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Efficacy of kinesio tape on bilateral pedal edema in selective types of edema

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Abstract

Study aim: To determine the effectiveness of kinesiology tape for treatment of bilateral pedal edema in different types of edema patients (renal, lymphatic).

Material and methods: Sixty patients of both sexes who had bilateral pedal edema took part in this study. They were randomized to two equal-size study groups. Group A (renal edema) included 30 patients (8 males and 22 females) aged 59.2 ± 5.2 years. Group B (lymphedema) included 30 patients (9 males and 21 females) aged 59.7 ± 5.3 years. Both groups underwent 60 minutes of supervised conventional physiotherapy sessions twice weekly in addition to kinesiology tape for 12 weeks. Pedal edema, functional capacity and quality of life were assessed using volumetric assessment and tape measurements, the six-minute walk test, the lymphedema quality of life scale (LYMQOL) and the World Health Organization Quality of Life questionnaire (WHOQOL-BREF) for both groups before and after treatment.

Results: After completion of the treatment program, the patients assigned to group B (lymphedema) achieved higher results in the volumetric assessment ($p < 0.001$), tape measurements ($p < 0.001$), functional capacity (6MWT) ($p < 0.001$), LYMQOL in all domains (function, appearance, symptoms, mood and overall quality) (overall $p < 0.001$) and WHOQOL in all domains (physical health, psychological, social, environment and overall quality) (overall $p < 0.001$). Patients assigned to group A (renal) did not show an improvement in their results ($p > 0.001$).

Conclusion: Kinesiology tape was found to be an effective method for reducing bilateral pedal edema in patients with lymphedema. This in turn can enhance functional capacity and quality of life.

Keywords: Renal – Lymph edema – Functional capacity – Quality of life

Introduction

Fluid retention in the tissues of the body causes the swelling known as pedal edema. The feet, ankles, and legs are the most common locations of edema-induced swelling. Typically, it is associated with the lymphatic or venous systems. The previous names for edema were dropsy and hydropsy [6].

Differentiating between unilateral and bilateral pedal edema is essential when assessing a patient. The presence of pedal edema on one side of the body is indicative of an obstructive condition, such as malignancy or venous thrombosis. Older persons are more likely to experience bilateral pedal edema, and this condition may be indicative of a systemic disease and has multiple causes [15].

Pedal edema, or swelling in the feet and ankles, can result from a variety of underlying reasons. Being aware of the probable causes can aid in timely diagnosis and treatment. Some common causes according to [2] and [24] are:

- Heart failure can cause pedal edema as the heart muscle weakens and pumps blood inefficiently.
- Kidney diseases can affect the organ's ability to filter liquids and manage salt. This causes general fluid retention, which is commonly seen as pedal edema.
- Advanced liver impairment impairs the organ's ability to regulate fluid volume. Fluid may leak from vessels into the legs and feet.

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- Medication side effects: Corticosteroids, antidepressants, and hormonal therapies are examples of prescription drugs that can cause fluid retention in the feet.
- Pregnancy: Hormonal changes and increased blood volume might produce minor edema in the lower limbs. This is normally safe, but it should be watched.
- Prolonged standing can lead to fluid accumulation in the feet and ankles due to gravity. The swelling subsides after resting.
- Sprains, fractures, and physical trauma to feet or ankles can harm blood vessels and soft tissues. Increased leaking produces localized edema.
- Blood clots can clog veins in the legs, preventing normal fluid outflow. This normally affects only one limb.
- Allergies can cause fluid to flow from dilated blood vessels, leading to edema.
- Low protein levels.

The kinesiology tape (KT) method includes eight procedures using two muscle techniques: underactive muscle correction (UMC) and overactive muscle correction (OMC), for encouraging and inhibiting muscular action, respectively. Correction treatments include lymphatic, fascial, tendon, ligamentous, mechanical, space, and functional [11].

KT procedures vary in terms of tape tension and application to the skin, depending on the tissues affected and therapeutic goals. KT has four primary effects: pain reduction in the fascia and skin, muscle support for appropriate mobility, and stimulation of lymph and blood circulation, which is important for routing and re-routing the lymphatic fluid in the lymphatic vessels to reduce swelling of the lower limb. It also improves proprioception and correction of joint irregularities [14].

According to one theory, kinesiology tape works by drawing the skin upwards, which in turn improves lymphatic drainage by creating more interstitial space under the skin. This, in turn, reduces edema and pain by relieving pressure within the interstitial spaces; the lymphatic system is the body's primary process for decreasing swelling and edema. Inflamed or swollen areas can benefit from the lifting action of kinesiology tape, which helps the underlying tissues drain excess fluids by creating a space between the skin and bone [10].

A comprehensive rehabilitation program in physical therapy is beneficial to pedal edema. Measurements of the circumferential limbs, posture, flexibility, and activity/fitness levels are all part of the first assessment that establishes a baseline for the legs. Instructions for the patient's everyday activities, edema precautions, resistance and aerobic exercise programs, as well as active range of motion (ROM), are provided. Successful treatment for edema, based on pathophysiology, includes manual lymphatic drainage, compression garments, and exercise [22].

Functional capacity refers to the maximum or optimum amount of effort that can be produced or the extent to which the patient can increase exercise intensity and maintain increased levels. It depends largely on cardiovascular fitness [7].

Functional capacity is negatively affected by changes in the structure as well as functions of the body, impairing the performance of activities of daily living. As a result of these functional limitations, one may experience anxiety, psychological distress, diminished self-esteem, and difficulty in social involvement, both at home and at work [17].

Functional deficits that develop among patients with renal edema and lymphedema as a result of the associated physical, sensory, emotional, and social impairments lead to significant failures in the level of health-related quality of life (HRQOL) [4].

Exercise therapy can improve physical performance and functional capacity in patients with disability. The improvements are likely to be clinically important through reduction of functional capacity limitations in everyday activities. Exercise therapy appears to be safe in rehabilitation of chronic diseases [13].

There is currently no research comparing the effectiveness of kinesiology taping on bilateral pedal edema in patients with selected types of edema. Thus, the goal of the study is to compare the effect of kinesiology taping on bilateral pedal edema in chronic kidney diseases patients and pedal edema (lymphedema) patients.

Materials and methods

Study design and ethical considerations

The study was carried out as an experimental single-blind randomized controlled trial. The study followed the Helsinki guidelines for conducting medical research and approval of the study was provided by the Research Ethics Committee of Faculty of Physical Therapy, Cairo University, Egypt [No. P.T.REC/012/ 002338]. Also, approval from Manshiat El Bakry general Hospital was obtained. The study lasted around one year, starting in September 2019 and ending in December 2021. Before starting, clarification of the procedures was made, then a signed consent was collected from each patient, ensuring the confidentiality of data and the right to withdraw at any time.

Participants:

The sample size was detected through the Steven Sampson equation. Based on the assumption that sample size was calculated based on an infinite community population (100,000,000) with the confidence level of 90%, a probability of 50% and the margin of error is 0.05%, a sample size of 60 patients with bilateral pedal edema was required and was recruited randomly from the Departments of internal medicine at Manshiyat AL Bakry Hospital. as a convenience sample and evaluated for eligibility criteria. Patients

were recruited in the study when they were medically and clinically stable, with duration of the bilateral pedal edema up to six months. Group A (renal edema) included 30 patients (8 males and 22 females) aged 59.2±5.2 in stage 2 (glomerular filtration rate (GFR) 60 to 89 ml/min/1.73 m²), with stage 3a (GFR between 45 to 59 ml/min/1.73 m²) and stage 3b (GFR 30 to 44 ml/min/1.73 m²) chronic kidney disease. Group B (lymphedema) included 30 patients (9 males and 21 females) aged 59.7 ± 5.3 in stage 1 (pitting) lymphedema, stage 2 (non-pitting) lymphedema, could walk independently or with an assistive device, and they had sufficient cognition to understand the instructions. Exclusion criteria were patients who had any history of cardiopulmonary dysfunction and hepatic defects assessed by blood test (complete blood count, serum electrolytes, alanine transaminase, aspartate aminotransferase, serum albumin, arterial blood gases), electrocardiogram, chest X-ray, ultrasonography, and echocardiography [9]. Also patients with significant deformity or advanced radiological changes (such as trauma and contusion) that might cause pedal edema were excluded as the study selected only patients with pedal edema due to renal and lymphatic causes (Fig. 1).

Randomization and blinding

Using SPSS computer software (SPSS Inc., Chicago, Illinois, USA, version 17), a table with randomized numbers was generated. Each patient owned a specific number that was assigned to one of two equal-numbered groups (n = 30). Serially numbered cards were put inside secured opaque envelopes and were opened by a blinded researcher who allocated each patient to his or her group. There were no dropouts after randomization.

Interventions

The main tools utilized in the present study can be divided into two categories: measurement tools along with equipment and therapeutic tools.

The measuring methods and equipment comprised tape measurements (girth measurements), the water displacement method (volumeter), and tools evaluating functional capacity and quality of life (LYMQOL scale and WHO-QOL-BREF).

The therapeutic equipment comprised treadmill, kinesiology tape, compression garments, compression bandages and free mechanical weights.

Outcome measures

The primary outcome for this study was the improvement and prevention of pedal edema. All patients were assessed carefully by the physician before study commencement.

Participants in this study received a good explanation of measurements and therapeutic procedures. Oral explanations were given to each patient regarding the study's essential rationale and primary objective.

Technical measurement phases

Technical assessment procedures were conducted through different categories:

- Measurements of circumferential edema formation:

From a comfortable supine lying position with the examined leg resting on a pillow under the knee, the measurements were taken at the following levels.

The center of the medial malleolus was determined and the edema size 5 cm above and below this point was taken.

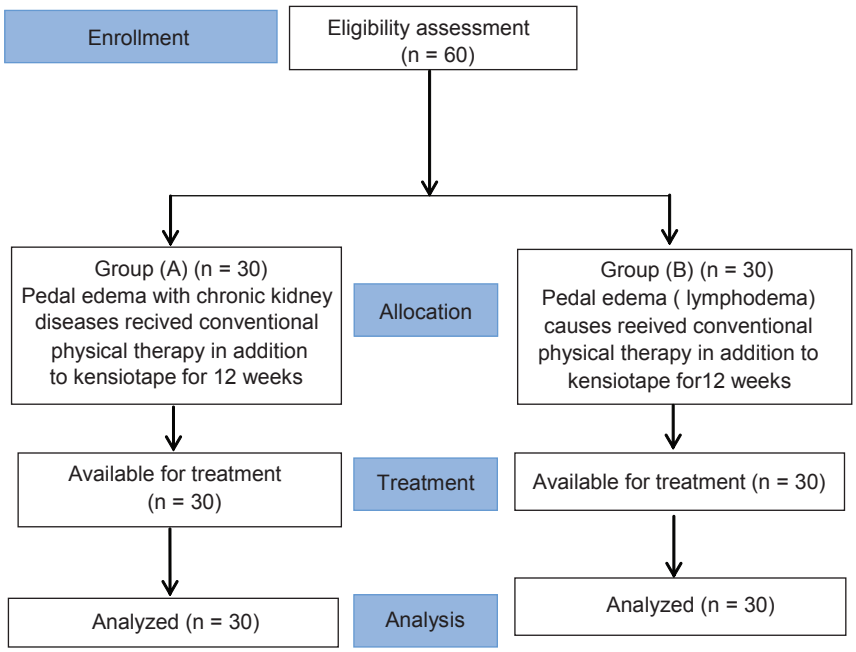

Figure 1. Participants' flow chart

The head of the fibula was determined and the edema size 5 cm, 10 cm and 15 cm below this point was taken. Then the mean size of all levels was calculated.

These steps were repeated to measure the edema size in the other leg [18].

- Volumetric assessment for edema:

Using the water displacement method before and after treatment, subjects were instructed to place the lower limb in a fully filled volumeter, resting the foot on it. The rater noted the volume of spilled water [1].

- Functional capacity:

The six-minute walk test (6MWT) was applied by making a person walk for a defined period of time and measuring the distance covered (6MWD) [8].

- Quality of life:

The LYMQOL scale (function, appearance, symptoms and mood) – a validated and reliable condition-specific QOL assessment tool which can be used for lymphedema of the limbs both in clinical assessment and as an outcome measure [25] – and the WHOQOL-BREF (measuring physical health, psychological, social relationships and environment) were used.

Therapeutic procedures

All selected patients were enrolled in a conventional physiotherapy program (including treadmill exercise, active resisted exercise utilizing sand bags as mechanical weight, a compression garment along with elastic bandages) as well as kinesiology tape.

1) Kinesiology tape

This procedure can be summarized in the following steps:

- Treatment duration was about 12 weeks.
- The patient washed the limb prior to starting treatment.
- Kinesiology tape was put on continuously, day and night.
- Kinesiology tape was replaced when the patient arrived at the clinic twice weekly.

Figure 2. Ankle Joint edema measurement (medial malleolus and foot)

Figure 3. Volumetric assessment for edema

Figure 4. Application of six-minute walk test

- Education was ongoing and included exercise and edema prevention and how patients could replace kinesiology tape when to remove it at home.

Following baseline tests, the intervention involved cleaning the skin with alcohol and applying kinesiology tape (Kinesiology Adhesive Sports Tape, ARES UNCUT Company, Korea; 5 cm wide x 5 m , black, pink, blue and beige) as per Kase et al.'s protocol [11] for the experimental intervention.

We used our own experience to neutralize the elasticity of kinesiology tape. According to the KT method's postulates [14], stretching the material beyond 50%, especially up to maximum elongation, results in loss of mechanical properties and recoil effect.

Kinesiology tape around 50 cm long was started by applying the anchor proximally to distally, in a fan shape, to the area of swelling of the pedal edema from the tibial plateau and head of the fibula, fanning the tails over the foot in a stretching pattern at 25% tension according to swollen leg length. This shape of application of kinesiology tape resembled the typical shape of lymphatic vessels [16].

2) Conventional physical therapy program

- Warm-up phase:

To avoid shocking the body into unexpected exertion, it was recommended to gradually apply physical stress to the cardiovascular system with light cardio. In preparation for subsequent, more challenging workouts, this 5-minute aerobic warmup proved perfect for increasing blood flow and muscle temperature, with active movement, specifically aerobic exercise [21].

- Active phase:

The next step is to walk at an intensity determined by the Karvonen formula, which takes into account both the maximal and resting heart rates to determine training zones. The target heart rate (THR) can be determined by subtracting the age from 220, which equals the maximum heart rate. Then, subtracting the resting heart rate from the maximum heart rate yields the heart rate reserve, which can be further modified by adding the training percentage to the resting heart rate. This range (60–70%) is ideal for active recovery exercise [23].

- Cool-down phase:

Cooling down after a running on treadmill allowed the heart rate to slow down gradually. Stretching muscles not only helped prevent soreness and injury, it also allowed time for undertaking a difficult workout. Transition from running to stretching was performed with an easy jog and then a walk for three to five minutes. Cooling down for five minutes then static stretching exercises were performed [21].

Statistical procedures

The evaluation sheet was filled out with the collected data. Statistical software on an IBM personal computer was used for sending this data to an IBM card. The following steps were a part of the statistical procedures along with tools:

Every individual in both groups had descriptive statistics including mean, standard deviation, range, as well as standard error calculated to examine the homogeneity and central deviation [19].

SPSS Statistics, version 17, was used for data analysis.

Each hypothesis was tested separately by utilizing the suitable statistical tools. For the data analysis the level of significance was set at 0.05.

The dependent T-test was used to compare the dependent variables (edema (volumetric assessment and tape measurements), functional capacity (6MWT) and quality of life (LYMQOL and WHOQOL)), within each group (before treatment and after treatment for patients in both study groups) to determine the level of significance.

The independent T-test was utilized to compare the dependent variable and independent variables between groups to determine the level of significance.

Figure 5. Kinesiology tape application for pedal edema

Results

The present study included 60 patients, with 30 randomized to each of the two groups. Both groups' demographic characteristics, including sex (P = 0.774) and age (P = 0.678), did not differ significantly from one another.

Regarding the values of volumetric (pedal edema) assessment, the results revealed no statistically significant change in the mean value when comparing the pre – and post-treatment values within group A, with a percentage decrease of 0.75%; however, there was a statistically significant decrease in group B, with a percentage of decrease of 27.33%. The results showed statistically significant differences in the mean values of volumetric (pedal edema) assessment among groups after treatment, favoring group B (Table 2).

Regarding the values of tape measurement (pedal edema) assessment, the results revealed no statistically significant change in the mean value when comparing the pre – and post-treatment values within group A, with a percentage decrease of 0.53%; however, there was a statistically significant decrease in group B, with a percentage of decrease of 24.40%.

The results showed statistically significant differences in the mean values of tape measurement (pedal edema) assessment between groups after treatment, favoring group B (Table 3).

Regarding the values of functional capacity (6MWT), the results revealed no statistically significant change in the mean value when comparing the pre – and post-treatment values within group A, with a percentage of increase of 1.77%; however, there was statistically significant increase in group B, with a percentage of increase of 17.83%. The results showed statistically significant differences in the mean values of functional capacity (6MWT) assessment between groups after treatment, favoring group B (Table 4).

Table 1. Baseline characteristics of patients

	Group A	Group B
	N	N
Male	8	9
Female	22	21
Total	30	30
Age [Years]		
Mean ± SD (min–max)	59.17 ± 5.22 (51–68)	59.73 ± 5.30 (52–68)

Table 2. Comparison of mean values and percentage of volumetric assessment before and after treatment in both groups (A and B)

Volumetric assessment [ml]	Group A	Group B	T	P-value
Pre-measure Mean ± SD (min–max)	1794 ± 386 (1200–2650)	1912 ± 238 (1600 – 2300)	–1.43	0.157
Post-measure Mean ± SD (min–max)	1798 ± 352 (1210–2520)	1386 ± 187 (1100 – 1790)	5.66	<0.001
Differences	–4 ± 96	526 ± 156		
T	–0.27	18.49		
P-value	0.79	<0.001		

P-value: probability value, P-value > 0.05 (non-significant), X; mean, SD: standard deviation.

Table 3. Comparison of mean values and percentage of tape measurements before and after treatment in both groups (A and B)

Tape measurements [cm]	Group A	Group B	T	P-value
Pre-measure Mean ± SD (min–max)	30.77 ± 5.30 (24–41)	32.13 ± 4.68 (23–41)	–1.06	0.294
Post-measure Mean ± SD (min–max)	30.86 ± 5.03 (24–41)	24.23 ± 3.99 (20–35)	5.66	<0.001
Differences	–0.10 ± 1.21	7.90 ± 2.78		
T	–0.45	15.54		
P-value	0.655	<0.001		

Table 4. Comparison of mean values and percentage of functional capacity (6MWT) before and after treatment in both groups (A and B)

6MWT [m]	Group A	Group B	T	P-value
Pre-measure Mean ± SD (min–max)	371 ± 32 (324 – 425)	359 ± 29 (312–423)	1.51	0.137
Post-measure Mean ± SD (min–max)	377 ± 30 (424 – 434)	422 ± 36 (371–501)	–5.40	<0.001
Differences	–6 ± 20	–63 ± 26		
T	–1.61	–13.36		
P-value	0.117	<0.001		

(6MWT): six minute walk test.

Regarding the values of quality of life (LYMQOL scale), the results revealed no statistically significant change in the mean values when comparing the pre – and post-treatment values within group A in all domains (function, appearance, symptoms, mood and overall quality), with the following percentage increases: Domain 1 5.05%, Domain 2 5.59%, Domain 3 5.65%, Domain 4 5.35%, and overall quality 2.33%; however, there was statistically significant increase in group B, with the following percentage increases: Domain 1 12.74%, Domain 2 14.43%, Domain 3 2.65%, Domain 4 19.95%, and overall quality 11.86%. The results showed a statistically significant difference in the mean value of quality of life (LYMQOL scale) assessment between groups after treatment, favoring group B (Table 5).

Regarding the values of quality of life (WHOQOL-BREF), the results revealed no statistically significant change in the mean values when comparing the pre – and post-treatment values within group A in all domains (physical health, psychological, social, environment as well as overall quality) with the percentage increase as follows: Domain 1 7.25 %, Domain 2 2.36%, Domain 3 2.65%, Domain 4 5.35% and overall quality 11.72%; however, there was a statistically significant increase in group B, with the following percentage increases: Domain 1 23.29%, Domain 2 19.20%, Domain 3 40.02%, Domain 4 52.56%, and overall quality 54.45%). The results showed a statistically significant difference in the mean value of quality of life (WHOQOL-BREF) assessment between groups after treatment, favoring group B (Table 6).

Table 5. Comparison of mean values and percentage of quality of life (LYMQOL) before and after treatment in both groups (A and B)

Group	Variables LYMQOL scale	Pre-measure Post-measure Mean ±SD		t-value	P-value
Group (A)	(Domain 1)	1.894 ± 0.327	1.961 ± 0.303	–1.180	0.248
	(Domain 2)	1.943 ± 0.252	2.033 ± 0.278	–1.649	0.110
	(Domain 3)	2.027 ± 0.310	2.107 ± 0.310	–1.197	0.241
	(Domain 4)	1.999 ± 0.254	2.078 ± 0.247	–1.302	0.203
	(overall quality)	5.100 ± 0.845	5.200 ± 0.805	–1.795	0.083
Group (B)	(Domain 1)	2.014 ± 0.279	2.260 ± 0.275	–11.240	<0.001
	(Domain 2)	1.995 ± 0.270	2.273 ± 0.247	–13.474	<0.001
	(Domain 3)	1.960 ± 0.304	2.300 ± 0.339	–11.129	<0.001
	(Domain 4)	1.889 ± 0.271	2.250 ± 0.266	–13.032	<0.001
	(overall quality)	5.533 ± 0.973	6.067 ± 0.640	-4.000	<0.001

(LYMQOL):lymphodema quality of life.

Table 6. Comparison of mean values and percentage of quality of life (WHOQOL-BREF) before and after treatment in both groups (A and B)

Group	Variables	Pre-measure	Post-measure	t-value	P–value
	WHOQOL-brief	(Mean ± SD)			
Group (A)	(Domain 1)	44.05 ± 6.03	46.42 ± 6.14	–1.61	0.117
	(Domain 2)	45.15 ± 4.47	46.11 ± 5.12	–1.39	0.174
	(Domain 3)	33.94 ± 8.65	34.72 ± 9.05	–0.98	0.337
	(Domain 4)	17.36 ± 6.70	18.98 ± 4.18	–1.66	0.108
	(Overall quality)	47.08 ± 15.29	50.00 ± 12.71	–1.49	0.147
Group (B)	(Domain 1)	41.44 ± 6.26	50.71 ± 5.96	–22.72	<0.001
	(Domain 2)	43.11 ± 5.21	51.12 ± 4.88	–15.65	<0.001
	(Domain 3)	30.39 ± 8.76	41.67 ± 9.29	–13.96	<0.001
	(Domain 4)	14.80 ± 3.85	21.78 ± 4.66	–11.44	<0.001
	(Overall quality)	40.00 ± 12.88	57.92 ± 9.56	–8.75	<0.001

(WHOQOL-brief): World health organization quality of life.

Discussion

The present study was carried out to evaluate the therapeutic effectiveness of kinesiology tape as well as a traditional physiotherapy program for bilateral pedal edema in patients with selected types of edema.

It was hypothesized that no significant differences would be found before and after the treatment program between the two study groups. However, the results of the current study rejected this hypothesis, as there were significant improvements after treatment in favor for group B compared to group A.

The findings of this study were in accordance with previous authors [16] who stated that kinesiology tape decreased the edema level with a conventional physical therapy program in lymphedema while there was no decrease of edema level in patients with renal impairment. It demonstrated that using kinesiology taping for the treatment of pedal edema was effective in reducing disability by creating alternative drainage pathways such as the lymphatic pathway.

The current study was in line with previous researchers [3] who reported that the application of kinesiology tape caused a decrease of edema due to lymphatic causes in addition to a conventional physical therapy program. It agreed with authors [5] who concluded that lymphatic applications of kinesiology tape decreased lymphatic congestion in intercellular spaces and the decrease of edema led to improvement in ROM in all lower extremity joints, especially pedal edema.

This study was in accordance with researchers [26] who noted that kinesiology tape was superior to bandage application due to its greater durability, ease of use, comfort, and simplicity in everyday tasks.

These results agreed with other authors [10] who reported that kinesiology tape and physical therapy modalities led to improvements in functional capacity and ambulatory ability, including increased walking velocity and decreased energy expenditure during ambulation in patients with pedal (lymph) edema.

These results also agreed with a previous study which reported that patients with bilateral edema had a high mean score in health-related QOL as well as moderate improvement in health-related QOL following physical therapy treatment and kinesiology tape in group B (lymphedema) had a significant influence on the treatment outcome [12].

However, the present study contradicted a previous conclusion [20] that kinesiology tape, as well as compression garments, do not have a preventative function in pedal edema of specific types (lymphatic, renal, and all types combined).

The current study found that applying KT only during the early stages of rehabilitation did not prevent muscle atrophy. This finding is consistent with a recent meta-analysis of the effects of KT on muscle strength, which found that KT did not increase strength gains in healthy individuals [5].

Finally, all participants in both groups reported benefits of training. Self-reported benefits of training included level of edema, functional capacity and different aspects of QOL.

The physiotherapy program in addition to kinesiology tape application proved a safe and effective step towards forming a bridge between physical therapy and community-based physical activity.

Based on these results, in this experimental design study, the results showed that both kinesiology tape and the traditional physiotherapy program are beneficial in enhancing functional performance in patients with pedal edema (lymphedema). However, the results revealed no significant improvement in patients with pedal edema due to chronic kidney diseases.

Nonetheless, the study may have potential limitations. First, the study was cross sectional and lacked response data. The sample size was small: only 30 patients in each group. Both study groups lacked a control group. As a result, additional research is needed to determine the responsiveness of this tool. Another restriction was the exclusion of patients with psychiatric disorders. These individuals were omitted because they were deemed incapable of fully comprehending all questions. Personal and individual differences between patients might result in unequal comprehension of information, affecting their understanding of the treatment procedure. Physical responses of the patients to medical treatment might affect the results of the study.

Conclusion

The following study conclusions can be drawn:

Kinesiology tape when combined with a traditional physiotherapy program had no significant effect in reducing renal pedal edema, whereas it had a significant effect on lymphatic pedal edema.

Kinesiology tape could be used with a conventional physical therapy program, and it could be an alternative choice for lymphatic pedal edema. A program of kinesiology tape and traditional physiotherapy should form a core for most patients with pedal edema aiming to reduce limb volume and improve circulation.

Conflict of interest: Authors state no conflict of interest.

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