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A Comparative Study Between Bimanual Coordination Exercise and Desensitization Therapy for Complex Regional Pain Syndrome

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ABSTRACT

Background: Complex Regional Pain Syndrome is a chronic pain condition usually triggered by an injury, characterized by severe pain, swelling, and changes in the skin's temperature and color in the affected area. CRPS involves dysfunction or damage to the central or peripheral nervous system, leading to abnormal pain processing and sensory disturbances. Treatment strategies focus on pain relief and functional restoration, with exercise therapy and sensory retraining gaining prominence due to their potential to induce neuroplastic changes and improve patient outcomes.
Purpose: The aim of this study is to compare the effectiveness of bimanual coordination exercises with desensitization therapy in individuals suffering from CRPS. The study seeks to determine which intervention more effectively reduces pain, improves motor function, and enhances sensory processing.
Method: A comparative study was conducted involving two groups of CRPS patients Group A receives bimanual coordination exercises, while Group B underwent desensitization therapy. Pain intensity was measured using the numerical pain rating scale (NPRS) and CRPS severity score was assessed with a standardized severity score. Both pre and post intervention values were recorded and analyzed statistical analysis included paired and unpaired 't' tests to determine the significance of differences within and between groups.
Results: Both interventions led to significant reductions in pain and CRPS severity scores within their respective groups. Group A (Bimanual coordination exercises) demonstrated a greater decrease in NPRS cores (mean differences = 3.13) compared to Group B (desensitization therapy, mean difference =2.13). Similarly, the reduction in CRPS severity score was higher in Group A (mean difference = 3.47) than in Group B (mean difference = 2.07). Then between group analysis confirmed that these differences were statistically significant, favoring bimanual coordination exercises for both pain reduction and functional improvement.
Conclusion: Both bimanual coordination exercises and desensitization therapy are effective in reducing pain and improving function in patient with CRPS. However, bimanual coordination exercises provide superior benefits compared to desensitization therapy. These findings support the integration of bimanual coordination exercises into rehabilitation programs for optimal management of CRPS.

Keywords: Bimanual coordination exercise, desensitization therapy, complex regional pain syndrome, CRPS.

INTRODUCTION

Complex regional pain syndrome (CRPS) is a chronic pain disorder that most often develops in an arm or leg following an injury, surgery, or trauma. The pain experienced is typically much more intense and persistent than would be expected from the original injury. In addition to ongoing pain, people with CRPS may notice swelling, changes in skin color or temperature, joint stiffness, and heightened sensitivity to touch.[1] The exact cause of CRPS is not fully understood, but it is believed to involve abnormal nerve signaling, inflammation, and issues with blood flow. The condition is divided into two types: CRPS type 1, which occurs without direct nerve damage, and CRPS Type 2, which is linked to a confirmed nerve injury.[2]

Bimanual coordination exercises involve using both hands together in a controlled and synchronized manner. These exercises can help people with complex regional pain syndrome (CRPS) by enhancing mobility, easing pain, and supporting the recovery of function in the affected limb. CRPS often leads to stiffness, weakness and reduced use of the affected hand, which can cause further loss of mobility. By engaging both hands in activities, the brain is encouraged to rewire its connections, promoting neuroplasticity and improving motor control. These exercises also help balance muscle activity and enhance coordination between both sides of the body. Common bimanual activities include mirror therapy, ball passing, finger tapping and object manipulation tasks. When performed regularly, these exercises can help reduce pain sensitivity, improve hand function and support overall rehabilitation for individuals with CRPS.[3]

Desensitization therapy is a method designed to help decrease pain and sensitivity in individuals living with complex regional pain syndrome (CRPS). CRPS often causes the affected area to become extremely sensitive to touch, temperature, movement, making daily activities difficult.[4] This therapy involves gradually exposing the painful area to different textures, temperatures and gentle movements to help the nervous system adjust and decrease overreaction to stimuli. Common techniques include rubbing the skin with soft fabrics, immersing the limb in different materials like rice or sand, applying mild vibrations. By consistently practicing desensitization exercises, the brain can learn to process sensations more normally, reducing pain and improving function over time. This method is often combined with other treatments like physical therapy and pain management for better recovery.[5]

MATERIALS & METHODS

Methods

30 patients with complex regional pain syndrome were selected based on the inclusion and exclusion criteria and they were divided into 2 groups, Group A and Group B. A pretest and posttest were conducted for the Group A and Group B on numerical pain rating scale and CRPS severity score for complex regional pain syndrome. First group (Group A) was treated with bimanual coordination exercises for complex regional pain syndrome. Second group (Group B) was treated with desensitization therapy for complex regional pain syndrome.

INCLUSION CRITERIA

Presence of symptoms such as pain disproportionate to the injury, allodynia, hyperalgesia, edema or motor dysfunction.
Adult aged 40 to 60 years
Onset of symptoms within the first 3 months.
Both male and female.
Clear evidence of type 1 (no major nerve injury) complex regional pain syndrome.

Patient with acute stage of complex regional pain syndrome.
CRPS severity score 6 to 10.
Stable vital signs and medical condition to participate safely in the study.
Complex regional pain syndrome affecting only the upper limb.

EXCLUSION CRITERIA
Patients who decline to participate.
Patients with pain conditions mimicking complex regional pain syndrome. Ex: neuropathy, rheumatoid arthritis, fibromyalgia.
History of somatic symptom disorder.
Severe psychiatric disorders. Ex: untreated depression, psychosis.
Uncontrolled diabetes or vascular disease affecting limbs.
Unstable medical conditions like cardiac, renal or hepatic conditions.
Complex regional pain syndrome with lower limb.
patient with dystrophic and atrophic stage of complex regional pain syndrome.
CRPS severity score above 10.

PROCEDURES

Intervention for Group A
Warm up
Wrist rotation
Finger stretches
Palm press
Bimanual coordination exercise
Mirror therapy
Symmetrical object manipulation
Pick and place
Rolling a ball
Asymmetrical movements
Circular drawing
Alternate grasp
Functional activities
Folding laundry
Pouring water
Cool down
Gentle massage
Breathing exercise
Frequency: Five to six times weekly
Duration: 30 minutes per session.

Intervention for Group B
Warm up
Breathing exercise
Treatment phase: Gradual exposure to stimuli
Week 1 to 2 gentle textures (cotton balls and soft fabrics)
Week 3 to 4 moderate textures (terry cloth, velvet and foam sponge)
Week 5 to 6 varied textures (denim, rough towels and sand paper)
Functional desensitization activity
Holding textured object
Immersion therapy
Cool down
Gentle massage
Breathing exercise
Frequency: Five to six times weekly
Duration: 30 minutes per session.

STATISTICAL ANALYSIS

Descriptive statistics for Numerical pain rating scale - Group A and Group B.

Group	NPRS	Mean	Standard deviation	Paired 't' value
Group A	Pre test	6.33	1.11	13.2558
	Post test	3.20	1.21	
Group B	Pre test	6.20	1.01	5.6695
	Post test	4.07	1.03	

Descriptive statistic for numerical pain rating scale in Group A shows that paired 't' test value of pre vs posttest values of group A was 13.2558 at 0.001% level which was greater than tabulated 't' value 2.5. Group B shows that paired 't' values of pre and posttest values of group B was 5.6695 at 0.0001% level which was greater than tabulated t values 2.5. This indicated a significant difference between the pre-test and post-test results of Group A and Group B for the NPRS. This exposed that there was significant reduction in posttest average NPRS scores for Group A and Group B.

RESULT - NUMERICAL PAIN RATING SCALE (POST TEST ANALYSIS)

	MEAN	STANDARD DEVIATION.	'T' VALUE	MEAN DIFFERENCE.
GROUP A	3.13	0.92		
GROUP B	2.13	1.46	2.2504	1.00

The unpaired 't' value of 2.2504 was greater than the tabulated unpaired 't' value of 2.14 which showed that there was a statistically significant difference at 0.0001 level between Group A and Group B.

The pre vs posttest mean of Group A was 3.13 and the pre vs posttest mean of Group B was 2.13 and the mean difference of Group A and Group B was 1.00 which showed that there was a significant reduction in numerical pain rating scale for Group A and Group B.

Descriptive statistics for CRPS severity score - Group A and Group B.

GROUPS	CRPS severity score	Mean	Standard deviation	Paired 't' value
Group A	Pre test	7.27	1.75	9.9032
	Post test	3.80	1.70	
Group B	Pre test	7.33	1.59	8.3277
	Post test	5.27	1.49	

Descriptive statistic for CRPS severity score in Group A shows that paired 't' test value of pre vs posttest values of group A was 9.9032 at 0.0001% level which was greater than tabulated 't' value 2.5. Group B shows that paired 't' values of pre and posttest values of group B was 8.3277 at 0.0001% level which was greater than tabulated t values 2.5. this showed there is significant difference between pre vs post test results of Group A and Group B for CRPS severity score. This exposed that there was significant reduction in posttest mean values in response to CRPS severity score in Group A and Group B.

RESULT - CRPS SEVERITY SCORE (POST TEST ANALYSIS)

	MEAN	STANDARD DEVIATION	'T' VALUE	MEAN DIFFERENCE
GROUP A	3.47	1.36		
GROUP B	2.07	0.96	3.2626	1.40

The unpaired 't' value of 3.2626 was greater than the tabulated unpaired 't' value of 2.14 which showed that there was a significant difference at 0.0001 level between Group A and Group B.

The pre vs posttest mean of Group A was 3.47 and the pre vs posttest mean of Group B was 2.07 and the mean difference of Group A and Group B was 1.40 which showed that there was significant reduction in CRPS severity score for Group A and Group B.

RESULT

The study which was conducted for 3 months period of intervention, Based on statistical analysis the results of this study showed that there was significant improvement in both Groups. The result also showed that the subject who participated in experimental Group A had shown good improvement in reducing pain and improving motor function than in Group B.

DISCUSSION

The purpose of the study was to compare treatment effectiveness of bimanual coordination exercise and desensitization therapy for complex regional pain syndrome. The numerical pain rating scale and CRPS severity score was taken as the parameter of quality the effectiveness of the

treatment bimanual coordination exercise and desensitization therapy.

The study sample comprised of 30 patients of which 15 group A and B. The mean age of subjects was 40 to 60 years. Among 30 subjects, 15 were treatment with bimanual coordination exercise and 15 were treated with desensitization therapy. The pre and posttest values were assessed by NPRS and CRPS severity score in Group A and Group B. The paired t test value of NPRS 13.25 and 5.66 and CRPS severity score is 9.90 and 8.32 respectively. The unpaired t test values for NPRS 2.25 and CRPS severity score is 3.26 respectively.

By analyzing the values of paired and unpaired t test the result showed a statistically significant results comparing with the table value with 0.05 level of significance of both groups between pretest vs post test results. The result obtained from statistical analysis indicate that there was a statistically significant difference between two groups in showing improvement in complex regional pain syndrome. The reducing pain and improving motor function was seen in all subjects received irrespective of the technique bimanual coordination exercise and desensitization therapy.

By the result alternate hypothesis is accepted and also there is significant difference between bimanual coordination exercise and desensitization therapy for the improvement in motor function and reducing pain. By analyzing the mean and standard deviation values the result showed the subjects who received bimanual coordination exercise is found to be more effective in improving motor function and reducing pain then desensitization therapy.

While consideration of improving quality of life in patients with CRPS patients the study shows there was effective and good improvement. A study conducted by B. Prudhi Tejasri et al., 2017 on response to desensitization therapy in post stroke pain syndrome to reduce pain. The result of the study supports the present study where the participants pain was decreased in terms of fugl - meyer assessment and nottingham sensory assessment.[6]

A study conducted by norman. R. Harden et.al.,2010 validate a continuous CRPS severity score (CSS) that reflect the extent of CRPS symptoms allowing better assessment of individual variations and enhancing research outcomes. Results showed that CRPS severity score significantly differentiated CRPS from non CRPS patients.[7] A study conducted by Saurov Saha et al. (2021) on response to mirror therapy in post stroke shoulder hand syndrome to reduce pain and swelling. The result of the study supports the current study where the participants pain was decreased in terms of numerical pain rating scale and figure of eight method.[8]

Bimanual coordination exercise produces significant physiological effects that contribute to pain relief and functional improvement through multiple mechanisms. Complex regional pain syndrome is associated with maladaptive changes in the brain somatosensory and motor cortices. Bimanual coordination tasks help regulate this cortical reorganization by restoring impaired tactile discrimination and enlarging cortical map size in the contralateral somatosensory cortex. These exercises enhance sensory motor integration between two hemispheres, which is often disrupted in complex regional pain syndrome. They also reduce peripheral and central sensitization by decreasing inflammation and abnormal nerve sensitivity. These exercises regulate autonomic nervous system imbalances, improving blood flow and reducing symptoms linked to sympathetic activity. Bimanual coordination exercise triggers the release of natural pain-relieving chemicals and boost moods, which aids in managing complex regional pain syndrome symptoms.[9]

Physiological effects of desensitization therapy.

Reduction of hypertonicity and muscle tension. Activation of the parasympathetic

nervous system. Habituation of pain and sensory inputs. Cortical and somatosensory reorganization. Counter conditioning through reciprocal inhibition.[10]

The bimanual coordination exercise has reduced pain by improving sensory motor function.

Therefore, bimanual coordination exercise more effective in reducing pain and improving motor function.

CONCLUSION

Bimanual coordination exercise demonstrates greater improvement in reducing pain and enhancing motor function compared to desensitization therapy for Complex Regional Pain Syndrome. While desensitization addresses sensory hypersensitivity, bimanual exercise promotes central nervous system remodeling and motor control restoration, leading to more comprehensive functional recovery. Combining both approaches may provide synergistic benefits in CRPS rehabilitation.

Declaration by Authors

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