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Effect of Action Observation Therapy on Pain, Kinesiophobia, Function, and Quality of Life in Adhesive Capsulitis Patients

Abstract

Background: Adhesive capsulitis is a common musculoskeletal health problem. Cortical changes along with maladaptive pain behavior has been reported in literature. There is a need to implement biopsychosocial rehabilitation approaches to achieve successful outcomes. Hence, this study aims to evaluate the effect of action observation therapy (AOT) on pain, kinesiophobia, function and quality of life in adhesive capsulitis patients. **Methods:** This single-center, prospective study was conducted in a group of 30 persons diagnosed with adhesive capsulitis patients (19 males, 11 females). Patients were randomly assigned into two groups. Patients in one group were given AOT along with conventional exercises, while the patients in the other group received only conventional exercises. The patients were evaluated before and after 4 weeks of intervention using numerical pain rating scale (NRS), pain catastrophizing scale (PCS), Tampa scale of kinesiophobia (TSK), Shoulder pain and disability index (SPADI) and 36-Item Short Form Survey (SF-36). **Results:** There was a statistically significant difference seen in pre and post intervention scores of the NRS, PCS, TSK, SPADI, SF-36 PCS and SF36 MCS ($p < 0.05$). **Conclusion:** The present study supports the addition of AOT to conventional exercises in rehabilitation of patients with adhesive capsulitis. AOT promotes a top-down approach leading to cortical reorganization and helps to reduce kinesiophobia and improve quality of life in adhesive capsulitis patients as compared to conventional exercises alone.

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ABSTRACT

Background: Adhesive capsulitis is a common musculoskeletal health problem. Cortical changes along with maladaptive pain behavior has been reported in literature. There is a need to implement biopsychosocial rehabilitation approaches to achieve successful outcomes. Hence, this study aims to evaluate the effect of action observation therapy (AOT) on pain, kinesiophobia, function and quality of life in adhesive capsulitis patients. **Methods:** This single-center, prospective study was conducted in a group of 30 persons diagnosed with adhesive capsulitis patients (19 males, 11 females). Patients were randomly assigned into two groups. Patients in one group were given AOT along with conventional exercises, while the patients in the other group received only conventional exercises. The patients were evaluated before and after 4 weeks of intervention using numerical pain rating scale (NRS), pain catastrophizing scale (PCS), Tampa scale of kinesiophobia (TSK), Shoulder pain and disability index (SPADI) and 36-Item Short Form Survey (SF-36). **Results:** There was a statistically significant difference seen in pre and post intervention scores of the NRS, PCS, TSK, SPADI, SF-36 PCS and SF36 MCS ($p < 0.05$) in both the AOT and conventional exercise groups. Also, significant difference was observed between AOT and conventional exercise groups in post intervention scores of TSK, SF-36 PCS and SF36 MCS ($p < 0.05$) with an effect size as 0.81, 1.67 and 1.54 respectively. However, there was no significant difference seen in NRS, PCS and SPADI scores between the two groups ($p > 0.05$). **Conclusion:** The present study supports the addition of AOT to conventional exercises in rehabilitation of patients with adhesive capsulitis. AOT promotes a top-down approach leading to cortical reorganization and helps to reduce kinesiophobia and improve quality of life in adhesive capsulitis patients as compared to conventional exercises alone.

Keywords: action observation therapy, kinesiophobia, pain, adhesive capsulitis, function, quality of life

INTRODUCTION

Adhesive capsulitis (frozen shoulder) is a common chronic musculoskeletal condition for which determining effective treatment strategies proves a challenge to many clinicians.¹ Evidently, there is demand for clarity of its treatment choices given that the prevalence rate is about 2%-5% in general population, more common in women and age group between 40 and 65 years.² It is characterized by insidious progressive shoulder stiffness, severe pain that worsens at night, and restriction in active and passive shoulder range of motion without any specific etiology.³ It not only affects the functional performance of an individual but also leads to socioeconomic burden, increased health care costs, absenteeism, loss of productivity, and impaired quality of life.¹

Varied conservative management approaches for adhesive capsulitis have been recommended over time with mixed outcomes in the literature. These strategies include joint mobilization techniques, electrotherapy modalities, stretching exercises, and physical therapy interventions.⁴⁻⁷ However, there is no universal consensus on the best single intervention, and therefore, a combination of treatment approaches is preferred.⁵ Recently published systematic reviews revealed that central pain processing mechanisms contribute to pain experience in chronic shoulder pain patients.^{8,9} Some authors have suggested an involvement of central pain mechanisms secondary to continuous nociception characteristic in the early stages of adhesive capsulitis.⁷ This is attenuated by the interplay of psychological factors which influence the underlying pain mechanisms.^{10,11} Changes in the central nervous system (CNS) processing along with increased activation of nociceptors in chronic pain ultimately leads to central sensitization.¹² This leads to cortical reorganization and maladaptive neuroplasticity due to prolonged periods of disuse or chronic pain.^{13,14}

Current rehabilitation of chronic shoulder pain is majorly focused on targeting input mechanisms and output mechanisms, whereas less attention is given to the central processing mechanisms.¹⁵ Restoration of maladaptive neuroplasticity may need to be actively targeted in rehabilitation programs to restore functional abilities.¹⁶ This has led to the advent of innovative rehabilitation approaches that address cortical reorganization via the mirror neuron system (MNS).¹⁷ Action observation therapy (AOT), a unique rehabilitation strategy, involves observation of action and execution of the observed action.^{18,19} AOT increases the excitability of the motor cortex leading to activation of frontal and parietal lobes. During observation of movement, mapping occurs along with gaining knowledge of those actions by executing them internally, thus promoting motor learning.¹⁷⁻¹⁹ AOT has been proved to be beneficial in conditions like cerebral palsy, stroke patient, Parkinson's disease, and Alzheimer's disease.²⁰⁻²³ It focuses on a top-down approach involving higher centers that control the peripheral circuits.^{14, 24} Action observation therapy is yet to be explored in adhesive capsulitis, despite its purported central mechanisms. Hence, the primary aim of the study was to evaluate the effect of action observation therapy on pain, kinesiophobia, function, and quality of life in adhesive capsulitis patients.

METHODS

An experimental study was conducted at the outpatient physical therapy department of a tertiary care center between June 2019 and February 2020 after receiving approval from the university Institutional Research Review Committee. Written informed consent was obtained from all participants before recruiting them in the study. A total of 30 adhesive capsulitis patients diagnosed by a physician were included in the study. Participants were selected as per the inclusion and exclusion criteria. Inclusion criteria were as follows: Men and women in age group of 40 to 65 years and diagnosed with adhesive capsulitis in the last month before starting the study. Exclusion criteria were as follows: rheumatoid arthritis; cancer; neurologic disorders; fibromyalgia; psychiatric illness; posttraumatic stress disorder; acquired immunodeficiency syndrome; any fractures or deformities of the upper extremity; any shoulder surgery within last 6 months; symptoms derived from cervical spine; and uncontrolled diabetic population.

Demographic characteristics like age, gender, dominance, educational status, and occupation were noted. Pain was evaluated using Numerical Pain Rating Scale (NRS). Pain catastrophizing was evaluated using the Pain Catastrophizing Scale, 13-item self-report measurement tool.²⁵ The Tampa Scale for Kinesiophobia (TSK), a self-report 17-item measure, was used to assess 'fear of movement-related pain'.²⁶ The Shoulder Pain and Disability Index (SPADI), a 13-item measure, was used to assess level of disability with higher scores representing increased level of disability.²⁷ A 36-Item Short Form Health Survey questionnaire (SF-36), a self-administered questionnaire, was used to assess quality of life. It involves computation of Physical Component Summary (PCS) and Mental Component Summary (MCS).²⁸ Baseline and 4 weeks' follow-up assessments were recorded. All questionnaires were administered in person. The participants were divided into two groups - experimental and control group using the SNOSE (sequentially numbered opaque envelopes) randomization method. Both experimental and control group protocol were carried out under the supervision of the physiotherapist for four weeks, three times a week, for a total of 12 sessions. The therapist administering the intervention protocol was a physiotherapist with a bachelor's degree in physiotherapy and five years of experience who was well versed with administering the AOT protocol. Group 1 received Action observation therapy and conventional exercises and Group 2 received only conventional exercises.

In AOT, observation of videos of upper limb activities and the execution of the observed activity was incorporated. Participants sat on the chair in a comfortable position two meters away in front of the laptop. Four common categories of movements and tasks

were selected in the action observation therapy protocol based on the related literature and clinical expertise: 1) shoulder active range of motion (AROM) exercises like shoulder flexion, extension, abduction, adduction, internal and external rotation; 2) overhead and reaching activities (approaching objects of varied sizes and weights placed at varied heights and locations); and 3) integration of upper limb functional tasks (combing hair, drinking water, wiping a table, wearing a belt, wearing a scarf and writing on the board).^{18, 19} After observing the act in a video clip for 2 min, they were instructed to execute the same actions that they observed, for 3 min. This sequence was repeated three times.

Conventional exercises included: 1) active range of motion exercises of shoulder (flexion, extension, abduction, internal and external rotation); 2) finger ladder exercises and wand exercises (use of stick as assistive device to perform active range of motion exercises) to increase the range of motion; 3) stretching for upper trapezius, pectoralis major and posterior capsule; 4) passive joint mobilization techniques; 5) strengthening exercises for shoulder flexors, abductors, internal and external rotators; 6) scapular stabilization exercises; and 7) eccentric exercises of shoulder. All exercises were given for 10 repetitions each.

Statistical Analysis

Data was analyzed using IBM SPSS version 24.0 software (IBM Corp., Armonk, NY, USA). Descriptive statistics were expressed in mean \pm standard deviation (SD) for continuous variables and frequency and percentage for categorical variables. The normality of data was assessed using Shapiro Wilk test. As data was following normal distribution pattern, parametric tests were used. Paired t test was used to compare pre- and post-treatment changes among the groups. Comparison between the groups was evaluated using unpaired t test. Level of statistical significance was set at $P \leq 0.05$.

RESULTS

Demographic characteristics of the participants are depicted in Table 1. The mean age of the participants was 63.53 ± 5.7 and 61.20 ± 5.55 years for experimental and control group respectively.

Table 1. Demographic characteristics of the participants.

Characteristics	Group 1 (N = 15)			Group 2 (N = 15)		
	N	%	Mean \pm SD	N	%	Mean \pm SD
Age (in years)			63.53 \pm 5.7			61.20 \pm 5.55
Gender						
Male	10	66.7		9	60	
Female	5	33.3		6	40	
Educational Qualification						
Degree	2	13.3		5	33.3	
Secondary	8	53.3		0	0	
Primary	5	33.3		8	53.3	
Uneducated	0	0		2	13.3	
Dominance						
Right	13	86.7		11	73.3	
Left	2	13.3		4	26.7	
Occupation						
Unemployed	5	33.3		4	26.7	
Employed	4	26.7		6	40	
Retired	6	40		5	33.3	

SD: Standard deviation

There was a statistically significant difference seen in pre and post intervention in NRS, PCS, TSK, SPADI, SF-36 PCS and SF36 MCS ($p < 0.05$) in both the groups. The pre- and post-treatment scores of all outcomes for both groups are shown in Table 2.

Table 2. Intragroup analysis in both the groups using paired t test.

Outcomes	Group 1			Group 2		
	Pre test	Post test	p value	Pre test	Post test	p value
	Mean \pm SD	Mean \pm SD		Mean \pm SD	Mean \pm SD	
NRS	5.6 \pm 1.18	3.06 \pm 1.16	0.000*	5.13 \pm 1.3	2.6 \pm 1.45	p < 0.001*
PCS	20.47 \pm 10.08	11.4 \pm 6.66	0.000*	15.73 \pm 9.83	11.33 \pm 8.86	p < 0.001*
TSK	39.4 \pm 6.41	31.33 \pm 4.98	0.000*	40.13 \pm 3.66	35.2 \pm 3.93	0.001*
SPADI	59.97 \pm 12.78	43.9 \pm 12.98	0.000*	64.91 \pm 10.67	45.78 \pm 15.8	p < 0.001*
SF-36 PCS	46.53 \pm 14.97	73.16 \pm 9.43	0.000*	49.83 \pm 9.29	62.47 \pm 11.58	p < 0.001*
SF-36 MCS	82.07 \pm 6.58	94.52 \pm 3.06	0.000*	90.7 \pm 6.41	94.06 \pm 4.96	0.024*

*p \leq 0.05

SD: Standard deviation; NRS: Numerical Pain Rating Scale; PCS: Pain Catastrophizing Scale; TSK: Tampa Scale of Kinesiophobia; SPADI: Shoulder Pain and Disability Index; SF-36 PCS: SF-36 Physical Component Summary; SF-36 MCS: SF-36 Mental Component Summary; p: paired t test

A significant difference was observed in TSK, SF-36 PCS and SF36 MCS (p<0.05) pre- and post- intervention scores between the two groups. However, there was no significant difference seen in NRS, PCS and SPADI scores between the two groups (p>0.05). The effect size reported for the parameters - TSK, SF-36 PCS and SF36 MCS was 0.81, 1.67 and 1.54 (Table 3).

Table 3. Intergroup analysis using and unpaired t test

Outcomes	Group 1	Group 2	p value	Effect size Cohen's d
	Mean Difference	Mean Difference		
	Mean \pm SD	Mean \pm SD		
NRS	2.53 \pm 0.51	2.53 \pm 0.74	1.000	-
PCS	8.93 \pm 4.56	5.87 \pm 4.19	0.065	-
TSK	8.06 \pm 2.89	5 \pm 4.5	0.035*	0.81
SPADI	16.06 \pm 6.76	19.23 \pm 11.53	0.366	-
SF-36 PCS	26.63 \pm 9.16	12.63 \pm 7.56	0.000*	1.67
SF-36 MCS	12.45 \pm 6.63	3.35 \pm 5.12	0.000*	1.54

*p \leq 0.05

SD: Standard deviation; NRS: Numerical Pain Rating Scale; PCS: Pain Catastrophizing Scale; TSK: Tampa Scale of Kinesiophobia; SPADI: Shoulder Pain and Disability Index; SF-36 PCS: SF-36 Physical Component Summary; SF-36 MCS: SF-36 Mental Component Summary; p: unpaired t test

DISCUSSION

The present study aimed to evaluate the effect of AOT on pain, physical function, and quality of life in patients diagnosed with adhesive capsulitis. Although not with a significant difference, it was observed that the addition of AOT reduced kinesiophobia and improved the quality of life when compared to conventional exercises alone.

This study demonstrated a significant difference in within group analysis of patients receiving AOT along with conventional therapy, as well as only conventional therapy, in pain, pain catastrophizing, kinesiophobia, disability, and quality of life. Current evidence suggests that chronic pain is a top-down and a bottom-up phenomenon.²⁹ Alteration in motor imagery performance and tactile acuity was observed in unilateral frozen shoulder patients.³⁰ This is associated with altered sensorimotor processing, loss of cortical representational areas, maladaptive neuroplastic changes and diminished cortical excitability. Along with this, prolonged pain inhibits the performance of movement and can trigger compensatory movements that lead to cortical impairment of motor processing.³¹ Another factor that influences the chronicity of pain is pain related fear of movement or kinesiophobia. Increased levels of kinesiophobia have a direct impact on the periaqueductal gray matter through the amygdala, thus interfering with the endogenous pain modulation pathways leading to further increase in pain perception.³²

The literature reveals that only few studies until now have focused on implementation of central nervous system-based approach for rehabilitation in chronic shoulder pain patients. A recent study evaluated immediate effect mirror therapy intervention in 69 chronic shoulder pain patients. It was observed that mirror therapy resulted in statistically significant improvements in pain, pain catastrophizing, fear avoidance, and shoulder flexion active range of motion (ROM) in patients with shoulder pain and limited active motion.³³ Another study showed that sensory remapping intervention applied to 25 patients with shoulder pain and limited ROM resulted in an immediate increase of shoulder ROM.³⁴

Graded motor imagery is also an approach which focuses on targeted activation of specific components of the pain neuromatrix without activating the neuromatrix.³⁵ Action observation therapy, a neuroscience approach, has been shown to improve cortical representation and excitability, influencing areas such as the primary motor cortex or the dorsal premotor cortex.¹⁹ AOT focuses on activation of mirror neurons which brings about the reorganization of the cortex.³⁶ AOT program focused on incorporation of simple movement progressing to different planes of movement and functional activities which assisted the participants to execute the action correctly. Larsen et al showed that application of AOT in chronic musculoskeletal pain promotes an increase in cortical excitability which concomitantly leads to reduction in perception of pain.³⁷ Another study by Volz et al revealed that modulation of pain occurs due to increased motor cortex excitability via the corticothalamic tracts and neural plasticity after administration of AOT in healthy subjects.³⁸ Reduction in pain permits the individual with adhesive capsulitis to perform movements and activities of daily living without fear, thus reducing the disability and improving quality of life.

A recently published randomized controlled trial utilized AOT in post-surgical orthopaedic patients for hip fracture or elective hip or knee replacement. After treatment, patients in the AOT group scored better than patients in the control group reflecting AOT as an effective adjunct to conventional therapy. The findings of this study suggested that reorganization of motor representations at central level occurring during AOT may affect performance, even when the skeletal structures to implement actions are impaired.³⁹

Action observation therapy promotes implementation of activities of daily living into the treatment protocol and to use real actions. These are the common activities performed by an individual regularly even before the pain. This promotes remapping of the brain with known actions instead of fragmented actions as in traditional physiotherapy. This may be also one of the reasons for improvement in function and quality of life.⁴⁰

Limitations

This study presents some limitations. Firstly, the sample size was small. Also, sample size was not pre-determined with power calculations. Secondly, the therapist was not blinded to the treatment protocol. Also, other interacting conditions confound these findings to a specific subsection of people with adhesive capsulitis as co-morbidities were not described in the baseline characteristics in the current study.

Recommendations

Only short-term effects of a 4-week intervention were studied in this research. Future studies can be targeted with larger sample size, longer term follow up, and incorporate AOT in different shoulder pathologies.

CONCLUSION

The present study provided preliminary results that support the addition of AOT in rehabilitation of patients with adhesive capsulitis in the absence of other chronic inflammatory conditions. AOT promotes a top-down approach leading to cortical reorganization

and helped to reduce kinesiophobia and improved quality of life in patients with adhesive capsulitis patients more effectively than only using conventional therapy.

Abbreviations

AOT: action observation therapy; NRS: numerical pain rating scale; PCS: pain catastrophizing scale; TSK: Tampa scale of kinesiophobia; SPADI: shoulder pain and disability index; SF-36: 36-Item Short Form Health Survey questionnaire; PCS: physical component summary; MCS: mental component summary; AROM: active range of motion; SD: standard deviation

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