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Società Italiana di Fisioterapia

CONTENTS

Appropriateness of physiotherapy intervention: do not forget the patient

R. GATTI

School of Physiotherapy, San Raffaele Scientific Institute, Milan, Italy

The health care system is a huge item of expenditure in all the western countries. The world economic crisis is constraining the political administrations to plan new organizational models, able to prevent the increasing deficit in the health care sector and to satisfy the needs of sick people. In this context eliminating the inappropriate use of health services can satisfy financial constraint without compromising quality of care. Thirty years ago Gertman and Restuccia[1] proposed the Appropriateness Evaluation Protocol (AEP), which is an instrument able to detect the efficiency of hospital utilization by assessing unnecessary hospitalization days. From its publication AEP has been frequently adopted by several researchers and managers and new versions, adapted to specific countries, have been developed[2].

The appropriateness identified by the AEP does not use "clinical appropriateness" in the same sense as we might mean usefulness of a clinical intervention for a particular patient. Instead the AEP measures that this intervention has been delivered with the highest possible efficiency, also considering the cost-benefit ratio of the intervention.

Is it correct to consider this kind of appropriateness in physiotherapy? Perhaps, but with a very important variable to take into account: the patient's behavior. More precisely we must consider the impact of the environment on the patient. In order to understand the relationship between patient and environment better, the characteristics of the outcomes measures adopted in physiotherapy can be considered. The outcome measures used for assessing the efficacy of physiotherapy treatments are often based on patient' behavior (*e.g.* the ability in walking, dressing, washing etc..) sometimes directly recorded by the patient (self-administered scales). In this regard Tesio[3] explains that one of the main characteristics in rehabilitative medicine is the use of latent variables as outcome measures. The variables measured in medicine can be divided into manifest variables which consider the interaction between the body parts and latent variables which consider the interaction between person and environment. The first group includes the easily measurable chemical and physiological parameters while the second group includes variables such as autonomy, which is derived from the measure of specific behaviors, for example items related to the activities of daily living.

We derive the efficacy of the physiotherapy intervention from the interaction between the whole person and the environment. Especially we must attend to the fact that patients can alter an intervention by changing the dose of therapy administrated to them. The efficacy of therapeutic exercise is based on the exercises' intensity and duration. Strength training has to be performed following the concept of overload[4], balance training has to be performed using challenging exercises, not only in subjects with balance disorders,[5] but also in aging subjects[6] or in subjects with chronic low back pain[7]. Assuming the exercise is the "drug" whose dose is affected by the patient's behavior, adherence to the

physiotherapist's instructions can alter the dosage. The situation is very different in conditions where the health practitioners can control the dose of therapy, as in the case of administration of pharmaceutics.

Moreover, physiotherapists know that the efficacy of their intervention changes a patient if the environment is modified. For example many patients are less independent in the hospital ward in comparison to what they are able to perform during the session of physiotherapy. The reverse situation can happen when the patients who are in their home demonstrate a greater motivation to express their autonomy. Also, the presence of the family members can modify the patient's behavior: the husband or the wife, the son or the daughter sometimes inhibit and other times facilitate the patient' performance. This modulating effect of the environment is a variable that is very difficult to control.

Although the "best" measures used in rehabilitation are chosen based on appropriate psychometric characteristics, they do not account for when the same item is performed by the same subject in different environments.

The study of this variability could be an interesting research topic in physiotherapy. This theme is not completely new. I know that some researchers have already begun to study this topic in subjects with central nervous system lesions.

In conclusion, in physiotherapy it could be possible to speak of appropriateness. But only if the patients' behavioural characteristics are a component in determining the appropriate use of health services and the quality of care.

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The use of non-thrust manipulation in a consecutive case series of patients who met the clinical prediction rule for thrust manipulation

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ABSTRACT

Aim. A recent comparative study suggested that thrust manipulation was more beneficial than non-thrust manipulation in patients with LBP who met a clinical prediction rule for thrust manipulation. The non-thrust manipulation technique used in the study was dissimilar to techniques used in clinical practice, thus questioning the transferability of the finding. The purpose of this case series was to evaluate the benefit of non-thrust manipulation in patients who met the CPR for thrust manipulation, after allowing the practicing clinicians to use a non-thrust procedure that was specific to the patient's condition, that was adapted based on the patient response, and was modified based on changes in the patient's outcome.

Methods. The study was a case series design. Six consecutive patients, who were originally enrolled as part of a randomized controlled trial, who were treated by two experienced physical therapists. The treatment intervention reflected the same time parameters and home exercise initiatives of the original CPR derivation and validation studies.

Results. Eight of the 11 patients demonstrated improvements in disability whereas all had high levels of reported recovery (60% to 100%). And 10 of them improved in self report of pain.

Conclusion. This case series found that patients who met a CPR for thrust manipulation who received non-thrust manipulation, improved over time. Further studies are needed to better support thrust versus non-thrust manipulation and to further determine whether the CPR is purely prognostic in nature. *(It J Physiotherapy 2011;1(3):65-72)*

Key words: Musculoskeletal diseases - Low back pain - Exercise - Occupational diseases.

Manipulation (both thrust and non-thrust) is a frequently recommended treatment tool for remediation of low back pain. Both forms of manipulation involve skilled application of a manual technique designed to either: 1) reduce disability or pain,[1, 2] or 2) increase range of motion.[3] Both are designed to affect a within-session change, which in turn is expected to affect a longer-term change (between-session) and progression toward improved disability.[4]

There are a myriad of types of both procedures; each involving different characteristics, set-up, and foci. Thrust manipulation involves an accurately localized or globally applied single, quick, and decisive movement of small amplitude, after careful positioning of the patient.[5] Non-thrust manipulation does not involve a thrusting procedure, but is characterized by rhythmic, repetitive, passive movements, well within the patient's tolerance, in voluntary and/or accessory ranges.[5] Between the two types, thrust manipulation does not generally involve modifications based on patient report of change during the procedure whereas non-thrust manipulation advocates this as a requirement for optimal outcome. It

is worth noting, that non-thrust and thrust manipulation, differ not only by technique of application (patient set up and directional aspects of the treatment of often the same) but by modification of the future application based on immediate patient response.

Both interventions are hypothesized to stimulate similar treatment effects. Thrust manipulation has been shown to provide a strong neurophysiological effect after administration (short term) [6] and a minor biomechanical effect (also short term).[6, 7] The effects of thrust-manipulation have been shown to carry over for 30 minutes to 5 hours,[6] have been shown to facilitate multifidi contraction,[8] and are hypothesized to function to catalyze normalized movements after application. [6] Although less studied than thrust manipulation, non-thrust manipulation also is hypothesized to provide short term neurophysiological and biomechanical effects and is also hypothesized to function as a catalyst for normalization of global movements after application.[9] In addition, non-thrust manipulation has been shown to alter fluid dynamics of the disc in the low back after repeated applications.[10]

Thrust and non-thrust manipulation have been recognized as beneficial for treatment of acute, subacute, and chronic low back pain when compared to sham therapy or placebo,[11] and have been included in a number of clinical practice guidelines for the treatment of low back pain.[12] Of the two forms of manipulation, thrust manipulation has been more frequently studied. Thrust manipulation is considered to be equally effective to comparators such as physical therapy exercises or interventions, back school, or therapies that included non-thrust mobilization, but not superior.[13] The evidence to support non-thrust manipulation is less robust primarily because there are fewer studies that have examined this method of manipulation.

Only one study [14] has directly compared thrust manipulation (two distinct methods) to non-thrust manipulation and did so in a select population of low back pain patients who met a clinical prediction rule (CPR) for spinal manipulation.[15, 16] The study design involved the use of three groups, two with thrust manipulation techniques and 1 using a technique described as a non-thrust procedure or "mobilization". The procedure for the non-thrust manipulation technique was as follows: The non-thrust manipulation technique was applied for 60 seconds at the L4 and L5 spinous process, and the technique did not use verbal feedback from the patient, nor did it require a reproduction of the patient's concordant/comparable/familiar sign. Although there are countless forms of non-thrust manipulation techniques used in clinical practice, the technique used in this study [14] is not reflective of most treatments applied in a practice setting. Most non-thrust techniques employ a method that targets the comparable/concordant/familiar sign of the patient and allows modification of the applied technique to produce a within session change in the patient. This form of application requires verbal communication between the clinician and patient, modification of the technique based on the outcome of the application, the changes in the stiffness perceived by the clinician and the response of the patient.[17] The form used in the study did not utilize any of these hallmark elements of most non-thrust techniques.

The two thrust manipulation techniques used in the trial [14] led to significantly improved long term outcomes when compared to the non-specific non-thrust technique, and the authors' suggested that their findings "support the generalizability of the CPR to an additional thrust manipulation technique, but not to a non-thrust manipulation technique". However, others have questioned the value of this finding indicating that restricting patients for inclusion to those who met the CPR may not be generalizable to outside population.[18] It is worth noting that when thrust and non-thrust techniques are applied in a conventional clinical manner to other body part regions such as the cervical spine, in absence of CPR-type criteria, the outcomes of the two procedures is the same.[19, 20]

Much work has gone into identifying those who are proper candidates for thrust and non-thrust manipulative techniques. Essentially, the concept associated with classification advocates that patients with dedicated pre-existing impairments should be more likely to improve with a focused treatment intervention. A clinical prediction rule has been proposed which is designed

to identify a sub-population of patients with low back pain who might benefit from manual therapy.[15, 16] CPRs are mechanisms used to classify patients and use a statistical assessment of a battery of variables to determine findings applicable toward a dedicated treatment approach. CPRs have gained much publicity of late and have been promoted as growth area for clinical practice and in the progression of treatment decision making.[21]

Preliminary evidence suggests CPRs may lead to favorable outcomes in LBP care.[15, 16] The aforementioned CPR utilizing thrust manipulation was derived from Flynn *et al.*,[15] which identified five variables: 1) score of less than 19 on the Fear-Avoidance Belief Questionnaire; 2) no symptoms distal to the knee; 3) symptom duration of less than 16 days; 4) at least one hip with more than 35° of internal rotation; and 5) hypomobility of the lumbar spine during a posterior–anterior assessment, that were associated with an improved outcome when thrust manipulation was applied (*versus* when not applied). The study was validated by Childs *et al.*[16] on a similar patient population and found that those who met the CPR and received spinal manipulative therapy were more likely to improve in pain and disability than those who met the rule and receive general low back exercises, based on the Agency for Health Care Policy and Research (AHCPR) guidelines.

The primary aim of this case series was to describe the outcomes of 11 consecutive patients who received non-thrust manipulation who met a CPR designed for thrust manipulation, in selective patients with low back pain. This study will contribute information to the literature in several ways. Firstly, some physiotherapists who practice in countries/states/regions are not allowed to perform thrust manipulation and have only non-thrust manipulation for clinical use. Secondly, more physical therapists use non-thrust manipulation in the care of patients with low back pain and a better understanding of the clinical benefits should improve our understanding of plausible outcomes. Lastly, the only comparative trial used a non-thrust procedure that is not conventionally used in clinical practice and a description of outcomes with use of a procedure typically performed in clinical practice may further shed light on the benefits of this procedure.

Materials and methods

Study population

This study was a case series, involving patients with low back pain who were part of a randomized clinical trial (RCT) that was designed to compare thrust and non-thrust manipulation. Patients who participated in this study were from 4 distinct outpatient physical therapy practices within the United States and were selected consecutively from the RCT if they were randomized into the non-thrust group and if they met the criteria for the lumbar thrust manipulative CPR. The RCT was a single blinded, equipoise controlled, experimental study in which either thrust or non-thrust manipulation and a dedicated home exercise program was provided for the first two visits of care. The home exercise program consisted of heel-rock, general movement based exercises, similar to those administered in two previous studies.[15, 16] For subsequent visits, physical therapists were allowed to use whatever means they considered beneficial for the patients care (thus, only the first two visits were truly controlled). This differs from the previous two studies.[15, 16]

For eligibility for enrollment in the RCT, patients had to be, 18 years of age or older, with mechanically producible LBP. For patients to meet inclusion requirements, they required a within session change in pain and/or range of motion during the assessment phase of the clinical examination; specifically during passive accessory examination. In other words, after the administration of the passive accessory examination, the patients had to have reported decreased pain and had to have demonstrated increased range during active spinal movements. This finding was used to determine if the patient was a candidate for manual therapy (regardless of type).

Exclusion criteria included the presence of any red flags (*i.e.*, tumor, metabolic diseases, RA, osteoporosis, prolonged history of steroid use, etc.), signs consistent with nerve root com-

pression (reproduction of low back or leg pain with straight leg raise at less than 45°, muscle weakness involving a major muscle group of the lower extremity, diminished lower extremity muscle stretch reflex, or diminished or absent sensation to pinprick in any lower extremity dermatome). Other exclusion criteria included prior surgery to the lumbar spine and current pregnancy.

Although not required within the RCT, for the case series we captured whether patients met and did not meet the criteria for a clinical prediction rule for thrust manipulation.[15] As stated previously, the rule involved: 1) score of less than 19 on the Fear-Avoidance Belief Questionnaire; 2) no symptoms distal to the knee; 3) symptom duration of less than 16 days; 4) at least one hip with more than 35° of internal rotation; and 5) hypomobility of the lumbar spine during a posterior–anterior assessment. Persons with 4 of 5 of these criteria were identified as "met" and were coded appropriately for the study.

Procedures

All 11 patients were treated by four experienced physical therapists that had undergone extensive manual therapy training and had received certification. When queried regarding personal equipoise [22] prior to the initiation of the trial, one physical therapist indicated that he felt non-thrust manipulation would lead to a slightly better outcome, another felt that thrust manipulation would lead to a slightly better outcome, and two felt there would be no difference between thrust or non-thrust manipulation.

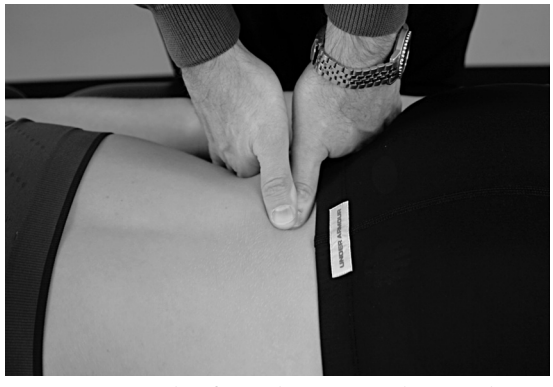

Figure 1.—Example of non-thrust manipulation technique used in the case series.

The treatment was designed to reflect actual clinical practice and involved an experimental element only within the first two visits; randomizing the first two visits is similar to the design of the CPR derivation and validation studies.[15, 16] After receiving a clinical examination that involved assessment of concordant/familiar/or comparable sign during accessory examination, and if the patients consented to be part of the study, they were randomized into two groups (thrust or non-thrust manipulation). Treatment for the first two visits involved only either thrust or non-thrust manipulation (depending on allocation) and a home exercise program. The clinician was allowed to determine the length of time between the first 2 visits and this time ranged from 1 day to 4 days. For this case series, a non-thrust technique was used (Figure 1). The clinician was allowed to select which non-thrust manipulation that they felt would be most beneficial for their patient (again, replicating actual clinical practice). For the first two visits, the clinician also assigned a standard home exercise program that involved heel-rock movements, the same movements used in the CPR study.[15, 16]

After completion of the first two visits, clinicians were allowed to perform any treatment procedure they felt would be beneficial for the patient population. This included any physical therapy related technique, whether it involved strengthening, movement-based methods, or other, as long as the clinician felt it fit within the treatment plan of the patient. Patients were discharged once the clinician felt the patient had met their maximal improvement within the current treatment program. There was no limitation on total visits. This case series reflects those patients who met the CPR and were consecutively allocated to the non-thrust treatment group.

Measures

All patients' demographic information was coded and patients completed a number of self-

report questionnaires, followed by a standardized history and physical examination at baseline (which included the patient response method of examination). Height, weight, age, gender, race, and duration of symptoms in weeks were captured. In addition, assessment of irritability (reactively of the current condition) and the patients' impression of which form of treatment (thrust or non-thrust) was considered the most beneficial (captured prior to the intervention and used to assess patient expectations) was tabulated.

Clinical report findings at discharge included total visits, compliance to the home exercise program (a qualitative assessment by the clinician scored as very compliant, compliant, not compliant, or extremely not compliant), and whether the patient was lost to follow up. Self-report findings were collected at the beginning of visit 3 and at discharge. All outcomes measures were collected and sealed into an envelope. The envelopes were mailed to a third party statistician who was not involved in the patient care process. The following self-report questionnaires were completed at baseline as well as each follow-up period, with the exception of the Fears Avoidance Beliefs Questionnaire (FABQw), which was captured at baseline and at visit 3.

The Numeric Pain Rating Scale

The Numerical Pain Rating Scale (NPRS) [23] was used to capture the patient's level of pain. Patients were asked to indicate the intensity of their current back pain, using an 11-point scale ranging from 0 "no pain" to 10 "worst pain imaginable."

The Oswestry Disability Questionnaire

The Oswestry Disability Questionnaire (ODI) [24] was used to measure disability and consists of 10 questions each scored from 0 to 5, with higher scores indicating greater disability. Scores were converted to a percentage score. A 50% reduction in the ODI from baseline has been considered a clinically important outcome.[24]

The Fear-Avoidance Beliefs Questionnaire

The Fear-Avoidance Beliefs Questionnaire (FABQ) [25] was used to quantify the patient's fear of pain and beliefs about avoiding activity. Each FABQ item was scored from 0 to 6 with higher numbers indicating greater fear-avoidance beliefs. The FABQ has 2 subscales; a 7-item work subscale (FABQW), and a 4-item physical activity subscale (FABQPA). Fear avoidance beliefs have been associated with current and future disability and work loss in patients with acute and chronic LBP.

Rate of recovery

We also captured self-report of recovery (0 to 100%). The response options included a continuous scale of 0% (not capable of doing anything they want) to 100% (fully recovered, capable of

Table I.—*Descriptive characteristics of the case series participants.*

Patient	Age (years)	Gender	Race	Irritable	Body Mass Index	Patient Expectations	Duration of Symptoms (weeks)	Number of Visits	Compliance with Home Exercise Program
Case 1	44	Male	Caucasian	No	24.4	Non-thrust	1	2	Very compliant
Case 2	66	Male	Caucasian	No	28.9	Non-thrust	1	8	Very compliant
Case 3	23	Female	Caucasian	Yes	19.9	Non-thrust	1	12	Very compliant
Case 4	43	Female	Mixed	No	23.9	Thrust	1	3	Very compliant
Case 5	48	Female	Caucasian	No	24.3	Non-thrust	3	10	Compliant
Case 6	58	Female	Caucasian	No	26.1	Non-thrust	78	13	Compliant
Case 7	55	Female	Caucasian	No	22.3	Thrust	10	5	Very compliant
Case 8	59	Female	Caucasian	Yes	23.2	Non-thrust	26	8	Very compliant
Case 9	48	Female	Caucasian	No	19.3	No Preference	1	3	Very compliant
Case 10	55	Female	Caucasian	Yes	27.4	Non-thrust	1	10	Compliant
Case 11	50	Female	Caucasian	No	27.4	Thrust	16	13	Very Compliant

Table II.—*Outcome measures of the case series participants.*

Patient	Baseline VAS	Baseline FABQw	Baseline Oswestry (%)	Final VAS	Final Oswestry (%)	Change FABQw	Change Score VAS	Change Score Oswestry (%)	Self Report of recovery (%)
Case 1	5/10	0	4	1/10	0	0	4/10	4	100
Case 2	7/10	9	56	2/10	8	6	5/10	48	85
Case 3	7/10	4	36	1/10	0	-3	6/10	36	95
Case 4	4/10	4	24	0/10	0	4	4/10	24	100
Case 5	8/10	8	4	0/10	0	0	8/10	4	100
Case 6	4/10	0	24	1/10	26	0	3/10	-2	100
Case 7	7/10	8	16	2/10	12	-3	5/10	4	90
Case 8	5/10	0	42	5/10	30	0	0/10	12	60
Case 9	3/10	18	32	0/10	2	10	3/10	30	100
Case 10	6/10	16	44	2/10	18	-1	4/10	26	85
Case 11	6/10	25	24	1/10	0	0	5/10	24	90

doing anything they want). The self-report of recovery is a variant of the global perceived effect scale,[26] and the face validity of self recovery rate scales is considered to be high.[26] This tool is often used as a reference standard against which the validity of other outcome measures is tested.[26]

Statistical analysis

Statistical analysis included descriptive statistics and report of baseline, end point, and change scores for pain, disability, FABQ, and rate of recovery.

Results

Eleven consecutive patients with low back pain were enrolled in the trial and were randomized into the non-thrust manipulation group who met the 4 of 5 criteria for the clinical prediction rule were seen from January 2011 to August of 2011. None of the patients were lost to follow up and 8 of the 11 demonstrated very high levels of compliance to their assigned home exercise programs. The age of the participants ranged from 23 years to 66 years. One patient had a duration of symptoms that was over 76 weeks and only 3 subjects exhibited irritability. Table I outlines the descriptive characteristics of the subjects.

Eight of the 11 patients improved by over 50% on the ODI: with 5 patients reporting no disability (0% on ODI) at discharge (Table II). All but one subject demonstrated a drop in VAS. The percent recovery ranged from 60% to 100%, with 5 of the 11 indicating 100% recovery at discharge. Only the FABQ work subscale demonstrated only marginal to no improvement consistently among the study participants.

Discussion

Ten of the 11 consecutive patients enrolled in the trial who were assigned to the non-thrust manipulation group demonstrated improvement from VAS and ODI baseline measures to discharge. Eight of the 11 demonstrated a 50% reduction in the ODI,[24] which has been identified previously as clinically important outcome as well. In this series, all but one patient (10 of 11) who met a CPR that was previously created as a tool to define subjects who will improve with thrust manipulation also benefited by pain reduction and demonstrated high levels of perceived rate of recovery, despite receiving treatment that consisted of non-thrust manipulation techniques.

This case series involved patients with ages 23 years to 66 years of age. The original derivation and validation studies of the thrust manipulation CPR involved subjects aged 35.5 (±11.1) years.[27] We feel that the widely disperse age group in our case series more accurately reflects ages seen in typical clinical practice. In addition, we feel the non-thrust technique used in the study was more closely reflective of methods used in clinical practice. Past studies have expressed the importance of combining patient feedback with the non-thrust procedure to im-

prove the validity of the procedure and to assure application to the truly affected level of lesion.[17, 28-30] In all 6 cases, the clinicians used a non-thrust technique that targeted the comparable/concordant/familiar sign of the patient and allowed modification of the applied technique to produce a compelling within session change in the patient. In 10 of the 11 cases, there were notable improvements.

Seven of the 11 patients indicated that they felt a non-thrust technique was more likely to improve their condition versus a thrust manipulation technique. Matching expectation with outcome has been investigated previously and there is some influence of expectation toward an outcome and actual outcome.[31] In an effort to control personal equipoise in the randomized clinical trial, we captured the expectations of the therapists and found that the one clinician, who felt that manipulation would be slightly better, still saw improvements in all of the patients that he treated (patients 1 through 4). His expectation did not seem to influence the patient outcome.

One last finding that is worth mentioning, yet cannot be determined by this study design, is whether the CPR captures variables that lead to good outcomes regardless of the intervention used.[32] Evidence exists to support this assumption through a recent evaluation that used a novel formula to control for prognostic elements used to classify patients for a treatment intervention. When the lumbar manipulation study by Childs *et al.*[16] was evaluated using the novel formula, the differences in treatment effect for the lumbar spine manipulation CPR was found to be associated with the prognostic capacity of the variables as well as a treatment effect.[33] Further exploration of this assumption is needed using a study design that can discriminate the true treatment effect of the CPR.

Limitations of the study

A case series has similar limitations to a case report including inability to assume cause in effect from the findings. In addition, the small sample of 11 subjects is not representative of most patients with low back pain and results may vary if administered on another series of individuals. There is a significant lack of homogeneity among the patients as far as duration of symptoms, severity of the condition, and age, which may also influence findings.

Conclusions

Ten of 11 consecutively enrolled patients from a clinical trial who met the clinical prediction rule for thrust manipulation of the lumbar spine also improved with a form of non-thrust manipulation, specially applied to the concordant level of the spine, and modified to the specific findings of each patient. Further studies that use a more appropriate design should explore whether a non-thrust manipulation applied in a manner that is consistent to clinical practice leads to outcomes that are similar to those of a thrust manipulation.

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ORIGINAL ARTICLE

Effect of a physiotherapy program in the management of musculoskeletal disorders in hairdressers: a randomized controlled trial

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ABSTRACT

Aim. Hairdressers are considered a high risk category to develop musculoskeletal disorders. Some studies suggest that these musculoskeletal disorders are mainly located in the upper limbs, the lumbar and cervical spine. The aim of this study was to assess the effect of physiotherapy exercises program in the management of musculoskeletal disorders in hairdressers.

Methods. A cluster randomized controlled trial was utilized. Twenty-eight hairdressers working in nine shops were randomly divided into two groups (Experimental *vs.* Control), with each shop as a unit of randomization. All the hairdressers in both groups received an ergonomic brochure. Ergonomic brochure consists of two parts: the first part informs the hairdresser about musculoskeletal disorders of their profession and offers ergonomic and postural advice. The second part contains a detailed description of the exercises and pictures that show the correct execution of exercises. The exercise program was conducted by a physical therapist. Data were collected at baseline and at a six weeks follow-up. The primary and secondary outcome measure recorded was the level of disability (Roland Morris Disability Questionnaire (RMDQ), Oswestry Disability Index (ODI) and the pain using a Visual Analogue Scale (VAS). Two-way ANOVA was performed to assess the between-groups variance before and after the intervention.

Results. Reported results show no significant differences between groups in terms of ODI, RMDQ (primary outcomes), VAS LBP and Cervical VAS (secondary outcomes).

Conclusion. The study does not support the efficacy of the experimental treatment compared to control treatment. We suggest to repeat the study with higher methodological standards. *(It J Physiotherapy 2011;1(3):73-9)*

Key words: Musculoskeletal diseases - Low back pain - Exercise - Occupational diseases.

There are many occupational risks related to the activities of professional hairdressers, which are not frequently studied, and therefore not considered in the formulation of health polices for this group of workers. Hairdressers are professionals whose working ability is affected by several adverse factors, such as work-related stress, poor work posture, repetitive work tasks, and exposure to sensitizing chemical agents that irritate the respiratory tract and the skin.[1] Hairdressers are considered a high risk category to develop, over the years, musculoskeletal disorders. Some studies suggest that these musculoskeletal disorders are mainly located in the upper limbs, the lumbar and cervical spine.[2-4] In a New Zealand original report [5] musculoskeletal discomfort, pain or injury are common among hairdressers and reduced job performance and productivity, increased time off work, and even early retirement. In the USA, hairdressing is a high-risk occupation associated with back pain that results in morbidity and reduced production.[6] In Finland, following asthma and hand eczema, musculoskeletal disorders are the prima-

ry cause of premature departure from the hairdresser profession.[1] A Korean study [7] evaluated work-related symptom prevalence among hairdressers and reported the prevalence of musculoskeletal symptoms in this way: neck (59.9%) shoulder (76.6%), upper back (41.2%), lower back (72.2%), arm and elbow (31.3%), wrist (44.2%), finger (35.0%), leg (71.1%). The work of the hairdressers is repetitive, requires use of force and awkward postures. Hairdressers work in a standing position with arms in a static position for a long time;[2, 3] their job requires continuous use of muscle strength to hold hair dryer, brush and scissors.[8] Occupation risk factors associated with the development of musculoskeletal disorders in hairdressers are related to biomechanical, organizational and psychosocial work factors.[9] The high prevalence of musculoskeletal disorders highlights the importance of disseminating recommendation for prevention of symptoms with regards to the provision of suitable furniture, equipment and work tools, environmental conditions and psychosocial work factors. Since 2000 the European Agency for Safety and Health has conducted EU-wide campaigns to raise awareness of the rising problem of musculoskeletal disorders related to work. With a report of 2010 did an new evaluation of the DMS. The results of previous research on the problems of the back and upper limb work-related were confirmed by this new research, and among the emerging issues, the need to increase and accelerate the return to work through a rehabilitation program, efficiency of which was demonstrated in the scientific literature, was identified.[10] In relation to what is stated in the literature, the main purpose of this study is to determine the effect of an exercise program in the management of musculoskeletal disorders and functional disability in hairdressers.

Materials and methods

Study design

This study is a Cluster Randomized Controlled Trial incorporating a combination of primary and secondary prevention strategies for limiting the occurrence and severity of musculoskeletal disorders (low back pain and neck pain) in hairdressers.

Study population

The study population was composed of 28 hairdressers employed in nine different shops buildings similar in size and furniture at the town of Forlì and Cesena, Italy. All the workers were female. Hairdressers had the same working hours but they were committed at different times in the work tasks of cutting, bending and shampoo. None of them had a medical history of serious injury, spinal surgery or malignant pathology. The Experimental Group (E) comprised 14 hairdressers from four shops, while the Control Group (C) consisted of 14 hairdressers from the remaining five.

Randomization and blinding

Each shop was considered as a unit of randomization in order to minimize the transfer of relevant knowledge from workers receiving the intervention to those receiving only the brochure, and thus avoid potential bias due to contamination. Shops were randomly divided into two groups, so that all the hairdressers of each shop belonged to the same group. Concealed allocation was performed by extracting pieces of paper, each reporting a number associated with a shop. The cluster randomization procedure allowed avoidance of incidental conversations between subjects of different shops, so that the participants were blinded to the intervention received by the other group.

Procedures

The study was conducted in the months of June and July 2010. After obtaining a written informed consent from all the participants, according with Italian standard of informed consent, demographic information was collected and presence of pain and disability was evaluated. The intervention started a week after the first evaluation, while the final evaluation was performed exactly six weeks after baseline evaluation. Hairdressers in Group C received only

Table I.—*Summary of physical therapy sessions.*

Exercise	Session 1	Session 2	Session 3	Session 4	Session 5	Session 6
Ante-version retroversion of the pelvis in supine position	1x10	1x10	1x15	2x10	2x15	2x20
Isometric contraction of the abdominal muscles	5x10s	5x10s	10x10s	15x10s	15x15s	20x15s
Lumbar extension in prone position	1x10	1x10	1x15	2x10	2x15	2x20
Stretching of the posterior muscles of the spine while sitting	2x30s	2x30s	3x30s	3x30s	4x30s	5x30s
Rotation of the head	2x10s	4x10s	6x10s	4x20s	6x20s	8x20s
Inclination of the head	4x10s	4x10s	8x10s	4x20s	6x20s	8x20s
Anteposition and retroposition of the head	1x10	1x10	1x15	2x10	2x15	2x30

an ergonomic brochure, whereas hairdressers in Group E received the same brochure and an exercise program conducted by a physiotherapist. The brochure described the ergonomic tips to prevent musculoskeletal disorders. The brochure consists of two parts: the first part informs the hairdresser about musculoskeletal disorders of their profession and offers ergonomic and postural advice. The second part contains a detailed description of the exercises and pictures that show the correct execution of exercises. The ergonomic brochure contains some ergonomic and postural advice to prevent musculoskeletal disorders: to use adjustable ergonomic chairs according to the stature of customers, to keep a stool near the chair of the customer and to put over a foot to relax a lower back by mechanical overload, during the work to control the position of the shoulders in the mirrors, avoid keeping shoulders in elevation and contraction.

Intervention

The exercise program was composed of six graded sessions, one for week, for six consecutive weeks. Sessions, each of one hour length, were conducted after the working hours in the store, gathering all the hairdressers from each shop. The exercises were selected after a careful observation of the posture maintained during the occupation of hairdresser. To counter the biomechanical overload caused by work, the exercises were targeted to the lumbar and cervical spin[11]. The physiotherapist prescribed exercises of anteversion and retro-version of the pelvis in supine position, isometric contraction of the abdominal muscles, lumbar extension in prone position stretching of the posterior muscles of the spine while sitting and finally exercises of rotation, inclination, anteposition and retroposition of the head (Table I). Most of exercises were executed in front of mirrors in the shops. The hairdressers were instructed to repeat their exercises at home without supervision of the physiotherapist. The physiotherapist provided explanations to the hairdressers about the possible etiopathogenetic factors of musculoskeletal disorders. The physical therapist explained advice on correct postures and movements to be taken at work and in everyday life.[12]

Outcome measures

The primary outcome measure used in this trial was the perceived level of disability as a result of musculoskeletal disorders, assessed by the following self-administered evaluation scales: the Roland Morris Disability Questionnaire (RMDQ), and the Oswestry Disability Index (ODI). The RMDQ is validated in Italian, and comprises 24 items in which greater levels of disability are reflected by higher numbers on a 24-point scale.[13]The RMDQ has been shown to yield reliable measurements, which are valid for inferring the level of disability, and to be sensitive to change over time for groups of patients with LBP.[14, 15] The ODI, is validated in Italian, and is structured in 10 sections corresponding to different activities of daily living, each scored on a six-point scale (0-5). Scores of 0-20% indicate minimal disability, 20-40% moderate disability, 40-60% severe disability, 60-80% crippled, 80-100% either bed-bound or exaggerating symptoms.[16, 17] Secondary outcome measure included the evaluation of cervical and lumbar physical pain. Participants were asked to rate the pain intensity of these two sites as pre-determined sites of pain on a Visual Analogue Scale (VAS). A 10

Table II.—*Demographic characteristics of the study population.*

	Group 0 (N.=14)	Skewness (P)	Group 1 (N.=14)	Skewness (P)	P
Age, years	38.36 ± 12.05	0.948[c]	38.14 ± 10.92	0.417[c]	0.9556[a]
Height, meters	1.62 ± 0.05	0.384[c]	1.61 ± 0.04	0.287[c]	0.5244[a]
Weight, kilogram	56.46 ± 7.67	0.142[c]	59.86 ± 11.69	0.047[c]	0.4143[b]
Body Mass Index	21.37 ± 2.26	0.225[c]	23.03 ± 3.39	0.087[c]	0.1214[a]
Work hours	8.86 ± 1.03	0.761[c]	8.54 ± 1.45	0.012[c]	0.1726[b]
Work experience, months	253.29 ± 159.65	0.752[c]	236.21 ± 149.01	0.987[c]	0.7714[a]

[a]*t*-test (between groups distribution); [b]Wilcoxon rank-sum test (between groups distribution); [c]P-value for the coefficients of Skewness [25] (within group distribution).

Table III.—*Comparison between the two groups before and after intervention for the four outcomes evaluated.*

	Baseline measures (mean values ± SD[c])		Comparison between two groups at baseline	Final assessment point measures (mean values ± SD[c])		Comparison baseline - final assessment point (P)	
	Group E (N.=14)	Group C (N.=14)	P-value	Group E (N.=14)	Group C (N.=14)	Group E (N.=14)	Group C (N.=14)
Low back pain VAS	2.71±3.34	2.50±3.37	0.8697[a]	1.86±2.74	2.07±3.02	0.4645[b]	0.7270[b]
Cervical pain VAS	3.00±3.35	2.07±3.17	0.4573[a]	2.57±2.93	1.93±2.84	0.7215[b]	0.9011[b]
ODI	4.64±5.29	4.64±5.15	1.0000[a]	4±5.38	3.36±3.23	0.7523[b]	0.4359[b]
RMDQ	2±1.75	1.57±1.65	0.5094[a]	1.71±1.82	1.14±1.35	0.6189[b]	0.4589[b]

[a]Student's *t*-test, [b]ANOVA between groups for repeated measures, [c]standard deviation.

cm VAS with 0 corresponding to no pain, and 10 to the worst possible pain was used. The VAS has been proved to be reliable and satisfactory in the measurement of pain. Subjects were considered symptomatic with VAS scores ≥1. It was shown that there is a good correlation between the results of the VAS scale and those of RMDQ (r=0.79 and P<0.001).

Data analysis

Continuous data were expressed as mean ± standard deviation. The skewness test [18] was used to test the normal distribution of demographic characteristics of both study population groups (C and E): in cases of normal distribution, continuous variables were tested with Student's *t*-test and for non-normal distributions two-sample tests were performed using the Wilcoxon rank-sum test (Table II). Student's *t*-test was performed at baseline to evaluate any difference between the two groups for the four outcomes evaluated (VAS-LBP, Cervical VAS, ODI and RMDQ – Table III). These four outcomes were than individually analyzed by a 2-way repeated-measures ANOVA for repeated-measures with Group (Experimental *vs*. Control) and Time (Follow-up *vs.* Baseline) as factors. This analysis was performed applying the between-groups ANOVA model to analyze any differences between the two groups (E and C – Table III) in relation to the four measurement scales employed. MedCalc version 11.5.1 (MedCalc Software, Mariakerke, Belgium) was used for all analysis except for the ANOVA analysis for which was used ezANOVA (Copyright 2007 by Chris Rorden). Both programs were set with significance at P<0.05.

Results

Reported results show no significant differences between groups in terms of ODI, RMDQ (primary outcomes), VAS LBP and Cervical VAS (secondary outcomes). Secondary outcomes (VAS-LBP and cervical VAS) reported a better improvement in group E than group C but there were not statistically significative results (Table III). Primary outcomes (ODI and RMDQ) reported a better improvement in Group C than Group E but also in this case there were not statistically significative results (Table III).

In Table II all p-values obtained with t-test and Wilcoxon test are more than 0.05 so the mean difference between the paired observations is not statistically significantly different from 0. When comparing the four outcome measures before intervention with Student's *t*-test (comparison of means, standard deviation and number of subjects of both groups – Table III) no statistical differences were found between groups. At baseline the characteristics of the two groups were homogeneous, in particular regarding to age, height, working hours and work experience (Table II).

Discussion

Our results report no significant differences between groups in terms of ODI, RMDQ (primary outcomes), VAS LBP and Cervical VAS (secondary outcomes). The values of lumbar VAS-LBP and VAS-CP reported a greater improvement in Group E than in group C (Table III), while the two scales for perceived disabilities employed (RMDQ and ODI) reported a more marked improvement in group C which was not followed by an improvement in symptoms of low back (Table III), differently from those described in the literature. Probably our results does not follow those expressed in the literature due to the kind of subjects included in the study. The hairdressers in fact are professionals often affected by different kinds of comorbidity in relation to the work stress for various anatomical structures. Therefore, the overall perception of disability in these individuals may not change substantially with the only improvement of VAS-LBP, except in some cases with subjects who report high severity of LBP. So the comorbidity may have a negative impact on the lack of correlation between patients' perception of disability and reduction in pain at the lumbar spine. Another reason for the ineffectiveness of the intervention could be the mild disability of the subjects, as documented by the low RMDQ and ODI scores at baseline. This is mainly due to the fact that our intervention was aimed to primary and secondary prevention in a specific work category, and the subjects recruited had no diagnosis of LBP and most of them were not symptomatic. In fact in our study population we obtained a point prevalence (baseline VAS ≥1) of 46.42% for LBP. This value appears lower with respect to the LBP prevalence reported for other occupational categories, like hospital workers (1 year prevalence of 58.8%) [19] and professional cooks (one-month prevalence of 74.3%). However, these values are not directly comparable as the point prevalence underestimates the prevalence. On the other hand, when considering the one-year prevalence, most subjects would not report a single slight or mild event as an episode of LBP during the previous 12 months, thus underestimating prevalence even in this case. In addition, our results may have been influenced by the low frequency of weekly sessions (one time per week) and an incorrect combination of exercises in relation to their type and their duration and sequence. In the literature we can find several reviews of the effect of exercises as a preventive measure for LBP, generally supporting the conclusion that exercise may have a positive effect, although there is no evidence to prove this.[20, 21] No evidence exists about the correct exercises protocol to use in primary prevention of LBP in a specific work category. Regarding secondary prevention, the current literature provides evidence for the effectiveness both of an extension-oriented treatment approach [22] and of strengthening exercises of the primary stabilizers of the spine [23] in reducing LBP recurrence and disability as compared to a classical approach or to no approach. Regardless of our results further investigation and preventive intervention based on different combinations of exercises, varying in intensity, anatomical region involved and duration of each exercise are suggest. No strong evidence was obtained in our research with regard to the effect of the ergonomic brochure, as Group C remained substantially unchanged for CP and LBP. The strengths of our study consist in the homogeneity of the population represented by a sample of hairdresser working category, so that all the participants were exposed to the same working environment and the good compliance of the participants in both groups with no dropouts at follow-up. Furthermore, the groups obtained are properly randomized, but at the same time its features do not overlap (Ta-

ble II). Finally all subjects included in the study concluded correctly the study and there were no drop-out patients.

Study limitations

The limitations of this study include the small sample size, the lack of a longer-term follow-up, the lack of physiologic assessment with different stages of LBP (acute, subacute or chronic), and the relatively short final assessment point and the lack of blinded conditions that might have affected the results. Also the very low value of disability obtained at baseline could be considered as normal variation of the baseline value, very close to the test-retest reliability of the instruments. Another limitation of study regards the morbidity of profession of hairdressers, in fact they suffer of different kinds of comorbidity in relation to the work stress for various anatomical structures and this can compromise the results. Furthermore, the application of a multilevel statistical model would be more appropriate for optimal data analysis. Finally the study described the pain but the duration of pain was not assessed.

Conclusions

This study does not support the efficacy of the experimental treatment compared to control treatment. No even evidence was obtained regarding the effect of the educational efforts of the ergonomic brochure. These results suggests to repeat the study with higher methodological standards, including a larger sample size, a longer-term follow-up and an initial clinical assessment for subgrouping classification. Moreover, since many factors may be relevant for the occurrence or recurrence of LBP and CP injury, a multidimensional approach would be more effective as it would presumably cover a wider range of risk factors. Independently from our results, a real need exists for further investigations and for preventive interventions based on multidimensional approaches with different combinations of exercises, varying in intensity, duration and typology in order to identify the correct program for the management of trunk complaints for each specific work category.

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REVIEW

Mirror therapy for upper extremities recovery after stroke: a systematic review

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ABSTRACT

Aim. Several therapeutic choices are possible for patients who have poor voluntary movement especially in early stages of stroke, for example the use of robotic devices, motor imagery or observation training and sensory illusion induced through the use of a mirror in mirror therapy (MT). The purpose of this review is to summarise the effectiveness of mirror therapy (MT) for treatment of upper extremities paresis after stroke.

Methods. Electronic databases were searched for randomised controlled trials (RCTs) comparing MT with other rehabilitative techniques or sham treatment in adults after stroke. The primary and secondary outcomes were reduction of arm motor impairment and improvement of arm motor function assessed immediately after treatment.

Results. Four RCTs of moderate methodological quality are included in this review. Treatment protocol among studies was heterogeneous in type of exercise and time elapsed since stroke. Three studies on 116 patients showed a reduction in arm motor impairment. Three studies showed an improvement of motor function.

Conclusion. MT seems to reduce the motor impairment and improve the motor function of the paretic arm, thus could be useful in patients exhibit poor motor capacity. *(It J Physiotherapy 2011;1(3):80-6)*

Key words: Exercise therapy - Stroke - Upper extremity.

Therapeutic interventions for regaining motor function after stroke focus on practice and repetition of functional tasks.[1] However, the most frequently cited task-oriented training strategies for the arm, such as repetitive task practice [2] or constraint-induced movement therapy,[3] require high motor capacity and therefore they do not represent the more suitable choice for patients with severe paresis after stroke.[4] The severity of paresis, especially after the first week from stroke onset, can predict the motor function recovery of the arm, which remains poor in 30% to 66% of cases.[5] Therapeutic choices for these patients often consist in use of electromechanical devices,[6] electrical stimulation,[7] robotic devices,[8] motor imagery,[9, 10] observation training [11] and in repetitive passive or assisted movement stimulation.[12] Another type of therapy used in these cases and cited as successful in recovery of function in stroke patients is the mirror therapy (MT) [13-15] based on a sensory illusion provocation.

Sensory illusion was originally proposed to overcome phantom limb in amputees, considered as a sort of disruption of the normal interaction between intention to move the limb and the absence of appropriate sensory (proprioceptive) feedback.[16, 17] Subsequently, MT has been proposed for other movement and sensory disorders. In literature clinical conditions have been explored to assess its effects: stroke, complex regional pain syndrome type I (CRPS1), complex regional pain syndrome type II (CRPS2), amputation and after hand surgery.[18, 19]

In a typical session of MT the patient sits in front of a mirror parallel to his midline blocking

the view of the affected limb, positioned behind the mirror. When looking into the mirror, the patient sees the reflection of the unaffected limb positioned as the affected limb.[19]

The theory of MT is supported by neurophysiologic studies although the precise mechanisms of the MT effect in stroke patients are still unclear. Movement mirroring activates the controlateral hemisphere,[20, 21] increasing cortico-muscular excitability in healthy subjects.[22, 23] Also the enhanced self-awareness and spatial attention have been proposed as potential mechanisms of MT.[21, 24]

In this review randomized controlled trials (RCTs) on the use of MT for upper extremity recovery in stroke patients are examined in order to explore the clinical potential efficacy of this therapy.

Materials and methods

Inclusion/exclusion criteria

RCTs with ischemic or haemorrhagic adult stroke participants (aged over 18 years) with paresis of an arm, comparing MT with other rehabilitative techniques or sham treatment were included.

For the purpose of this review MT was defined as the use of a mirror reflection of unaffected limb movements superimposed on the affected extremity.[19]

All interventions were considered irrespective of training time outside MT sessions and type of movement performed in training sessions and were pooled and discussed under the heading of MT.

Retrieved studies were excluded if they focused on the theoretical background of MT, if they were published in different forms other than article *in extenso* (*i.e.* abstract, editorial, letter to editors,…) and if they were written in languages other than English or Italian.

Outcomes

The primary outcome chosen for this review was reduction of arm motor impairment, the secondary outcome was level of arm motor function, both assessed at the end of treatment. At 4 to 6 month, the follow-up was evaluated with the same outcomes in addition to a measure of activity limitation.

Search strategy

The Cochrane Central Register of Controlled Trials (CENTRAL), PubMed, EMBASE, CINAHL and the Physiotherapy Evidence Database (PEDro) have been searched (last search June 2111). The search terms used to find all trials registers and databases were: cerebrovascular disorders; brain injuries; nervous system disease; hemiplegia; paresis; dystonia; stroke; upper extremity; illusions; mirror; visual; virtual; mirror therapy; feedback or therapy; reflect; reflection; illusion. An unsystematic hand searching, web searching and reference screening was added to the electronic search.

Statistical analysis

Retrieved references, after removing duplicates, were screened by reading titles and, if necessary, abstracts (Figure 1). Nine studies [26-34] potentially relevant for this review have been excluded for inability to retrieve full-texts. Data were extracted independently by two reviewers (EC & DC) and were recorded on a standardized checklist, incorporating: methods (*e.g.* randomization, blindness, completeness of follow up), details of participants (*e.g.* age, gender, time since stroke, side affected), type of intervention, inclusion and exclusion criteria and reported outcomes.

The quality of studies was assessed using the criteria in the Cochrane Reviewer's Handbook 4.2.6 more precisely a description of randomization, allocation concealment, blind structure, withdrawals/drop- outs and analysis of data.[35]

Results

Four RCTs were included in the review.[36-39] The age of patients varied from 30 to 80 years, about 80% had an ischemic stroke. The majority of subjects were in a subacute phase (3 to 12 months from stroke onset), one study included chronic stroke patients (Table I).[38]

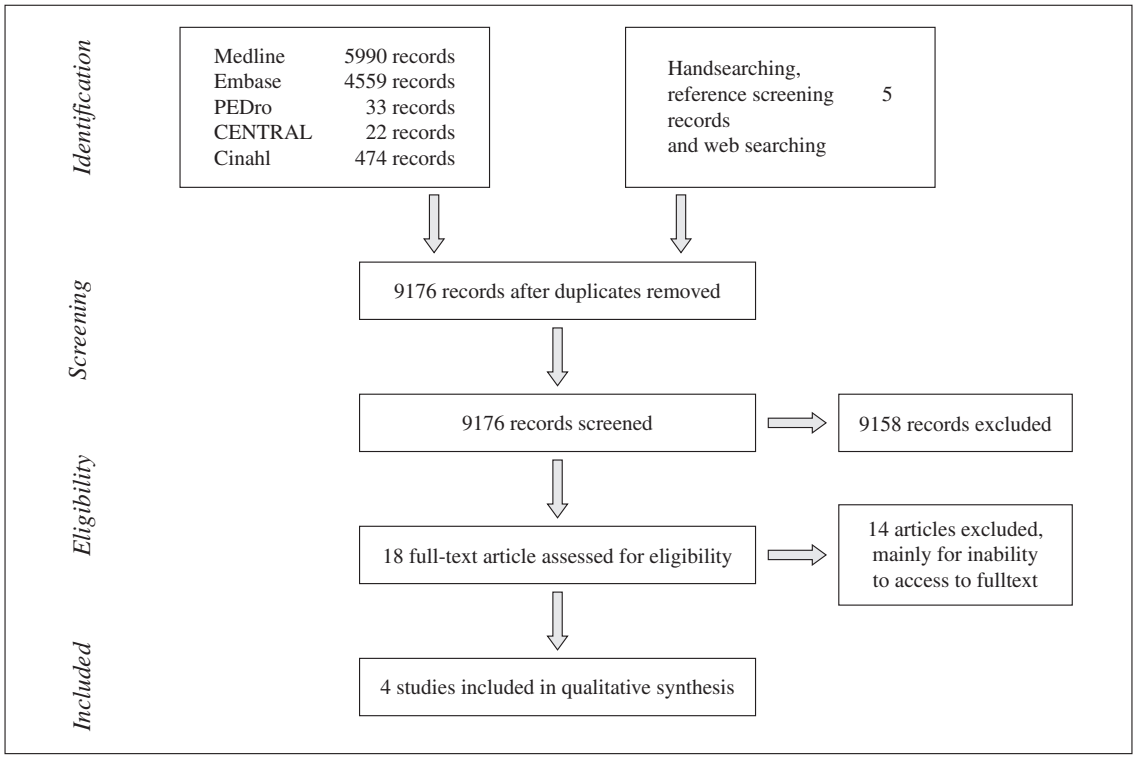

Figure 1.—Flow of information through the different phases of the systematic review.

Table I.—*Participants Characteristics*

Study	Sample size			Age	Time since Stroke (for inclusion)	% Female	% Ischemic	% Right Side affected	% Stroke Concordance
	Total	Mirror therapy	Control	Mean (range)					
Yavuzer *et al.*[36]	40	20	20	63.2 (43-80)	3 to 12 months	47	80	41	37
Cacchio *et al.*[37]	48	24	24	58.3 (40-78)	< 6 months	54	73	71	NR
Michielsen *et al.*[38]	40	20	20	57 (32-79)	> 1 year	50	70	NR	30
Dohle *et al.*[39]	36	18	18	56.5 (30-80)	< 2 months	27	100	NR	30

"Age" expressed in years; NR= Not reported; %values rapresent proportion of patients on the total sample size; "Stroke Concordance" refers to patient with dominant side affected.

Intervention

All the studies compared MT with a sham treatment in which patients were asked to watch directly their affected arm [38, 39] or a covered mirror. In one study [36] subjects were asked to move upper limbs on the sagittal plane while in other studies the movements were requested on all the planes [39] or addressed to task-oriented activities[38]. In the study of Cacchio *et al.*[37] patients did not perform movements with the affected limb.

All patients trained 0.5 to 1 hour per day five days a week for four to six weeks and received physiotherapy regularly outside MT sessions except in the study of Michielsen *et al.* (Table II).[38]

For intervention details see Table II.

Outcomes

Three studies assessed the reduction of arm motor impairment.[36, 38, 39] Three studies assessed arm motor function [37-39] and two [36, 39] measured activity limitation. Three studies [36-38] had a 6-months follow-up (Table II).

Table II.—*Intervention details and reported outcomes*

		Yavuzer *et al.*[36]	Cacchio *et al.*[37]	Michielsen *et al.*[38]	Dohle *et al.*[39]
Intervention details	Mirror therapy	Parasagittal distal movements of both extremities.	Parasagittal proximal and distal movements only of the unaffected upper extremity	Bimanual exercises also with objects	Symmetrical movements of both hands or arms
	Control therapy	Covered mirror	Covered mirror	No mirror	No mirror
	Treatment duration	0.5 h/day, 4 weeks	0.5 h/day*, 6 weeks	0.5 h/day, 6 weeks	0.5 h/day, 6 weeks
Reported outcomes	Motor impairment	Brunnstrom Stages		Fugl-Meyer	Fugl-Meyer
	Motor function		WMFT	ARAT	ARAT
	Activity limitation	FIM			FIM
	Pain intensity		VAS		
	Spasticity	MAS		TS	
	Follow-up	6 Months	6 Months	6 Months	None

* 1 h/day for last three weeks

Risk of bias

The randomization process was declared in all included studies and in two studies [36, 38] it was clearly described as performed by using a computer random number generator. The allocation concealment was adequate in two studies [38, 39] in which sealed envelopes containing assignments were opened after initial assessment and study inclusion, just before the start of the training. In all studies the assessor was blinded to treatment allocation. One study does not report patients' dropouts.[36] Few patients dropped out before the end of treatment protocol in two studies,[37, 38] while in the study of Dhole *et al.*[39] dropouts were more than 20% of initially recruited patients. In this case, dropouts were due mainly to lack of cost approval by the health insurance, medical worsening or withdrawal of patients' consent. In two studies [36, 39] only patients who completed the entire protocol were included in the analysis at the end of the treatment (Table II).

Primary outcome: reduction of motor impairment

Given the clinical heterogeneity in terms of type of patients (time since stroke) and MT protocol used it was not chosen to realize a meta-analysis.

Three studies,[36, 38, 39] including 116 patients, assessed the reduction of arm motor impairment after MT. Patients included in studies were similar in age, gender distribution and concordance of dominant side affected. One study [39] was conducted on acute patients, one on subacute [36] and the last [38] on chronic stroke patients. Reported results show an effect in reduction of motor impairment in all three studies.

Secondary outcome: arm motor function

Three studies,[37-39] including 124 patients, assessed the level of arm motor function after MT. Patients among studies were similar except for time since stroke experienced.[38] Another source of heterogeneity could be represented by the difference in treatment protocols, in fact in the study of Cacchio *et al.*[37] patients did not perform movement with the affected arm. Reported results show an effect in improvement of motor function in two [37, 39] of three studies.

Six month follow-up

Six months after the end of the treatment the reduction in arm motor impairment persisted in only one study [36] and the level of arm motor function was positive only in one study.[37]

The study of Yavouzer *et al.*[36] reported an improvement in reducing the activities limitation.

Discussion

Four RCTs [36-39] regarding the use of MT, defined as the use of mirror reflection of unaffected limb movements superimposed on the

Table III.—*Methodological quality of included studies*

Study	Description of Randomisation	Allocation concealment	Blinded assessor	Withdrowals	Analysis
Yavuzer *et al.*[36]	Yes	Unclear	Yes	NR	P
Cacchio *et al.*[37]	NR	Unclear	Yes	12%	I
Michielsen *et al.*[38]	Yes	Adequate	Yes	10%	I
Dohle *et al.*[39]	NR	Adequate	Yes	25%	P

For the allocation concealment the therm "Adequate" is used when the method of allocation is clearly described while "unclear" when the authors do not report any allocation concealment approach. For Blinding assessor "Yes" indicates the blind condition for at least one outcome; for Analisys P indicates an analysis "per protocol" I "per intetntion" and NR = Not reported

affected extremity [19] for the reduction of arm motor function of the more affected arm, are included in this review. These studies are heterogeneous in terms of type of patients included, as they focus both on acute and chronic stroke patients, and in the administration of the MT, as the movements asked to patients were different among studies' protocols. For these reasons a meta-analysis has been considered inappropriate and the qualitative synthesis of results should be considered carefully.

The general quality of studies was moderate to low. All trials attempted to blind the observers and in two [37, 38] of four trials the follow-up of patients was adequately reported and was analyzed according to intention-to-treat. However, half of the studies did not describe the method of randomization and allocation concealment, even though this does not correspond to bad practice. In fact all studies described the *a priori* procedure of sample size calculation and presented the calculated numbers of participants. Another difficulty in assessing the effect of MT could be represented by the positive perception induced by treatment not counterbalanced in control groups:[44, 45] it is possible that subjects in the experimental group are more motivated to perform the assigned task than the control group. This could partially explain the positive treatment effects. In fact, the illusion given by the mirror could stimulate a greater attention in performing the motor task, resulting in an increase in cortical activity compared to the execution of the movement by looking at both upper limbs or in a covered mirror.[38]

The study of Cacchio *et al.*[37] reported an increase upper limb motor function after a 4 weeks mirror therapy workout and the results were maintained at 6 months follow-up. Also, Yavouzer *et al.*[36] showed how in early phase after stroke a conventional rehabilitation program combined with mirror therapy was more effective in terms of motor recovery and hand-related functioning rather than a similar treatment without the mirror therapy. Similarly, Dohle *et al.*[39] demonstrated that the mirror therapy's application for 6 weeks improves motor, sensory and attentional skills measured by functional independence measure (FIM), action research arm test (ARAT) and Fugl-Meyer (FU). The study of Michielsen *et al.*[38] showed an increase in upper extremity motor function in patients with chronic stroke, but the observed effects on motor function did not persist at the follow-up. All these results support the hypothesis that mirror therapy is an effective method to enhance motor function, especially in subjects with acute stroke.[18, 23]

The main findings of this review suggest that in case of reduced movement capacity of upper extremity after stroke the motor impairment could be better overcome through the superimposed reflection of movements of the unaffected arm on the affected one.

Several underlying mechanisms for the effect of mirror therapy on motor recovery after stroke have been proposed. For example, it has been suggested that the mirror creates a positive visual feedback of successful performance of the action imagined with the impaired limb.[42] The mirror illusion of a normal moving affected hand seems to increase alertness and spatial attention towards this hand rather than an increased activity of motor areas. This fact is indicated by the

activation of precuneus and posterior cingulate cortex,[25] respectively activated when actions are being interpreted as being controlled by the self as well as during self-centred mental imagery strategies [43] and during spatial navigation.[44] These activations seem to be caused by the illusion of a virtual moving hand but it has been suggested that these activations are caused by a mismatch between the movement one performs and the movement that is observed.[38] In fact, it have been shown that the cingulated cortex is activated during conflict monitoring, specifically during action conflicts.[38, 45]

This systematic review presents several limitations, for this reason the authors' conclusions could be biased. Firstly, the review was not based on a structured protocol, consequently the included studies have a high clinical heterogeneity mainly due to the lack of inclusion criteria for the population of interest. Secondly, nine studies retrieved by the electronic search were excluded from this review despite the well-promising design because published only in abstract or in congress act form.[26-34]

Conclusions

The results of this review show that MT could be considered potentially useful for reducing upper extremity motor impairment after stroke. The therapy is easy to implement and patients can also be instructed to train on their own.[15] However, the use of this therapy is limited to fully collaborative patients without cognitive deficits.

It is important to continue studies to unravel the neuronal correlates of MT since a better understanding of the underlying mechanisms may lead to a more effective application and might help in selecting patients for which this therapy could be most effective.[25, 38] A better recording of unexpected side effects is necessary.

The manipulation of sensory inputs results in improvement of motor impairment and motor function of the affected arm, thus could be useful in patients who are incapable of active movements in order to lead them to more complex therapeutic exercises shaped on the patient's level of motor capacity.

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REVIEW

Effect of attentional focus instructions on motor learning and performance of patients with Central Nervous System and Musculoskeletal disorders: a systematic review

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ABSTRACT

Aim. Therapeutic exercises are administered during motor rehabilitation in order to cause long-term motor modifications. During the application of attentional focus strategies, External Focus of Attention (EFA) aiming at the movement effect has been reported to have more efficacy than Internal Focus of Attention (IFA) aiming at the movement characteristics in healthy subjects. Only few studies compared EFA and IFA in subjects with musculoskeletal or neurological disorders. The aim of this paper was to summarize the results about the comparison of EFA and IFA strategies applied in patients with Central Nervous System (CNS) and musculoskeletal (MSK) disorders.

Methods. MEDLINE, CINAHL, EMBASE, PEDro, DARE, and the Cochrane Library were searched from inception to December 2010. Eligible studies should be developed according to RCT or quasi-RCT design, enrolled patients with MSK or CNS disorders, and compared the efficacy of EFA and IFA. Outcomes were considered when related to movement dynamics or movement effects. Further, outcomes should be registered in the retention or in the transfer phase. The critical appraisal was done using the PEDro scale.

Results. Weak evidences suggest that EFA has more efficacy than IFA in influencing the execution of motor tasks. Patients with CNS disorders had higher short-term motor performance during reaching and balance tasks. Considering patients with MSK disorders, the long-term motor learning of patients with ankle sprain performing a balance task was higher in those patients treated with EFA.

Conclusion. Examination findings should be implemented with caution in clinical practice. Further studies should enroll symptomatic subjects in studies with high methodological quality.

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Key words: Physical therapy modalities - Motor skills - Exercise therapy.

The combination of several facilitations during the administration of therapeutic exercises has the purpose of achieving stable and long-term motor learning. This has always been a challenge in physical therapy practice.

Motor learning indicates a set of internal processes linked to practice and experience which lead to permanent changes of the motor behaviour.[2] The development of motor learning has been divided in 3 phases: acquisition, retention, and transfer.[3] The acquisition phase refers to the moment a subject experiences a task first. Then, in the retention phase the subject recalls the task in the same conditions after few days or weeks. Finally, the transfer phase occurs when the same task is carried out in different contexts.[3] Acqui-

sition phase has been shown to cause temporary modifications of the motor performance. In contrast, retention and transfer phases are involved on the long-term stability of the motor learning.[4, 5]

In order to influence the motor learning, therapeutic exercises usually administered in the aforementioned phases encompass several facilitations. Among these, researchers have included the verbal instruction given before or during the motor task execution. Its purpose is to implement the exercise with attentional focus strategies aiming at the specific characteristics involved in the motor task during the acquisition phase.[6]

Therefore, these instructions are used during attentional focus strategies to move the attention of a subject towards an informative source or an object.[7] Commonly, instructions are delivered in order to ease the subject focusing either on body movement production (internal focus of attention, IFA) or body movement effects in the environment (external focus of attention, EFA).[8] For instance, to keep the balance firmly during a training on a unstable platform, a subject might focus on the platform which he is standing on (EFA) or the feet position (IFA).[8]

Previous qualitative reviews reported that EFA increased more than IFA the short-term performance and long-term motor task learning in healthy subjects.[6, 9-12] These improvements were obtained after controlling for several confounding factors such as the skill type, the amount of therapist expertise and the age of participants.[11]

To our knowledge, there has not been any systematic review yet regarding the efficacy of EFA and IFA during the learning and the performance of motor tasks in subjects with musculoskeletal (MSK) or central nervous system (CNS) disorders. The purpose of this systematic review was to gather evidences regarding the use of EFA and IFA strategy during the rehabilitation of patients with CNS and MSK disorders with therapeutic exercises aiming at the learning and the performance of motor task.

Materials and methods

Protocol and eligibility criteria

A research protocol has been developed before the beginning of the review process.[13] To ensure a standardised and comprehensive framework for reporting, the review is written in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses: PRISMA.[14] Eligibility criteria were as follows: studies developed according to randomized controlled trial (RCT) or quasi-randomized controlled trial (quasi-RCT) design; studies enrolling male or female subjects with a diagnosis of MSK or CNS disorders and aged 18 to 90 years; studies regarding therapeutic exercises in which the efficacy of EFA verbal instructions (target-related) has been compared with IFA verbal instructions (movement-related). Further, studies had to report properly the follow-up registration of the outcomes during the retention phase (*e.g.* immediate, days, weeks) or the transfer phase (*e.g.* new context). Outcomes regarding both movement dynamics (kinematic and kinetic variables) and movement effects (task performance variables) were considered.[15]

Exclusion criteria were as follows: observational studies, studies considering attentional focus for feedback strategy purpose, studies analysing therapist's preference when applying attentional focus strategies, and studies without a clear description of attentional sources or patient's diagnosis.

Data sources, search, and study selection

An electronic search was developed for original research articles using the following computerised database from inception to December 2010: MEDLINE, CINAHL, EMBASE, PEDro, DARE and the Cochrane Library. Articles should be written in english, italian, french, spanish and german. Keywords and search strategy were as follows: "attentional focus" OR "focus of attention" OR "attentional focusing".

To ensure completeness of the literature search, the reference lists of all potentially eligible articles were hand searched. A review of the grey literature was planned with the same purpose. The list of journals screened is available upon request. Two independent reviewers (GR, SC) screened titles and abstracts of identified records for inclusion in eligibility process. If the abstract was relevant, then the full article was retrieved

and assessed for eligibility according to exclusion and inclusion criteria. If any discrepancies between reviewers persisted after discussion, a third reviewer (MT) made the final decision.

Data collection process

Two independent reviewers (GR, SC) extracted data independently on study design (RCT, quasi-RCT), subjects (number, age, male/female ratio, diagnosis), therapeutic exercise protocol (task type, number of trials, trial length, days of training, setting, execution's condition, type of provided attentional sources), reported outcomes (kinematic, kinetic, task performance variables), and follow-up (retention or transfer phase).

Risk of bias in individual studies

Methodological quality has been assessed with the PEDro scale[16] developed by the Centre for Evidence Based Practice in Australia on the basis of a core of general criteria made by a consensus panel for RCTs and quasi-RCTs critical appraisal.[17] Its validity [18] and reliability [19, 20] have been largely recognised. Each item is assessed present (1) or absent (0) on a total score of 10 points. Points are awarded for randomisation methods (2 points: random allocation and concealed allocation), blinding methods (3 points: participants, therapist, and assessor), data report (3 points: baseline similarity of groups, follow-up suitability, intention to treat analysis), and data analysis (2 points: between-group statistical comparison for at least one key outcome, point and variability estimates).[21] Thus, this score reflects the internal validity and the statistical analysis of a study. The item on eligibility criteria regards the external validity but it is not considered in the overall score.

None of the articles have been omitted from statistical analysis on the basis of the critical appraisal. Studies were classified according to previous criteria: "excellent" (PEDro 9-10), "good" (PEDro 6-8), "fair" (PEDro 4-5), "poor" (PEDro 0-3).[22] After a training period, two independent reviewers (GR, SC) assessed the methodological quality of the retrieved papers. If disagreement was not solve after discussion, the third author (MT) made the final decision.

Data synthesis and analysis

Principal results comparing EFA and IFA subgroups for all considered outcomes in the studies were extracted. When no conclusions on differences between EFA and IFA were reported in the text, results were inferred by tables or figures. Computation of agreement between raters regarding critical appraisal was performed by means of Cohen's Kappa.[23] Instead, the agreement of the eligibility process was assessed using k_w [24] with linear weights.[25] Hence, in order to calculate the agreement for inclusion of studies, three categories were identified: "not considered", "removed" or "accepted". The weight between choices "not considered" and "removed" was 0.5. A P-value <0.05 was considered statistically significant. Stata (v.11; StataCorp) was used for computation of agreement.

Results

Study selection

The identification process resulted in 1752 articles, after the removal of duplicates. Following the screening process, full text of 14 studies was retrieved on the basis of their titles and abstracts. During the eligibility process, 9 articles were discarded on the basis of exclusion criteria for the following reasons: 1) descriptive studies like poster, dissertation or cohort studies;[26-28] 2) employment of attentional focus as feedback strategy;[29] 3) analysis of therapist's preference when applying attentional focus;[30] 4) lack of a clear description of attentional focus' instruction;[31-33] 5) lack of a clear description of patient's diagnosis.[34] In total, five articles [35-39] fulfilled the inclusion criteria (Figure 1). Regarding the inter-reviewer agreement of the eligibility process, this was 99.9% with an inter-reviewer reliability (k_w) of 0.92 (95% CI: 0.88-0.96; P<0.001).

Study characteristics

Considering the participants sample, two RCTs enrolled 56 subjects with ankle sprain [38, 39]

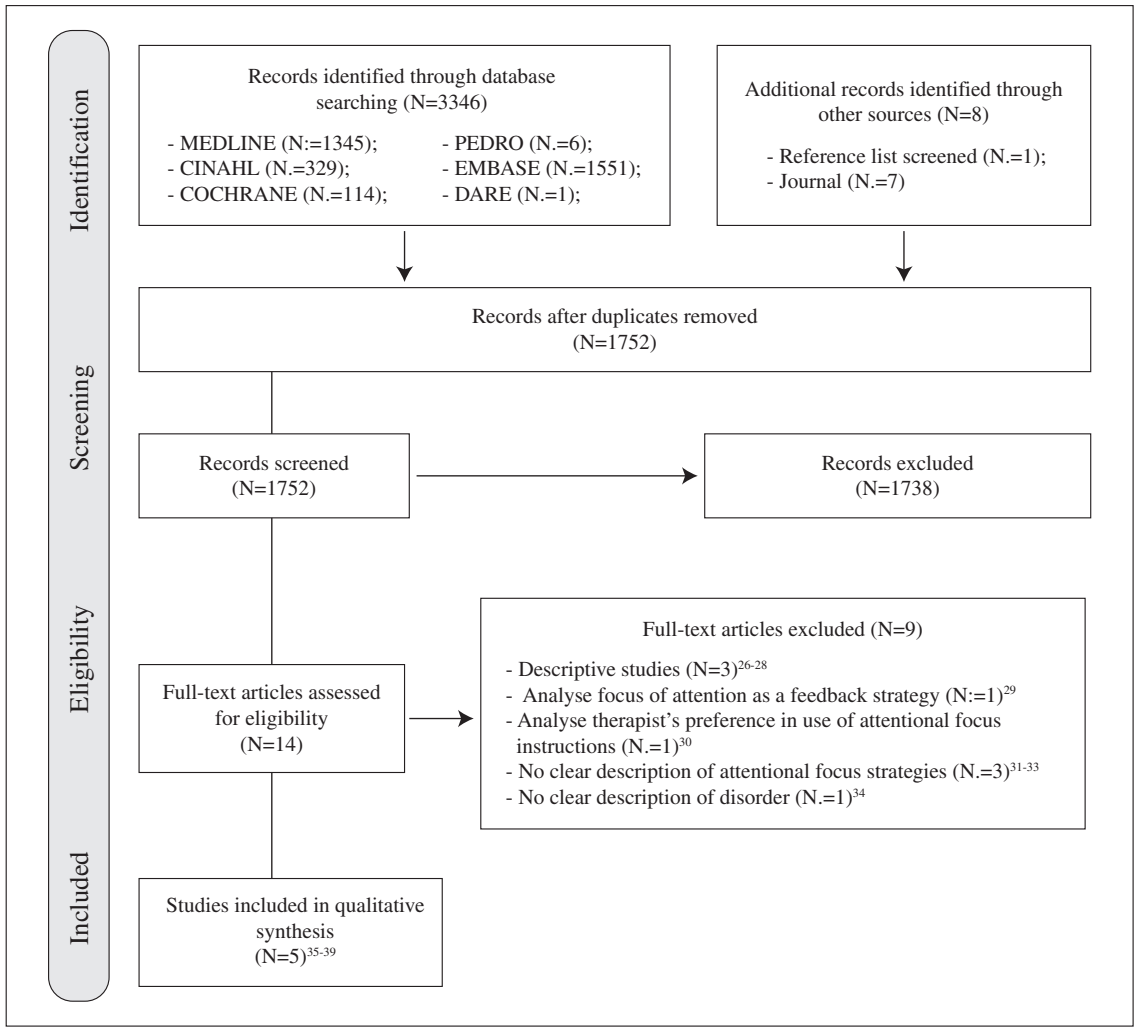

Figure 1.—Flow chart.

and three quasi-RCTs enrolled 16 subjects with stroke[37] and 36 subjects with idiopathic Parkinson.[35, 36] Sample size was inadequate in all the trials (16-40 participants) and the age was heterogeneous (19-80 years). Among 128 participants, 36 were allocated in the EFA group, 40 in the IFA group, and the remaining 52 received both interventions in different orders.

Four studies compared efficacy of EFA verbal instructions with IFA during balance tasks,[35-39] whilst one during reaching tasks.[37] On average, intervention length was 1.4 days (range 1-3), exercises repetition was 6 trials (range 3-10), and each trial lasted 18.7 seconds (range 15-20).

The outcomes regarded only movement effects (task performance variables) such as Centre-Of-Pressure (COP) displacement,[35] equilibrium score,[36] Overall Stability Index (OSI), Anterior/Posterior Stability Index (APSI), Medium/Lateral Stability Index (MLSI),[38, 39] movement time, movement unit, peak of velocity and percentage of time to peak velocity.[37] There were no outcomes concerning movement dynamics (kinematic and kinetic variables).

Follow-up measurements were taken in the retention phase immediately in three studies [35-37] and 48 hours later in the study by Laufer Y *et al.*[39] One study reported 48 hours follow-up

Table I.—*Characteristic of the study regarding CNS disorders.*

Study	Patient	Intervention				Outcome	Follow up
		Task	Condition	Instruction			
				EFA	IFA		
Wulf G *et al.*[35] q-RCT	N. = 14 (RI) Age = 52-80 y M/F = 10/4 Condition = idiopathic Parkinson disease (stage II or III)	Type = balance N. trial = 4 Time trial = 15 s Day = 1 Setting = participant's home	Standing position; unstable surface	Minimize movements of the disk	Minimize movements of your feet	COP	RT: 0 h
Landers M *et al.*[36] q-RCT	n° = 22 (RI) age = 61-86 y M/F = 17/5 condition = idiopathic Parkinson disease (stage II or III)	type = balance n° trial = 3 time trial = 20 sec day = 1 setting = physiotherapy research facility	Standing position; fixed support surface – surround; eyes open	Put an equal amount of pressure on the rectangles	Put an equal amount of force on your feet	ES	RT: 0 h
			Standing position; fixed support surface - surround eyes closed	Put an equal amount of pressure on the rectangles	Put an equal amount of pressure on your feet		
			Standing position; sway-referenced support surface and fixed surround; eyes open	Keep the rectangles levels	Keep your feet level		
			Seated position; use of right/left hand	Put this can from the shelf on the table. Pay attention to the can	Put this can from the shelf on the table. Pay attention to the your arms		
Fasoli SE *et al.*[37] q-RCT	N. = 16 (RI) Age = 32-79 y M/F = 10/6 Condition = stroke	Type = reaching N. trial = 8 Time trial = NR Day = 1 Setting = NR	Seated position; use of right/left hand	Put this apple off a shelf into a basket. Pay attention to the apple	Put this apple off a shelf into a basket. Pay attention to your arms	MT PV MU %TPV	RT: 0 h
			Seated position; use of right/left hand	Move an empty coffee mug from the table onto a saucer. Pay attention to the coffee mug	Move an empty coffee mug from the table onto a saucer. Pay attention to your arms		

q-RCT: quasi randomized controlled trial; RI: repeated intervention; NR: not reported; EFA: external focus of attention; IFA: internal focus of attention; COP: center-of-pressure displacement; ES: equilibrium score, MT: movement time; PV: peak velocity; MU: movements units; %TPV: percentage of time to peak velocity; 0h: immediate test; RT: retention test

in the transfer phase.[38] Studies characteristics are listed in Tables I, II.

An assessment of the efficacy of EFA compared with IFA through a meta-analysis was planned. However, it was not possible to conduct such analysis since there was patients' and outcomes' significant heterogeneity and a poor methodological quality of the included articles. Accordingly, there were insufficient data to conduct a meta-analysis.

Risk of bias within studies

The methodological quality of risk of bias within studies is presented in Table III. Overall, all the studies [35-39] had good external validity and statistical methods. However, the results of three studies [35-37] were seriously harmed by the risk of bias affecting items on internal validity. In fact, two of these [35, 37] had only the criterion subject random allocation *present*, while the third [36] none.

In contrast, two studies [38, 39] had higher internal validity. In fact, these scored as *present* also the items regarding the baseline comparability,[38, 39] blinding of assessor,[38, 39] and follow-up evaluation.[39] Items concerning the concealed allocation process, the blinding of subjects, the blinding of therapists, and the intention-to-treat analysis were *absent* in all the studies.[35-39] Thereby, one study was classified as "good",[39] one as "fair",[38] and three as "poor".[35-37]

Regarding the agreement of the methodological assessment, the inter-reviewer agreement was

Table II.—*Characteristic of the study regarding MSK disorders.*

Study	Patient	Intervention				Outcome	Follow up
		Task	Condition	Instruction			
				EFA	IFA		
Rotem-Lehrer N *et al.*[38] RCT	N. = 20 (IFA), 16 (EFA) Age = 19-33 y M/F = 36/0 Condition = ankle sprain (grade 1 or 2)	Type = balance N. trial = 10 (level 4), 10 (level 6) Time trial = 20 s Day = 3 Setting = outpatient	Standing position; unstable platform	Keep your balance by stabilizing the platform	Keep your balance by stabilizing your body	OSI APSI MLSI	TT: 48 h
Laufer Y *et al.*[39] RCT	N. = 20 (IFA), 20 (EFA) Age = 19-33 y M/F = 36/4 Condition = ankle sprain (grade 1 or 2)	Type = balance N. trial = 10 (level 4), 10 (level 6) Time trial = 20 s Day = 3 Setting = outpatient	Standing position; unstable platform	Keep your balance by stabilizing the platform	Keep your balance by stabilizing your body	OSI APSI MLSI	RT: 48 h

RCT: randomized controlled trial; EFA: external focus of attention; IFA: internal focus of attention; OSI: overall stability index; APSI: anterior/posterior stability index; MLSI: medium/lateral stability index; 48h: two days; TT: transfer test; RT: retention test

Table III.—*Risk of bias within the studies.*

Study	Eligibility criteria	Subject random allocation	Concealed allocation	Comparability at baseline	Blinding subject	Blinding therapist	Blinding assessor	Follow up evaluations	Intention-to-treat analysis	A between-group statistical comparison	A point measure	Score	Quality
Wulf G *et al.*[35]	1	1	0	0	0	0	0	0	0	1	1	3/10	Poor
Landers M *et al.*[36]	1	0	0	0	0	0	0	0	0	1	1	2/10	Poor
Fasoli SE *et al.*[37]	1	1	0	0	0	0	0	0	0	1	1	3/10	Poor
Rotem-Lehrer N *et al.*[38]	1	1	0	1	0	0	1	0	0	1	1	5/10	Fair
Laufer Y *et al.*[39]	1	1	0	1	0	0	1	1	0	1	1	6/10	Good

98% with an inter-reviewer reliability (k_w) of 0.96 (95% CI: 0.68-1.00; P<0.001).

Effect of attentional focus on CNS disorders

During balance task in idiopathic Parkinson, the investigation of three postural control tasks in the study by Landers *et al.*[36] showed the absence of significant difference between EFA and IFA during the immediate retention test. However, post-hoc test and subgroups analysis revealed an improved performance of the fallers subgroup treated with EFA in the most challenging condition (sway-referenced support surface).

In a similar sample, Wulf *et al.*[35] examined the effect of attentional focus during a postural task on an unstable surface, an inflated disk. Participants were instructed to focus on reducing the movement of their feet (internal focus) or of the disk (external focus). The results arising from the immediate retention test showed that the adoption of EFA resulted in a significant reduction of the postural sway.

In patient with *stroke*, a comparison of EFA instructions with IFA instructions during three reaching tasks was made by Fasoli *et al.*[37] This author reported that the use of EFA instructions led to significant improvement (effect size from moderate to large) of the short-term motor performance variables, such as movement time and peak velocity, in all the tasks. However, other performance variable, such as movement unit, which is the combination of acceleration and deceleration phases of reaching task, suggested a

Table IV.—*Effect of attentional focus instruction on CNS disorders.*

Study	Outcome	*Post-hoc test (EFA vs. IFA) or Anova*
Wulf G *et al.*[35]	COP	More-effective performance with the EFA than with IFA (P<0.001).
Landers M *et al.*[36]	ES	No significant EFA advantages for overall group (P>0.05); benefits of EFA in fallers group under sway-referenced condition (P<0.05).
Fasoli SE *et al.*[37]	MT	Significant improvement during all three tasks executed when given EFA instructions *vs.* IFA instructions (P<0.05).
	PV	
	MU	Significant improvement during one task when giving EFA instructions *vs.* IFA instructions (P=0.019).
	%TPV	No difference between EFA and IFA groups (P>0.05).

EFA: external focus of attention; IFA: internal focus of attention; COP: center-of-pressure displacement; ES: equilibrium score, MT: movement time; PV: peak velocity; MU: movements units; %TPV: percentage of time to peak velocity.

Table V.—*Effect of attentional focus instruction on MSK disorders.*

Study	Outcome	*Post-hoc test (EFA vs. IFA) or Anova*
Rotem-Lehrer N *et al.*[38]	OSI	Significant improvement in all stability measures only in the EFA group (P < 0.05) while the IIFA Group demonstrated significant difference between pre and post training in only one stability measure. No significant difference between the groups (EFA and IFA) either pre-training or post-training
	APSI	
	MLSI	
Laufer Y *et al.*[39]	OSI	In the EFA group at the most stable position (level 6) increased efficacy was observed in the APSI (P<0.001) and in the OSI (P=0.030) stability index. At level 4 improvements were noted either in EFA and IFA group
	APSI	
	MLSI	

EFA: external focus of attention; IFA: internal focus of attention; OSI: overall stability index; APSI: anterior/posterior stability index; MLSI: mediuml/lateral stability index.

greater efficacy (large effect size) of EFA instructions only in one task.

Efficacy of attentional focus in motor performance of CNS disorder is presented in Table IV.

Effect of attentional focus on MSK disorders

During balance task, patients with ankle sprain trained with EFA showed an improved learning in the 48-hours follow-up recorded in the transfer phase.[38] Further, significant pre-post training score differences were associated to not statistically significant changes over time for IFA group in all stability measures (OSI, APSI, MLSI). Group by time interaction was statistically significant for all stability measures.

Laufer *et al.*[39] found similar long-term results in the similar sample during the retention phase. In this study, postural control was tested in two conditions: most stable position (level 6), least stable position (level 4). Only the group of patients treated with EFA realized a statistically significant improvement between pre-training and post-training in the most stable position for two outcomes (OSI and APSI). Group by time interaction was statistically significant for both OSI and APSI. In the least stable position both groups experienced a significant improvement in OSI and APSI but no significant interaction effects between group and time was revealed. Regarding MLSI, no changes were found in both groups for each conditions of stability (level 6 and 4). Efficacy of attentional focus in motor learning of MSK disorders is presented in Table V.

Risk of bias across studies

The risk of bias affected seriously all the items regarding internal validity. Therefore, evidences arising from this review are weak because results might be distorted by the several bias found among the included articles.[13] In fact, a *selection bias* was feasible when data on sequence generation [36] were not reported or the allocation concealment was absent.[35-39] A *performance bias* might be present when the blinding of subjects and therapists was not stated.[35-39] In the case of information about blinding of assessors were

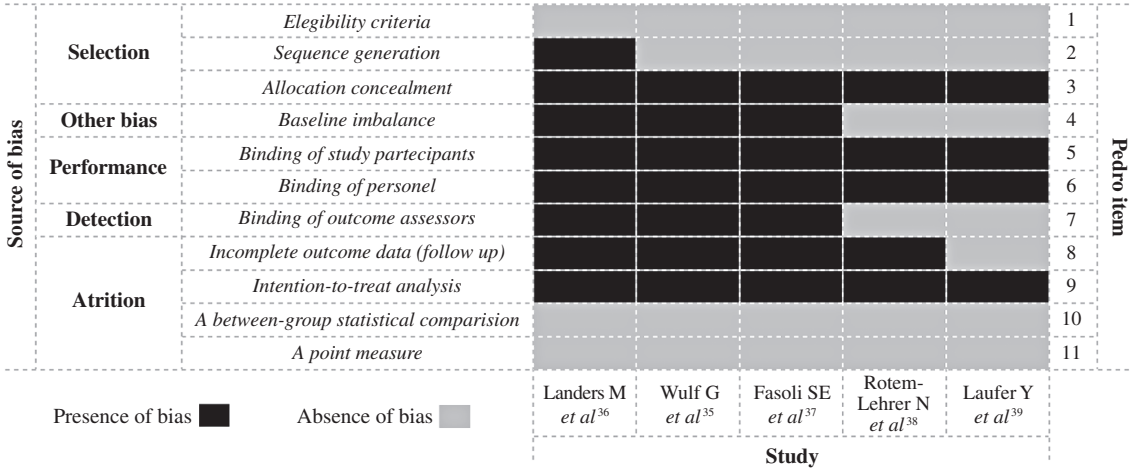

Figure 2.—Risk of bias across the studies.

not provided, a detection bias might have occurred.[35-37] An incompleteness of data regarding outcomes registration [35-38] and intention to treat analysis [35-39] could have produced an attrition bias. One more cause of bias was the presence of a baseline imbalance between group for the treatment outcomes.[35-37] A graphic representation of source of risk of bias across studies is presented in Figure 2.

Discussion

Effect of attentional focus on performance and motor learning

This review is the first evaluating qualitatively the role of verbal instructions during performance and learning of motor task in patients with CNS and MSK disorders. Thus, this represents an initial input for the research aiming at the investigation of the evidence-based planning of therapeutic exercises.

Overall, the efficacy of EFA was higher than IFA. An improvement of the short-term motor performance in CNS disorders has been reported in three studies [35-37] and considering MSK disorders, long-term motor learning has been showed in two studies.[38, 39]

Studies on patients with CNS disorders were poor of methodological quality. One of these reported that patients with stroke had shorter movement time and greater peak velocity in EFA condition during the execution of reaching tasks.[37] The observation of quicker movements could depend on the different sensory process elicited by the employed attentional sources. Hence, our hypothesis is that EFA involves the visual channel to obtain relevant object characteristics whilst IFA emphasises the proprioceptive source in order to control the motor task. Although both vision and proprioception concur in motor control, visual sensations are naturally privileged by patients to make more effective reaching movements.[40] Further, EFA does not influence the percentage of time to peak velocity and the movement units. A possible explanation could be that stroke cause a reduction of the capacity of making pre-programmed movements in response to instructions because of force generation deficit in the impaired extremity.[41]

In patients with idiopathic Parkinson, an higher equilibrium score [36] and a lower centre-of-pressure displacements [35] were found in the cases patients were treated with EFA rather than with IFA. Thus, the observed lower sway may be explained by the capacity of EFA information emulating external cues of overcoming the alteration of the intrinsic regulation of sequential movements due to damaged basal ganglia.[42] Besides, this sort of benefit on stability performance significantly emerged in higher difficult conditions (sway-referenced support surface)

and in subjects predominantly injured (fallers group).[36] This is in line with recent evidences which showed the delivery of higher difficult tasks as a necessary pre-condition to gain effective attentional focus.[43, 44]

Regarding patients with MSK disorders, two studies with fair [38] and good [39] quality investigated samples of patients with ankle sprain. These authors compared IFA with EFA and found that EFA induced a constant improvement of OSI and APSI during balance tasks.[38, 39] However, Laufer *et al.*[39] did not show any significant differences in the MLSI score. Such a discrepancy may be related to the unwillingness of patients with ankle sprain to load over damaged structures of lateral collateral ligament along a medium-lateral shearing load.[45]

The results of this review reflect what previously found in studies enrolling healthy subjects. In fact, EFA was found to have more efficacy than IFA in influencing performance and learning of several laboratory and sport skills such as standing balance,[8, 46-51] golf,[52-56] volleyball,[57] soccer kick,[57, 58] dart throwing,[59,60,61,62,63,64] baseball,[65] tennis,[53] jump,[66,67,68,69] basketball,[63, 70, 71] running,[72] force production,[73,74,75] postural and supra-postural task,[76-78] and oral-motor task.[79]

EFA and IFA have been shown to activate specific neural populations, respectively, of medial and lateral rostral prefrontal cortex.[80] The functioning of these strategies can be explained with the *constrained* action hypothesis.[46, 47] According to such a theory, trying to consciously control the movement (IFA) may alter the motor system functioning because of automatic control process interferences. Instead, focusing on the movement effects (EFA) would promote the use of automatic control processes. This allows the motor system to self-organise naturally because of a more effective motor unit recruitment and minimisation of agonist and antagonist muscle co-contraction.[49] Therefore, approaches promoting the automatism of movement seems to have higher efficacy than those directing the attention of novices on step-by-step coordination of their own movements.[81-83]

Moreover, several empirical data on behavioural performance outcomes suggest that EFA has more benefit than IFA. For instance, shorter probe reaction times (Rts) [46, 51] and higher frequency of low amplitude postural adjustments (mean power frequency, MPF) [46, 47, 49] have been found in healthy subjects employing EFA. This results indicate a reduction of attentional load and more fluid movements. Further, neurophysiological data reported an increment of movement efficiency with the use of EFA. In fact, a lower electromyographic (EMG) activity,[62, 68, 71, 73-75] a greater jump height and vertical centre-of-mass (COM) displacement,[66] a greater impulse and lower extremity joint moments,[67] a lower heart rate and alpha waves of electroencephalogram (EEG),[59] and a reduced oxygen consumption for a given output[72] have been recorded in EFA condition. This increased efficiency allows to realize a more optimal and economic motor control automatism.

Limits of systematic review

A common problem of every systematic review process is the role that publication bias could have in result validity. Nevertheless our effort in searching the literature over 6 database (location bias), from inception to December 2010 (time lag bias), including articles in 5 languages (language bias) and consulting the grey literature as well (citation bias), it may be that some relevant articles have been missed, thus leading to a modified estimate of results.[84, 85] Other possible restrictions arise from the eligibility criteria which concerned studies analysing task and outcome obtained from few heterogeneous clinical conditions in short-time trial.

Complex and variegated motor tasks, structured in long practice time, based on outcome on both movement dynamics (kinematic and kinetic variables) and movement effects (task performance variables),[15] and a bigger variety of CNS and MSK disorders[35,36,37,38,39] represent a necessary conditions to evaluate the impact that attentional focus strategies has on the cost/benefit ratio of re-learning training.[11]

Finally, the retrieved studies reported short-time retention and transfer test. However, longer follow-up are needed to augment the knowledge about stabilization process of learned imprint during attentional focus.[86]

Conclusions

Implications for research

This manuscript has been developed to give an initial input for further research about the efficacy on motor learning and performance of attentional focus strategies developed by verbal instruction. Future research questions should be based on well-designed studies, should enrol subjects with CNS and MSK disorders trained with complex and variable task, and use clinically relevant outcome measures and longer follow-up.

Implication for practice

The results of this review give preliminary evidence for the employment of EFA rather than IFA in influencing either motor performance in subjects with CNS or motor learning in subjects with MSK disorders. These conclusions could move the decision-making process towards the employment of attentional focus in clinical practice. However, caution is needed when interpreting the findings of this review because of the large heterogeneity and the methodological quality of the retrieved studies. Therefore, data from this review offer additional information in regard to the potential use of attentional focus during therapeutic exercise planning. However, the final decision should also consider therapist's expertise and patient's preference.

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