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Research Article

Effects of Respiratory Muscle Training on Cognitive Function and Social well-being of Spinal Cord Injury (SCI) Subjects

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Abstract

Objetive: To assess Effects of respiratory muscle training on cognitive function and social well-being of Spinal Cord Injury (SCI) subjects.

Setting: Indian Spinal Injuries Centre, Vasant Kunj, New Delhi, India.

Methods: A 4-week programme of respiratory muscle training (RMT) exercise regime was conducted in subjects with cervico-thoracic spinal cord injuries. Clinical evaluations before and after training comprised measures of QOL (cognitive function and social well-being) and 21 subjects were dropped out from this study.

Results: 84 subjects were recruited in intervention (Group-A) and control group (Group-B). Mean age was 31.40 in Group-A and 29.61 in Group-B. Significant difference was observed in SCI-QOL domains: Positive affect and Well-being, Depression, Anxiety, Self-care, Basic mobility (P≤0.005).

Conclusion: Respiratory muscle training (RMT) is a technique that shall be incorporated in the rehabilitation protocol in order to improve the cognitive function and social well-being of Spinal Cord Injury (SCI) subjects.

***Keywords:** RMT, SCI-QOL questionnaires, cognitive function, social wellbeing.*

Introduction

The term “spinal cord injury” refers to damage to the spinal cord injury due to an injury (e.g. car accident), illness, or degenerative disease (e.g. cancer). The site of spinal cord injury (cervical, thoracic, or lumbosacral) determines the nature and extent of motor and sensory deficits (1). Respiratory complications are a leading cause of morbidity and mortality in patients with progressive spinal, cervical, and chest injuries. Factors contributing to worsening lung conditions in these patients include muscle weakness and respiratory cramps (2). As a result, coughing is often inefficient, atelectasis tends to occur, and the risk of respiratory infections increases (3). In people with spinal cord injuries, quality of life decreases due to respiratory symptoms, including cough, mucus, and wheezing (4,5).

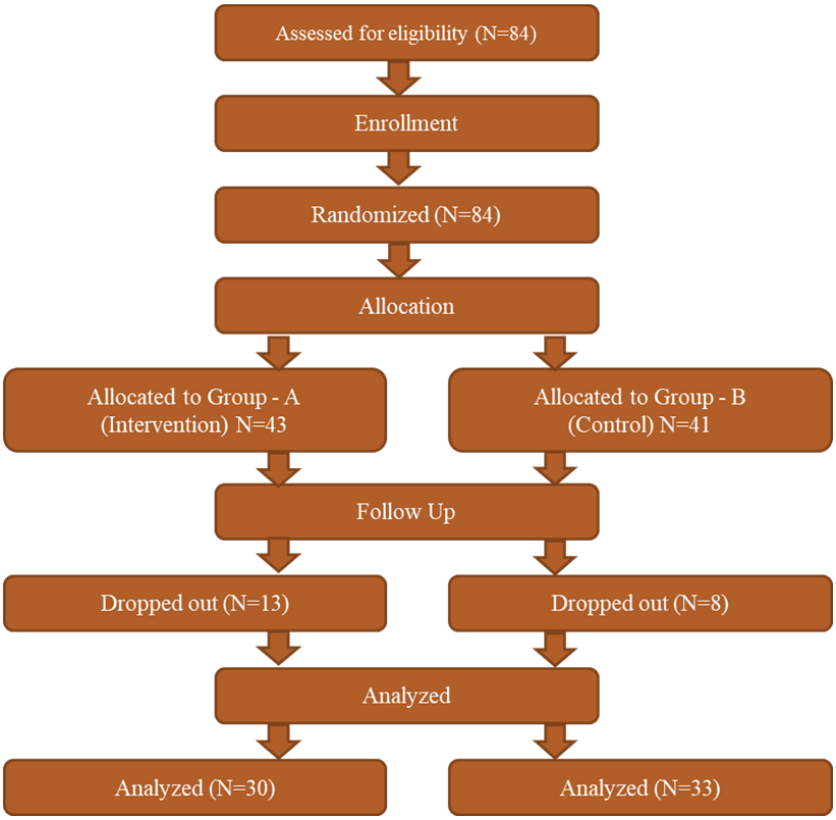
QOL (Quality of Life) is a broad and poorly defined concept. Quality of life is considered synonymous with health status, bodily function, perceived health status, subjective health, awareness of health, symptoms, desire for satisfaction, personal cognition, disability, mental disorder, well-being, and often such things (7).Several follow-up studies have identified severe impairments in various cognitive areas, along with the presence of depression and anxiety. According to a recent report, people with spinal cord injuries have an approximately 13 times higher risk of cognitive impairment than healthy people (6).

Respiratory muscle training (RMT) includes exclusive training such as resisted thoracic expansion, resisted diaphragmatic motion, Active cycle of breathing technique (ACBT), Inspiratory muscle trainer (IMT) of respiratory muscles, which is expected to improve respiratory function and bronchial hygiene, reduce shortness of breath, improve patient activity level, which helps patient to improve participation in other exercise program resulting in improvement in cognitive function and social welfare.

2. Methodology

After the approval from research review committee and ethical committee of Indian spinal injuries centre. A total of 84 Patients with spinal cord injuries (SCI) were recruited from the centre (ISIC) after exhaustive examination based on inclusion criteria includes Age: 18-49 years, Patients with lower cervical and upper thoracic spinal cord injury, Patients after 3 weeks of injury will be taken, Patients with intubation (TT tube), who are not on a mechanical ventilation and exclusion criteria includes Patient with intubation (ET tube), Patient, who are on mechanical ventilation, a recurrent infection characterized by fever, Unable to perform respiratory muscle training because of the presence of trauma around the face or unable to comprehend and 21 subjects were dropped out among 84 subjects. The eligible participants were given a detailed explanation about the study and asked to give written informed consent about the study. After receiving the consent, they were explained about SCI-QOL questionnaires version 1.0 (Positive affect and Well-being, Depression, Anxiety, Self-care, Basic mobility) which assess their quality of life (QOL), and they were requested to fill out the questionnaires before and after the 4 weeks of treatment. For the study two groups i.e. GROUP A (Intervention) and GROUP B (Control) based on convenient sampling were carved out. After taking baseline measurement, the subjects in GROUP A were given 20 sessions of 25-30 minutes of Respiratory Muscles Training (RMT) which includes resisted diaphragmatic and thoracic motion, active cycle of breathing technique (ACBT), inspiratory muscle trainer (IMT), while GROUP B received routine activities. At the end of the treatment of subjects of both groups, measurements were taken again.

Flow chart: below flow chart is showing the progress through the phase of the study that includes assessment for eligibility, enrolment, allocation, follow up, and data analysis.



3. Data analysis

Data analysis was performed using the Windows version of SPSS 21. The data were assessed for normal distribution. Mean ± standard deviation was used for describing the sample characteristics. During the study 30 participants were included in the intervention group whereas; 33 participants were included in the control group. For a normal distribution, Paired T-Test was used for Intragroup analysis, on the other hand, the chi-square test was used for Inter groups comparison. A statistical significance was set at $P \leq 0.05$.

4. Results

4.1 Sociodemographic data

This study involved the participation of 84 people who completed and returned the questionnaire.

The majority of respondents were male, and the population was homogenous as the below table 1 defines P-value.

VARIABLES	GROUP A (Intervention)	GROUP B (Control)	P-value
AGE (in years) Mean±SD	31.40±8.511	29.61±7.483	0.311
ISNCSCI LEVEL (N)	A=21 B=20 C=2	A=21 B=18 C=2	0.972
GENDER (N)	M=35 F=8	M=33 F=8	0.568
LEVEL OF INJURY	C=23 T=20	C=19 T=22	0.513

4.2 Within group comparison (intervention)

Table:1 shows comparison of domains in intervention group (pre to post).

Domains (Intervention Group)	Pre (Mean+SD)	Post (Mean+SD)	P-value
Anxiety	32.09±10.592	25.02±9.448	<0.001*
Mobility	22.35±7.612	26.77±6.571	<0.001*
Positive affect	52.21±7.536	54.30±7.498	<0.001*
Self-care	24.84±10.121	27.56±9.738	0.019
Well being	38.79±6.635	44.81±4.096	<0.001*
Depression	21.84±5.665	17.70±4.411	<0.001*

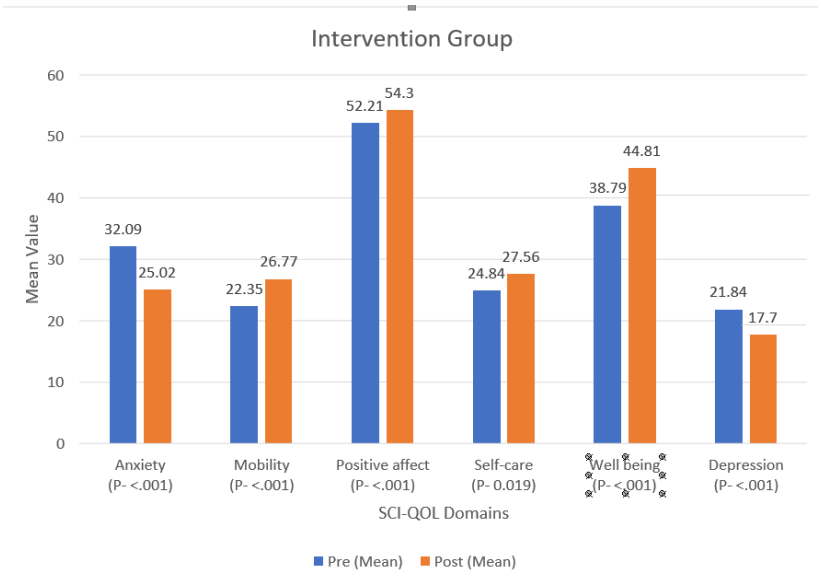


Figure : *Shows intragroup comparison of domains in Group –A (Intervention).*

4.3 Within group comparison (Control)

Within a group (Intervention), statistically significant improvement was observed in domains: anxiety(p=<0.001), mobility(p=<0.001), positive affect (P=<0.001), well-being (p=<0.001), depression(p=<0.001), unlike self-care, there was no significant change marked. Normal distribution of data conducted through paired T-Test.

Domains (Control Group)	Pre (Mean+SD)	Post (Mean+SD)	P-value
Anxiety	25.41±9.176	32.80±10.866	<0.001*
Mobility	37.10±4.236	39.88±5.913	0.002*
Positive affect	37.20±7.910	39.19±.465	0.008*
Self-care	41.44±6.348	41.93±6.787	0.414
Well being	36.07±7.692	38.00±8.441	0.010
Depression	33.20±9.078	34.27±11.000	0.388

Table:2 Shows comparison of domains in intervention group (pre to post).

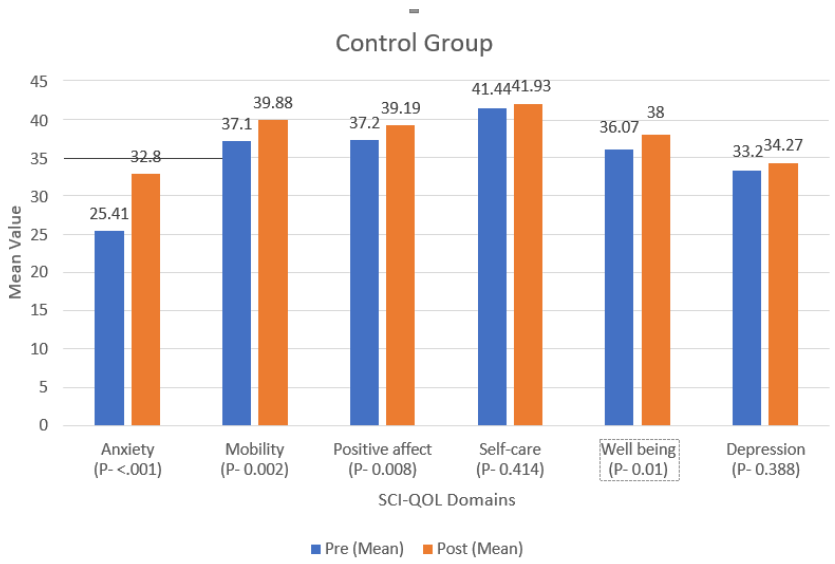


Figure 2: Shows intragroup comparison of domains in Group –B (Control).

Within the (control) group, there were statistically significant improvements noted in the following domains: anxiety (P = <0.001), mobility (P = 0.002), positive influence (P = 0.008), as well as other domains: self-care (P = 0.414).), well-being (P = 0.010), and depression (P = 0.388) were not significantly changed and were analysed using the paired T-test.

4.4 Between group comparison (intervention and control)

Difference	Intervention Group-A (Mean+SD)	Control Group-B (Mean+SD)	P-value
Anxiety	-7.07±5.435	+7.39±5.281	<0.001*
Mobility	+4.42±4.558	+2.78±5.466	0.139
Positive affect	+2.09±3.365	+1.98±4.558	0.893
Self-care	+2.72±7.343	+0.49±3.782	0.086
Well being	+6.02±6.049	+1.93±4.568	0.001*
Depression	-4.14±4.132	+1.07±7.875	<0.001*

Table:3 shows difference of domains in intervention group and control.

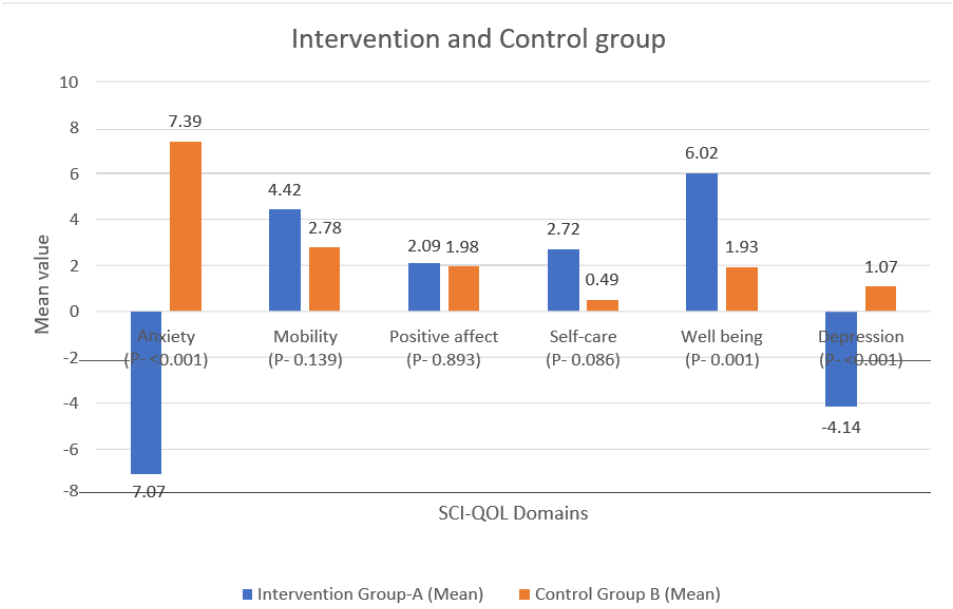


Figure 3: *Shows intergroup comparison of domains in Group-A (Intervention) and Group –B (Control)*

Between-group follow-up showed statistically significant improvements in the areas of anxiety (p = <0.001), well-being (p = 0.001), and depression (p = <0.001), but in self-care (P = 0.086).), mobility (P = 0.139), positive affect (P = 0.893), no significant changes were found. Statistical analysis was performed using the chi-square test.

5. Discussion

This study was conducted to evaluate the effect of respiratory muscle training (RMT) on cognitive function and social well-being of Spinal Cord Injury (SCI) subjects.

Anxiety:

Anxiety is a common problem in adults with spinal cord injury (SCI). It has been documented that up to 45% of injured people report excessive anxiety, fear, or panic (9). Increased anxiety and negative expectations are also associated with traumatic pain (8).

RMT has been found to alleviate dyspnea by increasing oxygen concentration at the tissue level, which improves the participation of the subjects in daily activities. Since dyspnea is one of the hurdles that prevent their participation in a regular exercise regime. Thus, this may explain the lower anxiety levels in subjects that have gone through vigorous RMT programs, leading to reduced anxiety levels in the intervention group. However, no improvement in anxiety levels was found in the control group.

A recent study found that 15-minute practice of Alternate Nostril Breathing Exercise (ANB) did not significantly reduce anxiety due to simulated public speaking in yoga-naïve subjects. However, the VAMS anxiety score in the test group was lower than that in the control group (10).

Depression:

High levels of depression in people with spinal cord injuries may be related to several factors such as comorbid medical conditions, associated traumatic brain injury, low socioeconomic status, low daily activities, poor social support, and poor/delayed response to treatment (11, 13).

The current study revealed that Respiratory muscle training has also a similar effect on depression as revealed by other studies. RMT has been found to improve dyspnea, and lead to improved oxygen levels that improve the participation in rehabilitation protocol along with better cognitive effect leading to lesser incidence of Depression.

In consensus to the current study, other studies have revealed that spinal cord injury subjects participating in sports activity had the lowest scores of depression and anxiety as compared to the inactive group (no sports participation). Due to the activation of small muscle mass in participants during physical exercise including sports activities, which help them to gain psychological benefits or confidence level (12,16).

In contrast to the current study, studies have also shown no significant improvement in Dyspnea after Exercise and suggested that dyspnea could either be situational or reactive in spinal cord injury. Hence, it can be altered by stopping the post-traumatic inflammatory response (17).

Positive Wellbeing:

Positive Well-being is the experience of health, happiness, prosperity, and the ability to manage stress. It has been observed that increasing medical complications, increased dependence on others, loss of social role, and less regular use of coping strategies are various factors that may affect the positive wellbeing of a person suffering from spinal cord injury. Data has also shown that the older population and recently traumatized participants experienced more depressed moods and lower life satisfaction. They also reported low social skills, innovation, and used negative and self-engagement strategies more frequently (14).

The current study reveals a significant improvement in the Positive Wellbeing domain after the treatment. It has been documented that breathing exercises, increase the activity of the isolated anterior Cingular cortex, the part of the brain directly involved in consciousness, leading to greater positive impact and well-being.

Self-care and Mobility:

Spinal cord injury subjects often have difficulties in self-management and mobility due to paralysis or deconditioning of various muscles. The most commonly affected muscles are muscles of the upper limb, lower limb, and respiratory muscles leading to restricted movements and lack of independence directly affecting the QOL (15).

Furthermore, lack/restricted mobility can have negative effects on the musculoskeletal, nervous, cardiopulmonary, haematological, gastrointestinal, endocrine, renal, and immune systems affecting recovery and participation in functional activities (18).

Studies have concluded that physical rehabilitation accelerates postoperative recovery speed, reduces pain, improves mobility, range of motion, balance, cardiovascular mental health of patients. (18).

In the current study, although there was a significant improvement observed in mobility in both the groups after the treatment but the interventional group showed better progress than the conventional group. The group that received advanced Respiratory training appeared to participate more in the exercise regimen due to improve cognitive function, lesser dyspnea levels, and better participation in the group therapy. Increased participation in the rehabilitation protocol led to improved strength of extremities' muscles, improved core stability, improved tolerance to exercise, and reduced risk of muscle fatigue and injury. Additionally, it has also been observed that the strength and coordination of scapular retractors are vital forwheelchair propulsion (19). Thus, patients undergoing strengthening exercises will lead to better mobility.

There was no significant improvement found in terms of self-care within the group.

6. Conclusion

Our study highlights the importance of RMT (ACBT, IMT, resisted thoracic expansion exercise, and diaphragmatic motion) along with physical exercise regimens in spinal cord injury subjects, as it not only improves respiratory function but also has a positive effect on cognitive function. Improved cognition and dyspnea levels lead to an increase in subjects' participation in the exercise regimen. Therefore, it is suggested that RMT should be included in spinal cord injury subject's rehabilitation programs.

Conflict of Interest

The authors declare no competing interest.

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