Original Article

Physiotherapy and Occupational Therapy Journal
Volume 13 Number 3, July- September 2020
DOI: http://dx.doi.org/10.21088/potj.0974.5777.13320.8

Effectiveness of Mulligan Taping on Pain, Grip Strength and Function in Lateral Epicondylitispatient: An Experimental Study

Ketki Choudhari Ingole[1], Asma Sharma Keshri[2], Meghana R Palkhade[3]

How to cite this article:

Ketki Choudhari Ingole, Asma Sharma Keshri, Meghana R Palkhade. Effectiveness of Mulligan Taping on Pain, Grip Strength and Function in Lateral Epicondylitispatient: An Experimental Study. Physiotherapy and Occupational Therapy Journal. 2020;13(3):123-132.

Abstract

This experimental study design investigated the effect of Mulligan taping on patients diagnosed with lateral epicondylitis who were treated with Mulligan mobilization and conventional therapy (Ultrasound therapy and Stretching). A total of 40 patients aged between 25 to 55yrs were randomly assigned in two groups. Group A - Experimental group n=20 receiving Mulligan taping, Mulligan mobilization and conventional therapy & Group B - Control group n= 20 receiving Mulligan mobilization and conventional therapy alone)

Both the groups received 10 treatment sessions for two weeks. Baseline measurements of 3 outcome measures NPRS (Numerical pain rating scale), Grip strength and functional activity were taken on day 1,5 and 10. Intra group analysis showed that both the groups had statistically significant improvement in NPRS score, Grip strength and functional performance, but inter group analysis showed group A receiving Mulligan taping had statistically significant improvement in all three outcome measures as compared to Group B. Study concludes that Mulligan taping when given in addition with Mulligan mobilization & conventional therapy gives more significant improvement in pain, grip strength and functional status in patients with lateral epicondylitis as compared to, when treated with Mulligan mobilization and conventional therapy alone.

Keywords: Lateral epicondylitis, Mulligan Mobilization with Movement, Mulligan taping, Conventional therapy, Grip strength, Numerical pain rating score, Functional pain status score.

Abbreviations - Lateral Epicondylitis (LE), Mulligan Mobilization with Movement (MWM), Grip Strength, Numerical Pain Rating Score(NPRS), Functional Pain Status Score (FPSS)

Introduction

Lateral epicondylitis is one of the commonest lesion of arm and was first described in by Runge in 1873.[1] The term lateral epicondylitis or tennis elbow is widely used to describe an overuse injury causing tendinitis of the extensor carpi radialis brevis (ECRB) that is characterized by pain and tenderness over the lateral epicondyle.[2] The term tennis elbow is a misnomer since it occurs in non-tennis players also.[3] There are numerous intrinsic and extrinsic factors causing lateral epicondylitis microtrauma caused due "repetitive strain injury", when muscles are overloaded than the load they can withstand or flexibility deficiencies in the forearm extensor muscle or inadequate forearm extensor power and endurance to withstand normal, forceful repetitive movements placed against forearm extensors.[4]

Recently, researchers have come to prefer the term tendinosis.[5,6] Physical examination will confirm tenderness over the common extensor tendon origin often localized to the extensor carpi radialis brevis. Isokinetic strength deficits may also be observed.[2,6] The grip becomes weak probably due to voluntary diminution of effort to avoid undue pain., sometimes wasting of the affected muscles is also seen in long standing cases.[7] Many traditional

Author Affiliation: [1-3]Assistant Professor, BKL Walawalkar College of Physiotherapy, Sawarde 415606, Maharashtra, India.

Corresponding Author: **Asma Sharma Keshri,** Assistant Professor, BKL Walawalkar College of Physiotherapy, Sawarde 415606, Maharashtra, India.

E-mail: aasma.sharma@gmail.com

interventions have been used to treat this condition, including non-steroidal anti-inflammatory drugs, corticosteroid injection;[8,9] cryotherapy in the acute stage followed by heat in the more chronic stage,[10] friction massage, rest;[10,11] ultrasound (US); [12] laser,[13] counterforce bracing[14,15] lateral extensor release,[16] progressive strengthening; and stretching exercise therapy.[17] As Garret et al. (2000)[18] concluded that "the traditional modalities of physiotherapy fail specifically to improve the quality of collagen in tendons or bring in new vascularity to promote tissue healing," new treatment measures must be studied for better treatment plan.

Mobilization with movement (MWM) is a type of joint mobilization developed by Brian Mulligan.[19] Mulligan's original theory for the effectiveness of an MWM is based on the concept related to a 'positional fault' that occur secondary to injury and lead to maltracking of the joint causing restrictions in physiological movement resulting in symptoms such as pain, stiffness or weakness (Mulligan, 2004). MWM's correct this by repositioning the joint causing it to track normally minimizing the compressive forces generated by that movement.[19]

Taping is one of the treatment techniques used in Physiotherapy. The basic rational for taping is to provide protection and support to an injured part while permitting optional functional movement. As essential rehabilitation tool, taping enhances healing, by allowing early activity within careful controlled ranges. It permits an early return to daily activities by protecting the area from further injury and avoiding compensatory injury elsewhere.[20]

Brian Mulligan has proposed taping techniques for various dysfunctions. It is effective in pain relief by maintaining the correction of the position fault thus limiting harmful movement and allowing pain free functional movement. so, it prevents further injury of involved structures enhancing its healing process. Maximum studies of Mulligan taping were done with adjunct with its Mulligan mobilization with movement in lateral epicondylitis but very few studies had been done on clinical efficacy of Mulligan taping.[19]

So, our purpose of study was to evaluate the effect of Mulligan taping when given along with Mulligan mobilization with movement and conventional therapy in the treatment of lateral epicondylitis in terms of pain and grip strength and functional activities.

Methodology

40 patients including both male and female aged 25 to 55yrs diagnosed with lateral epicondylitis by Orthophysicians who were send to physiotherapy department for treatment were included in study and were randomly assigned into two groups, Experimental group A (n= 20) and control group B(n=20). Patients with history of trauma, surgery, previous acute infection of elbow or patients who have undergone steroid injection within last 30 days were excluded from study. Patient with cervical spine dysfunction, radial tunnel syndrome or posterior interosseous nerve syndrome were also excluded. After detail explanation of nature of study, informed consent was obtained from all the patients who volunteered for the same. Patient were assessed for 3 outcome measures. Pain, grip strength and functional status.

Pain were assessed using Numerical pain rating scale where21

0 = No Pain

1-3 = Mild Pain (nagging, annoying, interfering little with ADLs)

4-6 = Moderate Pain (interferes significantly with ADLs)

7-10 = Severe Pain (disabling; unable to perform ADLs)

Grip strength was assessed with Hand dynamometer. A standard position for testing recommended by American society of hand therapist was used[22,23]

Fig. 1: Position of Hand while testing hand grip strength.

Functional status of the patient was assessed by Functional Pain Scale[24] Score –

0: no discomfort

1: slight discomfort

2: moderate discomfort

3: Quite a bit discomfort

4: Extreme discomfort

Activities given were as follows and score was recorded

- Usual work, housework or school activities.
- Usual hobbies, sporting or recreational activities
- Using tools or appliances
- Self-dressing
- Squeezing or gripping an object
- Opening doors with the involved limb.
- Activities such as sweeping or raking.
- Carrying a small suitcase with the involved limb.
- Opening a jar or can
- Writing or using a keyboard

The physical functions were tested using a functional pain scale, the patients were asked to perform above listed 10 activities. Subjects were asked to rate intensity of their pain from 0-4 accordingly in each activity. Maximum possible score on this scale can be 40. (Fig. 1)

Mulligans mobilization technique: Mulligan mobilization was given to both the groups with patient lying in supine position with elbow extended and forearm pronated. Distal humerus of the patient was stabilized by the therapist and therapist gave lateral glide to proximal forearm with webspace of another hand. Patient was asked to perform, the pain producing movement (such as gripping or wrist extension) during glide procedure . When glide is applied correctly, the patients will not complain of any pain. The dosage was 10 MWM in one set, 2 sets per session were given and a total of 10 sessions were completed in 2 weeks.[19] (Fig. 2)

Fig. 2: Mulligan Mobilization for Tennis elbow**.**

Mulligans taping technique: Mulligan taping treatment was given only to group A (experimental group) after receiving MWM treatment session. Kinesio tape was used for taping. Skin was shaved and cleaned with spirit prior the tape application. Subject was made to lie down on a plinth and tape is placed around elbow joint over extensor carpi radialis muscles, when the elbow is in slight flexion and forearm in pronation. At the beginning of taping, lateral gliding of extensor group muscles was done and then tape was applied over it maintaining the glide.[19] (Fig. 3)

Fig. 3: Mulligan taping maintaining lateral glide.

Fig. 4: Post Taping.

Both experimental and control groups were given Ultrasound at the intensity of 1W/Cm2 for the period of 5 min. Both groups were taught a self-stretching exercise regime. The wrist extensors were stretched in standing position by the patient with the shoulder flexed to 90˚, elbow extended, and the opposite hand pulling the wrist into flexion with stretch held for 30 seconds. It was done twice a day, three repetitions were performed and a 30-second rest between repetitions was allowed. (Fig. 4)

Assessment for NPRS, grip strength and functional pain scale score was recorded on 1st ,5th and 10th day of treatment.

Result

Table 1 : Distribution of age and gender.

	Experimental group (A)	Control group (B)	p value
Number of subjects, n= 40	20	20	
Mean age (yrs)	40.35	38.70	0.09NS p>0.05
Male/ female	12/8	9/11	0.34 NS p>0.05

Table 2: Intra group comparision of pain on NPRS in group A at 1st ,5th and 10th day.

Descriptive Statistics

	Mean	N	Std. Deviation	Std. Error Mean
1st Day	6.80	20	1.05	0.23
5th Day	5.15	20	0.98	0.22
10th Day	2.60	20	0.99	0.22

Student's paired t test

	Paired Differences					t	df	p-value
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
1st Day - 5th Day	1.65	0.48	0.10	1.42	1.87	15.07	19	0.000 S,p<0.05
1st Day – 10th Day	4.20	0.52	0.11	3.95	4.44	35.90	19	0.000 S, p<0.05
5th Day – 10th Day	2.55	0.60	0.13	2.26	2.83	18.85	19	0.000 S, p<0.05

Table 3: Intra group Comparison of pain on NPRS in group B at 1st ,5th and 10th day.

	Mean	N	Std. Deviation	Std. Error Mean
1st Day	6.45	20	1.05	0.23
5th Day	3.75	20	1.40	0.31
10th Day	1.50	20	1.19	0.26

Student's paired t test

	Paired Differences					t	df	p-value
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
1st Day - 5th Day	2.70	0.73	0.16	2.35	3.04	16.48	19	0.000 S,p<0.05
1st Day – 10th Day	4.95	0.60	0.13	4.66	5.23	36.60	19	0.000 S,p<0.05
5th Day – 10th Day	2.25	0.55	0.12	1.99	2.50	18.29	19	0.000 S,p<0.05

Table 4: Intra group Comparison of grip strength in group A at 1st, 5th and 10th day.

	Mean	N	Std. Deviation	Std. Error Mean
1st Day	23.40	20	3.39	0.75
5th Day	23.85	20	5.99	1.34
10th Day	23.90	20	1.44	0.32

Student's paired t test

	Paired Differences					t	df	p-value
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
1st Day - 5th Day	-0.45	3.80	0.85	-2.23	1.33	0.529	19	0.603 NS,p>0.05
1st Day - 10th Day	-0.50	3.20	0.71	-1.99	0.99	0.698	19	0.494 NS,p>0.05
5th Day - 10th Day	-0.05	5.51	1.23	-2.62	2.52	0.041	19	0.968 NS,p>0.0

Table 5: Intra group Comparison of grip strength in group B at 1st ,5th and 10th day.

Descriptive Statistics

	Mean	N	Std. Deviation	Std. Error Mean
1st Day	24.50	20	2.41	0.54
5th Day	24.90	20	2.38	0.53
10th Day	25.75	20	3.52	0.78

Student's paired t test

	Paired Differences					t	df	p-value
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
1st Day - 5th Day	-0.40	1.81	0.40	-1.25	0.45	0.98	19	0.338 NS,p>0.05
1st Day – 10th Day	-1.25	3.19	0.71	-2.74	0.24	1.75	19	0.096 NS,p>0.05
5th Day – 10th Day	-0.85	2.34	0.52	-1.94	0.24	1.62	19	0.122 NS,p>0.05

Table 6: Intra group Comparison of Functional Pain Scale in group A at 1st ,5th and 10th day.

Descriptive Statistics

	Mean	N	Std. Deviation	Std. Error Mean
1st Day	25.60	20	5.66	1.26
5th Day	21.15	20	5.49	1.22
10th Day	15.30	20	5.34	1.19

Student's paired t test

	Paired Differences					t	df	p-value
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
1st Day - 5th Day	4.45	1.66	0.37	3.66	5.23	11.92	19	0.000 S,p<0.05
1st Day – 10th Day	10.30	2.29	0.51	9.22	11.37	20.05	19	0.000 S,p<0.05
5th Day – 10th Day	5.85	1.87	0.41	4.97	6.72	13.97	19	0.000 S,p<0.05

Table 7: Intra group Comparison of Functional Pain Scale Score in group B at 1st ,5th and 10th day.

Descriptive Statistics

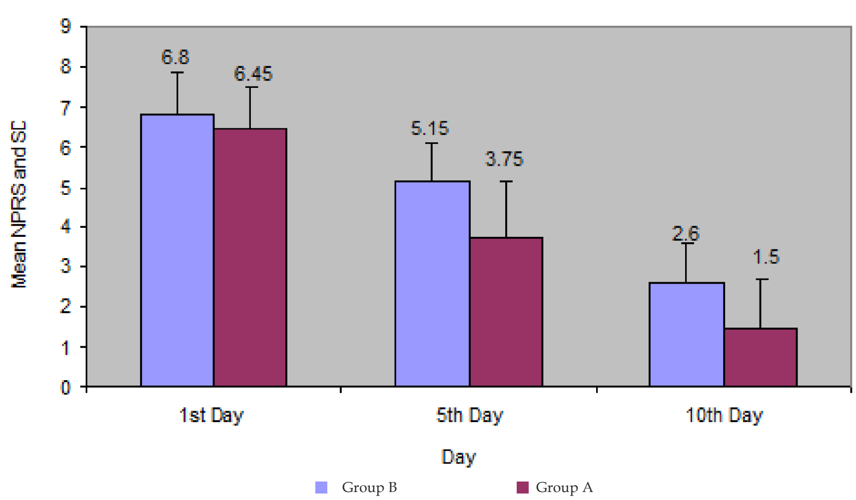
	Mean	N	Std. Deviation	Std. Error Mean
1st Day	19.95	20	6.24	1.39
5th Day	15.60	20	6.07	1.35
10th Day	10.05	20	5.86	1.31

Student's paired t test

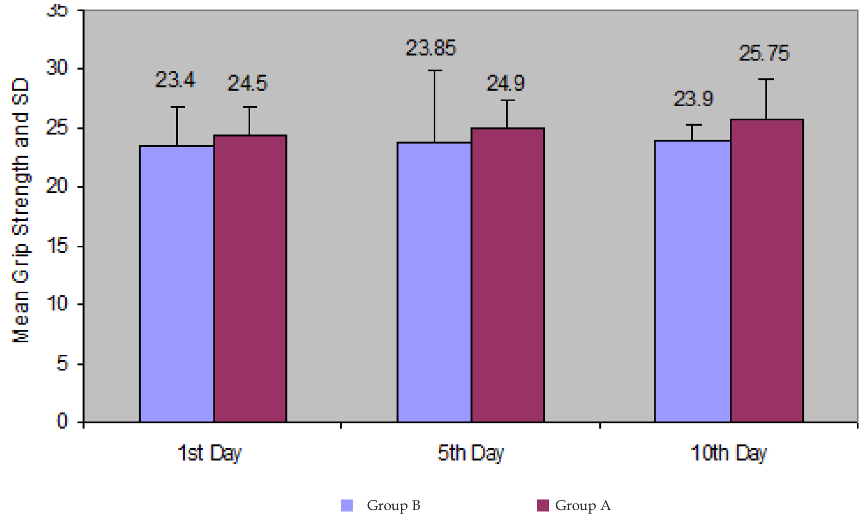
	Paired Differences					t	df	p-value
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
1st Day - 5th Day	4.35	1.34	0.30	3.71	4.98	14.42	19	0.000 S,p<0.05
1st Day – 10th Day	9.90	2.84	0.63	8.56	11.23	15.56	19	0.000 S,p<0.05
5th Day – 10th Day	5.55	2.18	0.48	4.52	6.57	11.34	19	0.000 S,p<0.05

Inter group comparison data

Graph 1: Inter group Comparison of pain on NPRS in both the groups A and Bat 1st 5th and 10th day.



Graph 2: Inter group Comparison of grip strength in both the group A and B at 1st ,5th and 10th day.



Graph 3: Inter group Comparison of Functional Pain Scale in both the groups A and B at 1st 5th and 10th day.

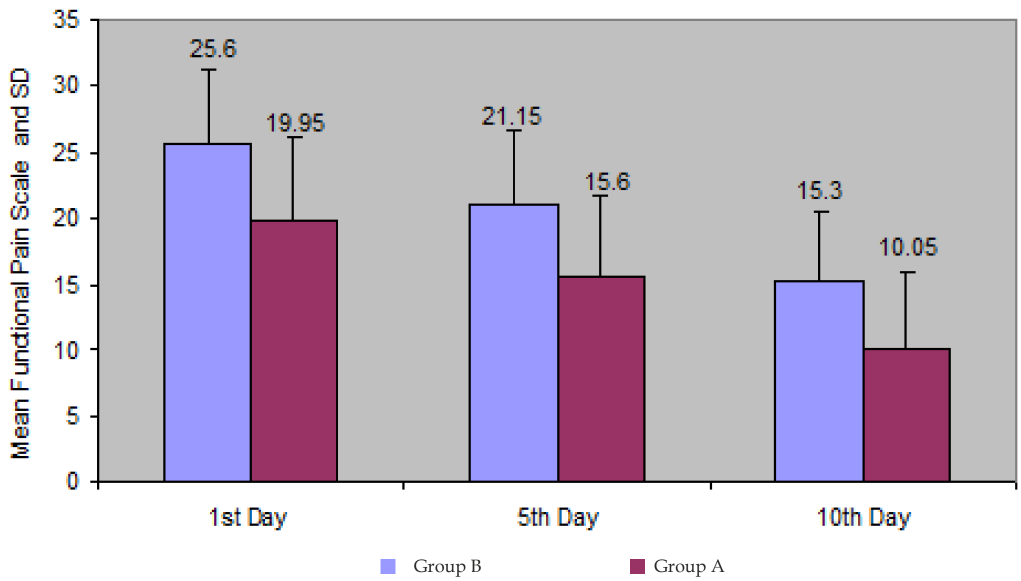


Table 8: (comparison of outcomes).

	Experimental group A			Control group B			Change			P value		
Outcome measures				1ST day	5TH day	10TH day	1ST day	5TH day	10TH day	1ST day	5TH day	10TH day
NPRS	6.45	3.75	1.50	6.80	5.15	2.60	0.35	1.40	1.10	0.300 NS	0.001 S	0.003 S
Grip Strength	24.50	24.90	25.75	23.40	23.85	23.90	1.1	1.05	1.85	0.245 NS	0.471 NS	0.036 S
Functional Status	19.95	15.60	10.05	25.60	21.15	15.30	5.65	5.55	5.25	0.005 S	0.004 S	0.005 S

a. *Age and gender distribution:* No significant difference was found in age and gender wise distribution of subjects in both the groups (p>0.05) Table 1.

b. *NPRS:* The mean values of pain on NPRS was taken for both the groups on 1st, 5th and 10th day of treatment session. By using 'paired t' test significant reduction in pain was found in both the groups. (Table 2 and 3).

But when control group and experimental group were compared for pain on NPRS on 1st , 5th and 10th day by using 'unpaired t' test, no significant change in pain was found at Day 1 (t=1.051, p=0.300NS) but significant change was found on 5th day (t =3.637, p= 0.001S) and 10th day (t = 3.168, p = 0.003S) (Table 8, graph 1)

The mean value of pain on NPRS in experimental group A was found less as compared to control group. Hence experimental group receiving Mulligan taping in addition with Mulligan mobilization MWM and conventional therapy is found to be more effective in reducing pain than control group B receiving MWM and conventional therapy alone.

c. *Grip strength:* The mean value of grip strength was taken for both the groups on 1st, 5th and 10th day of treatment session. By using 'paired t' test, no significant improvement was found in both the groups (Table 4 and 5)

But when control group and experimental group were compared for grip strength on 1st ,5th and 10th day by using 'unpaired t' test no significant change in grip strength was found on 1stday (t=1.81, p=0.245NS) and 5th day(t =0.728, p= 0.471NS), but significant change was found on 10th day (t = 2.173, p = 0.036 S) (Table 8, graph 2)

The mean grip strength in experimental group was found more than control group, and its improvement was significant on 10th day. Hence Mulligan taping, when given in addition with MWM and Conventional treatment is found to be more effective in increasing grip strength than MWM and Conventional treatment alone.

d. *Functional pain scale score:* The mean values of functional pain scale score were taken for both the groups on 1st, 5th and 10th day of treatment session. By using 'paired t' test. Significant decrease in functional pain scale score was found in both the groups. (Table 6 and 7)

But when control grp and experimental group were compared for functional pain scale score on 1st, 5th and 10th day by using 'unpairedt' testsignificant decrease in functional pain scale score was found on 5th day (t =3.02, p= 0.004S) and 10th day (t = 2.96, p = 0.005S) (Table 8, graph 3)

The mean Functional pain scale score in experimental group was found less as compared to control group. Hence Mulligan taping when given in addition to MWM and Conventional treatment is found to be more effective in improving functional activities of subject than MWM and Conventional treatment alone.

Discussion

Our study was carried out to compare the effect of Mulligan taping when given in addition with MWM and conventional therapy in terms of pain, grip strength and functional activities in patient with lateral epicondylitis when treated with MWM and conventional therapy alone.

In our study, chi square statistical analysis was used to compare the distribution of subjects according to the age and gender for both the groups. The paired 't' test was used for comparing effect of treatment through outcome measures within the group for both control and experimental group (intra group). Student unpaired 't' test was used to compare the statistical difference of outcome measures in between the control and experimental group (inter group), with $p<0.05$ taken as indicating statistical significance.

In our study we found that Mulligan taping when given in addition with Mulligan mobilization and conventional therapy resulted in better outcome in the patients than those treated with Mulligan mobilization and conventional therapy alone in terms of pain, grip strength and function. According to Melzack and Wall pain gate theory, stimulation of large diameter myelinated afferent neurons inhibits nociceptive afferent input at the spinal cord level. Descending pain inhibitory system also plays a role in pain inhibition.[25] Mulligan mobilization stimulates this descending pain inhibitory system thereby causing immediate pain relief. Brian Mulligan has proposed, taping techniques is effective in pain relief by maintaining the correction of the position fault thus limiting harmful movement and allowing pain free functional movement, so it prevents further injury of involved structures enhancing its healing process.[26,27] Taping has an effect on pain as cutaneous stimulation provided by the taping techniques stimulates the large mechanoreceptors thereby causing neural inhibition and decreased pain perception (Pooja Arora et al., 2012).[28]

In this study, it was found that experimental group receiving Mulligan taping had significant decrease in pain , as taping helped in maintaining the Mulligan mobilization glide for longer time. This allowed for maintaining the correction of positional fault for longer time thereby limiting harmful movements. It also allowed pain free functional movement thereby decreasing load distribution on ECRB junction. The present study support the findings of study done by Akram Amro MPH , Ina Diener PhD, (2010)[29] which concluded that Mulligan mobilisation with movement and Mulligan taping technique gives statistically significant improvement in pain and grip strength. Present study also support the findings of Alireza Shamsoddini1, Mohammad Taghi Hollisaz, PhD. Rahmatollah Hafezi, PhD (2010)[30], which investigated the initial effect of taping technique on wrist extension and grip strength and pain of individuals with tennis elbow. The result demonstrated a significant increase in grip strength. It is proposed that possible model of the mechanism of action for diamond taping in lateral epicondylalgia relates to its neurophysiologic effects on the nervous system, particularly the nociceptive system. In this neurophysiological model the tape may exert an effect on grip strength by primarily altering pain perception, either locally at the elbow by inhibiting nociceptors, facilitating large afferent fibers input into the spinal cord and/ or possibly by stimulating endogenous processes of pain inhibition.

Limitation

Study with larger sample size is required to examine the effects in larger affected population. Also, the follow up of the patients was not taken after two weeks to assess the long-term effect of the treatment given in the subjects. The neurophysiological mechanisms thought to be responsible for the effects of MWM also need to be explored further.

Conclusion

The study concludes that Mulligan taping when applied in addition to MWM and conventional therapy gives more significant reduction in pain and improvement in grip strength and functional status than when treated with MWM and conventional therapy alone in patients with lateral epicondylitis.

References

1. Wadsworth T G. Tennis elbow-Conservative, Surgical & manipulative treatment. Br. Med J 1987Mar 7 ;294(6572):621-24.
2. Carol. C, Garrett W. E. Tendon problems in athletic individuals. J. Bone Joint Surg Am 1997;79:138-150.
3. Mathew D. P, Painful conditions around elbow : Orthop Clin North Am 1999;79:138-150
4. Norris C. Sports Injuries –diagnosis and management, Butterworth Heinemann 3rd ed 2005:412-417
5. Boyer, Hastings, Lateral tennis elbow “Is there any science out there?” J Shoulder Elbow Surg 1999;8:481-91.
6. Baker CL, Nirschl RP. Lateral tendon injury: open and arthroscopic treatment. In: Altchek DW,Andrews JR, editors. The athlete’s elbow. Philadelphia7 Lippincott Williams & Wilkins; 2001.p. 91– 103.
7. Cyriax JH. The pathology and treatment of tennis elbow. J Bone Joint Surg 1936;18:92140.
8. Green S, Buchbinder R, Barnsley L, Hall S, White M, Smidt N, et al. Non-steroidal anti-inflammatory drugs (NSAIDs) for treating lateral elbow pain in adults. Cochrane Database Syst Rev 2001;(4). CD003686.
9. Assendelft WJJ, Hay EM, Adshead R, Bouter LM. Corticosteroid injections for lateral epicondylitis: a systematic overview. Br J Gen Pract 1996;46:209-16.
10. Kamien M. A rational management of tennis elbow. Sports Med 1990; Mar;9(3):173-91.
11. Cyriax JH. The pathology and treatment of tennis elbow. J Bone Joint Surg 1936;18:921-40.
12. Lundeberg T, Abrahamsson P, Haker E. A comparative study of continuous ultrasound, placebo ultrasound and rest in epicondylalgia. Scand J Rehabil Med 1988;20:99-101.
13. Haker EHK, Lundeberg TCM. Lateral epicondylalgia report of noneffective midlaser treatment. Arch Phys Med Rehabil 1991; 72:984-8
14. Altan L, Kanat E. Conservative treatment of lateral epicondylitis: comparison of two different orthotic devices. Clin Rheumatol 2008;27:1015-9.
15. Martin M, Anderson, MK, Hall, SJ. Sports Injury Management: USA; 1995.
16. Verhaar J, Walenkamp G, Kester A, van Mameren H, van der Linden T. Lateral extensor release for tennis elbowda prospective long-term follow-up-study. J Bone Joint Surg Am 1993;75A:1034-43

17. Pienimaki TT, Tarvainen TK, Sura PT, Vanharanta H. Progressive strengthening and stretching exercises and ultrasound for chronic lateral epicondylitis. Physiotherapy 1996;82:522-30.
18. Garrett WE, Speer KP, Kirkendall DT. Principles and practice of orthopaedic and sports medicine. Philadelphia, PA: Lippincott Williams and Wilkins; 2000 [chapter 18]p. 289-305.
19. Manual therapy NAGS,SNAGS,MWMS,etc by Brian R Mulligan , 6th edition 2010
20. Electrotherapy explained. Principles and practice book 3rd edition by John Low and Ann Reed.p94-96
21. http://painconsortium.nih.gov/painscales/numerical rating scale.pdf
22. L. Andrew Ashton , Stuart Myers : Serial Grip Strength Testing- Its Role In Assessment Of Wrist And Hand Disability . The Internet Journal of Surgery. 2004 Volume 5 Number 2
23. Arti S Bhargava, Charu Eapen, and Senthil P Kumar. Grip strength measurements at two different wrist extension positions in chronic lateral epicondylitis-comparison of involved vs. uninvolved side in athletes and non athletes: a case-control study.Journal of Sports Med Arthrosc Rehabil Ther Technol. 2010; 2: 22. Published online 2010 September 7.
24. Geetu Manchanda, Deepak Grover : Effectiveness of movement with mobilization compared with manipulation of wrist in case of lateral epicondylitis: Indian Journal of Physiotherapy and Occupational Therapy Vol. 2, No. 1 (2008-01 - 2008-03)
25. Taping techniques Principles book 2ndedition and Practise Rose Macdonald
26. Deepak kumar (BPT,MSPT-Accredited Mulligan,s concept teacher) Hands on workshop on Mulligan concept booklet by Deepak kumar (Dec 2010)
27. Megha S. Nair and Bharati D. Asgaonkar. EFFECT OF MULLIGAN TAPING ON QUADRICEPS STRENGTH, KNEE PAIN AND FUNCTION IN KNEE OSTEOARTHRITIS USING VISUAL ANALOGUE SCALE AND KOOS International Journal of Current Research Vol. 10, Issue, 09, pp.73820-73824, September, 2018 DOI: https://doi.org/10.24941/ijcr.32423.09.2018
28. Pooja Arora, Shilpa Yardi, Sujata Yardi: A study of immediate effects of taping in patients with knee osteoarthritis. Indian journal of physiotherapy and occupational therapy letter. July – Sept.2012; 6 (3):202 – 207.
29. Akram Amro, MPH a,b,*, Ina Diener, PhD b,c, Wafa’ Omar Bdair, BPT a, Isra’ M. Hameda, BPT a, Arwa I. Shalabi, BPT a, Dua’ I. Ilyyan, BPT : The effects of Mulligan mobilisation with movement and taping techniques on pain, grip strength, and function in patients with lateral epicondylitis. Hong Kong Physiotherapy Journal (2010) 28, 19- 23 .
30. Alireza Shamsoddini1; Mohammad Taghi Hollisaz, PhD,Rahmatollah Hafezi, PhD: Initial effect of taping technique on wrist extension and grip strength and pain of Individuals with lateral epicondylitis: Iranian Rehabilitation Journal, Vol. 8, No. 11, 2010