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ORIGINAL ARTICLE

Telephysiotherapy for the treatment of phantom limb pain: a quasi-experimental study

Telefisioterapia para o tratamento da dor no membro fantasma: um estudo quasi-experimental

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ABSTRACT

BACKGROUND AND OBJECTIVES: Phantom limb pain (PLP) is a common complication of limb amputation, with a prevalence ranging from 41% to 46% of cases. Despite its uncertain pathophysiology, evidence suggests multifactorial mechanisms to explain the painful phenomenon, which directly affects the individual's quality of life. This study aimed to analyze the possible influence of a telephysiotherapy protocol for PLP on quality of life, pain intensity, and pain perception in individuals with limb amputation, in a quasi-experimental context.

METHODS: A quasi-experimental study with a qualitative-quantitative approach, involving a sample of nine individuals. The instruments used were the McGill Pain Questionnaire, a verbal pain scale, the Short-Form Health Survey (SF-36), and an assessment form designed as an interview, all applied before and after the treatment protocol. The intervention consisted of an adaptation of the Graded Motor Imagery (GMI) protocol, conducted online via the Google Meet platform. Quantitative analysis was performed using the paired Wilcoxon test for nonparametric variables. The qualitative approach was analyzed using content analysis methodology.

RESULTS: No significant differences were observed in quality-of-life parameters, pain intensity, or pain perception. However, qualitative reports demonstrated a perceived improvement among participants.

CONCLUSION: The divergence between qualitative and quantitative results highlights the need for the development of specific questionnaires for PLP and its impact on the quality of life of individuals with limb amputation.

KEYWORDS: Amputees, Phantom limb, Telehealth.

RESUMO

JUSTIFICATIVA E OBJETIVOS: A dor no membro fantasma (DMF) é uma complicação comum da amputação de extremidades, com prevalência entre 41% e 46% dos casos. Apesar de sua fisiopatologia incerta, evidências sugerem mecanismos multifatoriais para explicar o fenômeno doloroso, que afeta diretamente a qualidade de vida (QV) do indivíduo. O objetivo deste estudo foi analisar a possível influência de um protocolo de telefisioterapia para a DMF na QV, intensidade e percepção da dor de indivíduos extremidades amputadas, em um contexto quasi-experimental.

MÉTODOS: Estudo quasi-experimental com abordagem quantiqualitativa, de amostra composta por nove indivíduos. Os instrumentos utilizados foram o Questionário de Dor de McGill, uma escala verbal de dor, o *Short-Form Health Survey* (SF-36) e uma ficha de avaliação elaborada no formato de entrevista, todos aplicados antes e após o protocolo de tratamento. A intervenção constituiu de uma adaptação ao protocolo de Imagens Motoras Graduadas (IMG), realizado de forma ***online*** pela plataforma *Google Meet*. A análise quantitativa se deu através do teste de Wilcoxon pareado para variáveis não paramétricas. A abordagem qualitativa foi analisada pelo método de análise de conteúdo.

RESULTADOS: Não houve diferença significativa nos parâmetros de QV, intensidade e percepção de dor, entretanto os relatos qualitativos demonstram percepção de melhora dos indivíduos.

CONCLUSÃO: A divergência entre os resultados qualitativos e quantitativos reflete a necessidade da elaboração de questionários específicos para DMF e sua influência na QV de indivíduos amputados.

DESCRITORES: Amputados, Membro fantasma, Telessaúde.

HIGHLIGHTS

- The article takes a quantitative and qualitative approach, since the qualitative part can contribute to understanding the experience of Phantom Limb Pain in individuals with amputated limbs
- Another highlight is the very subject of Pain in the Phantom Limb, which is still little explored in literature, especially in the Brazilian context
- Another highlight of is the use of telephysiotherapy, a resource that can be useful for treating individuals with mobility restrictions

INTRODUCTION

Phantom limb pain (PLP), first recorded by Ambroise Paré (1510-1590), refers to the neuropathic pain felt in the absent limb of amputees. It is considered a common sequela following amputations, with a prevalence of 41% and 46% between cases[1,2], and can start immediately or appear weeks, months or years after amputation[3].

Pathophysiology of PLP is uncertain, but it has been suggested that it is caused by the action of peripheral and central neurophysiological mechanisms in the nervous system. The peripheral mechanisms are related to the appearance of neuromas, excessive formations of fibrotic tissue in the area of nerve tissue that has been severed[4]. The central mechanisms are associated with the maladaptive reorganization of the primary somatosensory cortex and primary motor cortex, through the meta-plasticity property of the central nervous system[5]. The absence of sensory stimuli, caused by the interruption of afferent pathways related to the amputated limb, can generate incongruence between the cortical representation of the individual's body scheme and their current self-image[5].

Moreover, there is suggestion that the persistence and intensity of pain has a multidimensional influence[6], associated with psychosomatic factors that can act as triggers for a new painful experience[7], as well as climatic and mechanical triggers, associated with the detection, by the thermoreceptors and mechanoreceptors present in the skin of the residual limb, of changes in pressure, temperature, humidity or mechanical stimuli, which can increase the intensity of PLP in some individuals[7].

PLP can be physically and mentally debilitating and is a risk factor for comorbidities such as depression, anxiety and musculoskeletal pain[6]. Thus, it has a high impact on quality of life (QoL), affecting the potential for self-care and carrying out daily activities[2,6]. Early assessment and physiotherapy treatment are recommended. The assessment should identify the intensity of pain and note the aspects that influence its perception[6]. Physiotherapy treatment aims to minimize discomfort related to PLP, reduce the adoption of antalgic biomechanical patterns[3] and improve functionality. Traditional techniques include peripheral interfaces, transcutaneous electrical nerve stimulation (TENS) and Graded Motor Imagery (GMI)[6].

The GMI technique, described by Moseley[8], begins with the gradual activation of the primary somatosensory and motor areas, leading to the cortical reorganization of both[2]. It has three stages: Laterality Discrimination[8], Mental Practice[8] and Mirror Therapy[9]. Laterality Discrimination consists of presenting figures with images of limbs, either upper or lower, depending on the individual's amputation (upper limb figures for upper limb amputations and vice versa). The individual has to analyze the pictures for a short time and thus discriminate the laterality of the picture in question - whether it belongs to the right or left side of the human body[8].

Mental Practice of locomotor skills consists of performing standardized movements with the whole limb, during which the individual keeps their eyes closed. The individual must try to reproduce the same movements with the phantom limb[8]. In Mirror Therapy, the residual limb is hidden by a mirror, which reflects the healthy limb and produces visual feedback that the body scheme is healthy. Each stage of the GMI is based on acting on the cortical organization in a progressive way, so as to minimize the painful experience at the time the technique is being applied, while maintaining the gains after[8].

Telephysiotherapy is characterized by the set of activities related to physiotherapy, carried out in a non-face-to-face scenario[10]. This practice has been supported by the Federal Council of Physiotherapy since 2020, through COFFITO Resolution 516/2020[11]. Due to the need for early care and the possible functional limitations imposed on an individual who has suffered a recent amputation, telephysiotherapy has emerged as a treatment possibility both for issues related to the amputation itself and for the treatment of PLP, since none of the GMI stages depend on the physical touch of the physiotherapist. In addition, treatment for PLP requires the active participation of the individual in their rehabilitation, and telephysiotherapy can contribute to an understanding of the individual's greater autonomy[12,13].

Considering the impact of PLP on the QoL and health of amputees, the present study's objective was to analyze the possible influence of a treatment protocol adapted from the GMI technique through telephysiotherapy on amputees with PLP in a quasi-experimental context.

METHODS

Study design

This is a quasi-experimental study with a quantitative and qualitative approach, approved by the Ethics Committee for Research with Human Beings of the Santa Catarina State University (UDESC), under the CAAE approval and opinion number 37380220.5.0000.0118. The study is part of the macro-project "Telephysiotherapy for amputees in times of COVID-19: reinventing oneself to rehabilitate and integrate" and followed Resolution No. 466 CONEP/CNS/MS, of December 12, 2012, and its complements.

Sample selection

The inclusion criteria for the sample, selected by convenience, were unilateral extremity amputees of any etiology and level of amputation, over 18 years old, with symptoms of PLP. The exclusion criteria were individuals with neurological diseases, associated cognitive disorders, visual impairments, vestibular disorders or double amputees. In order to select the participants, screening was carried out on the referral list of the Multidisciplinary Rehabilitation of Amputees (RAMP - *Reabilitação Multidisciplinar de Amputados*) extension project at the Center for Health and Sports Sciences (CEFID -*Centro de Ciências da Saúde e do Esporte*), Santa Catarina State University (UDESC).

Instruments

The instruments used were the McGill Pain Questionnaire, the Short Form Health Survey (SF-36) and a verbal pain scale, as well as evaluation, weekly monitoring and reassessment forms created by the researchers.

The McGill Pain Questionnaire[14], validated for Portuguese by Pimenta and Teixeira[15], assesses pain quantitatively in four dimensions, so that the influences of the different components that make up the pain phenomenon can be discriminated[14]. The SF-36 questionnaire[16], validated for the Portuguese language by authors[17], assessed the individual's QoL multidimensionally, through 36 items divided into 8 dimensions[17]. To assess pain intensity, a descriptive verbal scale created by the authors was used, which graded pain by the following intensity descriptors: no pain (0), light pain (1), mild pain (2), moderate pain (3), severe pain (4).

The assessment and reassessment forms contained the individual's identification data followed by open questions: "How do you describe your pain and phantom sensation?", "Do you consider yourself independent?", "What are your leisure activities?", "What are your social activities?". The weekly follow-up form contained identification and the verbal pain scale, followed by open questions: "How do you describe your sensation/pain today?", "How do you describe the position of your limb today?", "How many times did you do the exercises during the week?" and "Observations on the exercises". Although the instruments were adapted for Google Forms, they were applied synchronously between the researcher and the individual, whose answers were transcribed by the researcher at the time of the interview.

Procedures

The treatment protocol was carried out online (telephysiotherapy) for six to eight weeks, once a week and lasting one hour, with a maximum of ten meetings. It was adapted from the GMI principle and included three-level Laterality Discrimination[8], Mental Practice[18] and Mirror Therapy[9] sessions from the fourth week onward. After each meeting, videos of the exercises were sent via the Whats App app to each participant, who was instructed to play them twice before the next meeting.

Laterality discrimination

Laterality Discrimination consisted of the presentation of 50 images of extremities in slide format, in Google Meet screen sharing mode. The images came from the Recognize™[19] application, in which the individuals had to answer whether that extremity represented the right or left side; due to limited access to the platform, initially the upper extremities were used for all individuals. The technique is based on the activation of somatosensory, premotor and motor areas contralateral to the phantom limb[2].

Mental practice of locomotor skills

The Mental Practice of locomotor skills, based on the principle of Motor Imagery[20], is based on the activation of the areas of the Central Nervous System responsible for understanding, planning and preparing movements, interfering in the kinetic-kinematic components of PLP[21]. With eyes closed, the individual had to perform the movements shown in Table 1, both with the intact limb and with the phantom limb.

Body scanner

Also, part of the Mental Practice was the Body Scanner, a preparatory technique that induces progressive muscle relaxation and concentration in order to perform the other exercises satisfactorily[22]. The subjects were instructed to lie down, close their eyes and concentrate on the voice of the researcher, who recited a standardized text in which the subject had to pay attention to the body structures mentioned, as shown in the following example:

> *First, focus on your head. Pay attention to its positioning. The weight it has, the weight it puts on the bed... if it "squeezes" the bed at some point... Notice if you can feel the temperature. If your head is turned to any one side... If it's leaning... If it wants to "touch" your shoulder... Notice all the details... all the sensations.*
>
> *In the Body Scanner, the intact limb and the phantom limb were treated without distinction in the speech, as follows:*
>
> *Slowly move your attention to the shoulder (left/right - start with the whole limb).... How it's positioned... if it's rotated... if it's too close to the ear... If it is, try to relax... Concentrate on these muscle, on the sensations it brings you... try to make it comfortable...*
>
> *Slowly turn your attention to the shoulder on the other side...How it's positioned... if it's rotated... if it's too close to the ear... If it is, try to relax... Concentrate on these muscles, on the sensations they bring you... try to find the most comfortable position...*

Table 1. Movements used in mental practice

Upper Limb Amputees (UL)	Lower Limb Amputees (LL)
Week 1:	**Week 1:**
Triple flexion (shoulder, elbow and wrist flexion combined);	Triple flexion (hip flexion, knee flexion and dorsiflexion combined);
Triple flexion combined with shoulder abduction.	Ankle dorsiflexion and plantiflexion.
Week 2 to 4/6:	**Week 2 to 4/6:**
Shoulder flexion and extension;	Hip flexion and extension;
Shoulder abduction and adduction;	Hip abduction and adduction;
Shoulder internal and external rotation;	Hip internal and external rotation;
Elbow flexion and extension;	Knee flexion and extension;
Wrist flexion and extension;	Ankle dorsiflexion and plantiflexion;
Wrist circumduction;	Ankle circumduction;
Finger extension and flexion.	Toe extension and flexion.

Mirror Therapy

In Mirror Therapy[9], the healthy limb was positioned in front of a mirror and the amputated limb on the opposite side. In this way, the individual performed symmetrical movements, observing the reflection of their healthy limb. It is thought that this illusion alters the representation of the body scheme in the brain, leading the individual to believe that it is intact[23].

In the first week, the individuals underwent the Body Scanner, laterality Discrimination and two Mental Practice exercises. From the second week onwards, the Mental Practice exercises were increased in terms of quantity and number of repetitions, while the Laterality Discrimination went up a level as the individual reached 70% of the previous level. In most cases, Mirror Therapy was introduced in the fourth week. In two cases, it was started in the fifth week due to the impossibility of using the mirror at home. The technique began with 5 minutes of familiarization and then performing the same movements listed in the Mental Practice, which progressed in number of repetitions over the weeks.

Data treatment and analysis

The qualitative data was analyzed using Bardin's[24] content analysis, based on the thematic axes of intensity, emotional aspects and description of pain, interference in daily activities, positioning of the phantom limb, aggravating factors and management strategies. After collecting the texts, the data was coded, classified and categorized, followed by inference and interpretation of each axis.

The reports of pain perception in the pre- and post-intervention periods were represented in illustrative figure format, validated with each participant. This representation is based on Davies et al.'s proposal[25] described as the patient's journey, a recent approach which aims to understand individual experiences in relation to a treatment[25]. The illustrations will be presented in a separate publication.

The quantitative data was analyzed using IBM SPSS®[26]. The variables were compared using the Wilcoxon test, with a significant level of $p<0.05$ and a 95% confidence interval.

RESULTS

Fifteen individuals were interviewed using the Google Meet platform. Of these, three were excluded from the study: two were two-legged and one had acute stroke sequelae. Twelve individuals started treatment, nine finished the protocol and the three dropouts were related to the need for surgery, logistical problems and difficulty accessing the internet.

Nine individuals completed the protocol with a mean age of 51±20.25. Table 2 summarizes the sociodemographic characteristics.

Only one individual had an upper limb amputation; among the lower limb amputees, four were transfemoral, three transtibial and one had a hip disarticulation. The average amputation time was 10.6 ± 18.93 months, with only one individual having had an amputation for more than one year. Among the causes of amputation were complications due to diabetes (n=2), infection (n=2), tumor (n=2), trauma (n=2) and vascular (n=1). Table 3 summarizes characteristics related to amputation and other health conditions.

Table 4 shows the results of the SF-36 questionnaire before and after intervention. The intensity of pain assessed by the verbal scale showed no significant change when comparing the pre (2.6[1.3]) and post (2.3[1.2]) intervention values. Table 5 describes the results of the pain intensity assessed by the verbal scale at each week of the intervention for each individual.

There were no significant results for the McGill questionnaire. Table 6 summarizes the results.

Table 2. Sociodemographic features of individuals.

Identification	Gender	Age (years)	Marital Status	Schooling	Laterality	Profession
PLP1	F	65	Married	Graduation Complete	Right-handed	Retired
PLP2	M	22	Single	High School Complete	Right-handed	Athlete
PLP3	M	18	Single	High School Complete	Right-handed	Student
PLP4	F	80	Widower	Elementary School Complete	Right-handed	Retired
PLP5	M	62	Divorced	Graduation Complete	Right-handed	Retired
PLP6	F	51	Single	Elementary School Complete	Right-handed	Massotherapist
PLP7	M	60	Married	High School Complete	Right-handed	Retired
PLP8	F	59	Widower	High School Complete	Right-handed	Retired
PLP9	M	44	Married	Elementary School Complete	Right-handed	Salesman

Table 3. Features of individuals in relation to amputation and health conditions.

Individual	Amputation time (months)	Level of amputation	Affected limb	Cause of amputation	Post-surgical complications	Associated conditions	Use of drugs	Use of prosthesis
PLP1	5	Hip disarticulation	LLL	Tumoral	NO	YES	YES	NO
PLP2	64	Transumeral	RUL	Traumatic	NO	NO	NO	NO
PLP3	2.5	Transfemoral	LLL	Infectious	YES	NO	YES	YES
PLP4	6	Transfemoral	RLL	Tumoral	YES	YES	YES	NO
PLP5	4	Transfemoral	LLL	Vascular	NO	YES	YES	NO
PLP6	3.5	Transtibial	LLL	Infectious	YES	YES	YES	NO
PLP7	1.5	Transtibial	RLL	Diabetes	YES	YES	YES	NO
PLP8	8.0	Transtibial	LLL	Diabetes	NO	NO	YES	NO
PLP9	2.0	Transfemoral	LLL	Traumatic	NO	NO	NO	NO

LLL = left lower limb; RUL = right upper limb; RLL = right lower limb.

Table 4. Results of the SF-36 Questionnaire.

Variables	Pre-intervention	Post-intervention	P value
SF-36 Functional Capacity	46.1 [33]	47.8 [26]	0.79
SF-36 Physical Aspects	38.9 [40]	38.9 [25]	1.00
SF-36 Pain	43.3 [28]	42.9 [25]	0.88
SF-36 General Status	67.3 [31]	76.1 [24]	0.109
SF-36 Vitality	57.8 [30]	60.6 [16]	0.83
SF-36 Social Aspects	69.4 [25]	79.2 [18]	0.28
SF-36 Emotional Aspects	71.4 [41]	81.0 [33]	0.65
SF-36 Mental Health	78.7 [22]	86.2 [14]	0.43

The variables are expressed by median [interquartile range].

Table 5. Description of pain intensity at each week of intervention.

Individual	Pre-assessment	S1	S2	S3	S4	S5	S6	S7	S8	Post-evaluation
PLP1	Moderate	Moderate	Intense	Intense	Painless	Painless	Painless	NA	NA	Painless
PLP2	Painless	Painless	Light	Light	Light	Mild	Painless	NA	NA	Painless
PLP3	Light	Light	Painless	Painless	Painless	Painless	Mild	Painless	NA	Painless
PLP4	Mild	Mild	Mild	Moderate	Painless	Painless	Mild	Painless	Painless	Painless
PLP5	Moderate	Moderate	Intense	Mild	Mild	Painless	Moderate	Mild	NA	Mild
PLP6	Light	Mild	Intense	Painless	Painless	Painless	Mild	NA	NA	Mild
PLP7	Painless	Painless	Painless	Painless	Painless	Painless	Painless	NA	NA	Mild
PLP8	Painless	Painless	Painless	Painless	Painless	Painless	Painless	NAPainless	NA	Painless
PLP9	Moderate	Mild	Moderate	Painless	Painless	Painless	Painless	Painless	NA	Moderate

NA: not applicable (individual completed the protocol the previous week).

Table 6. McGill Questionnaire Results.

Variables	Pre-intervention	Post-intervention	P value
Sensorial	20.2 [7.7]	12.8 [5.5]	0.09
Emotional	7.0 [2.2]	5.4 [0.9]	0.123
Cognitive	3.1 [1.8]	1.9 [1.1]	0.168
Miscellaneous	7.7 [3.4]	6.1 [1.8]	0.55
Total	38.0 [12.7]	27.8 [4.6]	0.078

The variables are expressed by median [interquartile range].

The reports of PLP4, PLP8 and PLP9 emphasize the self-perception of individuals in relation to their emotional aspects.

> *I want to get up without pain and get this anguish off my chest. I feel an enormous sadness, I lost my husband, niece, son and sister last year* [...]. (PLP4, female, 80 years old, pre-intervention).

> *I felt everything, and I got emotional, I felt my foot and calf and it bothered me* [...]. (PLP8, female, 59 years old, Week 1).

> *Everything is tingling today, I've felt pain every day during this week. I was really down on Sunday, I don't know what it was, but I'm better now*. (PLP9, male, 44 years old, Week 2).

This is most evident in PLP6's report in Week 6, when they associated the recurrence of PLP with a period of emotional stress.

> *I spent a whole week without feeling* [...] *phantom pain, t think I felt it today only because I went through some stress in the morning* [...].

The same participant, in Week 5, showed another association between PLP and emotional aspects, when she said she was surprised not to feel pain at a challenging moment during a consultation for another health reason, reporting: "[...] *I didn't even feel phantom pain in the hospital, and I was tense* [...]".

The interference of PLP on QoL was highlighted by three individuals, who reported difficulties in carrying out daily tasks due to the pain.

> *When I train with the crutch the phantom foot gets in the way because I get confused, it gets heavy, I can't coordinate and I almost fall over. My phantom leg feels very heavy when I'm standing*. (PLP1, female, 65 years old, Week 6).

> *I wanted to be able to adapt to this sensation when I drive it bothers me a lot, I didn't want to feel it all the time* [...]. (PLP2, male, 22 years old, pre-intervention).

> *My foot hangs down,* [...] *I've almost fallen because of it, because I forgot I didn't have a foot. It gets in the way of concentration and reading* [...]. (PLP5, male, 62 years old, pre-intervention).

Among the sensory components, the term that appeared most in the reports was "tingling", mentioned by eight individuals in more than one occurrence; six participants marked the same descriptor in the pre-intervention McGill questionnaire. The self-perception of this aspect differed between the individuals, who understood it both as pain and as a phantom sensation, as the reports show.

> *It's a painful tingling, the leg (is) stretched out, the knee feels like a little ball*. (PLP4, female, 80 years old, Week 3).

> [It's been] *much weaker* [the PLP], *it doesn't come in the form of pain anymore, it only comes in the form of a sensation, a tingling, and it's rarer during the day*. (PLP3, male, 18 years old, post-intervention).

In addition to tingling, reports associated with neuropathic pain (burning, shock, stabbing) were present in five individuals; as well as descriptions suggesting nociceptive experiences, for example crushing and squeezing, in four individuals.

> [...] *it starts with a tingling, then a stabbing sensation under the finger, and then it goes to the shin, it's always this pattern of pain* [...]. (PLP5, male, 62 years old, Week 7).

> *It hurt a lot in the last few days, yesterday it hurt all day,* [...] *it felt like it was crushing my ankle and it went up to my shin, it was intense, all day it would come and go 10 minutes later* [...]. (PLP9, male, 44 years old, Week 3).

Individuals PLP5, PLP6 and PLP8, with vascular etiology or a complication of diabetes, reported PLP similar to pre-amputation pain.

> [...] R*ight now I have pain in my calf, exactly where it hurt when I had to have it amputated. It's the same pain as the day I was in the hospital, not as intense but in the same place* [...]. (PLP5, male, 62 years old, Week 6).

> [...] *I feel the pain of my first amputation, when it was only the big toe, but it also goes up to the stump and stays on the left side, the first two toes are uncomfortable, it's like the pain of an ingrown toenail.* (PLP6, female, 51 years old, pre-intervention).

> [...] [I feel] *a light phantom pain in the area of the wound that resulted in the amputation*. (PLP8, female, 59 years old, Week 1).

When describing the positioning of the limb, two individuals gave a similar account.

> *I feel* [...] *my calf straining as if it were hanging from a chair, it's shorter* [than the whole limb]. (PLP5, male, 62 years old, Week 1).

> *My knee* [is] *bent, I feel my knee burning,* [...] *my phantom leg is shorter than the other*. (PLP1, female, 65 years old, Week 1).

Other positions, reported by PLP1, PLP3 and PLP5, mention that the phantom limb "goes through" furniture such as a mattress or chair, or "hangs" over the edge of the bed.

> *Sitting down, what I feel is the calf and the foot as if the leg were crossing the chair, right under the stump, I don't feel the thigh, only the calf and the foot and it doesn't touch the floor, the foot* [is] *stretched out, it swings from side to side*. (PLP1, female, 65 years old, post-intervention).

> [I feel] *my knee down on the bed and my foot tingling, but it's random, not well defined*. (PLP3, male, 18 years old, Week 1).

> [...] *the* [phantom] *leg sinks into the mattress, as if it were stuck in a hole and it keeps swinging as if it were on a high edge, without touching the ground*. (PLP5, male, 62 years old, Week 2).

Among the factors that aggravate PLP, the most cited are climate change (especially cold and rain), which was reported by seven individuals on more than one occasion.

> [...] *During the week* [I only felt] *a light pain, like a quick shock, just because of the cold, as it was a whole week of a lot of rain, the stump squeaked a little.* (PLP4, female, 80 years old, Week 8).

> [...] [I] *only* [felt] *a light pain in my heel yesterday, a cold pain that soon passed, I didn't feel it the other days.* (PLP8, female, 59 years old, Week 7).

Rest associated with prolonged sitting was mentioned by two participants as another aggravating factor for PLP, especially at night. Seven individuals reported adopting the strategy of moving the phantom limb at times of pain, as observed in the report of PLP7.

> [...] *Some days it hurts more, especially in the early hours of the morning, but when I feel it, I make movements and it gets better immediately, I make the movements to speed it up and I feel some relief.* (PLP7, male, 60 years old, Week 4).

Of the seven individuals, only PLP9 reported an episode in which the strategy of moving the phantom limb was unsuccessful, and PLP5 was unable to use it due to emotional limitations at the moment of pain.

> [...] *I had a lot of pain yesterday out of nowhere, it went on all day, every,* [...], *I tried to move it, but it was no use, and it was only that day, I hadn't felt phantom pain since last week.* (PLP9, male, 44 years old, Week 7).

> [...] *I've tried to do the movements when I feel pain but I can't, because it bothers me, I run out of patience.* (PLP5, male, 62 years old, Week 6).

Another strategy, mentioned by PLP1 and PLP8, concerns denying the phantom limb as a way of coping with pain. Especially in the case of PLP8, this dynamic may be associated with the difficulty of accepting the technique in the first few weeks, showing an important emotional component, which could be observed in the practice of the Body Scanner in Week 1 (S1).

> *I felt everything and I got emotional, I felt my foot and calf and it bothered me. I don't want to feel the phantom foot, I don't want to feel something that isn't here and I don't want to move it* [...].

Participant PLP6, during S1's Body Scanner, presented an emotional situation similar to the one reported above, although both differed in their pain coping strategies, and PLP6 did not use denial.

> *I cried [at the Body Scanner] because I felt like it* [the amputated limb] *was here again, but it was good.*

During S4's Mirror Therapy, however, PLP8's reports showed a change in coping, similar to PLP6's report,

> *My phantom foot is stretching out and doing it together! I've never had sensations before, new and very good, it's good to feel the foot you no longer have, but without pain, just the sensation. It's incredible to see my leg, it gives me hope.*

DISCUSSION

Comparing the quantitative and qualitative values pre- and post-intervention, there were no significant differences in the quantitative values, but there was a qualitative perception of pain reduction in the individuals' reports, which shows a divergence between the two study approaches.

One hypothesis for the lack of reduction in pain perception using the McGill questionnaire is the multidimensional nature of pain[6]. In this way, individuals perceive and interpret it in a heterogeneous way, without there being a specific component in which there is a greater predominance in all cases, however there is a divergence between the results of the questionnaires and the reports collected throughout the study.

Regarding QoL, issues associated with mental health, physical limitations and dependence on daily activities are not primarily attributed to PLP, but to the amputation itself[27]. However, as observed in the study[2] and in the reports of PLP1, PLP2 and PLP5, the PLP interfered with activities that have an impact on QoL, such as walking with crutches (PLP1), driving (PLP2), reading and bathing (PLP5). This demonstrates the importance of developing specific instruments capable of identifying the real impact of phantom limb pain on QoL and the impact it can have on the activities of daily living of individuals with amputation[2].

The perception that the phantom limb is shorter than the whole limb is called telescoping and was reported by two individuals (PLP1 and PLP5). Telescoping has a negative influence on Mirror Therapy because it can lead to a proprioceptive contradiction of the image represented in the reflection. In some cases, the divergence between the representation of the phantom limb and the image can lead to the illusion of a third limb[28]. Individuals who reported telescoping also had higher pre-intervention PLP intensity.

In addition to telescoping, reference authors[29] mention the presence of impossible anatomical positions for the phantom limb. This could be observed in the reports of PLP1, PLP3 and PLP5 when they mentioned that the limb "goes through" furniture or hangs over the edge of the bed. It's important to note that the reports relate to the perception of the limb's position, unrelated to other exteroceptive sensations[29,30], for example, it is not linked to the thickness of the mattress or the material of the chair.

Regarding the factors that aggravate pain, it is worth highlighting those that refer to climate change, reported by seven individuals on more than one occasion. This phenomenon was described by one author[7] in a prospective study aimed at analyzing the main triggers capable of triggering episodes of LBP. Storms and cold were the main ones listed among those induced by the weather. It is speculated that this is due to the detection, through thermoreceptors, of drops in barometric pressure, changes in humidity or temperature, making them more susceptible to painful stimuli; in the case of cold, the reduction in blood flow in the stump and consequent vasoconstriction is the basis for the onset of PLP[7]. Climate triggers are related to afferent stimuli, without cortical origin, unlike other PLP mechanisms.

Rest associated with prolonged sitting was mentioned by two participants as another aggravating factor, while seven used movement as a PLP management strategy. Leading authors[31] have

shown a significant association between the ability to move the phantom limb and a reduction in pain intensity.

The reference study[32] described the association between body image distortion and PLP, while another study[33] linked this association to the process of denial as a "defense mechanism in the elaboration of physical loss". Both point out that the loss of a limb can culminate in an abrupt change in body image, as in the case of the negative reports by PLP1 and PLP8, making it necessary to positively reintegrate this image into the new scheme. This argument may also explain PLP8's understanding of the treatment after Mirror Therapy.

The identification of factors that aggravate pain, as well as the development of management strategies, are part of the concept of pain empowerment[34]. It is applied to chronic pain in general and demonstrates the importance of encouraging self-knowledge; when individuals are unaware of the factors that aggravate or trigger their pain, they enter a process defined as vulnerability[13].

Although there is evidence in the literature in favor of GMI as a non-invasive treatment option for PLP, studies are still scarce[35,36], with heterogeneous protocols and no consensus on frequency, session duration and total treatment duration. Few studies have looked at the use of telephysiotherapy for the treatment of PLP, with only one study[12] comparing three different groups. As a result, it was found that tele-rehabilitation did not have superior effects to Mirror Therapy alone; however, this study differs from the present research because it used tele-rehabilitation in a complementary and asynchronous way, without the presence of weekly meetings with the individual.

The present study had some limitations, such as the lack of a control group, the discontinuity of treatment in some individuals, with episodes of absences or inability to start Mirror Therapy on the appropriate day, as well as the small sample size. The small sample size can be justified by the exploratory and in-depth nature of the study, whose saturation of qualitative data was achieved with this sample number. The quantitative approach, although with a small sample size, allows hypotheses to be generated for future studies.

There is also a possible memory bias, due to the fact that the reports were transcribed without prior audio recording, although this situation is close to clinical practice. Another issue is that telephysiotherapy may have a selection bias, since the study may exclude individuals who do not have access to the internet. It should also be pointed out that the study showed strong internal validity of the data since there was a considerable number of variables analyzed for each individual, which makes it possible to carry out a more personalized treatment suited to individual needs.

CONCLUSION

There was no significant difference in the parameters of QoL, intensity and perception of pain, however the qualitative reports show the perception of improvement of the individuals. This divergence between the results reflects the need to develop and validate a specific questionnaire for assessing PLP in Portuguese, so that it is possible to measure the intensity of pain and its direct interference in the QoL and functionality of individuals, excluding other factors such as the amputation itself, emotional aspects or associated diseases.

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