IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

TO COMPARE THE EFFECTIVENESS OF KINESIO TAPING WITH OR WITHOUT NEUROMUSCULAR TRAINING VERSUS CONVENTIONAL TREATMENT OF PATIENTS WITH CHRONIC NONSPECIFIC LOW BACK PAIN: A RANDOMIZED CLINICAL TRIAL

Amarjyoti Nayak[1], Supriya Awasthi[2], Abu Shohail Nizame[3], Narendra Kumar[3], Pallavi Prakash[3]

1.BPT, MPT, HOD, Sri Sri Nrusinghnath Ayurved College & Research Institute, Odisha, India.

2.BPT, MPT, Head, School of Allied Health Sciences, Noida International University, Gautam Budhh Nagar, UP, India.

3.BPT, MPT, Assistant Professor, Department of Physiotherapy, Noida International University, Gautam Buddh Nagar, UP, India.

Abstract

The Aim of the study was to compare the effectiveness of kinesio taping (KT) with and without neuromuscular training (NMT) versus conventional treatment in patients with chronic nonspecific low back pain. 60 subjects who fulfilled the inclusive and exclusive criteria were randomly allocated in 3 groups. Group A: 20 patients were received KT, NMT and conventional treatment in chronic nonspecific low back pain. Group B: 20 patients were received KT and conventional treatment in chronic nonspecific low back pain. Group C: 20 patients were received conventional therapy only in chronic nonspecific low back pain. To determine the effect of intervention the patients were assessed on the measures of oswestry disability index (ODI) and visual analog scale (VAS) on pre and 4-week post treatment of the study. Paired t test showed significant ($P<0.001$) decrease in ODI and VAS score in group A as compared to both Group B and Group C. The ANOVA showed significantly different mean change in ODI and VAS score among the groups. Tukey test showed significantly ($P<0.001$) different and higher mean change in ODI and VAS score of Group A as compared to both Group B and Group C. The study suggests that pain and disability was clinically and statistically significant improved in kinesio taping with neuromuscular training of patients with chronic nonspecific low back pain.

***Keywords*: Chronic low back pain, Kinesio taping, Neuromuscular training, Visual analogue scale, Oswestry disability index**

INTRODUCTION

Low back pain is one of the most common conditions that people experience in some point of life. It is a leading cause of limitation of activity and absence of work throughout the life and it harm to individual economic burden in social life[1]. Chronic non- specific low back pain is defined as low back pain which is not related to specific pathology like bone disorder, prolapsed intervertebral disk, radiculopathy, stenosis in lumbar spine, cauda equine syndrome, inflammatory disease like ankylosing spondylitis, tumor in lumbar area, osteoporosis, meningitis etc[1,2]. The prevalence of low back pain is reported to be as high as 84%[12] whereas for chronic nonspecific low back pain it is about 23%, 11-12% of the population being disabled by chronic nonspecific low back pain[11,12]. Kinesio taping is the most advanced technique that is considered to be an effectiveness in the musculoskeletal disorders[1,2]. It is

very useful and helpful for treatment purpose in chronic non-specific low back pain. Four benefits of Kinesio taping include normalization of muscular function, increase in lymphatic and vascular flow, reduction in pain and correction of possible joint misalignments [16]. It does not restrict the movement and has property to elevate the skin (EPIDERMIS) which is better for the circulation. According to KenzoKase, the elastic properties of kinesiotape when applied, has effects on the function of muscle fibers. By the application of kinesio tape which impact on the muscle units (sarcomeres) and produce physiological effects like to elongate or shorten thus muscle contractions[1]. Golgi Tendon Organs (GTO) are specialized mechanical receptors that are found throughout muscle and tendons. Stimulation of the GTO by direct pressure has been well documented to inhibit muscle over activation[1]. During assessment the therapist decides which technique and level of stretch give the bandage, which generating more or less tension on the skin[13]. It helps in to improve blood and lymphatic circulation, reduce pain and reduce muscle spasm. In the case which involves great activation of the paraspinal muscle in response to pain, it is used to inhibit excessive activation, thus increasing ROM, improving functionality and reduction pain[1]. Neuromuscular training is another useful treatment which improves muscle control to restore pain induced disturbance of movement control, and to increase muscle strength and endurance needed in heavy task like lifting and carrying etc[4].The use of a therapeutic exercise technique which are neuromuscular training (NT) in the rehabilitation of patients experiencing non-specific chronic low-back pain (LBP) who would benefit from trunk stabilization exercise. The various exercise programs are use also include like resistance tubing, stability balls, medicine balls, free weights, and weighted pulley systems. The purpose of this article is to describe the biologically it based on idea which altered stability and control of spine in people with low back pain[14] and also physiologically delayed onset of deep trunk muscles (multifidus and transvers abdominis)[14]. There are many conventional treatments for chronic nonspecific low back pain. The treatments included Acupuncture, Back school, Behavioral therapy, Exercise therapy, Massage, Spinal manipulation, and yoga[1]. Some drugs are used for purpose of treatment like to supports, Hot and cold therapy, therapeutic ultrasound and SWD[9]

The purpose of the study was to find out the new treatment plan with combination of kinesio taping and neuromuscular training which would be helpful for the population those who suffer from chronic nonspecific low back pain.

METHODOLOGY

The study was approved by institutional ethics committee. A written informed consent was obtained from each subject.

Ethical approval: This study was ethical approval by the Sharda University Research Ethics Committee.

Study design: Randomized controlled trial

Sample size: Convenient sample of 60 patients.

Source: Sharda Hospital, Department of Physiotherapy, First floor, F block.

Sampling – Criteria based purposive sampling

Selection criteria

Inclusion criteria:

1.Age: 20-50 years with both male and female gender

2.Diagnosed with chronic nonspecific low back pain

3.Duration> 3 months

Exclusion criteria:

1.Patient diagnosed with any of the followings:

1)Bone disorder in the spine (fracture)

2)Radicular nerve compression

3) Slipped intervertebral disc

4) Stenosis in lumbar spine

5) Inflammatory disorder (ankylosing spondylitis)

6) Tumor in lumbar area

2. Any known skin allergies

3. Previous spinal surgery or scheduled spinal surgery

PROCEDURE

60 Subjects fulfilled the inclusive and exclusive criteria were recruited. A written informed consent was obtained from each subject. These patients were assessed on the outcome measures of oswestry disability index (ODI) and visual analog scale (VAS) on pre and 4-week post treatment of the study. Subjects were randomly distributed using online website Randomization.com (https://:www.randomization.com) into 3 groups-**Group A:** 20 patients were received KT, NMT and conventional treatment in chronic nonspecific low back pain. **Group B:** 20 patients were received KT and conventional treatment (IFT, Hot pack and simple spinal extension and stretching exercises) in chronic nonspecific low back pain. **Group C:** 20 patients were received conventional therapy in chronic nonspecific low back pain. Kinesio taping used twice a week with I and Y strip pattern over the paraspinal muscle in lower back. IFT and hot pack used 10 mints according to the treatment protocol. Patient also followed the home exercise program which were given to him. The neuromuscular training performed every day of the week. After 4 weeks follow up taken and Group A (neuromuscular training and kinesio taping) performed better result than the Group B and Group C.

STASTISCAL ANALYSIS

Data were summarized as Mean ± SE (standard error of the mean). Pre and post group were compared by paired t test. Pre to post change (post-pre) in outcome measures of three groups were compared by compared by one way analysis of variance (ANOVA) and the significance of mean difference between the groups was done by Tukey HSD (honestly significant difference) post hoc test after ascertaining normality by Shapiro-Wilk's test and homogeneity of variance between groups by Levene's test. A two-tailed (α=2) $P<0.05$ was considered statistically significant. Analyses were performed on SPSS software (Windows version 17.0).

RESULTS

The present study evaluates the effectiveness of kinesio taping with or without neuromuscular training as an adjunct to conventional physiotherapy vs. conventional physiotherapy alone in treatment of patients with chronic non-specific low back pain. Total 60 patients were recruited and randomized equally into three groups and treated with neuromuscular training, kinesio taping and conventional therapy (Group A, *n=20*) or kinesio taping and conventional therapy (Group B, *n=20*) or conventional therapy (Group C, *n=20*) (Table 1 and Fig. 1). The outcome measures of the study were Oswestry Disability Index (ODI) and Visual Analogue Scale (VAS) scores measured in percentage (%) and mm. Both the outcome measures were assessed at pretreatment (Pre) and 4-week post treatment (Post). The objective of the study was to compare the outcome measures among the three groups.

Table 1: Group allocation and distribution of patients

Treatment/Intervention	Group	No of patients (n=60) (%)
Neuromuscular training, kinesio taping and conventional therapy	Group A	20 (33.3)
Kinesio taping and conventional therapy	Group B	20 (33.3)
Conventional therapy	Group C	20 (33.3)

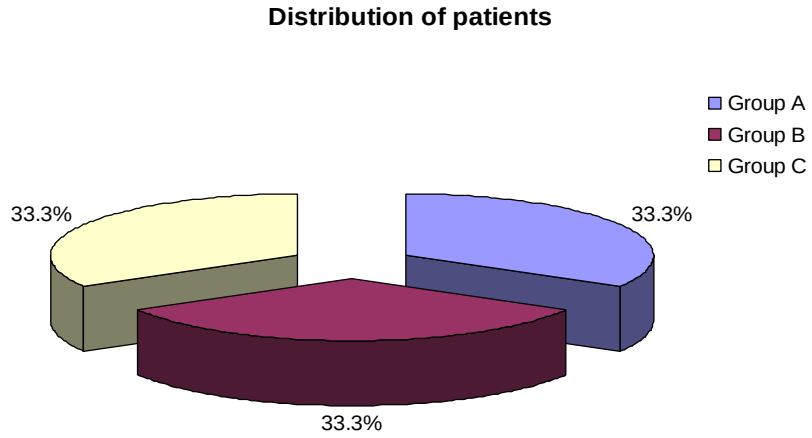


Fig. 1. Distribution of patients in three groups.

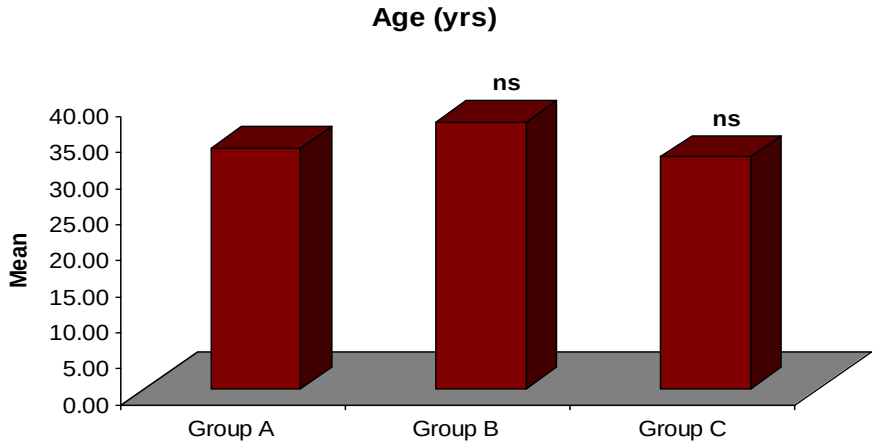
Demographic characteristics

The demographic characteristics (age) of three groups is summarised in Table 2 and also depicted in Fig. 2. The age of Group A, Group B and Group C ranged from 21-47 yrs, 21-50 yrs and 22-50 yrs respectively with mean (± SE) 33.50 ± 1.80 yrs, 37.10 ± 1.60 yrs and 32.30 ± 1.87 yrs respectively and median 35 yrs, 37 yrs and 32 yrs respectively. The mean age of Group B was slightly higher than other two groups. However, comparing the mean age of three groups, ANOVA showed similar age among the groups (F=2.02, P=0.143) i.e. did not differ significantly. In other words, subjects of three groups were age and sex matched and thus comparable and may not influence the study outcome measures.

Table 2: Age (Mean ± SE) of three groups

Group A (n=20)	Group B (n=20)	Group C (n=20)	F Value	P value
33.50 ± 1.80	37.10 ± 1.60	32.30 ± 1.87	2.02	0.143

Mean age of three groups was compared by ANOVA.



^{ns}p>0.05- as compared to Group A

Fig. 2. Mean age of three groups.

4.3 - Outcome measures

I. ODI

The pre and post ODI score of three groups is summarized in Table 3 and also shown in Fig. 3. In all three groups, the mean ODI score decreased (improved) comparatively after the treatment and the decrease (improvement) was evident highest in Group A followed by Group B and Group C the least (Group C < Group B < Group A).

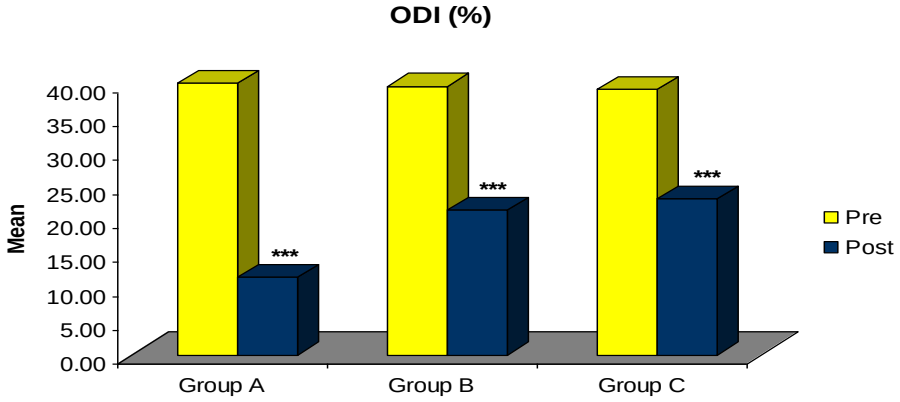
Comparing the pre and post ODI score of three groups, paired t test showed significant (P<0.001) decrease in ODI score at post as compared to pre in all three groups (Table 3 and Fig. 3). The pre to post mean change (improvement) in ODI score of Group A (71.4%) was found to be the highest followed by Group B (46.1%) and Group C (41.2%) the least.

To find out efficacy of one group (treatment) over other, the pre to post mean change in ODI score of three groups were further compared by ANOVA and summarized in Table 4 and also shown in Fig. 4. The ANOVA showed significantly different mean change in ODI score among the groups (F=18.33, P<0.001). Further, Tukey test showed significantly (P<0.001) different and higher mean change in ODI score of Group A as compared to both Group B and Group C but not differ (P>0.05) between Group B and Group C i.e. found to be statistically the same (Table 5 and Fig. 4).

Table 3: Pre and post ODI score (Mean ± SE) of three groups

Group	Pre (n=20)	Post (n=20)	Mean change (Post-Pre)	t value	p value
Group A	39.90 ± 1.66	11.41 ± 0.87	-28.49 ± 1.55	18.33	<0.001
Group B	39.50 ± 1.47	21.28 ± 0.43	-18.23 ± 1.52	11.98	<0.001
Group C	39.00 ± 1.43	22.92 ± 0.65	-16.09 ± 1.23	13.07	<0.001

Pre and post groups were compared by paired t test.



***P<0.001- as compared to Pre

Fig. 3. Pre and post mean ODI score of three groups.

Table 4: Pre to post mean change in ODI score (Mean ± SE) of three groups

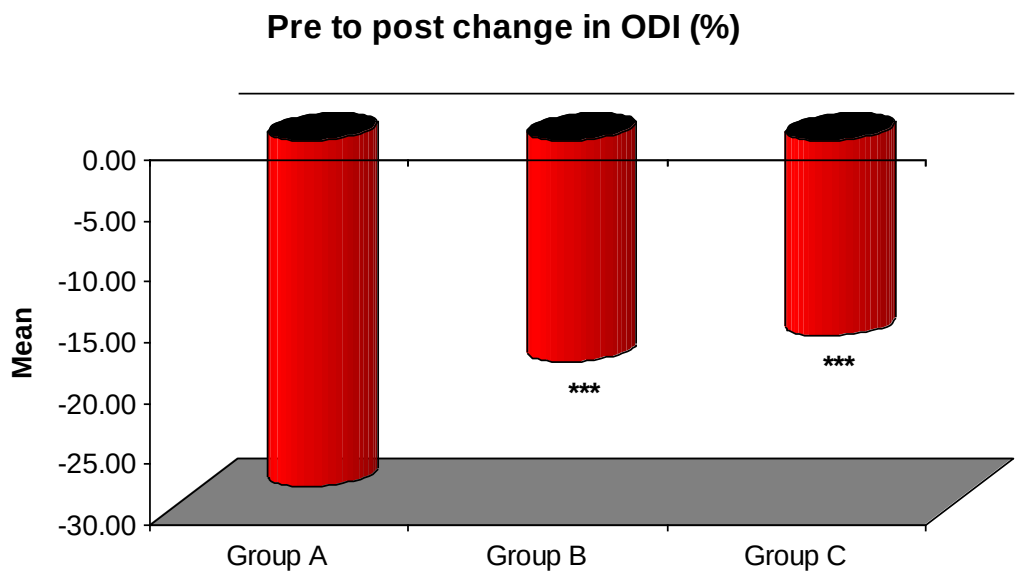
Group	Mean change (Post-Pre)	F Value	P value
Group A	-28.49 ± 1.55	21.33	<0.001
Group B	-18.23 ± 1.52		
Group C	-16.09 ± 1.23		

Mean change in ODI score of three groups was compared by ANOVA

Table 5: Comparison of difference in pre to post mean change in ODI score between groups by Tukey test

Comparison	Mean Diff.	q value	P value	95% CI of diff
Group A vs. Group B	-10.25	7.11	P < 0.001	-15.16 to -5.34
Group A vs. Group C	-12.50	8.66	P < 0.001	-17.41 to -7.59
Group B vs. Group C	-2.25	1.56	P > 0.05	-7.16 to 2.66

Mean change in ODI score between groups was compared by Tukey test



***P<0.001- as compared to Group A

Fig. 4. Pre to post mean change in ODI score of three groups.

II. VAS

The pre and post VAS score of three groups is summarized in Table 6 and also shown in Fig. 5. In all three groups, the mean VAS score decreased (improved) comparatively after the treatment and the decrease (improvement) was evident highest in Group A followed by Group B and Group C the least (Group C < Group B < Group A).

Comparing the pre and post VAS score of three groups, paired t test showed significant (P<0.001) decrease in VAS score at post as compared to pre in all three groups (Table 6 and Fig. 5). The pre to post mean change (improvement) in VAS score of Group A (86.9%) was found to be the highest followed by Group B (68.1%) and Group C (60.6%) the least.

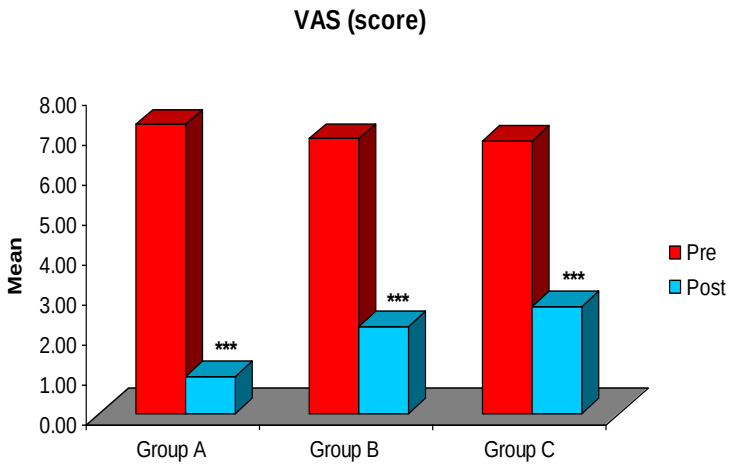
To find out efficacy of one group (treatment) over other, the pre to post mean change in VAS score of three groups were further compared by ANOVA and summarized in Table 7 and also shown in Fig. 6. The ANOVA showed

significantly different mean change in VAS score among the groups (F=25.88, P<0.001). Further, Tukey test showed significantly (P<0.001) different and higher mean change in VAS score of Group A as compared to both Group B and Group C but not differ (P>0.05) between Group B and Group C i.e., found to be statistically the same (Table 8 and Fig. 6).

Table 6: Pre and post VAS score (Mean ± SE) of three groups

Group	Pre (n=20)	Post (n=20)	Mean change (Post-Pre)	t value	p value
Group A	7.25 ± 0.19	0.95 ± 0.17	-6.30 ± 0.23	27.32	<0.001
Group B	6.90 ± 0.16	2.20 ± 0.14	-4.70 ± 0.23	20.39	<0.001
Group C	6.85 ± 0.18	2.70 ± 0.15	-4.15 ± 0.20	21.21	<0.001

Pre and post groups were compared by paired t test.



***P<0.001- as compared to Pre

Fig. 5. Pre and post mean VAS score of three groups.

Table 7: Pre to post mean change in VAS score (Mean ± SE) of three groups

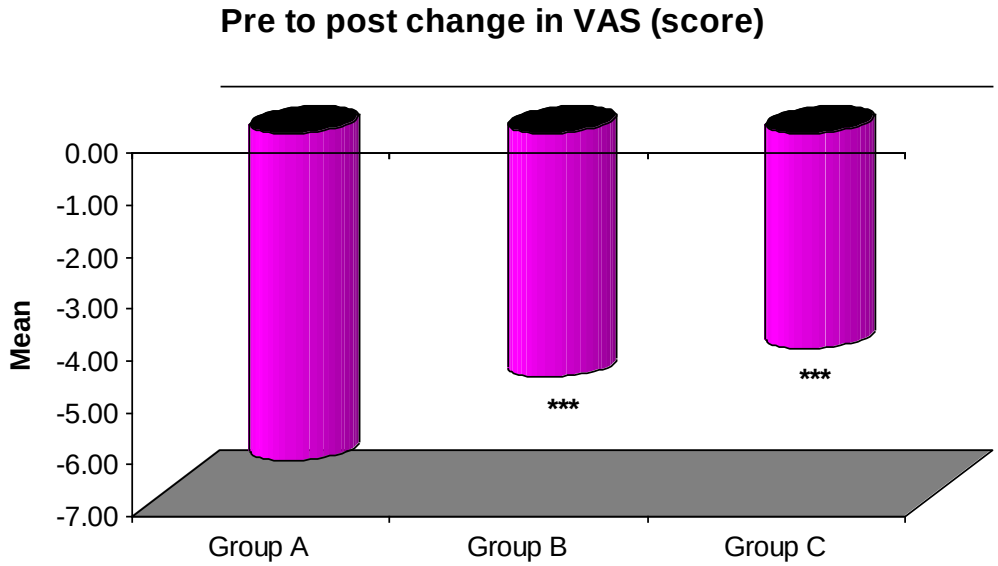
Group	Mean change (Post-Pre)	F Value	P value
Group A	-6.30 ± 0.23	25.88	<0.001
Group B	-4.70 ± 0.23		
Group C	-4.15 ± 0.20		

Mean change in VAS score of three groups was compared by ANOVA

Table 8: Comparison of difference in pre to post mean change in VAS score between groups by Tukey test

Comparison	Mean Diff.	q value	P value	95% CI of diff
Group A vs. Group B	-1.60	7.29	P < 0.001	-2.348 to -0.852
Group A vs. Group C	-2.15	9.79	P < 0.001	-2.898 to -1.402
Group B vs. Group C	-0.55	2.51	P > 0.05	-1.298 to 0.1977

Mean change in VAS score between groups was compared by Tukey test.



***P<0.001- as compared to Group A

Fig. 6. Pre to post mean change in VAS score of three groups.

DISCUSSION

According to the present study, this is the only study to examine the effect of kinesio taping with or without neuromuscular training as an adjunct to conventional therapy vs conventional therapy alone in symptom of chronic non-specific low back pain. Results indicated that pain (VAS) and disability (ODI) was clinically and statistically significant improved in kinesio taping with neuromuscular training than the other two interventional group (Group B & Group C).

On analyzed, it was found that ODI score decreased comparatively after the treatment, it was found to be highest in Group A followed by Group B and Group C (Group A > Group B > Group C). within group comparisons showed that highest improvement was seen in Group A (71%) followed by Group B (46%) and Group C (41%)). The ANOVA test showed significantly different mean changes in ODI score among the groups (F=18.33, P<0.001). Further, Tukey test showed significant (P<0.001) difference and higher mean change in ODI score of Group A as compared to Group B and Group C, however no difference was observed (P>0.05) between Group B and Group C.

Similar for VAS, in all three groups, the mean VAS score decreased (improved) comparatively after the treatment and the decrease was highest in Group A followed by Group B and Group C. The ANOVA showed significantly different mean changes in VAS score among the groups (F=25.88, P<0.001). Further, Tukey test showed significantly (P<0.001) difference and higher mean change in VAS score of Group A as compared to both Group B and Group C but no difference (P>0.05) was observed between Group B and Group C. This study suggested that Group A showed significant improvement than Group B and Group C, but it was not significant between Group B and Group C.

The result supported Asthana et al (2013)[1] who studied kinesio taping and stability exercises in chronic non-specific low back pain but there is no added benefit in combination of both the intervention. The present study was clinically significantly improved ($p<0.001$) in VAS and Oswestry scale as supported by Castro-Sanchez et al[28] who reported that after 1 week application of elastic taping in non-specific low back pain, patients experienced less pain, low back pain related disability than those given sham taping.

These findings are consistent with the work of Nemitalla MA et al (2013)[3] provided use of kinesio taping with conventional therapy which was clinically significant improved ($p<0.001$) in symptoms of the chronic non-specific low back pain. According to KenzoKase, kinesio taping alleviates pain and facilitates lymphatic drainage by microscopically lifting the skin. The taped portion forms convolutions in the skin, thus increasing interstitial space as a result of which the pressure and irritation are taken off the neural and sensory receptors. This helps to alleviate pain. Pressure is gradually taken off the lymphatic system, allowing it to drain more freely[23].

A further possible mechanism by which kinesio taping induced these changes may be related to neural feedback received by participants. Free-ending unmyelinated nerve fibers are abundant around joint capsules, ligaments, and the outer parts of the intraarticular menisci. They mediate pain when a joint is strained and operate in excitatory reflex to protect the capsule. Kinesio Tape can improve joint function by stimulating the proprioceptors within the joint by application over the ligaments and biomechanically supporting the joint[23]. Proprioceptors in the ligaments and joint capsules which provide information to the nervous system, it allows the musculoskeletal system to provide the perception of support and movement to the injured joint and also provide feedback into the tissues/joints to heal[38].

The results consistent with the finding of Aktar MW et al (2017)[25] who studied effect of core stability exercises and routine exercises therapy between two groups, TENS& Ultrasound also given to the both groups in the patients with chronic non-specific low back pain. Core stability exercise provide clinically ($p<0.001$) significant result than the routine exercise group. Same like by Julie AH et al (2001)[10] also provide significant of specific stabilization exercises in low back patients. Motor control exercise was also benefit for the patient with chronic nonspecific low back pain Leonado O.P et al (2009)[14], which is clinically and statically significant improved.

The main aim of the neuromuscular training is to improve the movement control and neuromuscular fitness of people who are engaged in heavy task like lifting, transferring and improper body posture in their work[4]. Ali S et al suggested that specific stabilization exercise has influence on pain and function in chronic non-specific low back pain. It proposed that the neuromuscular training is necessary for trunk stability and correct patterns of muscle recruitment[39] and central motor program can change after performing stabilization exercises[40].

Neuromuscular training is the activation of muscle prior to and in response to joint movements and loads[29]. It requires somatosensory system input and works in conjunction with voluntary muscle activation to provide dynamic joint stability[30]. Dynamic joint stabilization relies on the ability of receptors to transmit afferent (sensory) impulses to the CNS regarding joint proprioception and kinesthesia and muscle tension to help create an efferent (muscle) response[29].

In the present use of neuromuscular training with kinesio taping which is clinically significant, provide skill required perform daily activities in a manner that help to reduce pain, to avoid reinjury and related new episodes of low back pain. Reduction in pain levels help to provide encouragement and advice for self-care as well as induce the pain related fear to carry out physical activities.

The limitation of the study was short time period, which required more time find out the more significant result of the study. Sample size and lack of exercises, so more trials with large sample size and more exercises are needed to validate the findings of this study.

CONCLUSION

The present study hypothesized that Kinesio Taping conjunction with Neuromuscular Training will be significantly more effective than Conventional therapy alone and Kinesio Taping with conventional therapy, the alternate hypothesis was found to be true.

The present study concluded that Kinesio Taping with Neuromuscular Training are effective in the management of "chronic nonspecific low back pain" and suggests physiotherapists to use Kinesio Taping with Neuromuscular training in conjunction with Conventional therapy in clinical practice.

DISCLOSURE

The authors report no conflicts of interest in this work.

REFERENCES

1.Asthana D, Nijhawan MA, Kuppuswamy R. Effectiveness of kinesio taping in improving pain and ROM lumbar extension disability in patient with chronic nonspecific low back pain. International Journal of physiotherapy and research. 2013; 5:293-299.
2.Hagen L, Hebert JJ, Dekanich J, Koppenhaver S. Effectiveness of elastic therapeutic tapping on back extensor muscle endurance in patient with low back pain. Journal of orthopaedic and sports physical therapy.2015; 45:214-218.
3.Nemitalla MA, et al. Efficacy of adding the kinesio taping method to guideline endorsed conventional physiotherapy in patients with chronic nonspecific low back pain. BMC musculoskeletal disorders. 2013; 14:1-8.
4.Suni JH, et al. Neuromuscular exercise and back counseling for female nursing personal with recurrent nonspecific low back pain. BMJ open sports exercise. 2015; 1-9.
5.Akuthota v, Ferreiro A, More T, Fredericson M. core stability exercise principles. Curr. Sports medicine. 2008; 7:39-44.
6.Albahel F, et al. Kinesio taping for the treatment of mechanical low back pain. World applied science Journal. 2013; 1:78-84.
7.Mc Gill SM, Grenier S, Kavcic N, Cholewicki J. Coordination of muscle activity to assure stability of the lumbar. Journal of electromyography and kinesiology. 2003; 13:353-359.
8.Kibler WB, Press J, Sciascia A. Rehabilitation institute of Chicago. 2006; 36:189-198.
9.Mc Gill SM. Low back exercises evidence for improving exercise regimens. Physical Therapy.1998;78:754-765.
10. Hides JA, Jull GA, Richardson CA. Long term effects of specific stabilizing exercises for first episodic low back pain. The university of Queensland Australia.2001;26:243-248.
11. Balague F, Mannion AF. Nonspecific low back pain. Lancet 2012; 379:482-491.
12. Krismer M, Van Tulder M. Low back pain group of the bone and joint health strategies for Europe project. Best pract res clinic Rheumatoid 2007; 21:77-91.
13. Macro Aurelio, L Oliveir,T Yukio. Efficacy of kinesio taping in patient with chronic nonspecific low back. BMC Musculoskeletal disorder 2013; 14:1471-74.
14. L O.P Costa, CG Maher, et al. motor control exercise for low back pain. America physical therapy association. 2009; 89:1275-86.
15. Van Dieen JH, Selen LP, et al. Trunk muscle activation in low back pain patient. J electro myogrkinesio. 2003; 13:333-351.
16. Kase et al. effectiveness of kinesio taping in low back pain. Journal of physiotherapy. 2003; 58:89-95.
17. B W Kones, M W Van Tulder, et al. Diagnostic testing and treatment of low back pain. BMJ. 2006; 332:1430-34.
18. M Allegri, G Fanelli, et al. Mechanism of low back pain a guide for diagnosis and therapy. Canadian physiotherapy association. 2016; 5:1005-15.
19. LE Chaparro, AD Furlan, et al. Opioids compared with placebo or other treatment for low back pain. Spine. 2014; 39:556-563.
20. Kim Trobec, M Persolja. Efficacy of kinesio taping in reducing low back pain. Journal of health science.2017;7:1-8.
21. MA D Luz, et al. Effectiveness of kinesio taping in patient with chronic nonspecific low back pain. Spine.2018;2:12-20.

22. Marco AN Added, et al. kinesio taping does not provide additional benefits in patient with chronic low back pain. Journal of orthopaedic and sports physical therapy.2016;46:505-513.
23. Information guide authentic Kinesio designed and authorised by KezoKase.
24. Gockle M et al. perceived disability but not pain is connected with autonomic nervous function among patients with chronic low back pain. J Rehabilitation Med 2008; 40:355-358.
25. Aktar MW et al. Effectiveness of stabilization exercises and routine exercises therapy in management of pain chronic nonspecific low back pain. Pak medical science .2017;33:1002-1006.
26. Hosseinifar M et al. the effect of stabilization and McKenzie exercises on transvers abdominis and multifidus muscle thickness, pain and disability. J physical therapy science.2013;25:1541-1545.
27. Lehtola V et al. efficacy of movement control exercises versus general exercises on recurrent chronic non-specific low back pain. BMC Musculoskeletal Disorders.2012;13:50-55.
28. Castro-Sanchez et al. kinesio taping reduces disability and pain slightly in chronic nonspecific low back pain. J physiotherapy.2012;58:89-95.
29. Swanik CB et al. Reestablishing proprioception and neuromuscular control in the chronic back pain. J sports rehabilitation.1997;6:182-206.
30. Riemann BL et al. The sensorimotor system, part 1: The physiological basis of functional joint stability. J Athl Train.2002;37(1):71-79
31. Hodges PW. Transversusabdominis: a different view of elephant. Br J Sports Med.2008; 42:941-944.
32. Hides JA et al. Evidence of lumbar multifidus muscle wasting ipsilateral to symptoms in patients with acute/subacute low back pain. Spine.1994;19:165-172
33. Hides JA et al. long-term effects of specific stabilizing exercises for first episodic low back pain. Spine.2001;26:243-248.
34. Goel VK et al. a combine finite element and optimization investigation of lumbar spine mechanism with and without muscle. Spine.1993;18:1531-1541.
35. Panjabi M et al. Spinal stability and intersegmental muscle forces. Spine.1989;14:194-200.
36. Wilke HJ et al. Stability increases in the lumbar spine with different muscle group. A biomechanical in vitro study. Spine.1995;20:192-198.
37. JW Paul et al. Trunk muscle stabilization training plus general exercise only. Oxford academic Physical therapy.2005;85(5):209-225.
38. M.Paoloni et al. effectiveness of elastic tape in chronic low back pain European Journal of Physical & Rehabilitation Medicine.2011;47(2):237-44.
39. Skikic EM et al. The effect of McKenzie exercise for patients with low back pain. Boson J Basic Med Science.2003;3(4):70-75.
40. Zazulak B et al. Neuromuscular control of trunk stability, clinical implication for sports injury. J Am AcadOrthop Surgery.2008;16:497-505.