

# Mirror therapy and phantom sensations - a case study

( Terapia lustrzana a wrażenia fantomowe - studium przypadku )

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**Abstract** – Introduction. Phantom sensations are associated with feeling of presence of amputated limb. Scientifically defined as specific sensory or kinesthetic sensations related to the missing limb. Phantom sensations are perceived by majority of amputees. Phantom pain occurs in 50% of patients and appear within six months after amputation and last for several years.

The aim of the study. The aim of this casuistic study was to evaluate the effectiveness of mirror therapy in eliminating phantom sensations in 54-year-old patient after traumatic amputation of the left lower limb.

Methods. A self-designed, previously published questionnaire evaluating the occurrence, character and intensity of phantom sensations was carried out. Patient underwent a six-week therapy during which he stimulated the limb using a specially designed mirror and appropriate equipment. He wrote a journal in which he subjectively assessed the variability of perceived phantom sensations before and after each session. After the therapy, a questionnaire was performed once again to evaluate the effectiveness of mirror therapy.

Results. As a result of the mirror therapy, in the patient's subjective assessment, the pain decreased by 40% and its severity changed from medium to mild. Before the therapy, pain appeared often, after treatment was rare. The phantom limb became complete and reached the natural length.

Conclusions. Positive effects of therapy encourage to further research and introduction mirror therapy into treatment of amputees experiencing phantom sensations.

**Key words** - amputation, phantom limb sensation, phantom limb pain, mirror therapy.

**Streszczenie** – Doznania fantomowe fachowo określane są jako specyficzne odczucia sensoryczne lub kinestetyczne odnoszące się do brakującej kończyny. Postrzega je większość osób po amputacji. Ich rodzajem są bóle fantomowe, pojawiające się najczęściej 6 miesięcy po amputacji i trwające u około 50% pacjentów nawet kilka lat.

Cel pracy. Celem pracy kazuistycznej była ocena efektywności terapii lustrzanej w eliminowaniu wrażeń fantomowych u 54-letniego pacjenta, po amputacji urazowej lewej kończyny dolnej.

Metody. Przed i po 6-tygodniowej terapii przeprowadzono badanie autorskim kwestionariuszem do oceny występowania, charakteru i nasilenia wrażeń fantomowych. Podczas interwencji pacjent stymulował kończynę przy użyciu specjalnie zaprojektowanego lustra i odpowiednich przyrządów. Prowadził dziennik przebiegu terapii, w którym przed i po każdej sesji, subiektywnie oceniał zmienność odczuwanych wrażeń fantomowych.

Wyniki. W wyniku zastosowanej terapii lustrzanej, w subiektywnej ocenie pacjenta, ból zmniejszył się o 40%, a jego nasilenie zmieniło się ze średniego na łagodne. Przed terapią ból pojawiał się często, po interwencji rzadko. Fantom stał się kompletny oraz zbliżył się do naturalnej długości.

Wnioski. Pozytywne efekty terapii zachęcają do dalszych badań i wprowadzania terapii lustrzanej do leczenia osób po amputacji, zgłaszających wrażenia fantomowe.

**Słowa kluczowe** – amputacja, wrażenia fantomowe, doznania fantomowe, ból fantomowy, terapia lustrzana.

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## Authors' contributions to the article:

- A. The idea and the planning of the study
- B. Gathering and listing data
- C. The data analysis and interpretation
- D. Writing the article
- E. Critical review of the article
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**I. INTRODUCTION**

Phantom limb sensation (PLS) is the sense of the presence of an amputated limb and the specific sensory, kinaesthetic sensations related to the missing limb (Table 1). They are perceived by most people after amputation [1] and appear spontaneously or are induced by sensory stimuli from existing body parts [2].

Table 1. Examples of phantom sensations [3]

Sensory sensations	Kinesthetic sensations
feeling warm or cold, itching, tingling, electrical sensations.	phantom limb movement (PLM).

Amputation is associated with pain of various origins, e.g. stump pain and pain felt in the area of the lost limb - phantom limb pain (PLP) [4]. These various types of pain and phantom sensations may coexist and are referred to as phantom sensations [1].

Phantom pain occur in 50% of patients, appear within 6 months after amputation and last for several years [5,6]. They occur more often after upper limb amputation and are more common in women [7]. There are two peak periods in which patients experience PLP: one month and one year after amputation [8]. When phantom pain become chronic, it affects the quality of life and limits the functional possibilities.

The pathophysiology of phantom pain is not yet known. It is speculated that the central and peripheral nervous system play an important role in it [9-11]. The leading theory of PLP pathophysiology is cortical reorganization. Neuroplastic changes in the cortical map after limb amputation are most likely associated with the loss of receptors responsible for providing afferent information and the loss of the motor response generating effect [12].

There are various therapeutic methods for painful phantom sensations: pharmacological and non-pharmacological (Table 2).

Table 2. Pharmacological and non-pharmacological interventions used to treat painful phantom sensations [11]

Pharmacology	Non-pharmacological interventions
gabapenton, amitriptyline, tricyclic antidepressants, morphine based reparations, ketamine.	percutaneous electrical nerve stimulation, transcranial magnetic stimulation, spinal cord stimulation, use of dentures, hypnosis, acupuncture, mirror therapy.

Mirror therapy (MT) uses the mirror reflection of an intact limb and its volitional movements to create the illusion of painless position and movement in a phantom limb.

The aim of the case study was to assess the effectiveness of 6-week mirror therapy in a patient after limb amputation with accompanying pain and phantom sensations.

*Methods*

Research team used self-developed "Questionnaire for the assessment of phantom sensations after limb amputation" [13], evaluating the occurrence and characteristics of phantom sensations. The questionnaire consists of 8 sections, from A to H (Table 3). This tool allows, among other things, to verify whether the patient is accompanied by phantom sensations and what is their intensity (Tab. 3). The questionnaire was filled in by the physiotherapist during the conversation with the patient. For everyday pain assessment, the Visual Analogue Scale (VAS) was used, in which 0 means no pain at all and 10 is the strongest pain that can be imagined.

Table 3. Construction of the "Questionnaire for the assessment of phantom sensations after limb amputation" [13]

Section	Content	Details
A	sociodemographic data	gender, age, occupation, employment status, coexisting diseases, housing conditions
B	amputation history	cause and level of amputation
C	course of stump healing	complications, type of bandaging
D	pain before amputation	location, severity, aggravating factors
E	prosthesis	type of suspension of the socket, pain when wearing a prosthesis, frequency of wearing a prosthesis
F	stump pain	severity, aggravating factors
G	phantom sensations	situations in which they occur, length, shape, completeness of phantom limb
H	phantom pain	location, severity, situations in which it occurs

## II. ORGANISATION AND CONDUCT OF THE SURVEY

Patient was qualified to research project no. K/ZDS/006155, approved by the Bioethical Committee of the Jagiellonian University in Krakow in January 2019. Based on the results of the questionnaire, in February 2019, he was qualified for a 6-week MT, which took place at the patient's home. He was trained in the use of mirrors and therapy aids. The therapy was supervised by a member of the research team, who was responsible for weekly telephone contact with the patient, inquiring about his health condition and the course of therapy.

Basic tool for MT was a special long mirror for lower limb therapy, designed by the research team. Its length exceeded the length of the non-amputated limb (Figure 1). The additional equipment of the mirror was a screen covering the stump view from the patient's perspective. The ability to adjust the angle of inclination of the mirror allowed to set the device in such a way that the image visible in the reflection gives the actual illusion of the existence of a complete limb in its correct position. For the patient in question the angle of inclination was  $10^\circ$ .

During the therapy the patient was in a comfortable, sitting position with an unamputated lower limb exposed and the mirror was positioned in front of him in the sagittal plane. The therapy took place in an isolated room. Therapy sessions took place every 2 days, in the afternoons or evenings and lasted 15-20 minutes. Before and after each session the patient filled in the "Therapy Diary", in which he defined the appearance of phantom limbs, the occurrence and severity of stump pain and phantom pain.



Figure 1. Therapeutic mirror for lower limb MT

The first therapeutic sessions consisted of observing the reflection of a limb in a mirror. The next sessions consisted

in stimulating the limb with a massage (stroking, kneading), free exercises (bending - straightening fingers, ankle, knee) and touching the mirror surface with the foot. The next stage was the exercise and stimulation of the limb with instruments (Figure 2). In case of burning or cooling, thermal compresses were used with the possibility to heat or cool limb down.



Figure 2 Mirror therapy equipment

After the end of the 6-week mirror therapy, the patient was reassessed with a questionnaire.

## III. CASE REPORT

The study included a 54-year-old patient who was a driver and a construction worker. As a result of an accident at work, the left lower leg was damaged. In November 2018, it was decided to amputate the left lower leg below the knee. As a result of infection of the postoperative wound with *Staphylococcus aureus* bacterium and the deterioration of the patient's condition, the amputation was performed above the knee.

Before and during the examination, the man was not involved in the process of prostheticisation of the amputated limb. He was examined right-handed and right-legged, with right-sided ocular lateralization. He suffered from arterial hypertension and depression.

#### IV. PHANTOM IMPRESSIONS BEFORE MIRROR THERAPY

During the interview, the man reported severe stump pain (VAS 7), which was related to the weather change and occurred particularly in the afternoon and evening.

He confirmed the feeling of phantom limb presence all the time, regardless of the time of day, in such situations as: resting, stump touching, stump bandaging and during movement. The phantom limb was not identical to the other limb - it was shorter, incomplete (the patient felt no knee while feeling part of the and foot), it was not deformed. The lack of knee sensation clearly made it difficult for him to perform everyday activities and disturbed his movement. The patient was able to move it consciously and noticed that it sometimes moved on its own, against its own will.

Phantom pain often occurred at the site of an amputated calf and was rated 5 in the VAS. He described it as impulsive and felt it: tingling, itching, pinching, "as if a electric current was flowing" and crushing. It was not connected with the time of day, but it was present during such situations as: rest, touch of the stump, bandaging of the stump and especially in the place where the primary amputation was performed.

#### V. PHANTOM IMPRESSIONS AFTER MIRROR THERAPY

The pain in the stump decreased, the severity was assessed as mild (VAS 3) and occurred mainly in the evening. It intensified after exercises performed in the evening, with a change in the weather and as a result of intensive physical activity (longer time of moving on crutches and in a wheelchair on uneven terrain).

Phantom pain was related to the toe area, it was intermittent, impulsive, described as: tingling, stabbing, "as if a electrical current was flowing", "as if needle poking", crushing, of mild intensity. It occurred rarely and independently of the time of day (it increased during washing with hot water). After the mirror therapy, PLP was no longer present while touching the stump, with a bandaged stump, or during movement.

During and after MT the phantom limb became complete, the man started to feel that he "has" a knee. It was identical to the other limb, naturally arranged and about 10 cm shorter. The "regained" knee, "disappeared" only while performing the exercises in front of the mirror and "ap-

peared" afterwards. The patient was able to move the phantom limb on his own, e.g. during seating he could make side-to-side knee movements (knee straightening impossible), and while standing he could bend and straighten the phantom lower limb. This limb also moved by itself, against his will.

#### VI. DISCUSSION

During the therapy, using a mirror image of the preserved limb, the patient experiences an imaginary movement of the amputated limb. MT helps to reorganize and integrate the disturbed body scheme between proprioception and visualization of the missing part of the limb. The clinical effect of MT is more significant compared to other forms of treatment [10, 14].

The effectiveness of MT among patients with phantom pain has encouraged researchers to use it in other diseases: stroke, complex regional pain syndrome (CRPS) and other upper and lower limb pain syndromes [15-17].

Many studies demonstrate that MT is effective only in PLP after upper limb amputation or when the pain is severe to control [14]. In the above study, the intensity and incidence of PLP in the patient after lower limb amputation was reduced.

According to Schwarzer *et al.*, the overriding principle is the painlessness of the therapy and avoidance of providing the patient with unpleasant feelings related to the training [18]. In our own observation, positive effects related to interruption of training when pain or other unpleasant sensations appear were observed compared to continuation of the therapy session in the above mentioned cases. After the first week of therapy it was agreed that the therapy session should not exceed 20 minutes and training should be interrupted when the pain occurs.

Positive effects of MT may contribute to its inclusion in the standard treatment programme of PLP patients due to the simplicity of its application both: at home or in hospital, by the patient himself or physiotherapist

#### VII. CONCLUSIONS

When asked about his general conclusions on MT, the respondent found that stump and phantom limb pain decreased by about 40% (from 7 to 3; VAS scale) and did not occur as often as before the therapy. During the first days

of therapy the patient noticed a better mood, strong motivation to observe the reflection of the lower limb in the mirror and imagining that has two limbs of the same length. The family noticed that his well-being has significantly improved

The pain, which was initially particularly disturbing at night, did not become so severe at this time of day. In the 3rd week of therapy, the man noticed that exercises performed in the evening significantly intensify the pain. The research team decided to do the exercises before noon, which resulted in the reduction of the pain that occurred immediately after the end of the therapy session. Exercises lasting more than 20 minutes also exacerbated the pain, so the patient did not exceed this time.

The participant of the study paid special attention to the usefulness of the devices used during MT. The most useful where those with the highest degree of hardness (e.g. a wooden roller with spikes), which stimulated the limb the most strongly.

Among the factors that intensified the pain during the therapy, the examined included: change in the weather, increased physical activity, contact with hot water and nervousness. Mitigating factors included: well-being, regular mirror therapy (no longer than 20 minutes).

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