PAMELA

Evidence based guidelines for
Physical Medicine and Rehabilitation interventions
for the management of Phantom Limb Pain

Learning Objectives

1. Mirror therapy
2. (Graded) motor imagery
3. Prosthesis usage / Use of a functional prosthesis
4. Exercise / phantom exercise training
5. Sensory discrimination training
6. Virtual reality / Augmented reality
7. Biofeedback training
8. Additional recommendations

Introduction

The use of non-pharmacological and non-invasive treatment methods for phantom limb pain (PLP) after amputation is an essential element of pain therapy. Its primary position in the therapeutic setting results from patients high acceptance, low side effects and the possibility of implementing self-effective active analgesic strategies.

- Procedures from the field of Physical Medicine and Rehabilitation (PM&R) have limited scientific evidence in terms of their analgesic efficacy.
- Evidence for pharmacological treatments also remains limited

This teaching module presents commonly used methods, summarizing current literature and providing practical recommendations for clinical use.

- **Target audience:** physicians across disciplines in outpatient and primary care settings in Ukraine.
- **Focus is on** accessible, feasible interventions; highly specialized or experimental techniques are excluded.
- **Aim:** provide practical, user-oriented guidance tailored to clinical context and available resources for PLP management.

Methodology

The treatment recommendation is based on a systematic literature analysis, which determines the respective evidence level (1-5) of the treatment options.

Existing guidelines, systematic reviews, and randomized controlled trials (RCTs) were prioritized; no further search was conducted for already well-established methods.

Studies with low external evidence (< level 2) were excluded.

Step 1: Review and critical appraisal of national and international PLP guidelines, followed by preliminary treatment recommendations.

Step 2: Analysis of high-quality systematic reviews and meta-analyses (from Cochrane Library).

Step 3: Database search (PubMed, PEDro) for additional systematic reviews; results were screened for relevance.

Step 4: Targeted search for RCTs

Step 5: Final screening and analysis by experienced clinicians to develop practice-oriented treatment recommendations.

Mirror therapy

Mirror therapy (MT), which was proposed in the early 1990s as a treatment for PLP, is easy and economical. A mirror is used to view the reflection of the uninjured side of the body. The result is an illusion of increased function or reduced pain in the missing body part. A mirror is placed in a box in front of the body so that the amputee can only see the contralateral limb as well as the reflection of this limb, and then some exercises or movements are performed. It is assumed that MT enhances the coherence between motor impulsion and sensory feedback, thus reducing the deleterious cortical reorganization and removing the pain directly. MT is also used in the treatment of other disorders, such as complex regional pain syndrome and strokes. [1]

Studies show....

- significant beneficial effects of MT in pain reduction for patients with PLP [2-5]; except for one study [6]
- MT is optimal treatment for PLP [2]

MIRROR THERAPY IS RECOMMENDED AS A PROVEN ANALGESICALLY EFFECTIVE FORM OF THERAPY. THE THERAPEUTIC EFFECT CAN BE INCREASED BY COMBINING IT WITH OTHER TREATMENTS.

(Graded) motor imagery

GMI is a therapy carried out in three ascending phases, which are divided into i) lateralization exercises, ii) explicit motor imagery and iii) mirror therapy. It is used for cortical reorganization in the case of a hypothetical imbalance between sensory, motor and visual perceptions that can lead to PLP. In the 1st phase, left-right distinctions are made on images of the amputee (lateralization exercises). In the 2nd phase, an imaginary exercise of the missing limb is carried out using explicit motor imagery. In the third phase, mirror therapy is carried out, where a mirror is positioned so that the complete contralateral limb is mirrored to the amputee and the amputated limb cannot be seen. The amputee receives the visual information that both limbs can be moved without pain. All phases should build on each other and allow the learning and reorganization process to progress. [7, 8]

Studies show....

- that GMI effectively reduces PLP and is significantly superior to standard treatment using individual physiotherapy. [9]
- that GMI could be effective in reducing PLP [10]

AS PART OF GRADED MOTOR IMAGERY, MIRROR THERAPY CAN ALSO BE APPLIED USING LATERALIZATION EXERCISES AND MOTOR IMAGERY PROCEDURES IN A GRADED LEARNING AND REORGANIZATION PROCESS. THIS MAY BE INDICATED, FOR EXAMPLE, IF THE AMPUTEE HAS INSUFFICIENT VISUALIZATION SKILLS OR IF RE-TRAUMATIZING FLASHBACKS OCCUR IN THE CASE OF PTSD.

Prosthesis usage / Use of a functional prosthesis

In the current German guideline on rehabilitation after major amputation of the lower extremity, the use of a prosthesis is explicitly recommended for the treatment of chronic PLP. It is pointed out, that the amputee should be fitted with a prosthesis and mobilized as soon as possible.

Studies show...

- that amputees with active use of functional arm prostheses ("Sauerbruch-arm") have significantly lower levels of phantom pain [11, 12] - the results are questionable in their significance due to methodological deficiencies.
- that PLP was associated with dissatisfaction with the prosthesis. [13]
- that the frequency of prosthesis use was significantly related to the absence of PLP; higher prosthesis ownership (defined as the extent to which a prosthesis is experienced as being part of the body rather than an artificial device foreign to the body) was associated with lower PLP. [14]

No RCTs or systematic analyses on this topic available.

FROM A SCIENTIFIC POINT OF VIEW ONLY A LIMITED RECOMMENDATION DUE TO THE LACK OF HIGH QUALITY STUDIES CAN BE GIVEN.

Exercise / phantom exercise training

In phantom exercises, the imaginary movement of the phantom limbs is combined in the central nervous system with the execution of certain actual physical movements. The neurophysiological network, involved here, is similar to that of actual physical activities of healthy limbs.

Studies show...

- that 4 weeks of phantom exercises are more effective than 4 weeks of training therapy (both groups also received prosthesis training) in reducing pain. [15]
- that phantom exercise training added to standard of care (including mirror therapy and physiotherapy) reduced pain after 4 weeks of training. [16]

No guidelines, reviews or systematic meta-analyses of this form of therapy available.

PHANTOM EXERCISES CAN BE RECOMMENDED WITH RESTRICTIONS, BUT ROBUST DATA WITH LARGER CASE NUMBERS SPECIFICALLY FOR CHRONIC PLP ARE LACKING.

Sensory discrimination training

In sensory discrimination training, the patient is given a specific, defined and controlled stimulus. The patient is then asked to judge an aspect of the stimulus (e.g. the location) and is then given feedback on the accuracy of their judgement. [17, 18].

It has been shown...

- that studies on sensory discrimination training are rare (one systematic review [19], two RCTs [18, 20])
- that the quality of the available studies is low

NO RECOMMENDATION FOR SENSORY DISCRIMINATION TRAINING CAN BE MADE DUE TO THE LOW QUALITY OF THE STUDIES, THE LOW NUMBER OF PARTICIPANTS AND THE HIGH RISK OF BIAS.

Virtual reality / Augmented reality

The concept of virtual reality (VR) describes a computer-generated, interactive virtual environment. VR completely surrounds the user so that physical reality is largely hidden. The combination of VR and physical reality - for example, when digital elements are inserted into the real world using special goggles - is described as mixed reality (AR). [21] In the treatment of patients with PLP, various methods are used for visual imagination of the missing limb. Virtual motor tasks can be visualized via an interface on the remaining muscles on the residual limb, but tactile stimuli can also be transmitted using innovative prosthesis technology in order to optimize the exchange of information between the CNS and residual limb and thus contribute to a reduction in PLP. The innovative technical possibilities are being intensively evaluated and promising therapeutic approaches have been explored in mostly small case (series) studies.

Studies ...

- showed a reduction of PLP reduction after VR/AR application [22-27] but exhibit low sample sizes, high methodological heterogeneity, lack of control interventions and limited conclusions about the evidence.
- with a higher methodological quality (RCTs [28, 29]) although describe controversial results and showed no significant superiority to the control intervention (Sham-VR)

RECOMMENDATIONS FOR VIRTUAL/AUGMENTED REALTY CAN ONLY BE MADE TO A LIMITED EXTENT DUE TO A LACK OF METHODOLOGICALLY HIGH-QUALITY COMPARATIVE STUDIES.

Biofeedback training

Biofeedback training is used for sensory feedback by performing phantom movements and usually involves visual or tactile information. This information can be transmitted via different interfaces such as a screen or directly via the contact surface of the prosthesis. The aim is to equalize the sensorimotor incongruence between motor intention and proprioceptive feedback and to approximate the original physiological processes despite the missing limb part. This balancing of information is intended to counteract maladaptive plasticity by inducing somatosensory plasticity, reduce PLP and optimize compensatory movement patterns of the muscles.

Studies show...

- significant beneficial effects of biofeedback devices in terms of pain reduction using visual analogue scale for patients with PLP. [30-35]

DUE TO THE LOW LEVEL OF EVIDENCE, RESULTS ONLY PROVIDE INDICATIONS OF AN EFFECT OF BIOFEEDBACK TRAINING ON PLP, BUT THIS STILL NEEDS TO BE CONFIRMED IN RCTS.

Additional recommendations 1

- Physiotherapy improves function, deconditioning, activity, protects against immobilisation-related sequelae and increases embodiment

- The lack of RCTs can probably be explained by the methodological barriers; a control group design would be unethical.

Additional recommendations 2

- Occupational therapy increases the ability to act, body awareness, the practice of activities of daily living and consequently participation.

- Self-efficacy and independence has strong effects on the perception of pain. Unfortunately, we do not have any studies of the effectiveness on PLP.

Additional recommendations 3

- Testing of simple procedures with few side effects and high acceptance, such as TENS, action observation, biofeedback training, relaxation and massage, which are effective in chronic pain conditions.

- The use of (functional) prosthesis to improve function increases embodiment and, secondarily, an improvement in the body's own pain defense mechanisms can be assumed. Unfortunately, meaningful studies are also lacking here.

Remarks

In summary, there is a great need for methodologically high-quality clinical RCTs that evaluate methods for the treatment of PLP. There are numerous reasons why methodological and ethical/moral barriers make it difficult to conduct this type of study. A lack of comparable control interventions, sufficiently comparable study participants and high heterogeneity of the population to be analyzed as well as the great methodological diversity of innovative approaches ultimately lead to a lack of high-quality RCTs. Resulting systematic analyses are hardly possible due to these facts. It should be noted that, in particular, basal forms of therapy that, in addition to the targeted treatment of PLP, also include general mobility, the avoidance of immobilization-related deconditioning and its extensive consequences, such as physiotherapy, cannot be denied to a control group for ethical reasons. Innovative methodological ideas and evaluation methods with which this range of therapies can be tested are crucial here.

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For more information: Consult the complete guideline