ORIGINAL RESEARCH

Effects of Action Observation Therapy in Patients Recovering From Total Hip Arthroplasty Arthroplasty: A Prospective Clinical Trial

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ABSTRACT

Objective: The purpose of this study was to investigate the effectiveness of action observation therapy (AOT) compared with written information in patients submitted to a physical therapy program after primary total hip arthroplasty (THA).

Methods: We conducted a prospective clinical trial. Twenty-four patients with THA, 62.5% female (aged 69.0 ± 8.5 years), received AOT in addition to conventional physical therapy (experimental group) or written information in addition to conventional physical therapy (exercise and information group) for 10 sessions. Outcomes used were visual analog scale, hip active and passive range of motion, Barthel Index, Short Form 36 (SF-36) Health Survey, Tinetti Scale, and Lequesne Index measurements. All measures were collected at baseline and at the end of the intervention. Repeated measures analysis of variance was used to examine the interventions effects within groups and between groups.

Results: No relevant baseline differences were observed between groups. Both treatments produced statistically significant improvements on visual analog scale, active and passive range of motion, Barthel Index, SF-36, Tinetti Scale, and Lequesne Index immediately after the intervention (all, $P < .001$). SF-36 (physical functioning subscale) revealed a statistically significant intergroups difference ($P = .02$) after treatment.

Conclusions: Both treatments were effective at improving pain, functional status, quality of life, and gait features in patients with primary THA. In addition to conventional physical therapy, AOT improved perceived physical function more than written information.

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Key Indexing Terms: *Arthroplasty; Hip Replacement; Rehabilitation*

INTRODUCTION

The mirror neuron system, initially discovered in macaque prefrontal cortex, has been well documented and studied in humans in neuroimaging and noninvasive neurophysiological investigations.[1] Subliminal mirror system activation has been identified in humans observing an action performed by another human,[2] and studies on healthy humans indicate that action observation facilitates the observer's motor system.[3]

Action observation therapy (AOT) has been proposed as a feasible alternative method of stimulating the motor system, even when the severity of impairment does not permit efficient activation of the peripheral motor system effectors. According to this idea, a growing number of AOT-based interventions have been adopted for the rehabilitation of patients with stroke[4-7] or Parkinson disease[8] and for use in impaired elderly people.[9] Robert et al[10] highlighted that new information and communication technologies (ICT)—such as video and audio analysis techniques, computerized testing, and actigraphy—may represent promising new tools to improve functional and cognitive assessments of patients.

Action observation therapy, a top-down approach that can influence peripheral motor skills, is hypothesized to improve motor recovery in patients undergoing orthopedic

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surgery, but few studies have been conducted in this field. Park et al[11] observed that AOT may reduce pain and stiffness and improve function in patients undergoing total knee arthroplasty. Bellelli et al[12] reported positive results in improving functional independence and balance in patients who had undergone lower limb joint arthroplasty; these patients observed video clips of others performing daily actions and imitated these actions afterward. In this study, patients who were asked to observe video clips with no motor content and then to execute the same actions performed by patients in the experimental group had inferior results compared with the experimental group. However, the conclusions of this study are difficult to discuss because the authors considered and statistically analyzed patients with hip and knee arthroplasty as 1 group.

To our knowledge, no study on AOT has been conducted on a selected sample of patients undergoing primary total hip arthroplasty (THA). This orthopedic surgical procedure is among the most frequently performed, and rates are estimated to increase by 174% in the United States,[13] with a similar trend in European countries.

We hypothesized that ICT through AOT in addition to conventional treatment would improve motor recovery in patients undergoing primary arthroplasty. The purpose of this study was to investigate the effectiveness of AOT, compared with written information, in patients submitted to a physical therapy program after THA.

Methods

Study Design

We conducted a prospective clinical trial. Informed consent was obtained from all patients, and procedures were conducted according to the Declaration of Helsinki. The protocol was approved by the Local Ethical Committee of Istituto di Ricovero e Cura a Carattere Scientifico (IRCCS), Regione Lombardia, Italy, on May 14, 2014 (NCT02861638).

Participants

From May 2014 to October 2014, 30 patients, aged 50 to 80 years, were assigned consecutively to an experimental group or an exercise and information group. Patients admitted for elective primary THA who gave written informed consent were eligible for inclusion in this study. Each patient underwent subjective and physical examination performed by a physician experienced in orthopedic rehabilitation; this physician applied inclusion and exclusion criteria. Exclusion criteria were scheduled bilateral arthroplasty or previous THA, severe hearing or visual impairment, cognitive deficits (Mini Mental State Examination score ≤ 21[14]), and severe comorbidities (based on Cumulative Illness Rating Scale scores[15]). We also excluded patients who did not sign the informed consent.

Protocol

Patients in both groups were treated by a physical therapist with postgraduate orthopedic training and more than 10 years of clinical experience in musculoskeletal rehabilitation. The physical therapist was blinded to all data collected for this study.

Assignment to the experimental group or exercise and information group were assigned to one group until it reached capacity, and subsequent patients were assigned to the other group. All patients received 10 individual treatment sessions scheduled twice a day, at the same time of day, 5 days per week, for 2 weeks. All outcome measures were collected by an external assessor (physical therapist) blinded to the group allocation. Outcome measures were collected at baseline and after the intervention.

Experimental Group Intervention

Patients in the experimental group received a treatment intervention consisting of 15 minutes of conventional treatment and 15 minutes of AOT.

Conventional Treatment. Conventional treatment included passive mobilization, exercises, and transfer practice. The exercises initially were performed in the supine position and included ankle dorsiflexion and plantar flexion, quadriceps and gluteal contractions, hip and knee flexion, and hip abduction.[16,17]

Action Observation Treatment. Patients observed a video clip showing functional exercises and reinforcement of the lower limb and then were invited to imitate the actions they observed.[18] The video clip included some simple exercises (active mobilization of the lower limb in lying, sitting, and standing positions) and some daily living activities such as the transfer from lying to sitting and from sitting to standing, and vice versa.

Exercise and Information Group Intervention

Patients in the exercise and information group received a treatment intervention consisting of written information and 15 minutes of conventional treatment.

Conventional Treatment. Patients in the exercise and information group received same number, type, and duration of passive mobilization, exercises, and transfer practice as those in the experimental group.

Written Information. Patients received written information about exercises, reassurance about recovery, and instructions on self-treatment and daily living activities after THA.

Outcome Measures

An assessor who was blinded to patients' group assignment collected pretreatment measurements, which included patients' pain rating, functional status, quality of life, and gait features. Outcome measures used the visual analog scale,[19] the flexion and abduction active range of motion and passive range of motion,[20] the Barthel Index,[21] the Cumulative Illness Rating Scale,[15] the Short Form (SF-36) Health Survey,[22] the Tinetti scale,[23] and the Lequesne Index.[24] Outcome measures were collected in the same order.

After pretreatment measurements were taken, patients were assigned to the experimental group or theexercise and information group and received treatment sessions conducted by a physical therapist who was blinded to the patients' pretreatment measurements. The physical therapist collected in a descriptive form only essential information useful for planning conventional treatment and controlling adverse effects.

The same assessor who recorded the pretreatment measurements, and who remained blinded to group allocation, collected post-treatment measurements 5 minutes after the end of the last procedure.

The present document was prepared according to the editorial form of medical publishing and CONSORT publishing guidelines.[25]

Statistical Analysis

Data were analyzed using SPSS version 21.0 (IBM Corp., Armonk, NY), after an intention-to-treat analysis using the last value forward method. Group data were summarized using means and standard deviations. The Kolmogorov-Smirnov test was used to evaluate the normal distribution of the data. The Student *t* test was used to determine the level of significance of the differences between pretreatment and post-treatment measurements. A 2 × 2 repeated measures analysis of variance (ANOVA) was used to determine difference in time (preintervention and postintervention) as the intrapatient factor and difference in group (experimental or exercise and information) as the interpatient factor. The main hypothesis of interest was group × time interaction. Between-group differences were expressed as mean differences with 95% confidence intervals. Between-group effect sizes were calculated using Cohen's *d* coefficient. An effect size >0.8 was considered large, approximately 0.5 was considered moderate, and <0.2 was considered small. In all analyses, $P < .05$ was considered statistically significant.

Results

Thirty consecutive patients with primary THA were screened according to the eligibility criteria. Twenty-four patients (aged 69 ± 8.5 years; 62.5% female) who satisfied all eligibility criteria agreed to participate and were assigned to the experimental (n = 9) or exercise and information (n = 15) group. Patients with neurologic problems (n = 3), previous THA (n = 2), and cardiac pathologic conditions (n = 1) were ineligible. Patients did not modify their medication use during the study. Anthropometric and clinical characteristics were similar between the experimental and exercise and information groups; mean age was the only statistically significant difference, with the experimental group being older than the exercise and information group (Table 1).

Response to Treatment

Pain Intensity. Visual analog scale scores revealed a statistically significant effect of time difference ($F_{[1.0]} = 30.24$, $P = .001$) on pain intensity. The post hoc analysis revealed statistically significant within-group differences in experimental and exercise and information groups (both, $P = .001$). Between-group effect sizes were small ($d < 0.2$) (Table 2).

Range of Motion. Outcomes for flexion and abduction active and passive range of motion indicated a statistically significant time factor ($F = 52.45$; $F = 63.88$; $F = 33.74$; $F = 53.71$; all, $P < .001$, respectively). The post hoc analysis revealed statistically significant within-group differences in the treatment and exercise and information groups (all, $P = .001$). Between-group effect sizes were small ($d < 0.2$) (Table 2).

Functional Status. The Tinetti Scale and the Lequesne Index outcomes indicated a statistically significant time interaction ($F_{[1.0]} = 89.66$; $F_{[1.0]} = 65.06$; $F_{[1.0]} = 150.57$; all, $P = .2$, respectively). The post hoc analysis revealed statistically significant within-group differences in the experimental and exercise and information groups ($P < .001$). Between-group effect sizes were small ($d < 0.2$) (Table 2).

Quality of Life. ANOVA revealed a statistically significant effect of time for the SF-36 physical functioning subscale ($F_{[1.0]} = 42.78$; $P < .001$) and between-group differences ($F_{[1.0]} = 2.66$; $P = .1$). The post hoc analysis revealed statistically significant within-group and between-group differences ($P = .02$). Between-group effect sizes were greater in the post-treatment period (d = 1.19).

ANOVA revealed no statistically significant effect of time for the SF-36 (mental health subscale) ($F_{[1.0]} = 0.79$; $P = .4$) or for group × time ($F_{[1.0]} = 0.45$; $P = .5$) interactions (Table 2).

Discussion

This study investigated the effectiveness of ICT through AOT compared with written information in addition to a

Table 1. *Baseline Demographics for Both Groups* [a]

	Experimental (n = 9)	Exercise and Information (n = 15)	*P* value
Age (y)	75.4 ± 5.3	64.9 ± 7.4	.05
Female gender [n (%)]	3 (37.5%)	11 (73.3%)	—
Side, right [n (%)]	7 (87.5%)	15 (100%)	—
Waiting days before treatment	7.1 ± 2	7.7 ± 2.1	.6
Day hospital (total d)	20.0 ± 4.4	20.2 ± 2.3	1.0
BMI	29.5 ± 9.9	26.5 ± 4.8	.8
CIRS SI	1.5 ± 0.3	1.5 ± 0.2	.7
CIRS CI	2.8 ± 2.0	2.5 ± 0.8	.7
MMSE	28.3 ± 1.3	28.2 ± 0.8	1.0

BMI, body mass index; *CI,* comorbidity index; *CIRS,* Cumulative Illness Rating Scale; *MMSE,* Mini Mental State Examination; *SI,* severity index.

[a] Data are expressed as mean ± standard error.

Table 2. *Mean ± Standard Deviation for Outcome at All Study Visits for Each Group, Mean ± Standard Deviation Difference Within Groups, and Mean (95% CI) Difference Between Groups*

	Groups					Difference Within Groups	Difference Between Groups
	Baseline (T0)		Post-treatment (T1)		T1 − T0		
	Exp	EI	Exp	EI	Exp	EI	Exp − EI
Outcome	(n = 8)	(n = 15)	(n = 8)	(n = 15)	(n = 8)	(n = 15)	
VAS	77.9 ± 17.8	78.1 ± 15.3	46.4 ± 15.8	57.6 ± 16.0	−31.5 ± 7.3 [a]	−20.5 ± 5.9 [a]	−11.2 (−26.5 to 4.1)
A-ROM flexion	53.8 ± 13.0	58.1 ± 13.8	83.8 ± 14.1	80.8 ± 9.8	30.0 ± 5.7 [a]	22.7 ± 4.5 [a]	3.0 (−7.9 to 13.8)
A-ROM abduction	16.3 ± 15.5	15.4 ± 12.0	32.5 ± 10.0	27.1 ± 11.0	16.3 ± 2.7 [a]	11.4 ± 2.2 [a]	5.4 (−4.7 to 15.6)
P-ROM flexion	65.6 ± 18.4	72.9 ± 9.7	94.4 ± 11.2	87.7 ± 4.4	28.8 ± 5.9 [a]	12.9 ± 4.6 [a]	6.7 (−0.6 to 14.4)
P-ROM abduction	30.6 ± 5.6	24.2 ± 6.7	38.8 ± 6.4	32.5 ± 8.9	8.1 ± 1.8 [a]	8.8 ± 1.4 [a]	5.7 (−1.9 to 13.2)
Barthel Index	58.5 ± 12.9	62.9 ± 13.7	9.0 ± 6.8	86.6 ± 6.9	31.5 ± 4.6 [a]	23.7 ± 3.6 [a]	−3.4 (−3.1 to 9.9)
SF-36 Physical function	27.6 ± 3.9	24.7 ± 6.7	38.9 ± 6.8	31.4 ± 5.8	11.2 ± 2.1 [b]	6.8 ± 1.8 [a]	7.5 [b] (1.3 to 13.6)
SF-36 Mental health function	53.3 ± 15.7	49.8 ± 18.0	53.9 ± 8.1	53.9 ± 14.0	0.6 ± 4.0	4.1 ± 3.4	0.0 (−11.7 to 11.6)
Tinetti scale	15.9 ± 5.6	16.8 ± 4.0	23.8 ± 2.7	21.2 ± 3.9	7.9 ± 1.2 [a]	4.5 ± 0.9 [a]	2.5 (−0.7 to 5.8)
Lequesne Index	19.9 ± 2.6	18.8 ± 2.5	10.8 ± 3.1	13.6 ± 2.9	−9.1 ± 0.9 [a]	−5.2 ± 0.7 [a]	−2.7 (−5.6 to 0.1)

A-ROM, active range of motion; *EI,* exercise and information group; *Exp,* experimental group; *P-ROM,* passive range of motion; *SF-36,* Short Form 36 Health Survey; *VAS,* visual analog scale.

[a] Significantly different within group, $P < .05$ (95% confidence interval).

[b] Significantly different between group, $P < .05$ (95% confidence interval).

conventional physical therapy program for patients undergoing THA. Very few technologies have been designed for or rigorously tested in older adults, who often have physical and cognitive limitations not common among younger people.

Outcome measures considered physical, functional, and psychological results, according to the biopsychosocial model currently adopted in the rehabilitation field. Our results revealed that both groups experienced similar and statistically significant improvements in pain, range of motion, balance, and daily living function after the intervention. Action observation therapy was associated with better results concerning the physical functioning subscale of SF-36 Health Survey, which investigates self-perceived health related to some physical activities commonly performed in daily living and is responsive to both chronic diseases and minor relatively acute conditions.[26]

Hip and knee arthritis were determined to significantly affect the results of the physical functioning SF-36 subscale.[27,28] Total hip arthroplasty is considered to be a highly successful treatment, with >90% of patients having good to excellent results; corresponding improvements in the SF-36 have been well documented.[29]

Our study determined that AOT increased patients' perceived health status in relation to physical activities, although our results are worse than those of Park et al,[11] who obtained positive results in pain, stiffness, and function, and those of Bellelli et al,[12] who reported relevant improvements in functional independence and balance.

The difference between the experimental group and the exercise and information group in these studies can be related to the top-down effect that is a consequence of the observation of functional performances.[12,16] This effect may be reinforced by the imitation of observed actions, thus influencing peripheral motor skills and improving motor recovery.[30] Written information and examples, in the absence of practical strengthening, could not induce stimulation[31] similar that resulting from observation of video clips with no motor content.[12]

Action observation therapy increases the spectrum of rehabilitation strategies available to patients with traumatic or orthopedic diseases and allows providers to exploit top-down effects in rehabilitation, even when motor impairment is too severe to allow patients to move spontaneously (eg, a patient who cannot perform movements because of neural damage) or when movements are not permitted for clinical reasons (eg, pain, imposed immobility). Such situations are common also in older populations and in those with degenerative disorders (eg, knee or hip arthritis, rheumatoid arthritis).

Action observation therapy may be used during rehabilitation of patients with various disorders and dysfunctions. Improvement in physical functioning increases the opportunities for independent and social living in patients with chronic illnesses and can reduce the economic problems arising from extended hospitalization. In addition, AOT may be an effective approach to ensure continuous training after discharge because of its implicit characteristics and motivational aspects.[32,33]

Limitations

The limitations of this study are related to the small simple size and to some differences between the 2 groups,

such as the different number of patients, the greater age in the experimental group, and the possible differences in surgical procedures or surgeons. We did not also analyze whether patients in the 2 groups took the same amount of drugs during the period of treatment. Finally, the experimental group received 15 minutes of AOT twice a day, whereas the exercise and information group only received written information. Greater time spent with the physical therapist may have influenced our results.

The results of this study can be useful for further trials with larger samples. We suggest that future studies investigate the effect of AOT not only in the immediate phase after surgery, but also after discharge to support a speedy home recovery and to verify the effectiveness of different types and durations of video clips.

Practical Applications

- This integrated approach, combining action observation and conventional physiotherapy, can be added to the therapist's "tool box" of efficacious interventions.
- Action observation treatment in addition to conventional physiotherapy seems to increase the efficacy of rehabilitation of patients after total hip replacement.
- Action observation treatment could be considered as ancillary strategy in the rehabilitation of post surgical orthopedic patients.

Conclusions

In addition to conventional physical therapy, AOT improved perceived physical function more than did written information in patients with primary THA. No statistically significant differences were found in pain, hip range of motion, functional status, or gait features. This study partially confirmed positive findings from previous research conducted on AOT in different clinical conditions.

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No funding sources or conflicts of interest were reported for this study.

Contributorship Information

Concept development (provided idea for the research): J.H.V., S.N.
Design (planned the methods to generate the results): J.H.V., S.N.
Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): J.H.V., C.P., S.N.
Data collection/processing (responsible for experiments, patient management, organization, or reporting data): C.P., R.B., M.I.
Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results): J.H.V., S.N.
Literature search (performed the literature search): C.P., C.V., R.B.
Writing (responsible for writing a substantive part of the manuscript): J.H.V., M.I., C.P., S.N., C.V.
Critical review (revised manuscript for intellectual content, this does not relate to spelling and grammar checking): J.H.V., C.V., C.P., R.B., M.I., S.N.

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