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Interventions used by occupational therapy in the treatment of amputees with phantom limb: an integrative review

Intervenções utilizadas pela terapia ocupacional no tratamento de pessoas amputadas com membro fantasma: uma revisão integrativa

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ABSTRACT
Introduction: The phantom limb phenomenon is defined as the experience of having a missing organ responsible for generating sensations or pain, giving the perception that it is present. This condition involves physical, social and psychological alterations. Thus, the amputee needs multidisciplinary follow-up, which includes occupational therapists. This work aims to investigate the intervention strategies used by Occupational Therapy in the treatment of amputees with phantom limbs. Methodology: This is an integrative literature review. The bibliographic searches were carried out in the Embase and Scopus databases. To broaden the selection of references, the search extended to materials indexed in *Google Scholar*. Results: The final sample was composed of 54 papers, published between 2012 and 2022, and of these, only four papers were also conducted by occupational therapists. The country that most conducted studies regarding the theme of amputees with phantom limbs was the United States (25.9%). However, in Brazil no intervention study was found in the area. Discussion: The interventions performed by Occupational Therapy were: stump lining (Farabloc); prosthesis glove with sensory *feedback*; graded motor imagery associated with mental imagery and mirror therapy; and acupuncture. Conclusion: In the data analysis it was possible to notice the disparity of research focus, between those that involve and those that do not involve occupational therapists, since, in Occupational Therapy research, interventions go beyond the ideal of relieving or eliminating pain, aiming also to improve functional capacity, occupational performance and quality of life.

Keywords: Phantom limb, Occupational therapy, Amputees, Interventions.

1 INTRODUCTION

The phantom limb phenomenon is the experience of having an absent organ responsible for generating sensations or pain, giving the perception that it is present (DEMIDOFF *et al.*, 2007). In the 16th century, the surgeon Ambroise Paré (1510-1590) was convinced that the phantom limb expressed and validated the perpetuation of the human soul, even if matter was broken.

The phantom limb can trigger both sensations and phantom pain. Regarding painless sensations, they are more frequent and are divided into three types: kinesthetic (length, posture and volume); kinesthetic (spontaneous and voluntary movements); and exteroceptive (sensation of pressure, itching, temperature or touch) (ALMEIDA, 2020). Most amputee individuals (33% to 85%) experience pain, sometimes intense and persistent (5 to 10%) (LIMAKATSO *et al.*, 2019; KUFFLER, 2018).

In this sense, people who undergo the process of amputation suffer many changes in their lives, such as the perception of their body image. This image is the mental representation of the physical body, built according to the experiences of each person and represented by the way people perceive themselves in the world (SILVA, 2013). Besides body image, there is the body schema, which corresponds to the neurological structure responsible for generating proprioceptive information through our experiences with the external world. On the other hand, body image is linked to the affective experience that the subject develops with his/her body (FRANCO, 2005; NESSIMIAN & GOMES, 2022).

It is understood, then, that the phantom limb is understood as the brain's failure to adapt to the new body image or the expression of an attempt at body reintegration. This occurs because there is a mapping of the body in the cerebral cortex known as Penfield's Homunculus (SILVA, 2013). It is pointed out that there are two homunculi, one sensory and one motor, in each cerebral hemisphere. Therefore, the amputated area has a representation in the parietal lobe of the brain, in its post-central gyrus and this makes it difficult to interrupt the sensation of the amputated limb (DE BENEDETTO *et al.*, 2002; DI NOTO *et al.*, 2013; SOUZA *et al.*, 2016).

According to Quadros (2010), the explanations that justify the existence of phantom limb are divided into three categories: peripheral, spinal, and central (QUADROS, 2010). The peripheral theory states that the cause of phantom limb pain is associated with irritation of the nerve endings near the stump. The nerves remaining in the residual limb form neuromas, with alterations in the electrical properties in their membranes, increasing the sensitivity of cytokine and amine receptors, amplifying the nociceptive process. The spinal theory attributes the fact to the increased activity of peripheral nociceptors, awakening synaptic changes in the neurons of the dorsal horn of the spinal cord (MACHADO, 2008).

In another conception, the core theory reinforces Melzac's (1990) concept of the neuromatrix, where the body is represented in the encephalon by a matrix of neurons. It is created from lived sensory experiences, generating "neural signals" from the body in the brain. Melzac argues that phantom sensation is the continuation of neural signals, even in the absence of the structure. Phantom pain, on the other hand, would be the result of poor reorganization of the neuromatrix (QUADROS, 2010).

In general, the phantom limb phenomenon involves physical, social and psychological alterations. Thus, the person needs a multidisciplinary follow-up with a team formed by physician(s), physical therapist, occupational therapist, psychologist, nutritionist, social worker, physical education professionals and prosthetist (DE BENEDETTO *et al*., 2002).

Considering that the rupture of a limb is a great loss that generates denial, anger, guilt, impotence, and finally, adaptation. Therefore, it is important that the treatment of trauma is also carried out by the occupational therapist, for his practice enables the mediation and facilitation of the construction of the new body image, of the function, of the increase in well-being and quality of life, of the organization of the routine, of adaptations for the performance of ADLs, and of the social participation of the individual in his social environment.

Therefore, considering that the work of occupational therapists also involves the conditions of amputation and the phantom limb, it is worth emphasizing the importance of the knowledge and study of the varieties of techniques, strategies and interventions for the treatment of pain and/or of this phenomenon. Thus, this work will present the possibilities of intervention used in this treatment, deepening the therapeutic practices used by occupational therapists in this scenario.

2 METHODOLOGY

This is an Integrative Literature Review, which sought to expose articles that present the interventions adopted to treat amputees with phantom limb. Through critical analysis, it was possible to identify which therapies were being used in general and which were also being practiced by occupational therapists.

In the initial stage, the following guiding question was defined: What are the treatment strategies also used by Occupational Therapy for amputees with phantom limb? Subsequently, the bibliographies were searched from April 3, 2022 to April 4 of the same year in the following databases: EMBASE and SCOPUS. To broaden the selection of references, the searches were extended to the academic materials indexed in *Google Scholar*. To this end, the following descriptors present in the Descriptors in Health Sciences (DeCS/MeSH) and their synonyms in singular and plural were used: *"phantom limb", "phantom pain", "phantom sensation", "amputees", "amputation", "limb amputation", "Occupational Therapy", "occupational therapists", "occupation", "treatment", "intervention", "rehabilitation", "therapy",* *"biopsychosocial factors", "biopsychosocial", "activity of daily living (ADL)", "biopsychosocial model", "quality of life", "acupuncture", "auriculotherapy", "mirror therapy", "desensitization".*

The above descriptors were cross-referenced using the Boolean operators AND and OR, but the search strategies were different for each database, since they have search fields with distinct specificities.

As for the inclusion criteria, the following were established: studies published in English, Spanish, and Portuguese; studies published in the last 10 years; studies that include interventions and forms of treatment for amputees with phantom sensation and/or pain; studies carried out in humans with amputated upper and/or lower limbs. For exclusion, the following criteria were adopted: literature review articles; articles with texts that were not available in their entirety; studies that did not deal with phantom pain and/or sensation in amputated limbs; studies with the use of electrostimulation resources, with no other intervention of interest to the study; studies with surgical interventions; pharmacological interventions, with no other intervention of interest to the study. To minimize or eliminate biases, the evaluation and selection of titles and abstracts was done by two reviewers (CM) and (AC), and in cases of disagreement, a third researcher was involved (CG).

After searching the articles, they were exported to an *online* tool called "*Rayyan - Intelligent Systematic Review*" in order to exclude duplicate articles in an automated way. Then, the studies were included or excluded in this platform by reading the titles and abstracts, and then the search was performed for the studies designated for reading in full (OUZZANI *et al*., 2016).

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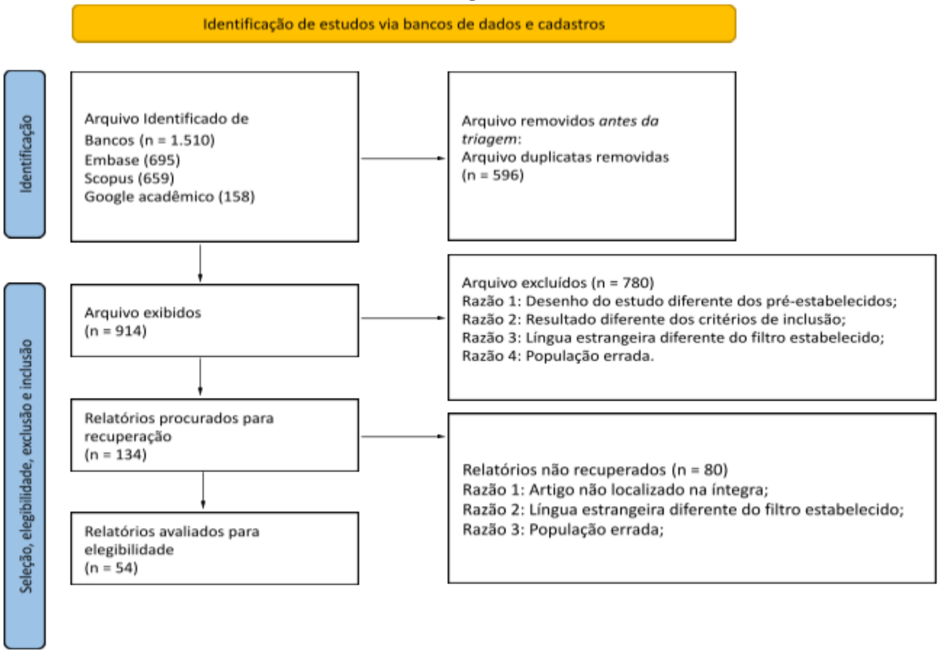
3 RESULTS AND DISCUSSION

Figure 1 - PRISMA flowchart with the result of the search performed and the studies excluded and included in each step



Source: Authors, adapted from MOHER *et al*. (2015).

Table 1 - Summary of information collected from articles - authors, year and study design

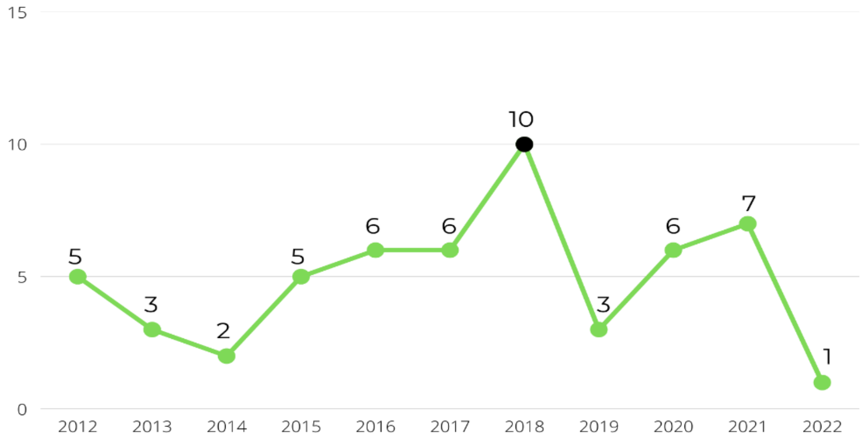
Author(s)	Year	Study design
1. Hsiao et al.	2012	Double-blind, randomized, simulation-controlled study
2. Kotlyar et al.	2012	Case Report
3. Clerici et al.	2012	Case Report
4. McGeoch & Ramachandran	2012	Case Report
5. Farrington et al.	2012	Case Report
6. Davies et al.	2013	Case Report
7. Perry et al	2013	Case Report
8. García et al.	2013	Case Report
9. Tung et al.	2014	Randomized controlled trial
10. Brunelli et al.	2015	Prospective randomized
11. Houston & Dickerson	2015	Pilot study with cross-sectional design
12. Lee et al.	2015	Case Report
13. Sano et al.	2015	Not specified
14. Wake et al.	2015	Pilot Study
15. Fisher et al.	2016	Placebo-controlled randomized double-blind crossover study
16. Vélez	2016	Applied longitudinal research
17. Osumi et al.	2016	Quantitative study
18. Anghelescu et al.	2016	Retrospective study
19. Ortiz-Catalan et al.	2016	Clinical trial
20. Gover-Chamlou & Tsao	2016	Case Report
21. Trevelyan et al.	2016	Randomized controlled feasibility study
22. Griffina et al.	2017	Cohort study
23. Zanfir et al.	2017	Controlled Clinical Trial
24. Ichinose et al.	2017	Controlled Clinical Trial
25. Finn. et al.	2017	Randomized Clinical Trial

26. Chau et al.	2017	Case Report
27. Ramsey et al.	2017	Case Report
28. Veena et al.	2018	Comparative study with random sampling method
29. Rothgangel et al.	2018	Multicenter, three-arm, randomized controlled trial.
30. Husum et al.	2018	Open-label, randomized, semi-controlled case-control
31. Nunzio et al.	2018	Not specified
32. Lendaro et al.	2018	clinical trial, double-blind, randomized controlled
33. Perry. et al.	2018	Clinical trial
34. Wakolbinger et al.	2018	Randomized controlled pilot study
35. Osumi et al.	2018	Case Report
36. Tkachenko & Stepanova	2018	Not specified
37. Ramachandran et al.	2018	Case Report
38. Grap et al.	2019	Case Study
39. Matalon et al.	2019	Experimental Design
40. Rothgangel et al.	2019	Mixed methods, prospective study
41. Limakatso et al.	2019	A single-blind randomized clinical trial
42. Mallik et al.	2020	Prospective randomized controlled non-blinded
43. Kulkarni et al.	2020	Prospective pilot study
44. Yanagisawa et al.	2020	Single-blind randomized crossover study
45. Wijk et al.	2020	Longitudinal cohort
46. Lendaro et al.	2020	Case Study
47. Attalla & El-Sayad.	2020	Quasi-experimental design
48. Gunduz et al.	2021	Randomized, blinded, simulation-controlled study.
49. Beisheim et al.	2021	Cross-sectional pilot study
50. Guo et al.	2021	Case Report
51. Santer et al.	2021	Case Report
52. Segal et al.	2021	Randomized trial
53. Zaheer et al.	2021	Randomized controlled trial
54. Folch et al.	2022	Case Report

After searching the aforementioned databases, 1,510 references were located, and of these, 596 were removed for duplicates. Then, the titles and abstracts of the remaining 914 articles were read, resulting in a total of 780 articles excluded due to noncompliance with the inclusion criteria. Of the 134 papers that were read in full, 80 were excluded as a result of the reasons stated in the PRISMA flowchart. At the end of the selection, 54 papers were elected to compose this review, as shown in Figure 1 and Table 1.

As for the year of publication of the articles, all are between the time frame of 2012 to 2022, with prevalence in the years 2018 (n=10) and 2021 (n=7), as shown in Figure 2.

Figure 2 - Years of publications.



Source: Authors (2022)

Regarding the countries in which the studies were carried out, the prevalence was in the United States (USA) (n=14; 25.9%) and Japan (n=6; 11.1%). It is worth noting that no Brazilian studies were located that met the inclusion criteria, demonstrating the scientific scarcity that Brazil faces in the scenario of treatment of amputees with phantom limbs.

The age of the study samples ranged from 7 to 87 years; the time of amputation of the samples varied from recent amputations (1 week) to 53 years of amputation and the time of sensation/pain varied with onset soon after amputation up to 36 years among the included research samples.

Regarding the interventions performed to treat the pain and/or sensation of the phantom limb, the following results were obtained: Mirror therapy 21.6% (21); Virtual reality 16.5% (16); Motor and sensory exercises 8.2% (8); Motor imagery, mental imagery or mental visualization 7.2% (7); Pharmacotherapy and associated therapies 6.2% (6); Electrostimulation and associated therapies 5.2% (5); Phantom motor exercises 5.2% (5); Acupuncture 5.2% (5); Stump wrapping (Farabloc, electromagnetic shielding) 3.1% (3); Muscle relaxation 2% (2.1); Rehabilitation orientation protocol 1% (1); Ultrasound 1% (1); Sensory feedback (visual, tactile, auditory and proprioceptive) 5.2% (5); Massage 1% (1); Haptic (tactile and proprioceptive feedback) 1% (1); Prosthetic glove with sensory feedback 1% (1).

Given this, 54 papers and their interventions were analyzed, and of these, only four papers (7.4%) were also performed by occupational therapists: stump coating (Farabloc) (HOUSTON & DICKERSON, 2015), prosthetic glove with sensory feedback (WIJK *et al*. 2020), graded motor imagery associated with mental imagery and mirror therapy (TE) (LIMAKATSO *et al.*, 2019), and acupuncture (TREVELYAN *et al*. 2016). Mirror therapy was performed in association with the stump coating (Farabloc) as well as the motor imagery group. These four researches also had the participation of professionals from other health fields in their authorship and execution. In a similar way, one study had the participation of occupational therapists working with the control group, but they were not the authors of the study, thus being left out of this accounting.

In order to present the interventions extracted from the articles in this literature review, they were grouped by similarities, to favor their understanding. It is noteworthy that many studies associated more than one technique in their intervention plans and they will be presented separately due to this categorization.

3.1 MIRROR THERAPY (MTT)

In the work done by Griffin *et al*. (2017), amputee participants performed symmetrical and concomitant movements of the phantom and intact legs/feet. They performed ankle flexion and extension, moved the foot from side to side, and rotated the foot in a circle.

The study by Rothgangel *et al*. (2019) randomly divided their participants into 3 groups: GROUP A - exercises with the intact limb in front of the mirror - motor, sensory exercises and phantom motor execution; GROUP B - received traditional mirror therapy, but, did not participate in the subsequent tele-treatment after discharge. Instead, participants were directed to perform self-administered mirror therapy as much as they felt necessary in a home setting. GROUP C (control) - received the same amount of motor and sensory exercises as groups A and B on the intact limb, but without the presence of the mirror, turning their gaze to the intact limb.

Rothgangel *et al*. (2019) evaluated two interventions in their study: traditional mirror therapy and a tele-treatment using augmented reality mirror therapy. The use of mirror therapy took place in different modalities: (1) motor and sensory exercises and (2) mental imagery practice facilitated by the image in the mirror. After this, the therapists were instructed to develop an appropriate and specific treatment program for each participant. For the tele-treatment, the following step-by-step was assigned: (1) phantom limb pain monitoring, (2) digital exercise programs using traditional mirror therapy, (3) augmented reality mirror therapy using the tablet's integrated camera, (4) audio-visual instruction of mental practice in the mirror, (5) limb laterality recognition training, (6) communication with the therapist and other participants, and (7) information and questions about the treatment.

Clerici *et al*. (2012) described the following practice in front of the mirror: looking at, touching, stroking, scratching, and moving the leg. When performing these movements, the participant had the impression of doing this with his right leg, the one he had amputated. In a diary he reported: "It felt like I was on the beach, a sensation I had not experienced for years.

Husum *et al*. (2018) combined mirror therapy and tactile sensory *feedback*. In mirror therapy, the person will move the foot changing from a neutral position to maximum dorsal flexion while closely observing the reflection of the intact limb in the mirror. A third modality is the combination of mirror + tactile stimulation, so both are performed daily.

Folch *et al*. (2022) describe the use of mirror box therapy, in which the participant performed the process under the supervision of a therapist. Three sets of 10 repetitions were performed: 1st set: slowly move the right foot 10 times to the right; 2nd set: slowly move the right foot 10 times to the left; 3rd set: slowly lift the right foot about 30 degrees, for 10 times.

Finn *et al*. (2017) paired mirror therapy with motor imagery. For the mirror therapy group, they were directed to place their intact hand in front of a mirror placed vertically at the sagittal midline and perform abduction/adduction movements of the thumb and fifth finger, flexion/extension of the thumb, fingers, wrist and hand, pronation/supination of the hand. In another perspective, the group assigned to receive covered mirror therapy, which was covered with an opaque sheet to prevent viewing the reflection of the intact limb. The mental visualization group, on the other hand, were asked to mentally visualize the phantom limb performing the movements described above, without motorically activating its muscles, just imagining the movements.

In the study by Ramsey *et al*. (2017), there was the agglutination of mirror therapy with pharmacological therapy, in which the participant is directed to look in the sagittally positioned mirror and recall their lost limb, while going through a series of tactile movements and exercises. Tkachenko & Stepanova (2018) associated mirror therapy and muscle relaxation, being embedded within psychotherapy. McGeoch & Ramachandran (2012), on the other hand, used mirror therapy alone to promote the reflection of a healthy limb focusing on the place where the participant felt the ghost was.

Chamlou & Tsao (2016) used self-administered mirror therapy at home after receiving detailed instructions from a physician via *email*. Participants were instructed to move the healthy limb slowly while viewing the reflected image in the mirror, as well as move the phantom limb concurrently to mimic the mirror movements, which were knee flexion and extension, plantar and ankle rotation. For the upper limb, they were instructed to open and close the hand in a fist shape, flexion and extension of the wrist and elbow. The movement speed of the intact limb was increased due to the reported sensation of phantom movement, so phantom movements followed the reflection the participant saw in the mirror.

In the work of Ramachandran *et al*. (2018), the use of mirrors was combined with the use of a specific drug, and he was proposed to see the reflection of his intact leg, visually recalling his limb before it became phantom. A similar improvement occurred when the intact leg was massaged, creating the illusion of the phantom leg being massaged.

In Farrington *et al*.'s (2012) research, mirrors were associated with a Haptic bar with *tactile feedback*. Based on this, a sensory illusion was constructed with the visual *feedback* from the haptics-enabled mirror, providing the amputee user with tactile and proprioceptive feedback and the ability to interact with a haptic slider, adding sensory modalities to the illusion generated by the mirror.

In the work of Grap *et al*. (2019), mirror therapy was coupled with pharmaceuticals and Cognitive-Behavioral Therapy. The mirror visualization technique comprised the use of mirror reflection at the hospital bedside, so that the participant visualized their intact limb and the reflection of it in the ghost position, while attempting to cognitively move the amputated limb.

Mallik *et al*. (2020) talked about mirror therapy, physical therapy, and motor imagery. Participants in the mirror therapy group performed joint movements while looking into a mirror. The study did not detail the development of this specific technique.

The study by Gunduz *et al*. (2021), on the other hand, divided its participants into 4 groups: covered mirror therapy; mirror therapy; sham *transcranial direct current stimulation* (tDCS) and active tDCS, with tDCS performed simultaneously with the mirror therapy intervention. Participants were asked to perform a sequence of the following exercises: light tactile stimulation; active range of motion - flexion and extension; functional task - simulating writing the alphabet with the lower limb; all using the unaffected limb and while doing so, observed their reflection in the mirror under use of TDCS. During active mirror therapy, participants were asked to stay focused on mirror observation and awareness of their phantom limb. In the covered mirror therapy, the same tasks were performed, and participants were asked to imagine the movement as if it were appearing in the mirror. After 10 combined sessions, participants were instructed to continue using mirror therapy at home for a period of 2 weeks.

Vélez's (2016) research did a combination of mirror therapy, motor exercises, and the use of Trabert currents. In the mirror therapy, motor exercises were performed in front of him. In this case, the currents were applied after the use of the mirror.

The study done by Limakatso *et al*. (2019), brought together the practices of mirror therapy, graded motor imagery, motor imagery, and routine physical therapy. In this way, the last two weeks of this intervention were focused on the use of mirror therapy. In it, participants were presented with a photograph of a healthy limb in a particular position and were asked to move their healthy limb and phantom in a manner similar to that position in the image, while watching the reflection of that movement in the instructed to simultaneously move the mirror.

Mirror therapy, in the work of García *et al*. (2013), was performed in conjunction with routine physical therapy. Participants placed their healthy leg inside a box with a vertical parasagittal mirror, to preserve the visual perception that there were two legs. Movements were performed for 15 min, while observing the mirror image of the movement in the mirror, associated with the Physical Therapy sessions.

The work of Anghelescu *et al*. (2016) addresses mirror therapy, pharmacotherapy, and motor exercises. The mirror therapy session consisted of placing the person's remaining limb in the mirror box, forncing instructions to perform simple motor exercises, described in the "motor exercises" session. At the end, participants were instructed to perform mirror therapy at home as they found necessary.

The research by Segal *et al*. (2021) brought together mirror therapy and different types of electrostimulation (CBT and DCSET). Mirror therapy was performed as follows: participants sat in their wheelchairs in a quiet treatment room, receiving a mirror that was allocated between their lower limb, aiming to reflect the image of the healthy limb. During the treatment, people were instructed to alternate between the movements of plantar flexion and dorsiflexion and inversion and eversion of the foot and to concentrate on the image that was being reflected.

In the research by Zaheer *et al*. (2021) the mirror was placed sagittally close to the person's body. The amputees could see the reflection of their healthy limb in that mirror. The rules of mirror therapy were instructed and the person was instructed to look at the reflection of the intact limb in the mirror, and symmetrical movements should be performed. Then she freely chooses which movements she wants to repeat in front of the mirror, performing the practice daily for 15 minutes.

3.2 DIE COATING (FARABLOC AND ELECTROMAGNETIC SHIELDING)

Of the articles evaluated, two presented interventions involving Farabloc technology stump covers (HSIAO *et al*., 2012; HOUSTON & DICKERSON, 2015) which is a limb covering mesh designed to protect the stump from the high frequencies of electromagnetic fields (greater than

1MHz), (CLEMENT & TAUNTON, 2001). The study by Hsiao *et al*. 2012 used a real and a fake Farabloc cover in their group and directed participants to wear it over their prosthesis.

On the other hand, in the work of Fisher *et al*. (2016) which refers to the study covering electromagnetic shielding coating, two coatings were used, however, in one Umbrellan technology was used, which provides electromagnetic shielding properties, and in the other, the fabric was non-conductive, not providing the shielding effect. The results obtained from the participants who completed the research using Umbrellan technology showed that maximum pain and well-being were improved.

3.3 VIRTUAL/AUGMENTED REALITY

There have been 16 research studies involving the use of virtual reality as a treatment possibility. In the study by Zanfir *et al*. (2017), participants were divided into two groups: the first would receive virtual reality and the second, kinesiotherapy. In each virtual reality activity, participants performed three repetitive tasks: placing the virtual representation of the phantom limb on a colorful, illuminated square, touching a virtual ball, and lifting the leg at 45° to touch a virtual bar. The control of the virtual limb movement was performed using a joystick.

Rothgangel *et al*. (2019) combined two therapies, one using traditional mirror therapy and the other with augmented reality mirror therapy teletreatment. For the teletreatment, the steps involving augmented reality are described in the "Mirror Therapy" section. Ichinose *et al*. (2017), on the other hand, associated virtual reality with sensory feedback. The development of the intervention is described in the section dealing with sensory *feedback.*

On the other hand, Kulkarni *et al*. (2020) used only virtual reality therapy, which provided *software* for visualizing an avatar of the upper limb to represent the amputated limb. With this, a 3D visualization of a ball game was started and in it, the participant was to use the missing limb within the visualization. The movement of the participant's stump was tracked and transposed into reflection to control and guide the phantom limb that was in the virtual environment.

The work of Osumi *et al*. (2016), also uses only virtual reality in their intervention study. During the intervention, participants used a computer monitor that displayed a graphic image of an intact arm in a mirror (forming the virtual phantom limb). Intent on moving the two limbs symmetrically, it was perceived by participants that the limb occupied by the phantom showed voluntary movement.

Beisheim-Ryan *et al*. (2021) describe an intervention in which participants were to perform an online foot identification task, such that they were to also judge whether random images represented left or right feet (i.e., left-right discrimination), this in a timely manner, and without limb movement to facilitate identification.

Sano *et al*. (2015) combined virtual reality with sensory *feedback*, and in that study, each participant performed a manual reaching task that required them to touch a certain target object with their amputated arm in the virtual environment. When the affected phantom reached the object, it disappeared with a crashing sound and vibration stimulus.

The study by Perry *et al*. (2018) deals with the use of a virtual avatar in which participants were to follow its movements by imitation within a virtual reality system. At the end of each session, participants commanded the movements of the virtual avatar's limbs during a period called "free play" and this was possible due to electromyographic recording of the muscle activity of their residual limbs.

In the work of Chau *et al*. (2017) a virtual environment of a 3D kitchen was developed, inspired by what mirror therapy advocates, as it enables the control of virtual hands by using the 3D monitor on the head, through myoelectric control of the virtual hand and by motion tracking. In this way, the participant was able to explore the objects and handle them inside the kitchen.

In another study, Perry *et al*. (2013) included virtual reality techniques and motor exercises, with the intention that participants should imitate the movements performed by a virtual avatar. Before actively starting the treatment, participants performed training in the virtual system, in which they moved based on the images contained in the computer, which were to: make cylindrical grasp; train and evaluate spherical, lateral or pointer grasp, as well as movements with the fingers (thumb, index finger, middle finger, ring finger and little finger).

Wake *et al*. (2015) integrated in their study a virtual reality system that emitted sensory stimuli (visual, auditory and tactile) to promote the perception of voluntary movements of the phantom limb. To do so, participants had to reach with their virtual phantom limb a target inserted into the system, and this target was next to a plane that was positioned at the height of the participant's shoulder line. The target disappeared whenever the virtual phantom hand touched it, with the emission of a collision sound and vibration stimulus.

In the study conducted by Osumi *et al*. (2018), through a virtual reality environment, collaborators were able to control their phantom limbs in virtual space through movements with their intact limb. When participants moved their hands bilaterally, the sensation of producing intentional movements in their phantom limbs was induced. The short-term rehabilitation protocol comprised a single session involving three tasks: placing the ball into the hallway using the hands, lifting and releasing the object; tracing the figure-of-eight represented in the virtual world with their virtual phantom limb at a comfortable speed; loading small blocks with bilateral movements with a free amount of loading at a time.

Yanagisawa *et al*. (2020) addressed the use of virtual reality and in this system the research participants were trained to move a virtual hand controlled by the brain-computer interface, which was built to classify the movements of the intact hand from motor cortical currents, performing this process for three consecutive days. The participants were visually guided by means of commands such as "grab" or "open" to move the phantom hand without necessarily moving other parts of the body. Immediately after this step, the participants performed the same task, however, using the intact hand.

Lendaro *et al*. (2018) combined, in one group, virtual reality therapies with motor imagery (control) and in another, virtual reality with phantom exercises (experimental). It should be noted that participants in both groups were on painkillers. In the experimental treatment, motor activity is decoded by interpreting the signals from the stump muscles via myoelectric pattern recognition. In this way, it is possible to visualize and control these movements in the virtual environments, retrieving the kinetic sensations related to the limb before the amputation. On the other hand, in the control treatment, participants could not produce/perform phantom movements, but could imagine themselves performing such movements, while watching them performed autonomously by the virtual reality environments.

The research developed by Lendaro *et al*. (2020) involves virtual reality and phantom exercises. The intention of movement is inferred by the myoelectric activity of the stump muscles. After recording myoelectric signals, participants can command the environment in the following ways: a virtual reality environment with a virtual limb (phantom) that is freely controlled by the subject; an augmented reality environment allows the subject to visualize themselves (in real time) with a virtual arm/leg superimposed over their stump; a running game is controlled by the subject's limb movements; a *Target Achievement Control* test is used to have the subject match the target postures presented in random order on the screen in a 10-second time frame. The patients took these devices home and used them independently over 12 months, as this allows interpretation of how a clinical therapy can be replicated in home settings.

The study by Ortiz-Catalan *et al*. (2016), which addressed virtual reality, combined this technique with phantom motor exercises. Each session lasted 2h and consisted of: pain assessment; placement of electrodes and fiducial marker; motor execution practice in augmented reality; race car game using phantom movements and combination of random target postures of a virtual arm in virtual reality.

3.4 MOTOR PHANTOM EXERCISES

This technique uses the contraction of the muscles present in the residual limb to move the phantom that exists in that limb (BRUNELLI *et al*., 2015; LENDARO *et al.*, 2020; RAFFIN *et al.*, 2012). Among the five researches that involved phantom exercises, none of them applied this therapy in an individual way, since the study by Brunelli *et al*. (2015) used the therapy in an associated way with progressive muscle relaxation and motor imagery; Lendaro *et al*. (2018) applied interventions that combined virtual reality with phantom motor execution in one group and associated drug, virtual reality and motor imagery in another.

Lendaro *et al*. (2020) performed this integrated with virtual reality; Ortiz-Catalan *et al*. (2014) related phantom motor execution with virtual reality, mediated by placing electrodes on the residual limb to capture myoelectric activity and transferring this to the virtual reality system; finally, Zaheer *et al*. (2021) which included imagining the movement of the phantom limb trying to perform these movements.

3.5 MUSCLE RELAXATION

Brunelli *et al*. (2015) and Tkachenko & Stepanova (2018) used the progressive muscle relaxation technique in their intervention plans, developing "body scanning and *scanning*" activities, which involves becoming aware of and visualizing the physical body. In the study by Brunelli *et al*. (2015), this technique was performed together with motor imagery and phantom exercises; in the work done by Tkachenko & Stepanova (2018), it was performed combined with mirror therapy.

3.6 PHARMACOTHERAPY AND ASSOCIATED THERAPIES

Ramsey *et al*.'s (2017) work linked the medication use of gabapentin and amitriptyline with mirror therapy and tactile sensory *feedback*; Grap *et al*. (2019) used gabapentin and clonidine along with Cognitive Behavioral Therapy and Mirror Therapy; Davies (2013) included clonidine, diazepam, pregabalin, paracetamol, tramadol, and venlafaxine in conjunction with Acupuncture; Lendaro *et al*. (2018) made use of analgesics with virtual reality, imagery, and phantom exercises; Anghelescu *et al*. (2016) made interaction of opioids, gabapentin, amitriptyline, and methadone with mirror therapy and motor exercises; Ramachandram *et al*. (2018) interacted psilocybin, mirror therapy, and massage.

3.7 ULTRASOUND THERAPY

Only one study involved the use of ultrasound therapy, which was in association with motor exercises on the stump. In that study, a second group received Transcutaneous Electrical Nerve Stimulation (TENS). The results of this paper signal that both groups had positive effects in their therapies, but the group that used ultrasound performed less well in pain relief compared to the TENS group, which had more effective results after 15 weeks of treatment.

3.8 COGNITIVE-BEHAVIORAL THERAPY (CBT)

Only the work of Grap *et al*. (2019) introduced CBT in their intervention, and in it, said therapy was associated along with mirror therapy and pharmacotherapy, due to the history of depression and anxiety presented by the participant, which persisted and accentuated after the amputation.

3.9 TACTILE DISCRIMINATION TRAINING

The research of Wakolbinger *et al*. (2018) contemplated the use of tactile discrimination training and in it the residual limb of the participants were covered with a cardboard and there the points to be stimulated were marked. The first (most distal) point was 2cm proximal to the end of the stump (i.e., near the old hand/foot). Thus, the participants had to report the points that were being stimulated and this discrimination provided pain relief.

3.10 MOTOR IMAGERY, MENTAL IMAGERY, OR MENTAL VISUALIZATION

A graded motor imagery program has been developed for amputees with phantom limbs in an attempt to relieve referred pain. This program establishes the following sequence of strategies: judgment of left and right lateralities through imagery; imagined movements and mirror therapy (LIMAKATSO *et al*., 2019).

From this perspective, the work done by Brunelli *et al*. (2015) performed combined muscle relaxation training, movement and phantom exercises, while the control group performed routine physical therapy.

The work by Matalon *et al*. (2019) organized the intervention as follows: the collaborator was to sit quietly with eyes closed while listening to the motor imagery script. The script was constructed with a focus on functional movement patterns and tasks that were meaningful to the participant, such as walking, balancing, and reaching for objects. These scripts guided him through the proper action and biomechanics of motor skills to imagine himself moving safely and functionally. At the end, the participant was guided to take guided deep breaths.

In Tung *et al*.'s (2014) research, such practices were adopted: 1 group of participants performed visual observation treatment and another group performed mental visualization/motor imagery. The treatment consisted of seven movements that were imitated by the amputee's phantom limbs while visually observing the limbs of an external participant with healthy limbs moving. On the other hand, in the case of mental visualization, the movements to be imagined were: abduction and adduction of the hallux; flexion and extension of the foot, toes and knee (for above-knee amputees); inversion and eversion of the foot; rotation of the foot around the ankle.

Finn *et al*. (2017) assigned their participants between two groups: mirror therapy or control group, which was divided between covered mirror or mental visualization therapy. The latter group were asked to mentally visualize the phantom limb by performing the following movements: abduction/adduction of the thumb and fifth finger, flexion/extension of the thumb, fingers, wrist, and elbow (for transhumeral amputees), and pronation/supination of the forearm.

In the work of Mallik *et al*. (2020) the participants went through an amputee rehabilitation program, with exercises geared to promote flexibility, strengthening, dynamic balance, and cardiovascular fitness. There was a group focused on mirror therapy practice. In addition, there was a mental visualization group, in which the participants were instructed to concentrate on the sensations in each area of the body, and after reaching a state of relaxation, they were encouraged to imagine the sensation of moving the phantom. In addition, they were to imagine the sensation of the foot resting on the couch, the position of the toes, and the temperature of the foot.

In the study proposed by Lendaro *et al*. (2018), virtual reality therapies were associated with motor imagery in one group and virtual reality with phantom exercises in another. All participants were on continuous use analgesics. With regard to the motor imagery group, participants did not perform phantom movements, but imagined themselves performing such movements while watching their autonomous reproduction by the virtual reality environments.

The research developed by Limakatso *et al*. (2019), involves a graded motor imagery program already mentioned above, which involves mental visualization. This occurs when participants focused on imagined movement training, as in a *software* application they were instructed to move their amputated limb in a sinuous manner, starting from the way they felt the phantom was positioned to the posture shown in the image provided, and then imagine moving it back to its original position.

3.11 MOTOR AND SENSORY EXERCISES

Some studies that make up this review introduced motor and sensory exercises associated with the techniques used or in isolation. The study by Rothgangel *et al*. (2018) randomized study collaborators into three groups: mirror therapy with basic motor exercise practice using various objects and phantom motors; sensory exercises; traditional mirror therapy and self-administered mirror therapy; the control group received the same amount as the previous groups, but without the use of a mirror, as they were instructed to look at the intact limb only during all exercises. After four weeks, the employees performed self-administered motor exercises with the healthy limb at home.

The research by Rothgangel *et al*. (2019) united mirror therapy, motor and sensory exercises, and virtual reality. Thus the practice of motor and sensory exercises was performed in front of the mirror, following such a sequence: (1) basic motor exercises, (2) sensory exercises, (3) functional motor exercises with objects, and (4) mental practice facilitated by the image in the mirror.

The work of Tung *et al*. (2014) deals with an intervention aimed at bilateral amputees and in it, two groups of participants were formed, in which one group performed visual observation treatment and the other performed mental visualization/motor imagery. In the mental visualization practice, the movements to be imagined were: abduction and adduction of the hallux; flexion and extension of the foot, toes, and knee; inversion and eversion of the foot, rotation of the foot around the ankle. On the other hand, in Perry *et al*.'s (2018) research, the participant observed and mimicked the virtual avatar's limb movements, which were flexion and extension of the wrist, pronation and supination of the forearm, and opening and closing of the hand.

The research by Gover-Chamlou *et al*. (2015) deals with the use of mirror therapy and motor exercises: participants were then directed to move the intact limb slowly in front of the mirror and simultaneously move the phantom limb in the same way. The movements were: plantar and knee flexion and extension, wrist and forearm, foot rotation at the ankle, opening and closing the hand in a fist shape were the upper limb movements

The study by Veena *et al*. (2018) performed a combination of three therapies in two different groups, where one group used TENS + motor exercises on the stump and the second did ultrasound and motor exercises on the stump as well. These exercises done on the stump promoted stretching and strengthening in it.

Vélez (2016), in his research, associated the techniques of mirror therapy, electrostimulation with Trabert currents and motor exercises. In front of the mirror, participants performed the following exercises: opening and closing of the hands; abduction and adduction of fingers; flexion and extension of the wrist; simulation of orchestral conducting and random movements were also performed.

The research regarding the study by Anghelescu *et al*. (2016) combined pharmacotherapy with mirror therapy and motor exercises, so that participants were required to place their residual limb in a mirror box space and perform exercises such as ankle pumps, ankle circles, and quadriceps contractions.

3.12 ACUPUNCTURE

Five papers integrate the use of Acupuncture in their interventions, and one of them will be described in the section devoted to papers involving occupational therapists. The work done by Kotlyar *et al*. (2012) involving acupuncture used the Yamamoto New Scalp Acupuncture (YNSA) technique, Yamamoto cranioacupuncture, which treated severe chronic phantom pain, with needles on points corresponding to the cranial nerves and brain, on the scalp. The research of Lee *et al*. (2015), performed acupuncture application in three conditions: application on intact hand; on prosthetic hand; on fake tissue hand. Using functional magnetic resonance imaging, the brain areas activated during acupuncture stimulation in these three conditions were verified. The best result was reported with stimulation in the prosthetic hand, activating the insula and sensory-motor cortex areas.

The study by Guo *et al*. (2021) performed acupuncture application on the limb contralateral to the amputee with 30 minutes of stimulation, with complete elimination of phantom pain. The intervention practiced by Davies (2013) combined drugs and acupuncture to treat pain and phantom sensation.

3.13 MASSAGE

The study by Wakolbinger *et al*. (2018) included massage in their intervention for the control group, with daily application of 15 minutes of massage to the residual limb for two weeks, with prior guidance from a physical therapist. The other group received tactile discrimination training.

3.14 ELECTROSTIMULATION AND ASSOCIATED THERAPIES

In the work by Gunduz *et al*. (2021) the following therapies were used in four groups of participants: ordinary and covered mirror therapy; sham and active Transcranial *Direct Current*

*Stimulation (*tDCS); tDCS was performed simultaneously with the mirror therapy intervention. For this, the anodic electrode was placed on top of the primary motor cortex (M1) contralateral to the amputation side and the cathodic electrode on the contralateral supraorbital area.

Nunzio *et al*.'s (2018) research, meanwhile, involved muscle activation at the stump level by placing eight surface bipolar electrodes and differential electromyography amplifiers with wireless data transmission embedded in an elastic band, so this practice was coupled with tactile and visual feedback.

From this perspective, the study by Vélez (2016) applied Trabert currents, mirror therapy, and the practice of motor exercises. Trabert currents act on the afferent pathway of the spinal cord and it is believed that they are able to reorganize sensitive memories, producing changes at the spinal and cortical level. Thus, when Trabert currents are combined with mirror therapy, it is possible to reorganize sensory memories and generate restoration of cortical reorganization.

The study by Veena *et al*. (2018) used TENS, ultrasound therapy, and the stump motor exercises. Both groups used motor exercises, but one used TENS and the other used ultrasound. The group using TENS showed better reductions in pain levels.

In turn, another study combined in one group mirror therapy alone; mirror therapy and simulated Transcranial Direct Current Stimulation (tDCS); and in another group performed mirror therapy and tDCS (SEGAL *et al*., 2021).

3.15 REHABILITATION ORIENTATION PROTOCOL

A protocol of guidelines for rehabilitation of hospitalized amputee patients was developed by a nursing service, as explained by Attalla and El-Sayad (2020). In it, there are the following guidelines: a) Stay active (not staying in the same position for long periods of time, not wearing tight clothing), b) Observe the skin for signs of inflammation and irritation, c) Use of amputation wrap below the knee (4 to 6 hours), d) Pain relief: massage, touch and squeeze to desensitize the residual limb; slowly squeeze and release the muscle, warm the limb; in cases of edema, use a shrink wrap or stocking on the limb, e) Positioning and stretching, f) Exercises for movement in the stump.

3.16 SENSORY FEEDBACK (VISUAL, TACTILE, AUDITORY, PROPRIOCEPTIVE)

Work by Ichinose *et al*. (2017) stimulated visual, tactile, and proprioceptive *feedbacks* within a virtual reality system. In this system, participants were instructed to "touch" virtual objects that appeared in the virtual environment with the affected virtual upper limb along with the intact upper limb. Upon touching the target object, auditory (a collision sound) and also tactile (vibration of the motor) *feedback* was activated. Tactile *feedback* was also applied to the cheek when the virtual affected limb touched an object (cheek condition). There were 2 more conditions defined, which was application of the tactile feedback to the intact hand (intact hand condition) or no application condition (no stimulus condition).

Husum *et al*.'s (2018) research involved mirror therapy, tactile therapy, and combined mirror and tactile therapy. With regard to tactile therapy, participants were to lie in bed, without making eye contact with the stump, just focusing on feeling the tactile stimuli, for 5 minutes, both in the morning and at night. The stimuli consist of: exploring the skin of the medial, frontal, lateral and dorsal parts of the stump using a stone, a wooden stick, a soft brush, a soft cloth and a soft feather. In the case of the combined treatment of mirrors and tactile stimuli, they are performed separately, but one is performed in the morning and the other in the evening.

The study by Sano *et al*. (2015) brings the combination of a virtual reality system that applies tactile sensory *feedback to* the participants. They were to move their upper limbs in the virtual environment. When the affected hand reached the object, it disappeared, and a collision sound and tactile vibration stimulus appeared. The vibration motors were placed on the five fingertips of each participant's intact hand using a glove. The target object was positioned at random spaces in the system, within reach after each touch.

The publication by Wake *et al*. (2015), on the other hand, developed a multimodal virtual reality system (with visual, auditory, and tactile stimuli) that has been described previously in the virtual reality section. The vibrating stimuli were added to the participants' clothes and gloves.

The work devised by Nunzio *et al*. (2018) deals with the use of electrostimulation associated with sensory *feedback* via electrodes. The goal of the intervention was to promote muscle activation at the stump level, by means of surface bipolar electrodes and differential electromyography amplifiers with data transmission. With this, eight micro-vibrators were implemented for tactile stimulation and an intuitive visual representation as visual *feedback* represented on a screen.

3.17 ROUTINE PHYSIOTHERAPY

The research conducted by Zanfir *et al*. (2017), divided the participants into two groups, one intended for intervention with virtual reality and the other with Kinesiotherapeutic Physiotherapy. During the exercises, participants underwent three sessions of 30 minutes each, performing exercises for muscle toning in the amputated lower limb (leg and thigh); postural exercises, aimed at releasing the contraction and avoiding the vicious position of the stump, as well as toning the healthy muscles of the lower limbs.

The work of Mallik *et al*. (2020) deals with an intervention plan in which participants were divided into 3 groups: a) amputee rehabilitation program (flexibility, strengthening, dynamic balance, and cardiovascular fitness exercises); b) mirror therapy; and c) motor imagery.

Santer *et al*. (2021) used gait training to achieve pain relief. The intervention consisted of strengthening exercises for the muscles that stabilize the hip and pelvis when moving the lower limb. Strengthening of the healthy limb was also implemented to address the dynamic valgus and pronation tendencies observed during the initial examination performed with the person standing and video analysis of gait during running. Dynamic exercises were also performed to improve balance and strength in weight distribution on the prosthesis. This intervention plan started with the athlete's walking prosthesis and progressed to the running blade prosthesis, using multi-planar and multi-height *stepping* and *lunging* exercises. One strategy adopted to increase confidence with the use of the prosthesis was called "fast feet" and consisted of rapidly shifting weight transfer from one leg to the other.

The study by Limakatso *et al*. (2019), addressed the use of a previously mentioned graded motor imagery program. The control group performed routine Physical Therapy. The research by García *et al*. (2013) associated mirror therapy with physical therapy, so that both were done together. Zaheer *et al*. (2021) performed Physical Therapy with conventional therapeutic exercises in their control group.

3.18 HAPTIC WITH VISUAL AND PROPRIOCEPTIVE FEEDBACK

In the work by Farrington *et al*. (2012) a device provides the user with tactile and proprioceptive *feedback*, in which the user is in contact with a haptic slider, which reflects the intact limb in the space intended for the phantom, however, the view of the stump is blocked. Instances (ways of configuring the device) were defined to adapt the functioning of the device to the specificities of each participant. The instances are: stimulus modality, volitional movement, and multisensory interaction.

Thus, stimulus modality refers to the sensory system that is receiving the physical stimuli. Volitional Movement deals with the movements allowed and the control the user has of the perceived phantom, and this includes unilateral or bilateral movement of the limb, control of the phantom with the ipsilateral or contralateral side of the brain in relation to the amputation,

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movement of the residual limb, and the presence or absence of a prosthesis (FARRINGTON *et al*., 2012).

4. DISCUSSION

4.1 STUDIES INVOLVING THE PRACTICE OF OCCUPATIONAL THERAPISTS

4.1.1 Graded motor imagery, imagined movements and mirror therapy from an occupational therapy perspective

As already exposed in the previous sections, this intervention brings together the techniques of graded motor imagery, imagined movements, and mirror therapy, in addition to assigning the participants in the control group to physiotherapeutic treatment. The results obtained showed that the participants in the experimental group had reduced pain and showed significant improvements in the interference of pain with function and with health-related quality of life. The control group also showed a reduction in pain levels, however, this reduction was not fixed, increasing again over time (6 months) (LIMAKATSO *et al*., 2019).

This disparity of results between the two groups, regarding functionality, can be explained by the fact that the use of motor images promoted reconstitution of the body image, after the physical or mental visualization of an intact body. Soon, the memories of functionality (those prior to the amputation) are resumed and accentuated, and no matter how much the person has the absence of a limb in their daily life, they have the perception that their body can be functional, as long as external and internal adaptations are performed (FONSECA, 2019).

In addition, there is the proprioceptive memory of the limb, which stores and informs the brain of the body's position in space, and this directly influences cortical reorganization, as many phantom limbs position themselves in the same posture they were in before amputation. Thus, in amputation, the memory engrams of the amputated limb remain active, even with the absence of visual feedback from the limb. Then, the proprioceptive memory enables the functionality of the limb, after evaluations and necessary adaptations (GENTILI *et al*., 2002).

With regard to functionality, the interventions currently performed by occupational therapists with amputees are: maximization of functional independence in ADLs, stimulation of improved range of motion and residual limb strength, and mastery of the prosthetic device used (SMURR *et al*., 2009; SMURR et *al.,* 2008; YANCOSEK, 2011; CANCIO *et al.,* 2019).

4.2 PROSTHETIC GLOVE WITH SENSORY FEEDBACK

The study by Wijk *et al*. (2020) used a non-invasive air-mediated sensory feedback system employed to a prototype prosthetic hand glove. This system promotes mechanotactile stimulation as well as applies pressure to the fingertips. Initially a map of the phantom hand was created by means of the areas of the forearm in which the participants reported sensation and pain. When using the prosthesis for the first time, they confirmed whether the pressure sensations felt on the digital pulps of the fingers somatotopically corresponded to the map of the phantom hand. Among the studies performed by occupational therapists, this is the only study that was not repeated or performed by other professionals in the other studies.

The results obtained showed that this sensory *feedback* system has positive qualities in relation to provoking a sense of completeness and appropriation of the body, in addition to the sensory *feedback* fed back by the prosthesis. Despite the phantom pain relief signaled by the participants, occupational performance with the prosthesis did not improve (WIJK *et al*., 2020).

The feeling of having the complete body again experienced by the participants is explained due to the restitution of the body image that existed before the amputation, even if by means of a prosthesis. In addition, the body schema was also stimulated through the use of the equipment, as it promoted kinesthesia, tactile sensations, and proprioception to the brain, being an external experience (medium) unified with the body, generating internal sensations (SIMIONATO *et al*., 2018).

In addition, this sensory *feedback* returned to the body through the prosthesis activated somesthetic areas in the somatotopic correspondences of the amputee hand and forearm, and the mechanotactile afferent of the stimuli received favored the use of motricity, since hand sensitivity is fundamental for motor performance and motor learning, in agreement with Hudspeth *et al*. (2013). However, in this study, occupational performance was not as favored as assessed. It is recommended that a new study be conducted to verify how long exposure to a sensory stimulus is necessary for sensory-motor integration to occur.

4.3 FARABLOC STUMP LINING

Houston & Dickerson (2015) implemented an intervention that included the use of a Farabloc technology dressing for the amputated limb. It was worn over the residual limb dressing for 23 hours/day for the acute group. In turn, the subacute group wore the Farabloc dressing after the prosthesis was removed. Mirror therapy was also performed in association with the use of the Farabloc dressing, performing a series of 15 repetitions of simultaneous bilateral active range-of-motion exercises for each joint, while directing their gaze to the non-intact limb reflected in the mirror.

In this process, pain interference with activities of daily living (e.g., self-care, walking, car transfer, low chair transfer, and sleep) and well-being (e.g., satisfaction, mood, quality of life) was assessed at three points in time (pre- and post-treatment and maintenance). The results are very positive, both for quality of life and pain reduction.

In the conception of Occupational Therapy, despite pain generating difficulties in the activities of daily living, it is considered that the profession must observe all the abilities that already exist in people, even in conditions that apparently limit their functional capacity. Thus, the occupational therapist observes the need for individuals to adapt to different contexts and produce changes, in order to understand what resources are needed for these adaptations in daily life (CASTANHARO & WOLFF, 2014).

The results obtained with the use of Farabloc were favorable for significant improvements in the areas of self-care, walking, car transfer, sleep, mood, and quality of life, for participants with acute pain. For participants with subacute pain, improvements indicated significant advances in sleep and well-being. A reduction in the time required for prosthesis placement decreased from 12 weeks to 8 weeks for acute amputees and an improvement in wear tolerance from 0-2 hours to 8-12 hours (HOUSTON & DICKERSON, 2015).

From this perspective, it is observed that Occupational Therapy is also concerned with the impact that this condition has on occupational performance during the practice of ADLs, considering that the amputation of a limb generates functional loss, even if temporary. As far as mobility (DLA) is concerned, as assessed by the aforementioned study, it is affected after the loss of a limb. This functional loss may cease when, for example, the use of a prosthesis is implemented to restore function. The occupational therapist is responsible for monitoring and guidance in activities of daily living, often acting in the rehabilitation of amputees, either with the use or non-adaptation of prostheses or other Assistive Technology equipment (RODRIGUES JR *et al*., 2018)

Thus, it is possible to perceive the importance given by Occupational Therapy to ADLs, for the core of the profession is centered on the occupations and potentialities born from these, and not on the pain itself. Thus, the relief of pain and/or sensation is the initial focus of treatment in Occupational Therapy, because this allows for progress in meeting the established goals and in quality of life, reaching satisfactory occupational performance, with adaptations or not, as is the case of this research that used the Farabloc cover to decrease the intensity of pain and to evaluate the positive impacts of its use in ADLs (DÊLLE-MADALOSSO & MARIOTTI, 2013).

The study by Houston & Dickerson (2015) proves that the effectiveness of the results is due to the two techniques combined, since no parameter was used to differentiate the effectiveness of one compared to the other. Research in Occupational Therapy points out that the combination of techniques usually causes more effective results in the functionality of the subjects (BRITO, 2012).

4.4 ACUPUNCTURE

The work of Trevelyan *et al*. (2016) combined acupuncture (systemic and auricular) and usual care, in which participants received a combination of the two, or only usual care, which includes: medical intervention, pharmacological, Physical Therapy and Occupational Therapy. In it, acupuncture was performed contralateral and ipsilateral, with needling of the following points: Shen Men, Autonomic Nervous System (sympathetic) and points corresponding to the amputated limb. Points on the lower back area were also punctured: LI4 + LR3, LR3, GV20 SP10, and also points referring to the specific symptoms of the participants.

The results achieved outline that acupuncture was perceived as beneficial and effective for the relief of phantom pain. With regard to quantitative data, acupuncture demonstrated clinically significant change in mean pain intensity (raw change = 2.69) and worse pain intensity (raw change = 4.00).

In this study, the therapies used in usual care were not detailed, only the professions involved were mentioned. In any case, it is known that, according to the results, acupuncture was more effective for the treatment of phantom pain than usual care. Much is due to the fact that acupuncture has analgesic points, anti-inflammatory points, muscle relaxants, local points for balancing the circulating energies in that area (the leg area, for example), among others.

It is worth emphasizing the existence of Resolution No. 221 of May 23, 2001 - which provides for the practice of acupuncture by Occupational Therapists and other provisions (COFFITO, 2011). The occupational therapist, with the use of acupuncture, aims to expand the capacity to improve the self, avoiding reductionism and leveraging holistic practices, enhancing the improvement of other techniques and therapies, besides, consequently, improving the occupational performance, social participation, well-being and quality of life of people (MOTA, 2012).

Of the 54 interventions, only four were studies that included occupational therapists as authors. However, it is possible to notice that many therapies used are similar to the practices used by Occupational Therapy, generating afferent sensorial stimuli and provoking efferent motor responses. It is observed that a significant number of the interventions operate from the application of sensory stimuli, aiming to obtain brain responses that cause cortical reorganization, through the mechanism of brain plasticity and thus reduce the levels of pain and/or phantom sensation.

5 FINAL CONSIDERATIONS

During the data analysis it was possible to notice the disparity in the focus of the research, between those that involve and those that do not involve occupational therapists, since, in Occupational Therapy research, the interventions go beyond the ideal of relieving or eliminating pain, aiming also to improve functional capacity, occupational performance, and quality of life.

The small number of intervention studies that relate Occupational Therapy and the phantom limb is also noteworthy, as well as the inexistence of Brazilian publications involving the connection of the two themes. This highlights a scenario that challenges Occupational Therapy to seek, to become aware and to position itself as a great ally in offering care in many unexplored territories that permeate human health.

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