Effects of Mirror Therapy Applied in Patients after Stroke – Literature Review

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ABSTRACT

Introduction. Stroke is characterized as the rapid development of clinical signs of focal and/or global disorders of brain function causing changes in sensory, motor, and cognitive planes. Goals. To analyze the effectiveness of Mirror Therapy (ET) in motor and cognitive function in stroke patients. Methodology. This is a descriptive research, literature review between the years 2007 to 2022, found in the platforms Scientific Electronic Library Online (Scielo), Phisiotherapy Evidence Database (PEDro), USP Journal and Pubmed database on the theme of the study by the descriptors in health (DeCS), stroke, Mirror Therapy, Motor and Cognitive Rehabilitation, Neuroplasticity and Physical Therapy. Initially, 248 articles were identified using keywords; Initially, 191 were excluded, being duplicate articles and totally out of topic, of the remaining 57, 45 were excluded in the second stage for presenting electrothermophototherapeutic resources in their methodology. Leaving 12 articles for being purely related to the topic. Findings. Mirror therapy provides recovery from brain damage by enabling neuroplasticity; improves the sensitivity and functionality of the affected limb and improves motor skill and cognition mastery when associated with systematized and standardized kinesiotherapy in stroke patients. Conclusion. The association of physiotherapy with ET consists in the improvement of motor and cognitive functionality, which may be associated with other physiotherapeutic techniques or performed alone.

Keywords: Mirror Therapy, Stroke, Motor and Cognitive Rehabilitation, Neuroplasticity, Physical Therapy.

1 INTRODUCTION

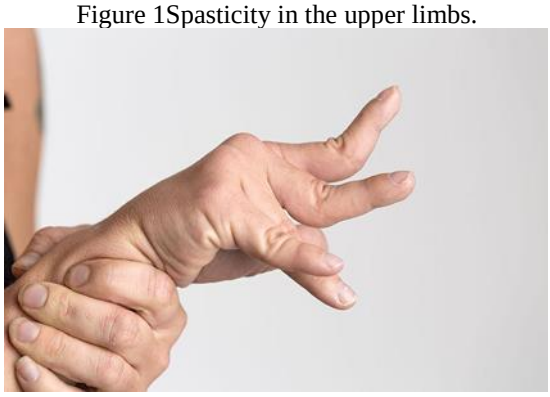
According to the World Health Organization (WHO, 2013) the Stroke is characterized as the rapid development of clinical signs of focal and/or global disorders of brain function causing changes in sensory, motor and cognitive planes, according to the area of extension of the lesion, and can be classified as hemorrhagic or ischemic.

In the hemorrhagic classification occurs the rupture of an artery causing the extravasation of blood in the intercerebral space. In the ischemic classification there is a deficit in blood supply in a certain area of the brain in a period of more than 24 hours, which can be embolic or arteriosclerotic. (FIGUEIREIDO; PEAR TREE; MATTHEW; 2020)

According to Ferreira (2016) risk factors may include: obesity, cardiovascular diseases, diabetes mellitus, carotid atherosclerosis, hypertension, sedentary lifestyle, smoking, behavioral conditions (emotional and stress) and genetic predispositions.

The most common clinical manifestations caused by stroke are hemiparesis, weakness of an entire side of the body and hemiplegia which, in its most severe form, causes complete paralysis of half the body. These are often associated with weakness or spasticity of the extremities (figure 1 and figure 2), lack of motor coordination leading to imbalance and impairing the individual's dependence on their functional activities causing limitations in their autonomy. (FIGUEIREIDO; PEAR TREE; MATTHEW; 2020)

Figure 1Spasticity in the upper limbs.



Source 1Books Kingdom. Available in: What is the difference between spasticity and rigidity - Accounting 2023 (books-kingdom.com)

Figure 2 Spasticity of the lower limbs.

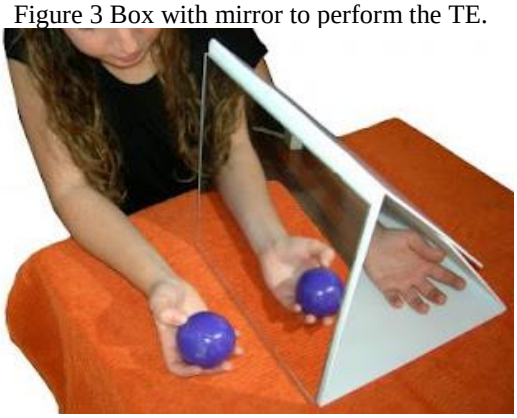
Source 2 Live well. Available in: https://guiaviverbem.com.br/espasticidade-tem-cura/

We can observe several manifestations that may also be associated and that cause direct motor and sensory impairments. Among them: somatosensory deficits, pain, visual deficits, paresis and plegias, speech and language disorder, dysphagia, perceptual and cognitive dysfunction, affective disorders, bladder and bowel dysfunction, balance and motor coordination dysfunction and indirect impairments such as: venous thromboembolism, reduced flexibility, subluxation, shoulder pain and reflex sympathetic dystrophy. Facts that are aggravating the involvement of stroke (Hospital Israelita Albert Einstein; 2020).

Mirror Therapy was initiated in 1992 by Ramachadran and Roger in amputee patients and was later used in patients with motor loss and imprecision of movement. Although ET has its focus on the treatment of pain of a phantom limb, that is, amputees, in patients affected with stroke, this therapy has as a strategy the observation of the movements of the unaffected limb in an attempt to imitate them with the affected limb in a synchronized way with the mirror, thus acting through visual perception, provoking an external feedback (mirror) and internal feedback (mental practice) (BEN et al., 2020).

For the execution of this therapy it is necessary to use a box with a mirror attached to the sagittal plane of the patient to be treated, the healthy limb should be positioned in front of the mirror and the affected limb behind it (figure 3). Some protocols are based on the execution of isolated movements such as extension, flexion, pronation and supination or, in the performance of functional tasks such as folding clothes and eating for example, the latter protocol, according to recent studies, being more effective in patients with stroke (SILVA; VIEIRA, 2017).

Figure 3 Box with mirror to perform the TE.



Source 3 Physio Informs. Available in: https://fisioterapiajoaomaia.blogspot.com/2013/05/a-utilizacao-de-espelho-na-reabilitacao.html

It is believed that this therapy, through the reflected images and their interaction with the central nervous system, stimulates neuroplasticity resulting in an effective functional recovery after stroke, making it necessary in the recovery of movements, sensitivity, enabling an improvement in function and consequently providing greater independence (SILVA; SCALLOP; 2017).

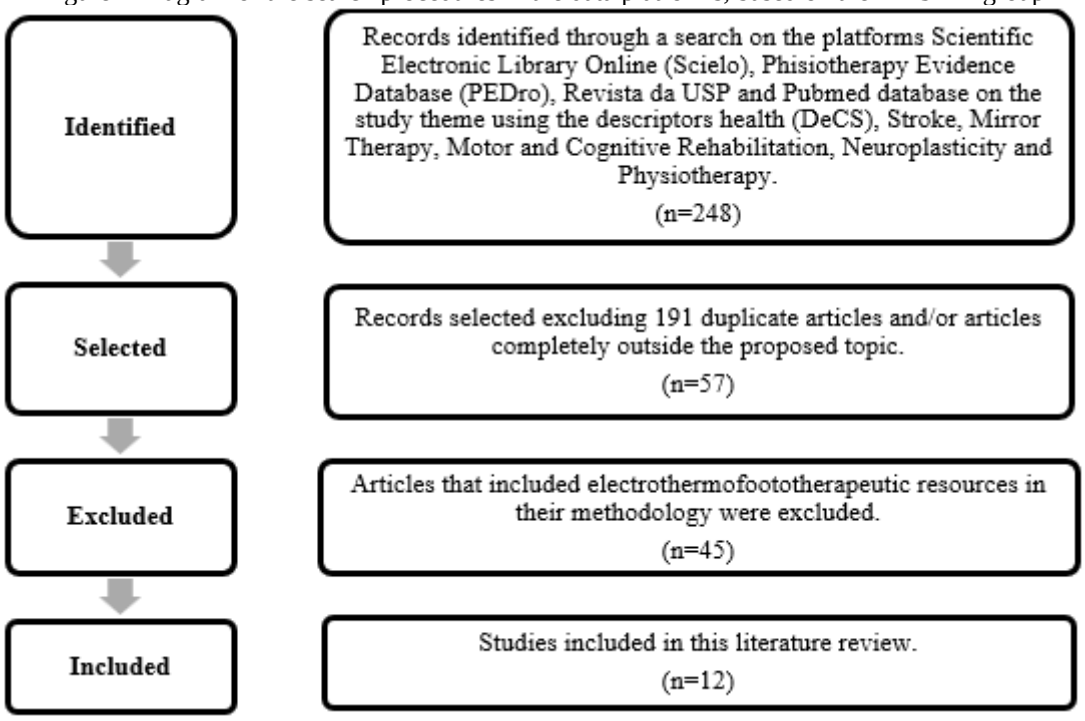
Therefore, the present study aimed to evaluate the effects of mirror therapy in patients affected by stroke in publications already evaluated.

2 METHODOLOGY

The summary of the procedures of this literature review was made according to the criteria of PRISMA (2009) and can be seen in Figure 4.

This article adopted as methodology the literature review. Research based on information obtained electronically on the platforms of Pubmed, Scielo, Portal de Revistas da USP, PEDro and Google Scholar, in national and international journals between 2007 and 2022. The references established for the research were ET in MMSS and its effects in stroke patients.

Figure 4 Diagram of the search procedures in the data platforms, based on the PRISMA group



3 FINDINGS

Table 1 presents results obtained by the authors through their research. They were presented grouped together, highlighting the conclusion of each study on the effectiveness of mirror therapy.

Table 1. Summary of the articles used on the efficacy of mirror therapy in patients with stroke.

Author/ Authors	Title	Methodology	Conclusion
SÜTBEYAZ, et al., (2007)	*Mirror therapy enhances lower-extremity motor recovery and motor functioning after stroke.*	Randomized study with participants with stroke included in a Rehabilitation Program performed 5 days a week, 2 to 5 hours a day, in 4 weeks.	Mirror therapy combined with a conventional rehabilitation program improves the mobility and functionality of LLLLs when compared to LLLL.
DOHLE, et al. (2009)	*Mirror Therapy Promotes Recovery from Severe Hemiparesis: A Randomized Controlled Trial.*	Thirty-six patients with severe hemiparesis due to a first ischemic stroke in the territory of the middle cerebral artery were included, no more than 8 weeks after the stroke. They completed a 6-week protocol of additional therapy (30 minutes per	ET soon after stroke is a promising method for improving sensory and attentional deficits and for supporting motor recovery in a distal plegic limb.

		day, 5 days per week), with random assignment to mirror therapy (TM) or equivalent control therapy (CT). The main outcome measures were the Fugl-Meyer subscores for the upper extremity, assessed by independent evaluators using videotape. The patients also underwent functional and neuropsychological tests	
MACHADO, et al. (2011)	Mirror therapy applied to the functional recovery of post-stroke patients.	This opinion article was based on 10 other articles from 1992 to 2007, which dealt with mirror therapy in patients with stroke.	Mirror therapy is a safe and useful possibility that has demonstrated positive results in the functional recovery of patients with post-stroke hemiparesis.
FIGUEIREDO; PEREIRA; MATEUS. (2011)	Mental practice in upper limb rehabilitation after stroke – clinical cases	Four patients with acute stroke with motor sequelae of hemiplegia or hemiparesis participated in the study. Two underwent mirror therapy associated with kinesiotherapy and the other two performed only kinesiotherapy.	The response of motor improvement associated with the mirror was observed only in paretic patients, suggesting the need for further studies in plegic patients.
GOMES; MEJIA. (2014)	Functional recovery of stroke patients after mirror therapy.	The research was done through a literature review on stroke, the Mirror Neuron Theory, Mirror Therapy and its effectiveness in recovering the functionality of patients who have suffered stroke.	It can be concluded that the effectiveness of mirror therapy applied to stroke is shown by the improvement of sensitivity, hemiplegia and functionality of the affected limb, the mirror therapy technique associated with other types of therapies also show to be effective to obtain the functionality lost by stroke.
Medeiros, et al. (2014)	*Effects of Mirror Therapy Through Functional Activites and Motor Standards in Motor Function of the Upper Limb After Stroke.*	Six patients with hemiparesis of the arm at least six months post-stroke were randomized to a group of functional activities and a group of motor patterns. Both groups performed 15 mirror therapy sessions for 30 minutes.	This study showed improvement in functional impairment regardless of the type of movement made during mirror therapy
BRUNETTI, et al. (2015)	*Potential determinants of efficacy of mirror therapy in stroke patients – A pilot study.*	Participants were 11 patients with subacute stroke with severe paresis of the upper limb, receiving hospital rehabilitation. After a set of pre-assessments, four weeks of ET were applied, followed by a set of post-assessments.	It was concluded that the initial motor function was confirmed as a crucial determinant of motor recovery. In addition, the activity response to the mirror illusion in both precuneus was considered a candidate for determining the efficacy of ET.

YELDAN, et al. (2015)	*The Effects of Very Early Mirror Therapy on Functional Improvement of the Upper Extremity in Acute Stroke Patients.*	Patients with stroke were separated into two groups, a mirror therapy group in conjunction with neurodevelopment and a neurodevelopmental group only.	The results of this pilot study revealed that mirror therapy too early has no effect on functional improvement and further studies are needed to determine the results of early application of mirror therapy in stroke rehabilitation.
MOTA, et al. (2016)	Mirror therapy in the upper limb of patients after stroke.	This is a quasi-experimental study of the before and after type. The study included 10 post-stroke patients who were undergoing physical therapy and presented paresis in the upper limb.	It can be concluded that the mirror therapy contributed to the participants of this research to obtain good evolution in the aspects studied, especially in relation to the range of motion (ROM) of the affected upper limb.
SILVA; VIEIRA. (2017)	The effectiveness of mirror therapy in the process of motor and functional recovery in patients with stroke.	The research was conducted by reviewing scientific articles available in the electronic databases PeDro, PubMed, SciELO, PsychInfo, Science Direct and Lilacs, published between 2007 and 2017. The inclusion criteria were: clinical case studies; randomized controlled trials related to mirror neuron theory; and the efficacy of mirror therapy in the motor and functional recovery of the upper limb in female and male participants, aged over eighteen years and diagnosed with ischemic stroke and with a maximum of two years of injury.	The analyzed studies prove that mirror therapy is an extremely useful method when used alone or combined with other treatments that promotes a cortical reorganization, causing functional and motor gains, as well as the development of bilaterality.
WOOST, et al. (2018)	*Physical Exercise and Spatial Training: A Longitudinal Study of Effects on Cognition, Growth Factors, and Hippocampal Plasticity.*	In the present study, we investigated a sequential combination of physical activity for cognitive improvement in healthy youth and adults. To this end, we compared the effects of eight 20-minute cycling sessions, sixteen 30-minute sessions of spatial training, a combination of both, and included a passive control cutoff.	The visual stimulation associated with motricity can leverage the neural stimulation processes, causing the nerve conduction speed to rise, and may thus be related to the improvement of gross and fine motor coordination, such as gait and reasoning
LIVEIRA, et al. (2020)	Mirror therapy in physiotherapeutic treatment and post-stroke patients: a systematic review	This study is a systematic review of the literature. The following databases were used: MEDLINE, PubMed, LILACS, SciELO and PEDro, including publications between 2014 and 2019, in Portuguese and English.	When the mirror therapy technique is used in the studies in evidence, it is noted that it is quite effective for patients with sequelae of the disease, because it brings a decrease in the degree of paresis from severe to moderate.

Source 5 Research data.

4 DISCUSSION

According to the Brazilian Academy of Neurology (ABN), stroke represents the leading cause of death and disability in Brazil. Mirror therapy is a finding that has instigated much interest in recent years, being a mechanism based on the observation of action (CASTRO et al., 2018; CORBETTA et al., 2018). According to Ben (2020), A Unified Protocol of the technique focused on the stroke is necessary to improve its performance, being defined as the use of a mirror reflex of movements of unaffected limbs superimposed on the affected extremity, in addition to being a form of treatment of phantom pain, it is used to assist in perception problems and hemiparesis after stroke.

Dohle et al. (2009), report that sensory motor recovery is more apparent in the first three months after the individual suffers a stroke. In contrast, Yeldan; et al. (2015), state that the therapy applied early did not contribute to a significant improvement in the functions of the upper limb. However, it cannot be concluded that ET had a greater influence in each phase, judging that there were positive results in all of them. In general, with the use of ET it was found a significant improvement in the gross and fine motor functions of the upper limb and that this therapy provided significant changes in the functional independence of the individual. According to Dohle (2009), observation also modulates the ability to alter cortical somatosensory representations, thus obtaining the recovery of the sensation of temperature and proprioception.

Taking into account the findings of Machado, et al. (2011), a pilot study conducted with 9 patients, it was possible to observe the improvement of the functional variable at moderate levels in 3 patients; mild in 3 patients, and practically nil in the other 3 patients. Subsequently, case reports and series related to the beneficial effects for hemiparesis after stroke were found. Another 2 studies by Sütbeyaz, et al., (2007) and Yavuzer, et al., (2008) showed significant improvement in hemiparesis. All studies used 40 volunteers with hemiparesis, being observed as characteristic in the first the clinical condition in the lower limbs (LLLL) and in the second in the upper limbs (MMSS) up to 12 months after stroke. The volunteers were randomly distributed into groups, being: mirror therapy (movements of the lower limbs for the first study and movements of MMSS for the second) or control, where all volunteers received physiotherapy protocols as an intervention. Significant improvements in sensorimotor deficits were also observed in favor of the experimental group when compared to the control group. After the first study carried out by Ramachandran and Rogers (1992), other studies were inspired for the use of therapy because of questions about the effectiveness of the technique, as they presented good results. Thus, according to this study, it is believed that the therapy presents a significant potential for future applications in neurological treatments.

According to Lima (2015), with the performance of mirror therapy periodically, the patient tends to become less anxious about the movement of the limb affected by the injury, thus allowing the increase of movement and consequently the progression of the rehabilitation process.

Brunetti et al. (2015), on the other hand, used ET together with the Bonn protocol, which consists of proximal movements combined with distal variations. In the study by Gaspar et al. (2011) ET was used allied to mental practice exercises that consists of a training method in which the internal reproduction of a motor act is repeated countless times with the intention of promoting, learning and improving a motor skill. In both studies it was possible to observe the development of bilaterality in individuals.

According to Mota (2016), only in relation to spasticity was not demonstrated improvement with the application of this technique. This ineffectiveness can be attributed to the fact that the mirror therapy does not have a direct action on the muscle spindles, which is fundamental for the reduction by delaying the transmission of nerve signaling, however, it can be concluded that the mirror therapy contributed to the participants of this research to obtain good evolution in the aspects studied, especially in relation to the ROM of the affected upper limb.

In the analysis made by Silva and Vieira (2017) demonstrated that therapy can be effective when performed alone or in combination. Five studies that were analyzed used the conventional ET method together with exercises composed of flexion and extension of the shoulder, fingers, elbow and wrist and movements of pronation and supination of the forearm. In the study by Medeiros et al. (2014), two modalities were compared: ET with isolated movements and ET with functional tasks. It resulted in a significant improvement in the cognition domain, however, no difference between the groups was reported.

In recent studies, according to Silva and Vieira (2017), individuals in the acute, subacute and chronic phases were evaluated that caused similar effects regarding the effectiveness of ET in the recovery of functionality, strength gain, manual dexterity, fine motor coordination, range of motion and development of bilaterality.

Therefore, non-drug interventions such as mirror therapy, and the elevation of physical exercise levels in patients affected by stroke, demonstrate significant functional improvements in these individuals, because visual stimulation associated with motor skills can leverage neural stimulation processes, causing nerve conduction speed to rise, thus being related to the improvement of gross and fine motor coordination and reasoning (WOOST et al., 2018).

Thus, the use of the mirror therapy technique associated with other forms of treatment in post-stroke patients is very effective in reducing the degree of paresis from severe to moderate and great improvement in patients in the subacute phase, especially if performed in conjunction with passive mobilization, stretching and kinesiotherapy, bringing significant results in patients with chronic stroke. (OLIVEIRA; et al., 2020)

5 FINAL CONSIDERATIONS

Taking into consideration the aspects observed in this study we can conclude that ET is a mechanism based on the observation of the action that provides a recovery of brain damage by stimulating neuroplasticity. In addition, it is a treatment considered effective because it results in the improvement of the sensitivity and functionality of the affected limb, improvement of motor skills and in the domain of cognition, and can be combined with functional kinesiotherapy and the practice of systematized and equalized physical exercises. Thus, we note that mirror therapy can help in the treatment of stroke, especially when affected in the upper limbs, and it is necessary to develop new research for other damages to the Central Nervous System.

REFERENCES

BEN, A. J.; et al, 2016. "Resumo Clínico - AVC". Porto Alegre-RS. Disponível em: neurologia_resumo_avc_TSRS.pdf (ufrgs.br) Acesso em 15/03/2021.

BRASIL, Ministério da Saúde, 2013. "Diretrizes de Atenção à Reabilitação da Pessoa com Acidente Vascular Cerebral".

BRUNETTI, M.; et al. "Potential Determinants of Efficacy of Mirror Therapy in Stroke Patients: A Pilot Study". 2015. Restor neurol neurosci. 2015;33(4):421-34, doi: 10.3233/RNN- 140421.

BRUNETTI, Maddalena; MORKISCH, Nadine; FRITZSCH, Claire; MEHNERT, Jan; STEINBRINK, Jens; NIEDEGGEN, Michael; DOHLE, Christian. Potential determinants of efficacy of mirror therapy in stroke patients – A pilot study. Restorative Neurology And Neuroscience, [S.L.], v. 33, n. 4, p. 421-434, 19 ago. 2015. IOS Press. http://dx.doi.org/10.3233/rnn-140421.

CASTRO, Pedro Oliveira e; MARTINS, Maria; COUTO, Glória; REIS, Maria. Mirror therapy and self-care autonomy after stroke: an intervention program. Revista de Enfermagem Referência, [S.L.], v. , n. 17, p. 95-106, 20 jun. 2018. Health Sciences Research Unit: Nursing. http://dx.doi.org/10.12707/riv17088.

CORBETTA, Davide; SARASSO, Elisabetta; AGOSTA, Federica; FILIPPI, Massimo; GATTI, Roberto. Mirror therapy for an adult with central post-stroke pain: a case report. Archives Of Physiotherapy, [S.L.], v. 8, n. 1. 23 fev. 2018. Springer Science and Business Media LLC. http://dx.doi.org/10.1186/s40945-018-0047-y.

DOHLE, Christian; PÜLLEN, Judith; NAKATEN, Antje; KÜST, Jutta; RIETZ, Christian; KARBE, Hans. Mirror Therapy Promotes Recovery From Severe Hemiparesis: a randomized controlled trial. Neurorehabilitation And Neural Repair, [S.L.], v. 23, n. 3, p. 209-217, 30 out. 2008. SAGE Publications. http://dx.doi.org/10.1177/1545968308324786.

HOSPITAL ISRAELITA ALBERT EINSTEIN, 2020. Acidente Vascular Cerebral. Disponível em: Principais informações sobre o AVC. 28 de outubro de 2021, https://vidasaudavel.einstein.br/principais-informacoes-sobre-o-avc/. Acesso em: 10 de setembro de 2021.

FERREIRA, Fhilipe. Santos.; A Influência da terapia do espelho nos membros superiores em pacientes pós-AVE: Uma revisão bibliográfica. Interfisio. 2016. Disponível em: A Influência da Terapia Espelho nos Membros Superiores em Pacientes Pós-Ave: Revisão Bibliográfica – InterFISIO . Acesso em 20 setembro 2021.

FIGUEIREDO, Ana Rita Gonçalves de; PEREIRA, Alexandre; MATEUS, Sónia. Acidente vascular cerebral isquémico vs hemorrágico: taxa de sobrevivência. HIGEIA: Revista Científica da Escola Superior de Saúde Dr. Lopes Dias, 2020.

GASPAR, Bruna Esequiel; HOTTA, Tássia Tamy Hirono; DE SOUZA, Luciane Aparecida Pascucci Sande. Prática mental na reabilitação de membro superior após acidente vascular encefálico–casos clínicos. ConScientiae Saúde, v. 10, n. 2, p. 319-325, 2011.

GOMES, Rita de Fátima Marinho; MEJIA, Dayana Recuperação funcional de pacientes com AVE após a terapia do espelho. 2014. Pós graduação em fisioterapia em neuro funcional, Faculdade Sul–Americana/FASAM.

MACHADO, Sergio Machado; VELASQUES, Bruna; PAES, Flávia, CUNHA, Marlo; BASILE, Luis F.; BUDDE, Henning; CAGY, Maurício; PIEDADE, Roberto; RIBEIRO, Pedro. "Terapia-espelho aplicada à recuperação funcional de pacientes Pós-Acidente Vascular Cerebral."Revista Neurociências 19.1 (2011): 171-175.

MEDEIROS, Candice Simões Pimenta; FERNANDES, Sabrina Gabrielle Gomes; LOPES, Johnnatas Mikael; CACHO, Enio Walker Azevedo; CACHO, Roberta de Oliveira. "Effects of mirror therapy through functional activites and motor standards in motor function of the upper limb after stroke. Fisioterapia e pesquisa 21 (2014): 264-270., doi: https://doi.org/10.590/1809-2950/87821032014.

MOTA, Dreyzialle Vila Nova; MEIRELES, André Luís Ferreira de; VIANA, Marcelo Tavares; ALMEIDA, Rita de Cássia de Albuquerque. Mirror therapy for upper limb rehabilitation in chronic patients after stroke. Fisioterapia em Movimento, [S.L.], v. 29, n. 2, p. 287-293, jun. 2016. FapUNIFESP (SciELO). http://dx.doi.org/10.1590/0103-5150.029.002.ao07.

OLIVEIRA, Thayana Fernanda da Silva; MORAES, Ana Priscila Santos; ALVES, Márcio Eduardo Silva; SOUZA, Maria Cristina Damascena dos Passos; GOMES, Vinicius de Queiroz. A TERAPIA DO ESPELHO NO TRATAMENTO FISIOTERAPÊUTICO DE PACIENTES PÓS ACIDENTE VASCULAR CEREBRAL: revisão sistemática.. Fisioterapia na Saúde Coletiva: Perspectivas para a Prática Profissional, [S.L.], p. 19-30, 2020. Editora Científica Digital. http://dx.doi.org/10.37885/201001713.

SILVA, Aline Alves da; VIEIRA, Kleber Sulpino. A EFICÁCIA DA TERAPIA ESPELHO NO PROCESSO DE RECUPERAÇÃO MOTORA E FUNCIONAL EM PACIENTES COM ACIDENTE VASCULAR ENCEFÁLICO. Revista Brasileira Ciências da Saúde - Uscs, [S.L.], p. 104-109, jul. 2017. USCS Universidade Municipal de Sao Caetano do Sul. http://dx.doi.org/10.13037/ras.vol15n53.4699.

SÜTBEYAZ, Serap; YAVUZER, Gunes; SEZER, Nebahat; KOSEOGLU, B. Füsun. Mirror Therapy Enhances Lower-Extremity Motor Recovery and Motor Functioning After Stroke: a randomized controlled trial. Archives Of Physical Medicine And Rehabilitation, [S.L.], v. 88, n. 5, p. 555-559, maio 2007. Elsevier BV. http://dx.doi.org/10.1016/j.apmr.2007.02.034.

WOOST, Luise; BAZIN, Pierre-Louis; TAUBERT, Marco; TRAMPEL, Robert; TARDIF, Christine L.; GARTHE, Alexander; KEMPERMANN, Gerd; RENNER, Ulrich; STALLA, Günter; OTT, Derek V. M.. Physical Exercise and Spatial Training: a longitudinal study of effects on cognition, growth factors, and hippocampal plasticity. Scientific Reports, [S.L.], v. 8, n. 1, 9 mar. 2018. Springer Science and Business Media LLC. http://dx.doi.org/10.1038/s41598-018-19993-9.

YAVUZER, Gunes; SELLES, Ruud; SEZER, Nebahat; SÜTBEYAZ, Serap; BUSSMANN, Johannes B.; KÖSEOğLU, Füsun; ATAY, Mesut B.; STAM, Henk J.. Mirror Therapy Improves Hand Function in Subacute Stroke: a randomized controlled trial. Archives Of Physical Medicine And Rehabilitation, [S.L.], v. 89, n. 3, p. 393-398, mar. 2008. Elsevier BV. http://dx.doi.org/10.1016/j.apmr.2007.08.162.

YELDAN, Ipek; HUSEYđNSđNOGLU, Burcu Ersoz; AKđNCđ, Buket; TARAKCđ, Ela; BAYBAS, Sevim; OZDđNCLER, Arzu Razak. The effects of very early mirror therapy on functional improvement of the upper extremity in acute stroke patients. Journal Of Physical Therapy Science, [S.L.], v. 27, n. 11, p. 3519-3524, 2015. Society of Physical Therapy Science. http://dx.doi.org/10.1589/jpts.27.3519.