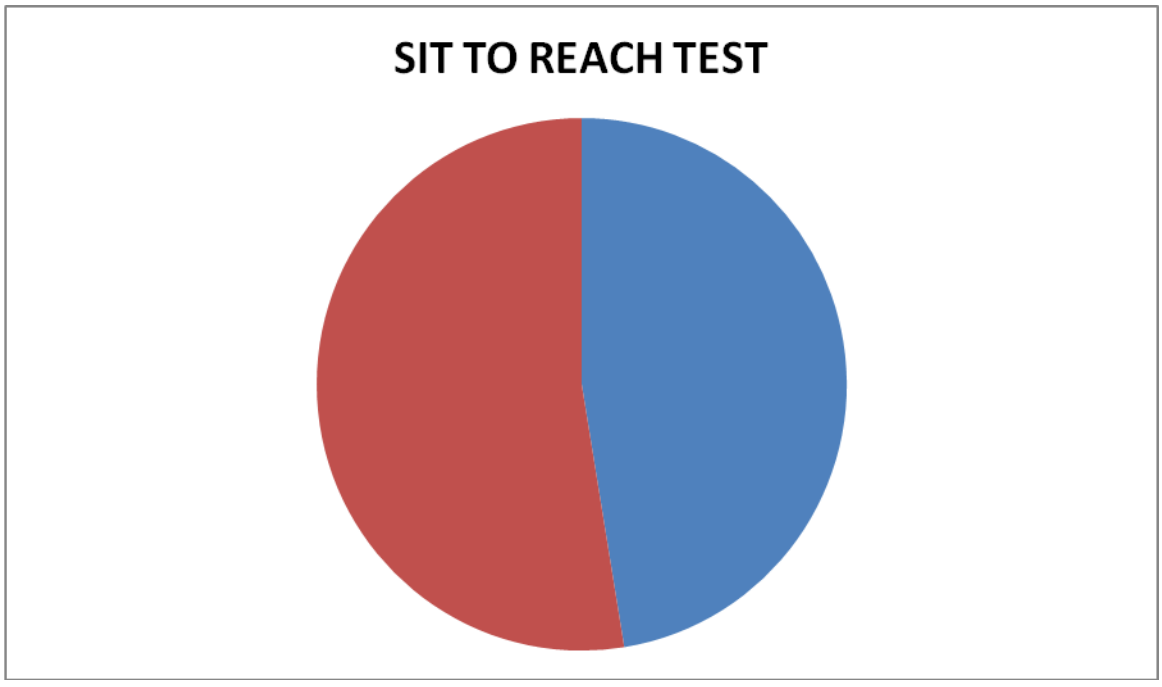
TABLE 6

GROUP A AND B (SIT TO REACH)

SIT TO REACH TEST	N	Mean	SD	Std. Error Mean	Mean Diff	df	t	P
GROUP A	20	10.2	1.43	0.32	1.1	19	2.39	<0.0001**
GROUP B	20	11.3	0.97	0.21				

**Significant

CHART 6



Interpretation:

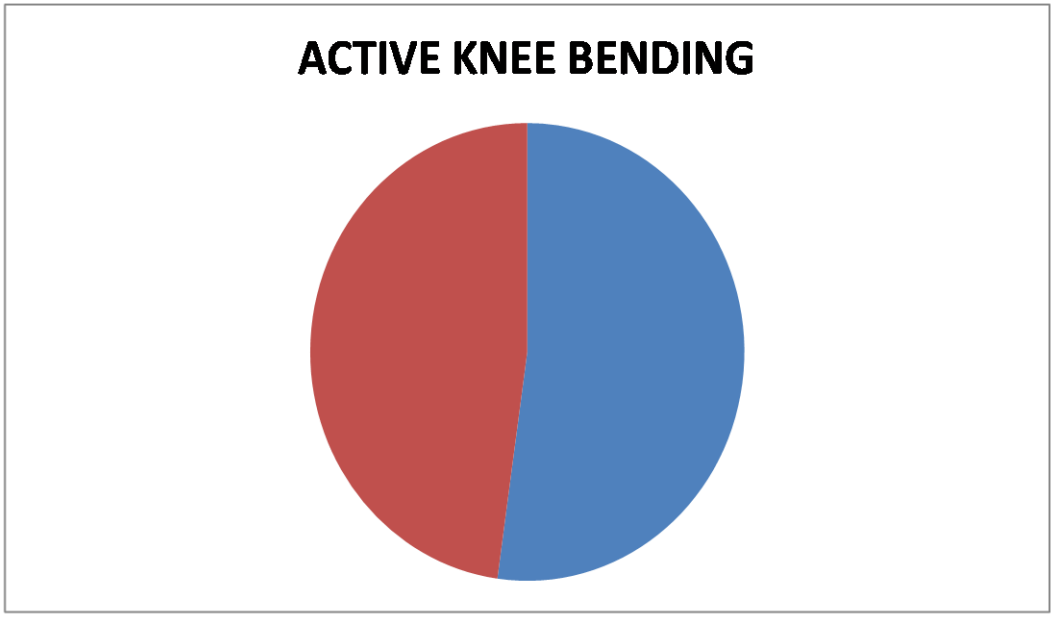
The above table and chart shows the mean value, mean difference, t value and p value of sit and reach test between group A and group B. $p < 0.0001$ was significant.

TABLE 7

GROUP A AND GROUP B

ACTIVE KNEE BENDING	N	Mean	SD	Std. Error Mean	Mean Diff	df	t	P
GROUP A	20	105.5	5.10	1.14	9.5	19	1.95	<0.0001**
GROUP B	20	96	4.16	0.93				

GRAPH 7



Interpretation:

The above table and chart shows the mean value, mean difference, t value and p value of active knee bending between group A and group B. $p < 0.0001$ was significant.

DISCUSSIONS

The purpose of this research project was to identify the effects of Kinesio Tape and ballistic stretching and compare the effect on hamstring flexibility.

There are three muscles in the back of the thigh that are collectively known as the hamstrings--the semimembranosus, the semitendinosus and the biceps femoris. One of their major characteristics is that they cross two major joints, the hip and the knee. The hamstring muscles are the major flexors of the knee and also aid hip extension.Individuals who sit for prolonged periods of time are predisposed to developing tightness in the hamstrings, as are athletes who compete in sports that require bursts of speed, such as sprinters. Tight hamstrings can be a serious problem for both athletes and non-athletes alike. Tight hamstrings increase the risk of lower back pain and knee pain, conditions that can hamper one's performance in sport and exercise**.**

One of the main treatments for people with tight hamstrings is stretching. Its effectiveness has been questioned and some studies report that it may actually increase the incidence of injury prior to an event. This may be true because the stretch prior to the activity injures the muscle and the muscle tears at that injury site when it is load with more force.

According to Mori A, Takasaki M, "Activation of Cerebral Cortex in Various Regions After Using Kinesio Tape Nihon University, kinesiotaping.com; July 2011" Kinesio Tape (KT) has been used and proven to increase somatosensory recognition and proprioception from the periphery to the cortex. It has also been speculated to help promote posture and walking in the elderly.

During a study of ankle sprains performed by Jayson M. Goo, it was found that the athletes who did not receive the Kinesio Tape as part of their post injury rehab had increased joint effusion and increased time to recovery and return to sport.

"The major four major effects of Kinesio Taping is to relieve pain or abnormal feeling on the skin and fascia, supports the muscle in movement (with expanding effects), removes congestion of lymphatic fluid or hemorrhages under the skin, and corrects misalignment of the muscle, fascia, and joint." (K Kase. Adjunctive Therapy to Increase the Effects of Kinesio Taping; 2005).

A study was performed on dancers associated with muscle disorders and fatigue. Kinesio Tape was used to correct biomechanical movements/habits, thus allowing them to create more power throughout their movements and effectively improve their performance. (A Futakawa. Treatment for the Disorders of Dancers Analysis of the Effects of Kinesio Taping on the movement of dancers; 2005)

Dr. Heather Murray researched the effects of Kinesio Tape used as postural therapy and the results were that the tape helped improve posture of scapular disorders and significantly relieve posterior and anterior musculature pain. (HM Murray. Effects of Kinesio Taping on Posture and Presence of Upper Extremity Pain; 2001)

Kinesio Tape has also been proven to help stroke victims due to the fact that "restoring trunk and scapular alignment after the stroke is critical in an effective treatment program for the upper extremity in hemiplegia". (E Jaraczewska, C Long. Kinesio Taping in Stroke: Improving Functional Use of the Upper extremity in hemiplegia. *Topics in Stroke Rehabilitation*; 2006; vol 13.3 pg 31-42.)

The ballistic stretching is characterized by the use of vigorous and rhythmic movements of a body segment throughout this range of motion in order to lengthen a muscle or muscle groups.

McMillian et al. found increased T-drill, medicine ball throw, and five-step-jump performance after dynamic stretching but not after static stretching. Similar results were obtained by Little and Williams who found that dynamic stretching was most effective to prepare for high-speed activities 10-m sprint, flying 20-m sprint, and agility) and that static stretching was not detrimental to performance.

Research often reports ballistic stretching to be less effective at improving flexibility than other types of stretching. One of the reasons for the lower effectiveness of ballistic stretching for improving static flexibility is inhibitory effect of the stretch reflex. Ballistic stretching is associated with increased potential of injury to the musculotendinous unit because of

involvement of higher functions. The musculotendinous units of untrained and sedentary individuals may not be able to withstand this vigorous type of stretching without sustaining muscle damage.

Of those examined, only one evaluated the effects of a ballistic stretching routine on maximum vertical jump height. The finding of the current investigation is consistent with results from Unick et al. They found no significant difference in maximum vertical jump height after completing three sets of a ballistic stretching routine as part of a warm-up.

In this study both the group showed improvement in hamstring flexibility but the group treated with Kinesio taping showed significantly more effective than the ballistic stretching group.

Ballistic stretching traditionally is used less often than static stretching, except when considering the similarities between this method and dynamic stretching. Dynamic stretching, which is widely used by collegiate athletes, is performed by repeating forceful sport-specific movements, whereas ballistic stretching is thought of as repeated bouncing maneuvers, not necessarily as a sport-specific motion. However, both methods contain ballistic traits.

Ballistic stretching has been negatively labeled by fitness professionals as potentially harmful when not performed correctly, most likely due to the incidence of injuries received by the less-trained general public. Despite this perception, Kumar and Chakrabarty have shown ballistic stretching to be more effective than static stretching, when performed properly, for increasing ROM.

CONCLUSIONS

The study was performed to compare the effectiveness between Kinesio taping versus Ballistic Stretching for improving hamstring flexibility in collegiate athletes. This study concludes that both the interventions having significant effect within the groups. While comparing Kinesio taping showed statistically more effective then ballistic stretching for improving hamstring flexibility for collegiate athletes.

LIMITATIONS AND RECOMMENDATIONS

Limitation of the Study

- Shorter Duration.
- Small number of sample
- The Study was performed for collegiate athletes only

Recommendations for further study

- Further study could be done with large number of sample
- Further study could be done on professional players also.
- Study could be done on different age group.
- Different interventions could be added for improving hamstring flexibility.
- Different type of professionals may be use in further study.

REFRENCES

1. Scott Davis D, Paul E Ashby, Kristi L Mccale, Jerry A Mcquain, Jaime M Wine. The effectiveness of 3 stretching techniques on hamstring flexibility using consistent stretching parameters. J Strength and Condi Research 2005;19(1):27-32.

2. Odunaiya NA, Hamzat TK, Ajayi OF. The effects of static stretch duration on the flexibility of hamstring muscles. African journal of biomedical research 2005;8:79-82.

3. Karthikeyan Rajendran, Ilayaraja Alagia Thiruvevenkadam, Arunkumar Nedunchezhiyan. Static stretching versus hold relax (PNF) on hamstring flexibility in sedentary living college students. Int. J Physiother Res.2016; 4(2):1436-43.

4. Esola MA, McClure PW, Fitzgerald GK, Siegler S. Analysis of lumbar spine and hip motion during forward bending in subjects with and without a history of low back pain. Spine. 1996; 21: 71-78.

5. Muyor JM, Alacid F, Rodríguez-García PL, López-Miñarro PA. Influencia de la extensibilidad isquiosural en la morfología sagital del raquis e inclinación pélvica en deportistas. Int J Morp. 2012; 30(1):176-81.

6. López-Miñarro PA, Muyor JM, Alacid F. Influence of hamstring extensibility on sagittal spinal curvatures and pelvic tilt in high-trained young kayakers. Eur J Sports Sci. 2012; 12(6) 469-74.doi10.1080/17461391.2011.575476.

7. López-Miñarro PA, Alacid F. Influence of hamstring muscle extensibility on spinal curvatures in young athletes. Sci Sports. 2010;25:188-93. doi:org10.1016/j.scispo.2009.10.004.

8. Gajdosik RL, Albert CR, Mitman JJ. Influence of hamstring length on the standing position and flexion range of motion of the pelvic angle, lumbar angle, and thoracic angle. J Orthop Sports Phys Ther.1994; 20:213-9.

9. López-Miñarro PA, Muyor JM, Alacid F, Rodríguez PL. Influence of sport training on sagittal spinal curvatures. In: Wright AM, Rothenberg SP, editors. Posture: Types, Assessment and Control. New York: Nova Publishers Pub Inc.; 2011. p. 63-98.

10. O'Hora J, Cartwright A, Wade CD, Hough AD, Shum GLK. Efficacy of static stretching and proprioceptive neuromuscular facilitation stretch on hamstrings length after a single session. J Strength Cond Res. 2011; 25:1586-91. doi: 10.1519/JSC. 0b013e3181df7f98.

11. Puentedura EJ, Huijbregts PA, Celeste S, Edwards D, Alastair I, Landers MR et al. Immediate effects of quantified hamstring stretching: Hold-relax propioceptive neuromuscular facilitation versus static stretching. Phys Ther Sport. 2011;12:122-6.doi: 10.1016/j.ptsp.2011.02.006.

12. Muyor JM, López-Miñarro PA, Casimiro A. Effect of stretch- ing program in an industrial workplace on hamstring flexibility and sagittal spinal posture of adult women workers: A ran-domized controlled trial. J Back Musculoskelet Rehab. 2012;25(3): 161-9. doi: 10.3233/BMR-2012-0323.

13. López-Miñarro PA, Muyor JM, Belmonte F, Alacid F. Acute effects of hamstring stretching on sagittal spinal curvatures and pelvic tilt. J Hum Kinet. 2012; 31: 69-78.

14. Marr M, Baker J, Lambon N, Perry J. The effects of the Bowen technique on hamstring flexibility over time: A randomised controlled trial. J Bodywork Mov Ther. 2011; 15: 281-90. doi:10.1016/j.jbmt.2010.07.008.

15. Hopper D, Deacon S, Das S, Jain A, Riddell D, Hall T, et al. Dynamic soft tissue mobilisation increases hamstring flexibility in healthy male subjects. Br J Sports Med. 2005; 39: 594-8. doi:10.1136/bjsm.2004.011981.

16. Quintana E, Borrallo L, Rodrígues C, Alburquerque FA. Immediate effects of the suboccipital muscle inhibition technique in subjects with short hamstring syndrome. J Manipulative Physiol Ther. 2009;32: 262-9. doi:10.1016/j.jmpt.2009.03.006.

17. Shadmehr A, Hadian MR, Naiemi SS, Jalaie S. Hamstring flexibility in young women following passive stretch and muscle energy technique. J Back Musculoskelet Rehabil. 2009;22(3): 143-8. doi: 10.3233/BMR-2009-0227.

18. Castellote-Caballero Y, Valenza MC, Martín-Martín L, Cabrera-Martos I, Puentedura EJ, Fernández-de-Las-Peñas C. Effects of a neurodynamic sliding technique on hamstring flexibility in healthy male soccer players. A pilot study. Phys Ther Sport. 2013;14(3):156-62. doi: 10.1016/j.ptsp.2012.07.004.

19. Merino R, Fernández E, López I, Mayorga D. The acute effect of Kinesiotaping on hamstring extensibility in university student. J Phys Educ Sport.2011;11(2)23-27.

20. Espejo Antúnez L, Apolo Arenas MD. Revisión bibliográfica de la efectividad del Kinesiotaping.Rehabilitacion. 2011;45 (2):148-58.

21. Espejo L, Maya J, Cardero MA, Albornoz M. Hamstring extensibility increase after applying electrical muscular elongation. Fisioterapia. 2012;34(3):112-7.

22. Askling CM, Tengvar M, Saartok T, Thorstensson A. (2008). Proximal hamstring strains of stretching type in different sports: injury situations, clinical and magnetic resonance imaging characteristics,return to sport. Am J Sports Med. 36(9)1799- 1804. PMID:18448581.

23. Halseth T, McChesney JW, DeBeliso M, Vaughn R, Lien J.(2004). The effects of kinesio taping on proprioception at the ankle. Journal of Sports Science and Medicine. 3: 1-7.

24. Kase K, Wallis J, Kase T. (2003). Clinical Therapeutic Applications of the Kinesio Taping Method. 2nd ed. Tokyo, Japan: Ken Ikai Co; pp:10-20.

25. Mori S. (2001). How Kinesio taping method can induce effectiveness for treatment of scapular arch [in Japanese]. 16th Annual Kinesio Taping International Symposium Review. 50-53.

26. Murray H, Husk LJ. (2001). Effect of Kinesio Taping on proprioception in the ankle. The Journal of Orthopaedic and Sports Physical Therapy. 31: A-37.

27. Slupik A, Dwornik M, Bialoszewski D, Zych E. (2007). Effect of Kinesio Taping on bioelectrical activity of vastus medialis muscle. Preliminaryreport. Ortop Traumatol Rehabil. 9(6); 644-651. PMID: 18227756.

28. Thelen M, Dauber JA, Stoneman PD. (2008) The clinical efficacy of kinesio tape for shoulder pain: a randomized, double-blinded, clinical trial. Journal of Orthopaedic & Sports Physical Therapy. 38(7):389-395. PMID: 18591761.

29. Bandy, WD, Irion, JM, and Briggler, M. The effect of time and frequency of static stretching on flexibility of the hamstring muscles. Phys Ther 77: 1090–1096, 1997.

30. LaRoche, DP and Connolly, DA. Effects of stretching on passive muscle tension and response to eccentric exercise. Am J Sports Med 34: 1000–1007, 2006.

31. Malone, TR, Garrett, WE, and Zachazewski, JE. Muscle: Deformation, injury, repair. In: Athletic Injuries and Rehabilitation. Zachazewski, JE, Magee, DJ, and Quillen, WS, eds. Philadelphia: WB Saunders Company, 1996. pp. 86–88.

32. Taylor, DC, Dalton, JD, Seaber, AV, and Garret, WE. Viscoelastic properties of muscle-tendon units: The biomechanical effects of stretching. Am J Sports Med 18: 300–309, 1990.

33. Vujnovich, AL and Dawson, NJ. The effect of therapeutic muscle stretch on neural processing. J Orthop Sports PhysTher 20: 145–153, 2004.

34. Woolstenhulme, MT, Griffiths, CM, Woolstenhulme, EM, and Parcell, AC. Ballistic stretching increases flexibility and acute vertical jump height when combined with basketball activity. J Strength Cond Res 20: 799–803, 2006.

35. Henderson G, Barnes, Portas MD. Factors associated with in-creased propensity for hamstring injury in English Premier League soccer players. J Sci Med Sport. 2010; 13(4): 397- 402. doi:10.1016/j.jsams.2009.08.003.

36. Croisier JL, Forthomme B, Namurois MH, Vanderthommen M, Crielaard JM. Hamstring muscle strain recurrence and strength performance disorders. Am J Sports Med. 2002; 30:199-203.

37. Davis DS, Ashby PE, McCale KL, McQuain JA, Wine JM. The effectiveness of 3 stretching techniques on hamstring flexibility using consistent stretching parameters. J Strength Cond Res. 2005; 19(1):27-32.

38. Kyoung-I Lim, Hyung-Chun Nam, Kyoung-Sim Jung.Effects on Hamstring Muscle Extensibility, Muscle Activity, and Balance of Different Stretching Techniques.J Phys. Ther. Sci 2014;26:209-213.

39. Kinesio taping in treatment and prevention of sports injuries Sean Williams, Chris Whatman, Patria A Hume, Kelly Sheerin Sports medicine 42 (2), 153-164, 2012.

40. Journal of Strength and Conditioning Research, 2005, 19(1), 27–32q 2005 National Strength & Conditioning Association. ijlpr 2020; doi 10.22376/ijpbs/lpr.2021.11.3.L43-49. International Journal of Medical Research & Health Sciences, 2016, 5, 5:36-41.