Effect of Mirror therapy with Tactile Discrimination Training on Phantom Pain and General Health post Amputation

Hasnaa Eid Shaban Mosa [1,2], Masouda H. Atrous [3], Sabah E. Nady[4], Entsar K. Mohammed[5]& Omima Said M. H. Shehata [6]

[1,5,6] Medical Surgical Nursing, Faculty of Nursing, Menoufia University. Egypt.
[2]Medical Surgical Nursing, Nursing Faculty, Jouf University, KSA.
[3] Critical Care and Emergency Nursing, Faculty of Nursing, Alexandria University, Egypt.
[4]Family and Community Health Nursing, Faculty of Nursing, Menoufia University, Egypt.

Corresponding author: Dr/ Hassnaa Eid
email: heshaban@ju.edu.sa.

Abstract

Phantom pain is a common consequence of amputation, it is difficult to treat and usually associated with discomfort, impairment, interruption of daily activities, and declining general health. By engaging in mirror therapy and tactile discrimination training, one might lessen pain and other symptoms associated with psychological and physical complaints. **The aim**: To examine the effect of mirror therapy with tactile discrimination training on phantom pain and general health post amputation. **Setting**: Data were collected from neurological outpatient clinics of Menoufia University Hospital, Egypt. **Design***:* Quasi-experimental design. **Subjects**: A purposive sample of 100 patients with phantom pain. **Tools**: Four tools were used to collect data: (I) A structured interviewing questionnaire, (II) Defense and Veteranspain rating scale, (III) General health scale and (IV) Self-reported compliance sheet. **Results**: Initially, 74% of the study group were complaining severe pain, but this percentage decreased to 54.0% and 44.0% respectively after two and four months. Also, 78% of the study group initially was dependent with poor physical ability, but after two months the percent decreased to 8% and was eliminated (0.00%) by four months. There was a significant negative correlation between the study group's compliance and pain level and general health after 4 months. **Conclusion**: A noticeable phantom pain reduction with general health improvements among amputees after mirror therapy with tactile discrimination training was explored. **Recommendations**: The appropriate simple and cheap mirror therapy with tactile discrimination training should be implemented among all amputees for phantom pain reduction as illustrated in the current study.
Key words: Amputation, General health, Phantom pain & Mirror therapy and tactile discrimination training.

Introduction

Phantom pain (PP) is a painful sensation perceived in a part of the body which no longer exists. Its cause can differ from trauma, neoplasm, deformities, infection and circulatory problems which may be resolved by amputation to reduce pain and disability but, up to eighty percent of these cases return to the hospital postoperatively complaining of phantom pain **(Hanyu-Deutmeyer, A. A., Cascella, M., & Varacallo, M. 2023).** Scientifically phantom pain caused by anatomical movement of adjacent somatosensory and motor regions into a deafferented brain contralateral cortical region of affected extremity **(Gunterstockman et al., 2023)**.

Phantom pain is a major factor affecting a

patient's overall health following amputation, more so than the physical and psychological difficulties of losing a limb. It prevents the patient from using prosthesis as much as they would like to, reduces their mobility, and makes it difficult for them to resume their regular daily activities. Additionally, it is having a detrimental effect on their general health in general **(Buch, N., Qerama, E., Brix Finnerup, N., & Nikolajsen, L., 2020).**

Patients typically report phantom pain as having a searing, stinging, piercing, and fluctuating warm and cold feeling that comes and goes. Furthermore, patients could feel as though the limb is moving or is in an unusual posture. physical, psychological, or environmental trigger may exacerbate the onset of symptoms **(Kaur & Guan, 2018)**.

Neuroma discomfort, fibrosis, and lingering local tissue inflammation are the main causes of phantom pain. Its incidence has been linked to a number of variables, including the degree of amputation, the etiology, and pre-amputation discomfort. Additionally, it may be connected to psychological issues like mental stress and physical problems like weather variations or pressure on the amputation stump **(Wang et al., 2021).**

The behavioral practice is a newly emerging non-pharmacological management strategy for phantom pain. Combining mirror therapy with tactile discrimination training lead to positive effect which enhancing visual and motor feedback association that reduce the hurtful cortical reorganization **(Sturma, A., Hruby, L., Vujaklija, I., Østlie, K., & Farina, D., 2021).** Mirror therapy practice is movement representations, implemented by unaffected extremity to liberate non- hurtful mirror therapy movement in the affected extremity. This restores the attached cortical motor and sensory regions, which limiting pain, physical and psychological manifestations linked to sensory information cutting. Actually, after amputation, the primary sensory and motor cortical regions attached with amputated limb are no longer elicited. Also, make gradual replacement of functional neuro-imagery by nearby cortical regions, which will limit the pain and other systemic and psychological symptoms **(De Nunzio et al., 2018).** On the other hand, tactile discrimination training with different stimuli that apply to the stump, allow for identification of right region and frequency of stimulus. this will reduce the pain with its accompanied different physical and psychological symptoms through reversal of cortical reorganization which in turn improving Amputees' independence in performing daily activities as well as their overall general health **(Wakolbinger, R., Diers, M., Hruby, L. A., Sturma, A., & Aszmann, O. C., 2018).**

Study significance:

The percentage of amputees experiencing phantom pain is rising every day compared to earlier, reaching 98% nowadays. The disparity in incidence rates may be caused by amputees' ignorance of phantom pain and other related physical and psychological problems compared to nowadays (**Abdi, 2022).** The therapeutic approach for this kind of pain after amputation is complex due to lack of available treatment alternatives, and pain medication addiction, so new therapies like discrimination training and mirror therapy aim to reduce this centrally produced pain. Large-scale experiments have thus been conducted to learn more about these therapeutic approaches that are developing non-pharmacologically **(Wakolbinger et al., 2018).** Thus, the aim of this study was to examine the effect of mirror therapy with tactile discrimination training on phantom pain and general health post amputation.

Aim

To examine the effect of mirror therapy with tactile discrimination training on phantom pain and general health post amputation.

Hypotheses:

- Study group will exhibit lower level of phantom pain than control group after mirror therapy with tactile discrimination training.
- Study group will exhibit improvements in levels of independence and daily activity performance than control group after mirror therapy with tactile discrimination training.
- Study group will exhibit improvement in their general health with little physical & psychological complains than control group after mirror therapy with tactile discrimination training.

Methodology

Design: Quasi-Experimental design was utilized to conduct the study.

Setting: An outpatient's clinic of Neurology at Menoufia University Hospital, Egypt.

Subject: A purposive sample of one hundred amputees with phantom pain matching the selected inclusion criteria. Who are randomly divided equally to two groups, each one included fifty patients: Study group (A): Who apply mirror therapy with tactile discrimination training in addition to the routine medical treatment. **Controlgroup (B):** Who carry out only the routine medical treatment.

Inclusion criteria: Adults of both genders agreed to participate in the study with unilateral upper / lower extremity (right / left) amputation.

Exclusion criteria: 1. Patients with bilateral lower/upper extremity amputation as the patients will depend on their unaffected limb on their application of the study intervention. 2. Cerebrovascular accident, injured spinal cord, head trauma, and psychiatric disorders as they may wrongly influence the results.

Sample size

Based on the research practical phase, which lasted two months and involved about 134 cases. About fifty patients a month made up the patient flow rate. Patients who actually participated in the study were100, who completed the interventions while the remaining patients were excluded because of refusal, lack of participation and not completed the questionnaire. Epi Info Program 7 employed the following formula to calculate the sample size with an 80% power and a 95% confidence level. n is equal to [DEFF*Np(1-p)] / [(d2/Z21-α/2* (N-1) +p*(1-p)] where DEFF is the design effect (for cluster surveys), d is confidence limits, p is the expected frequency of the outcome factor in the population, and N is the population size **(Yamane, 1967).**

Tools: Four tools were used for data collection.

Tool I: A structured interviewing questionnaire: Developed by researcher to assess all studied amputee's characteristics. Comprised of two parts:

Part one: Characteristics of both studied groups: included gender, education, marital status, work nature, residence and age, duration of amputation, amputation cause, amputated extremity, amputation level & walking distance.

Part two: Dependence level questionnaire: Developed by researcher to determine the extent to which patients depend on others to perform the activities of daily living. 12 questions to be done alone or with help as sitting ability on wheel chair, dressing, eating, bathing, stairs ascending and descending, flexing the trunk and returning to upright position, assistive devices may be used for help in perform any task as cane, crutch, and wheelchair.

Scoring system: Ranged from

(1-24) as 1-8 indicating poor physical ability with total dependence, from 9 to 16 indicating accepted physical ability with interdependence and from 17 to 24 indicating good physical ability with completely independence.

Tool II: Defense and Veterans pain rating scale: Numerical scale with descriptive words, coding colors and symbols, developed by **Nassif TH, Hull A, Holliday SB, Sullivan P, Sandbrink F. (2015)** to evaluate pain severity.

Scoring system: Ranged from (0-10). 0 means no pain; mild from 1 - 4 /& green, moderate from 5 - 6 /& yellow and severe from 7 – 10 /& red.

Tool III: General health scale: Adopted from **Goldberg & Williams, 1988**, for general health assessment.

Scoring system: The scale consisted of 12 questions, 6 of them asking about physical while the remaining 6 questions asking about psychological health assessment. Patients' respond take score zero indicating never, one indicating sometimes and two indicating always. Total score ranging from zero to 24 where zero to 8 reflecting poor, 9 to 16 reflecting accepted, and 17 to 24 reflecting good general health.

Tool IV: Self-reported compliance sheet. Developed by researchers to assess patient's compliance with mirror therapy & tactile discrimination training.

Scoring system: Each one of the two question'sresponse took two if patient was completely complied, one if comply to some extent andzero if not comply at all with intervention.

Tools development

All tools of the study were developed by the researchers after reviewing the recent relevant literature and used to collect data except tool II and III.

Validity

Three experts in medical surgical nursing f rom the Menoufia University Faculty of N ursing and two experts in surgical specialti es from the Menoufia University Faculty o f Medicine tested the content validity of ea ch instrument. Their opinions were elicited regarding tools format and consistency. Accordingly, the necessary adjustments we re made.

Reliability: Test retest was used to ascertain reliability of tools, the period between each test was 2 weeks and these patients were excluded from the sample. Cronbach alpha reliability values for each tool as: tool one was 0.89, tool two was 0.92; tool three was 0.88 and 97 for the fourth.

Pilot study: It was performed to test the practicality and applicability of the tools and to determine any obstacles that may be encountered during the period of data collection. It applied on 10 % of patients who excluded after that from the sample.

Ethical considerations:

The Menoufia University Faculty of Nursing's Research and Ethics Committee provided formal approval number 887 on 16/11/2022. Also, after presenting the aim of the study and the methodology of data collecting, official approval was taken from the neurological outpatient clinic's authorities. Each participant gave his consent. Participants were told that participation was optional and that they might leave at any moment, for any reason. They were informed of the aim of the study and given the assurance that the information they provided would be kept private and used solely for study completion.

Work field: 4 stages were done:

Assessment & interviewing stage:

Data were collected from neurological outpatient clinic from January 2023 to September 2023. The researchers interviewed patients and explained the study's aim and procedures. It was agreed upon to take part in this investigation. Using the tool (I), the researchers gather baseline

data of sociodemographic, medical, and amputation-related information throughout this phase of the study. Tool (II): A pain rating scale is used to measure pain. A structured interviewing questionnaire was used to collect baseline data from interviews with each patient of the two groups. This stage took ten to fifteen minutes.

Planned stage:

An illustrative colored booklet was prepared in simple Arabic language for study group as a guide, the booklet included definition, triggering factors, pain characteristics with detailed description of mirror therapy and tactile discrimination. Experts in medical surgical nursing, as well as specialists in surgery and neurology, evaluated it to ensure that the information was feasible, clear, and relevant. To create the training strategy, the researcher reviewed the more recent relevant literature.

Implementation stage:

Researchers in this stage worked in the clinic of neurology two days a week, from nine to two O'clock, using prepared equipment such as a screen and an appropriate mirror. Every patient met individually; oral instructions guided by a colorful instructional booklet outlining the intervention's theoretical framework. The practical intervention supported with video, demonstration, and re-demonstration technique. Every patient had two sessions, each lasting around thirty minutes. Two procedures made up the two sessions as the following:

Mirror therapy:

Noureen, A., Ahmad, A., Fatima, A., Siddique, K., & Abbas, Z. (2022).

- Getting the environment ready.
- Restrict external stimulants.
- Take off all of the patient's accessories from the unaffected extremity.
- Put patient in comfortable position.
- Carryout mirror therapy practice for 20-25 minutes.
- Assess the pain severity; while patient on a chair or bed.
- Expose the upper or lower extremities; place a mirror between them; allow the patient to watch the unaffected extremity in the mirror, with the stump hidden behind it; and have the patient focus entirely on applying movements repetitively on foot and hand from extension to maximum flexion of dorsal every morning and evening for five minutes. Patient should observe the reflected image of the unaffected extremity in the mirror.
- Finally, using tool (II), the researchers determine the degree of pain, respond to any question and end training when patient is able to practice alone.

Tactile discrimination training:

Chen, L., Feng, Y., Chen, B., Wang, Q., & Wei, K. (2021).

- Lying patient recumbent while focus on sensation with touch rather than looking at the stump.
- Carefully applies five different tactile discrimination stimuli to the dorsal,

lateral, frontal, and medial regions of stump.

- Five minutes each morning and evening should be spent with a stone, wood, soft brush, soft fabric, and a soft feather.
- If the patient does mirror therapy in the morning firstly before the tactile, prioritizing tactile training above mirror therapy at night, and vice versa. Then ask patients to find the tactile stimulus.

Evaluation stage:

Over the course of the 4-month intervention, researchers took a number of measurements to determine the practice's efficacy, but they only documented three of them, before intervention (initial); after 2 months to ensure patient's compliance and after 4 months. Researchers evaluate each patient's degree of dependency on everyday activities and the intensity of their pain at each stage. This stage took about twenty minutes. Comparison between both groups results finally done.

Statistical analysis

Version 26 of Statistical Package for the social Science Software (SPSS) on IBM compatible computer used for collected data to be tabulated & analyzed. $\bar{x} \pm SD$ used to express quantitative data then analyzed through student t-test and mann whiteny U test. No &% used to express qualitative data then chi-square test expresses its analysis. Fisher exact test was utilized in place of other methods if the predicted values in one or more cells in a 2x2 table were less than 5. The degree of monotonicity in a connection may be ascertained using Spearman's correlation. Each of these tests had three level: significance= P0.05, >0.05 non-significant, and 0.01 highly significant.

Results

Table (1): Distribution of both studied groups according to their socio-demographic characteristics, reveals a non-statistically significant difference in both groups' characteristics with mean age of study and control group was 48 and 49 years respectively. More than half of study and control groups (54% and 56% respectively) were depended on muscular effort in their jobs. In relation to patients' ability to walk, more than a third of study and control groups (31% and 38% respectively) weren't walk more than 50 meters.

Figure (1): Study group compliance with mirror therapy and tactile discrimination training throughout study phases, presents that after two months about two thirds (64.0%) of study group were completely complying with mirror therapy and tactile discrimination training then, the percentage elevated to 78% after 4 months with a statistically significant difference at P value 0.03.

Figure (2): **Pain severity among studied groups throughout study phases,** shows that; initially about three quarters (74%) of study group were complaining of severe pain, but the percent decreased to 54.0% and 44.0% respectively after two and four months. On the other hand, initially about two thirds (66%) of control group had severe pain then, the percentage elevated to 74% after four months with a statistically significant difference between both groups.

Figure (3): Dependence with physical activity performance level among patients of both groups throughout study phases, expresses that initially more three quarters (78%) of the study group were dependent with poor physical ability, but after two months the percent decreased to 8% then eliminated (0.00%) by four months. On the other hand, initially more than a third (38%) of control group were dependent with poor physical ability, then percentage elevated to 52% and 72.0% respectively after two and four months with a statistically significant difference between both groups.

Figure (4): Means and standard deviations of physical and psychological complaints (general health) among patients of both groups throughout the study phase, displays a noticeable reduction in study group patients' physical and psychological complaints which reflects an improvement in their general health. But sustained elevations in physical and psychological complaints which reflects deteriorated general health among control group patients were seen.

Table (2): Correlation between study group's compliance with learned practice and pain, dependence and general health after 2 & 4 months, illustrates a significant negative correlation between study group's compliance and pain level after 2and 4 months and general health after 4 months. Moreover, there is a nonsignificant negative correlation between study group's compliance and their dependence level in performing daily activities after 2 & 4 months.

Table (1) Distribution of both studied groups according to their characteristics.(n=100)

Data		Studied groups				X^2	P-Value
		Study		Control			
		No.	%	No.	%		
Age/ year ($\bar{X}$ ± SD)		48.6±12.5		49.6±11.9		0.401	0.689
Gender	♂	36	72	37	74	0.051	0.822
	♀	14	28	13	26		
Education	**Illiterate & Basic**	35	70	35	70	2.15	0.543
	Middle	9	18	7	14		
	University & above	6	12	8	16		
Marital Status	**Single**	6	12	6	12	3.6	0.308
	Married	42	84	37	74		
	Widow	2	4	5	10		
	Divorced	0	0	2	4		
Job efforts	**Muscular**	27	54	28	56	0.048	0.976
	Mental	6	12	6	12		
	Not employed / Housewife	17	34	16	32		
Residence	**Urban**	11	22	12	24	0.056	0.812
	Rural	39	78	38	76		
Affected extremity	**Upper**	19	38	12	24	2.291	0.129
	Lower	31	62	38	76		
Amputation in relation to joint	**Below**	22	44	27	54	0.64	0.317
	Above	28	56	23	46		
Amputation cause	**Malignancy**	3	6	3	6	1.59	0.901
	Gangrene	25	50	27	54		
	Trauma	16	32	13	26		
	Bone infection	2	4	2	4		
	Ischemia	4	8	5	10		
Duration of amputation	**≤ six months**	50	100	50	100	--	--
	> six months	0	0	0	0		
Ability to walk	**≤ Fifty meters**	31	62	38	76	2.29	0.129
	> Fifty meters	19	38	12	24		

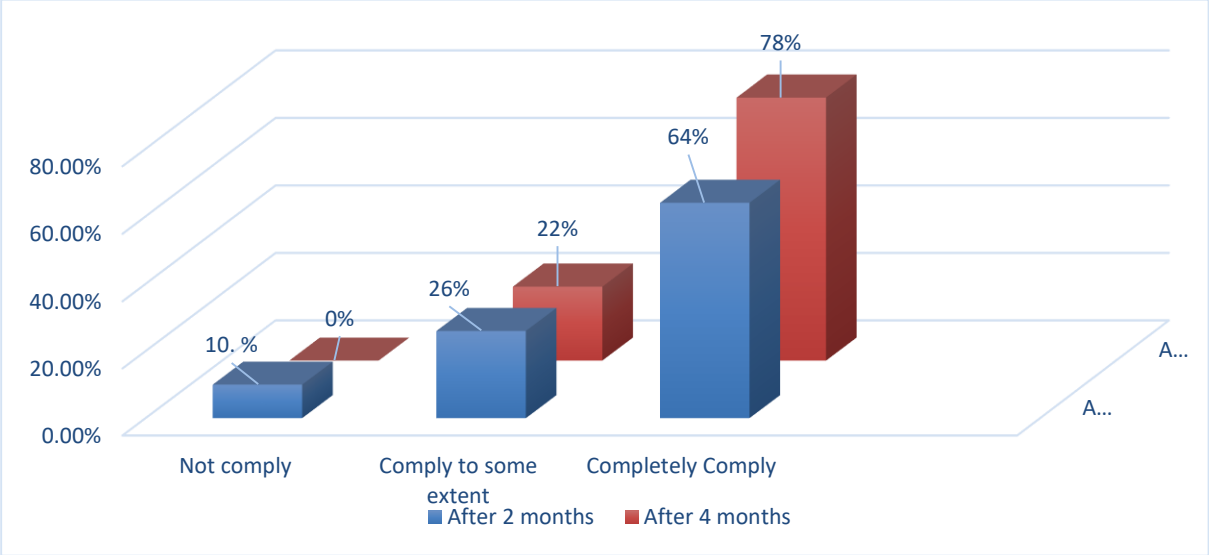

Figure (1): Study group compliance with mirror therapy and tactile discrimination training throughout study phases: (n=100)

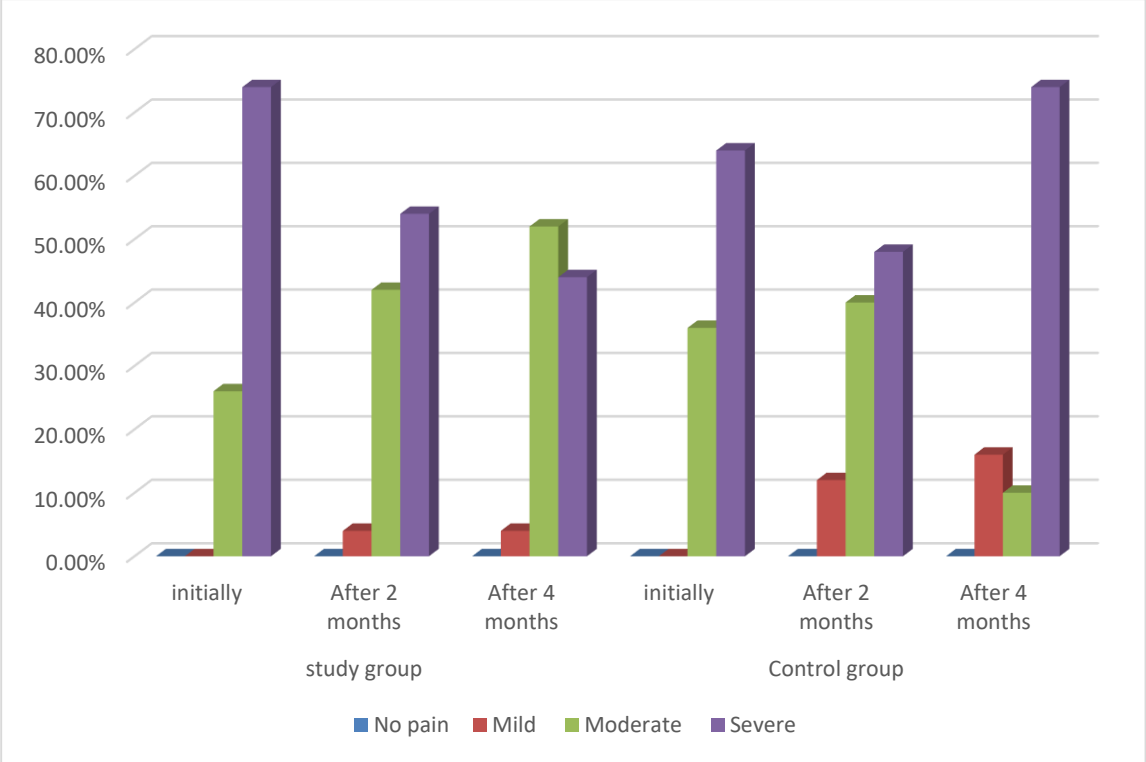

Figure (2): Pain severity among studied groups throughout study phases. (n=100)

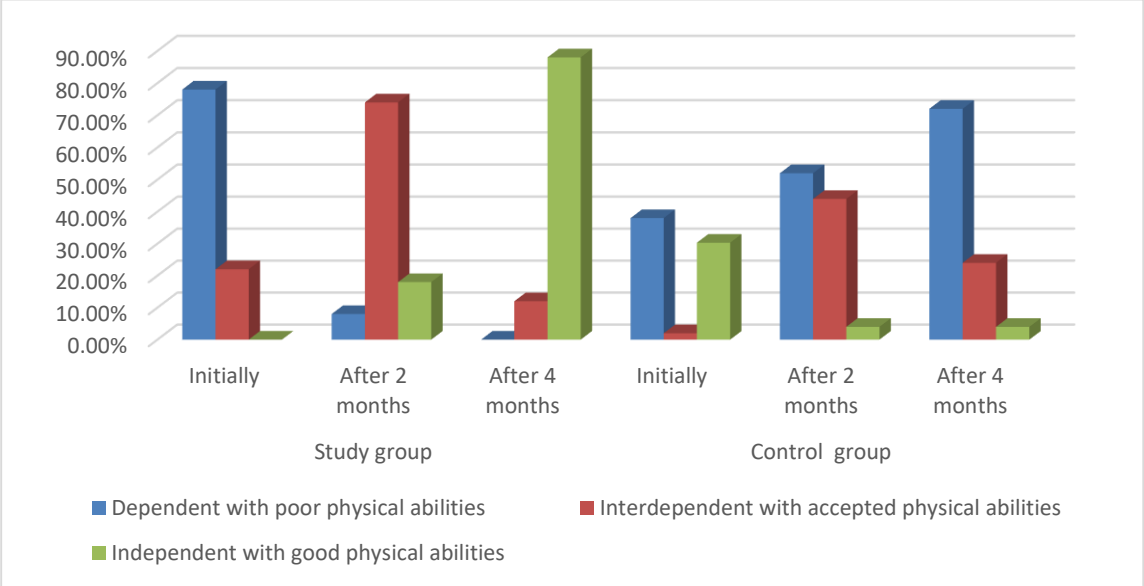

Figure (3): Dependence with physical activity performance level among patients of both groups throughout study phases: (n=100)

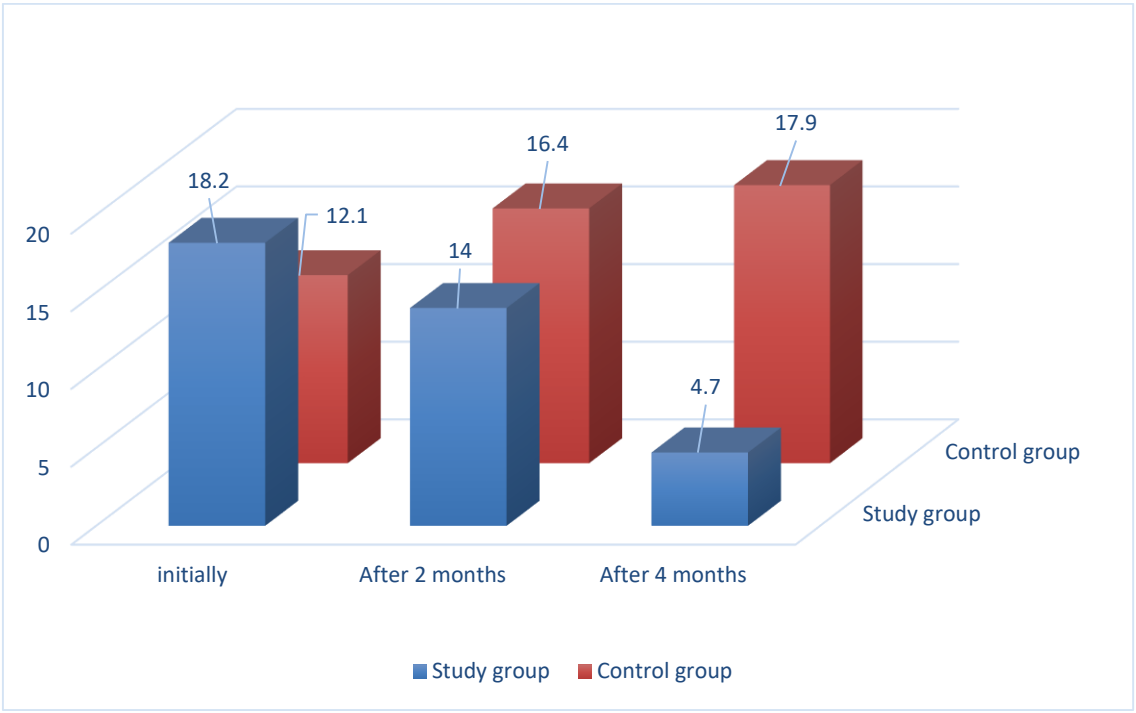

Figure (4): Means and standard deviations of physical and psychological complaints (general health) among patients of both groups throughout the study phases: (n=100)

Table (2): Correlation between study group's compliance with learned practice and pain, dependence and general health after 2 & 4 months: (n=100)

Spearman's rho			Compliance for 2 months	Compliance for 4 months
Pain	**2 months**	**R**	-0.346*	
		Sig. (2-tailed)	0.014	
	4 months	**R**		-0.507**
		Sig. (2-tailed)		0.001
General health	**2 months**	**R**	-0.138	
		p. value	0.341	
	4 months	**R**		-0.303*
		p. value		0.032
Dependance	**2 months**	**R**	-0.115	
		p. value	0.428	
	4 months	**R**		-0.184
		p. value		0.200

Discussion

There is a spread experienced by up to 80% of amputees with phantom pain and several other physical and psychosocial impairments **(Fuchs, X., Flor, H., & Bekrater-Bodmann, R., 2018)**. Current researches suggest that mirror therapy with tactile discrimination training is the first non-pharmacological choice recommended that will eliminate the physical and psychosocial patient's complaints **(Limakatso & Parker, 2021).** So, the aim of this study is to examine the effect of mirror therapy with tactile discrimination training on phantom pain and general health post amputation.

The first hypothesis was accepted because, about three quarters of study group were initially complaining severe pain, but the percent decreased after two and four months in contrast to control group. This finding was verified by a study by **Chi et al. (2019)** titled "Virtual reality for spinal cord injury-associated neuropathic pain," which approved the effectiveness of their intervention, allowing amputees to significantly reduce their pain. **From the viewpoint of researchers**, this may be related to the effectiveness of interventional training in blocking pain stimuli, so that patients regain control of their affected extremity when they see their unaffected extremity reflected picture move, making it appear as though the amputated limb **(Chi, B., Chau, B., Yeo, E., & Ta, P., 2019).**

The second hypothesis was also accepted, more three quarters of the study group were dependent with poor physical ability. The patient's functional impairment ranged from limited mobility and self-care active participation to increased fall incidence and decreased physical activity. After two and four months, the study group's performance on daily tasks gradually improves, but in comparison to the control group, the study group becomes more independent. The study "Effectiveness of Rehabilitation Nursing Protocol on Phantom Pain and Lifestyle Modification Among Patients with Lower

Limb Amputation" by **Attalla and El-Sayad (2020)** provided support for this finding by highlighting the effectiveness of intervention in reducing pain and motor impairment while also improving daily activity performance and enhancing general health. **Researchers link this back to** the patient's increased sense of empowerment as they experience less pain and better health in general following mirror therapy with tactile discrimination training **(Attalla & El-Sayad, 2020).**

Furthermore, the **third hypothesis was accepted** as the study group's general health improved and their number of physical and psychological complaints decreased as a result of receiving mirror therapy and tactile discrimination training. **Kania's 2019** study, "Massage Therapy in Amputee Rehabilitation and Care," supported this finding by showing that amputees' general health significantly improved post intervention **.**

After four months, there was a highly statistically significant negative association observed between the pain severity and the study group's compliance. The findings aligned with the research conducted by **Mallik, A. K., Pandey, S. K., Srivastava, A., Kumar, S., & Kumar, A. (2020)** in their study "Comparison of Relative Benefits of Mirror Therapy and Mental Imagery in Phantom Limb Pain in Amputee Patients at a Tertiary Care Center," which concluded that the therapy was an efficient and reasonably priced means of reducing phantom pain. **According to researchers**, this has to do with study group members adhering to mirror therapy exercises with tactile training more regularly, which lessens the intensity of pain **(Mallik et al., 2020).**

Similarly, four months following the intervention, there was a significant negative relationship between the general health of the study group and their level of compliance. In a related study, "Mirror Therapy for Phantom Limb and Stump Pain," by Ol**, H. S., Van Heng, Y., Danielsson, L., & Husum, H. (2018)** found that stump pain following trans-tibial amputations may be considerably reduced with four weeks of therapy, which also helped to lessen the accompanying physical and psychological aspects. **In the opinion of researchers**, this is because study group members followed through with regularly practiced tactile discrimination training with mirrors, which resulted in a decrease in both physical and psychological complaints, which in turn improved the overall patient's health **(Ol et al., 2018).**

Ultimately, after two and four months, there was a nonsignificant negative correlation observed between the study group's compliance and dependence degree in carrying out everyday duties. According to a study by **Aagaard**, **T. V., Moeini, S., Skou, S. T., Madsen, U. R., & Brorson, S., (2022)**, titled "Benefits and Harms of Exercise Therapy for Patients with Diabetic Foot Ulcers," patients' functional dependence on carrying out activities of daily life significantly decreased following mirror therapy and tactile discrimination training. **Researcher's opinion** indicates that, this is because the study group members followed through on regular practice sessions with tactile discrimination training, which resulted in improved general health with minimal to no pain and psychological and physical complaints, increasing their degree of independence in carrying out their daily activities **(Aagaard et al., 2022).**

Limitations

Because many study participants were depending on muscular efforts, exogenous factors as physical triggers and climate change, which may activate their phantom pain, it was assumed to minimize the significant efficacy of these uncontrolled

variables.

Conclusion

Hypotheses were accepted based on findings that explored a noticeable phantom pain reduction with general health improvements among amputees after mirror therapy with tactile discrimination training.

Recommendations

For practice:

- The appropriate simple and cheap mirror therapy with tactile discrimination training
- should be implemented among all amputees for phantom pain reduction as illustrated in the current study.
- Distribution of illustrative pamphlets among all amputees should be routinely applied.
- Replication and duplication of the study are recommended to confirm its efficacy.

For education:

- Authorized personnel should apply the phantom pain risk assessment to all amputees periodically.
- To advance nurses manual competency in mirror therapy with tactile discrimination training updating periodically should be implemented.

Acknowledgement: thanks for all help in completing this study.

References

Aagaard, T. V., Moeini, S., Skou, S. T., Madsen, U. R., & Brorson, S. (2022). Benefits and Harms of Exercise Therapy for Patients With Diabetic Foot Ulcers: A Systematic Review. Int J Low Extrem Wounds, 21(3), 219-233.https://doi.org/10.1177/1534734620954066

Abdi, S. (2022). Current understanding of phantom pain and its treatment. Pain physician, (25), e941-e957.

Attalla, H., & El-Sayad, H. E. (2020). Effectiveness of Rehabilitation Nursing Protocol on Phantom Pain and Lifestyle Modification Among Patients with Lower Limb Amputation. Biomedicine and Nursing, 6(3), 20-34.

Buch, N. S., Qerama, E., Brix Finnerup, N., & Nikolajsen, L. (2020). Neuromas and postamputation pain. Pain, 161(1), 147-155. https://doi.org/10.1097/j.pain.0000000000001705.

Chen, L., Feng, Y., Chen, B., Wang, Q., & Wei, K. (2021). Improving postural stability among people with lower-limb amputations by tactile sensory substitution. Journal of neuroengineering and rehabilitation, 18, 1-14.

Chi, B., Chau, B., Yeo, E., & Ta, P. (2019). Virtual reality for spinal cord injury-associated neuropathic pain: Systematic review. Ann Phys Rehabil Med, 62(1), 49-57. https://doi.org/10.1016/j.rehab.2018.09.006

De Nunzio, A. M., Schweisfurth, M. A., Ge, N., Falla, D., Hahne, J., Gödecke, K., . . . Farina, D. (2018). Relieving phantom limb pain with multimodal sensory-motor training. J Neural Eng, 15(6), 066022. https://doi.org/10.1088/1741-2552/aae271

Fuchs, X., Flor, H., & Bekrater-Bodmann, R. (2018). Psychological Factors Associated with Phantom Limb Pain: A Review of Recent Findings. Pain Res Manag, 2018, 5080123. https://doi.org/10.1155/2018/5080123

Goldberg, D. P., & Williams, P. (1988). A user's guide to the General Health Questionnaire. Windsor: NFER-Nelson.

Gunterstockman, B. M., Knight, A. D., Mahon, C. E., Childers, W. L., Cagle, T., Hendershot, B. D., & Farrokhi, S. (2023).

Relationship between phantom limb pain, function, and psychosocial health in individuals with lower-limb loss. Prosthet Orthot Int, 47(2), 181-188. https://doi.org/10.1097/pxr.0000000000000191

Hanyu-Deutmeyer, A. A., Cascella, M., & Varacallo, M. (2023). Phantom limb pain. In StatPearls [Internet]. StatPearls Publishing.

Kania A. (2019). Massage Therapy in Amputee Rehabilitation and Care. https://www.amputee-coalition.org/resources/massage-therapy-in-amputee

Kaur, A., & Guan, Y. (2018). Phantom limb pain: A literature review. Chin J Traumatol, 21(6), 366-368. https://doi.org/10.1016/j.cjtee.2018.04.006

Limakatso, K., & Parker, R. (2021). Treatment Recommendations for Phantom Limb Pain in People with Amputations: An Expert Consensus Delphi Study. Pm r, 13(11), 1216-1226. https://doi.org/10.1002/pmrj.12556.

Mallik, A. K., Pandey, S. K., Srivastava, A., Kumar, S., & Kumar, A. (2020). Comparison of Relative Benefits of Mirror therapy Therapy and Mental Imagery in Phantom Limb Pain in Amputee Patients at a Tertiary Care Center. Arch Rehabil Res Clin Transl, 2(4), 100081. https://doi.org/10.1016/j.arrct.2020.100081.

Nassif TH, Hull A, Holliday SB, Sullivan P, Sandbrink F. (2015). Concurrent Validity of The Defense and Veterans Pain Rating Scale In VA Outpatients. Pain Medicine. 2015 Nov 1;16(11):2152-61. DOI: 10.1111/Pme.12866.

Noureen, A., Ahmad, A., Fatima, A., Siddique, K., & Abbas, Z. (2022). Effects of routine physical therapy with and without mirror therapy on phantom limb pain and psychosocial adjustment to amputation among prosthetic users. Physiotherapy Quarterly, 30(2), 8-14.

Ol, H. S., Van Heng, Y., Danielsson, L., & Husum, H. (2018). Mirror therapy therapy for phantom limb and stump pain: a randomized controlled clinical trial in landmine amputees in Cambodia. Scand J Pain, 18(4), 603-610. https://doi.org/10.1515/sjpain-2018-0042

S**turma, A., Hruby, L., Vujaklija, I., Østlie, K., & Farina, D.** (2021). Treatment strategies for phantom limb pain. Bionic Limb Reconstruction, 113-124.

Wakolbinger, R., Diers, M., Hruby, L. A., Sturma, A., & Aszmann, O. C. (2018). Home-Based Tactile Discrimination Training Reduces Phantom Limb Pain. Pain Pract, 18(6), 709-715. https://doi.org/10.1111/papr.12657.

Wang, F., Zhang, R., Zhang, J., Li, D., Wang, Y., Yang, Y. H., & Wei, Q. (2021). Effects of mirror therapy on phantom limb sensation and phantom limb pain in amputees: A systematic review and meta-analysis of randomized controlled trials. Clinical Rehabilitation, 35(12), 1710-1721.

Yamane, T. (1967). Research methods: determination of sample size. University of Florida, IFAS Extension.