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Effectiveness of Circuit Resistance Training Versus Progressive Resistance Exercises on Shoulder Pain among Paraplegic Patients

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Abstract: ***91% of the studied paraplegic wheelchair users suffered from chronic shoulder pain. This pain is due to the overuse of joint in day to day activities. Pain will limit the function and it affects the daily living activities of the patient. Resistance training programmes will effectively increase muscle strength and upper limb functionality, by decreasing shoulder pain. Aims and Objectives: To compare the effectiveness of circuit resistance training versus progressive resistance exercises in reducing shoulder pain and improving upper extremity function and strength among paraplegic patients. Methodology:30 paraplegic wheelchair users wereselected on the basis of inclusion and exclusion criteria, and divided equally into two groups, Group A and Group B. Each group consists of 15 subjects. Group A received CRT and Group B received PRE, 1 hour a day 3 times /week for 8 weeks. The outcome measures used are DASH questionnaire, Wheelchair User's Shoulder Pain Index and Handheld Dynamometer. Results: The calculated value for disability is 3.687, with the p< 0.05. So, CRT group shows more significance in improving function. The calculated value for pain is 2.048 with p = 0.05. So, there is no significant difference for pain between groups. The calculated value for strength on left side is 4.69 with p< 0.05 and on right side is 3.15 with p<0.05. So, CRT group shows more significance in improving strength. Conclusion: The study revealed that Circuit Resistance Training demonstrated more significant improvement in upper limb function and strength. And both CRT and PRE group shows reduction in shoulder pain among paraplegic wheelchair users.***

Keywords: Circuit Resistance Training; Progressive Resistance Exercises; Pain; Strength; Function

1. Introduction

According to WHO, the term spinal cord injury refers to damage to the spinal cord resulting from trauma or from disease or degeneration [1]. In India, approximately 1.5 million people live with SCI [2]. Symptoms of spinal cord injury depends on the severity of injury and its location on the spinal cord. Symptoms may include complete or incomplete loss of sensory or motor function. Paraplegia is the partial or complete paralysis of the lower half of the body with the involvement of both legs that is usually due to injury or disease of the spinal cord in the thoracic or lumbar region.Most paraplegics will be dependent on a wheelchair as a mode of transportation [3].

91% of studied paraplegic wheelchair user's s suffered from chronic shoulder pain. This pain is the result of overburdening of the joint in the everyday life of these patients. Paraplegic patients must use their upper extremities as load limbs, for activities like wheelchair propulsion, transfers and other weight bearing tasks. These repeated high loads and high pressure, in conjunction with abnormal distribution of stress transmitted across the sub acromial area during transfer or propulsion of a wheelchair, contributes to the development of upper-limb pain in paraplegics [4]. Tendinitis of the rotator cuff and shoulder impingement syndrome are considered the most common intrinsic causes of shoulder pain and disability. Shoulder impingement syndrome is a syndrome involving tendonitis of the rotator cuff muscles as they pass through the subacromial space, the passage beneath the acromion [5]. Pain will limit the function and it affects the daily activities of the patient. So, it is very important to make patient independent by reducing shoulder pain. There are a different types of resistance training programmes in reducing shoulder pain and improving upper extremity function and strength [6].

Circuit resistance training [CRT] is a form of resistance training for body conditioning or endurance training using high-intensity aerobics. It targets strength building and muscular endurance. It is a method of physical conditioning in which one moves from one exercise to another [7]. When one circuit is complete, the subject repeats the same set of exercise again for the next circuit [8].

Progressive resistance exercises [PRE] is a method of resistance training for increasing the strength of a weak or injured muscle by gradually increasing the weights. There are a lot of studies proving that resistance training programmes will effectively increase muscle strength and upper limb functionality, by decreasing shoulder pain in paraplegic wheelchair users [9]. But there is a scarcity of literatures in regarding comparing the effects of different resistance training programmes and to find out which one is more effective in paraplegic patients. The present study attempts to fill up this void in literature.

2. Methodology

The study was designed to compare the effectiveness of circuit resistance training versus progressive resistance exercises in reducing shoulder pain, improving upper extremity function and strength among paraplegic patients. .Ethical approval was obtained from the Ethical committee of Medical Trust Hospital, Cochin, Kerala. The independent variables were circuit resistance training and progressive resistance exercises whereas the dependent variables were pain, strength and function.

Study Design:
Two group pre-test and post-test Experimental study.

Sampling Method:
Convenient Sampling.

Study Duration:
3 months.

Sample Size:
- N = 30
- 15 in each group (Group A and Group B)

Outcome Measure:
- **Dash Questionnaire-** To assess upper extremity function.
- **Wheelchair Users Shoulder Pain Index-** To assess pain.
- **Handheld Dynamometer**- To assess strength.

Selection criteria: -
Inclusion criteria
- Patients with complete spinal cord injury below T5 neurological level.
- Only males are included.
- Patients with complete motor loss in lower limb i.e., ASIA scale grade A and B
- Full time manual wheelchair users for at least 6 months.
- Adults [18-55yrs] are included
- Mini mental state examination score>24
- Patients who are willing to participate

Exclusion Criteria
- Known or serious suspected cardiac disease or any orthopaedic complications.
- Patients with cognitive dysfunction.
- Patients with motor or sensory loss in upper limb

Sampling Procedure: -
Thirty subjects were selectedon the basis of inclusion and exclusion criteria, fromPunarjeevan Rehabilitation Centre for Paraplegic Patients, Thrissur.Subjects were divided into two groups, Group A and Group B. Each group consist of 15 subjects.

Group A- Receive conventional therapy along with Circuit Resistance Training 1 hour a day, 3 times /week for 8 weeks.
Group B- Receive conventional therapy along with Progressive Resistance Exercises 1 hour a day, 3 times /week for 8 weeks.

3. Procedure

Both groups starts with a 15 mnts of conventional physiotherapy as warm up. During the warm up,patients stretched their shoulder muscles.

The CRT group underwent 3 sets of 6 different strength exercises with 10 repetitions designed for the shoulder muscles. Each training session was preceded by a 2 minute arm ergometry without resistance. Exercises include Biceps curl, Triceps press, Overhead press, Horizontal butterfly, Arm ergometry, Horizontal row and Latissimus pull down.A circuit consisted of 3 such cycles performed without interruption and with rest between manoeuvres limited to 10 seconds needed to change the position. Resistive weights for training were 50% of the 1 RM value calculated during strength testing.

The PRE group performed upper extremity isotonic strengthening exercises using weight cuffs. Delorme's strengthening program was used for the patients, performing 10 repetitions in each set with 2 minutes of rest in between sets. The weight for the first set was 50% of the 10 repetition maximum (RM), for the second set 75% of the 10 RM, and for the third set it was 100% of the 10RM. The 10 RM is determined by the maximum bearable weight, that can be lifted 10 times without rest.Exercises include Shoulder flexion, Shoulder extension, Shoulder abduction, Shoulder adduction, Shoulder internal rotation, Shoulder external rotation, Elbow flexion and Elbow extension.

4. Results

4.1 Paired 'T' Test (Within Group)

When comparing the pre-test and post-test values of disability in group A the mean reduction is 6.60. And the calculated t value is 7.21. Since the significance (p-value) is less than 0.05, we can conclude that the reduction in the disability, 6.60 is significant. So, Circuit Resistance Training shows significant reduction in disability among paraplegic patients.In group B, the mean reduction in disability is 2.60. And the calculated t value is 4.45. Since the significance (p-value) is less than 0.05, we can conclude that the reduction in the disability, 2.60 is significant. So Progressive Resistance Exercises shows significant reduction in disability among paraplegic patients.

When comparing the pre-test and post-test values of pain in group A, the mean reduction is 5.86. And the calculated t value is 6.23. Since the significance (p-value) is less than 0.05, we can conclude that the average reduction in the pain, 5.86 is significant. So, Circuit Resistance Training shows significant reduction in pain among paraplegic patients. In group B the mean reduction in pain is 3.60. And the calculated t value is 6.16. Since the significance (p-value) is less than 0.05, we can conclude that the reduction in the pain, 3.6 is significant. So Progressive Resistance Exercises shows significant reduction in pain among paraplegic patients.

When comparing the pre-test and post-test values of left side strength in group A,the mean improvement 1.01. And the calculated t value is 6.26. Since the significance (p-value) is less than 0.05, we can conclude that the improvement in strength, 1.01 is significant. So, Circuit Resistance Training shows significant improvement in left side strength among paraplegic patients. In group B, the mean improvement in strength is 0.21. And the calculated t value is 4.00. Since the significance (p-value) is less than 0.05, we can conclude that the improvement in strength, 0.21 is significant. So Progressive Resistance Exercises shows significant improvement in strength among paraplegic patients.

When comparing the pre-test and post-test values of right side strength in group A,the mean improvement is 0.80. And

the calculated t value is 4.85. Since the significance (p-value) is less than 0.05, we can conclude that the improvement in strength, 0.80 is significant. So, Circuit Resistance Training shows significant improvement in right side strength among paraplegic patients. In group B, the mean improvement in strength is 0.22. And the calculated t value is 2.71. Since the significance (p-value) is less than 0.05, we can conclude that the improvement in strength, 0.22 is significant. So Progressive Resistance Exercises shows significant improvement in strength among paraplegic patients.

Table 1: Paired 'T' Test values

Paired 'T' Test (Within Group)		GROUP A (CRT group)				GROUP B (PRE group)			
OUTCOMES		DASH-Q	WUSPI	HHD LT	HHD RT	DASH-Q	WUSPI	HHD LT	HHD RT
MEAN	Pre-test	60.93	63.60	3.26	3.33	60.00	59.46	3.26	3.18
	Post-test	54.33	57.73	4.27	4.13	57.40	55.86	3.48	3.40
S. D.	Pre-test	6.52	8.60	1.47	1.42	6.74	9.19	1.61	1.57
	Post-test	5.34	8.59	1.96	1.56	5.91	7.71	1.58	1.56
Table 'T' value		2.14							
Calculated 'T' value		7.21	6.23	6.26	4.85	4.45	6.16	4.00	2.71
p value		p < 0.05	p < 0.05	p < 0.05	p < 0.05	p < 0.05	p < 0.05	p < 0.05	p < 0.05

4.2 Independent 'T' Test (Between Group)

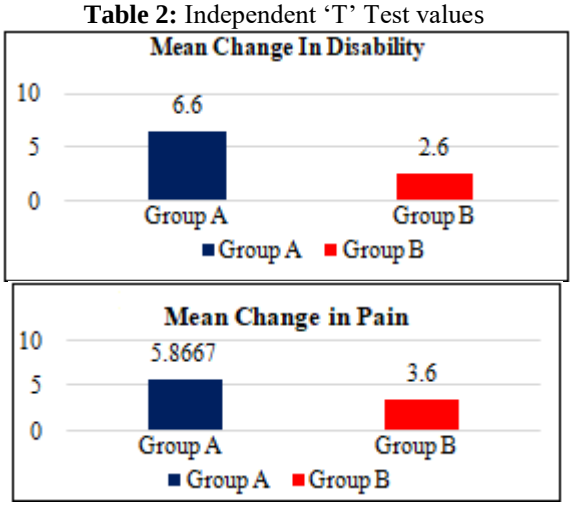
Independent 't' test was used for the inter group comparison. Significance level kept p<0.05. In comparison of Pre-Test and Post-Test differences of disability in group A and group B, the calculated value is 3.687 which is greater than the table value 2.04, withthe p< 0.05. So, CRT group shows more significance in improving function.

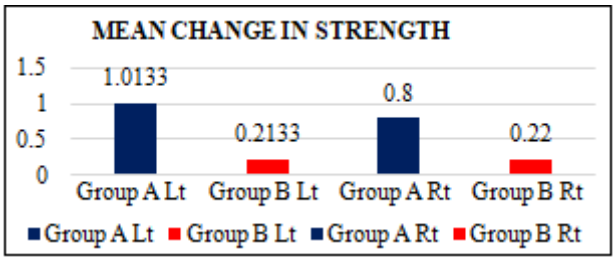
In comparison of Pre-Test and Post-Test differences of pain in group A and group B, the calculated value for pain is 2.048 which is equal to the table value 2.04 with p = 0.05. So, there is no significant difference for pain when compared between groups.In comparison of Pre-Test and

Post-Test differences of strength in group A and group B, the calculated value for strength on left side is 4.69 which is greater than the table value 2.04 with p< 0.05. And the calculated value for strength on right side is 3.15 which is greater than the table value 2.04 with p<0.05. So, CRT group shows more significant in improving strength.

The result shows, improvement in both groups. Even though both groups showed improvement, more significant improvement in function and strength was shown by the CRT group. And there is no significant difference in pain when compared between groups.

Table 2: Independent 'T' Test values





5. Discussion

The long-time dependency of a paraplegic patient on wheelchair may result in chronic shoulder pain. This pain is due to the overburdening of joint in their day to day activities The repeated high loads and high pressure, in conjunction with abnormal distribution of stress transmitted across the sub acromial area during transfer or propulsion of a wheelchair, contributes to the development of shoulder impingement syndrome that leads to upper-limb pain in paraplegics. Pain will limit the function and it affects the daily living activities of the patient. So, it is very important to develop a strategy that consider shoulder complications, which affects upper limb functionality in spinal cord injury patients. Exercise is a feasible, conservative and therapeutic intervention for the treatment of shoulder pain among wheelchair users.

P Serra et al, reported that resistance training programmes will effectively increase muscle strength and upper limb functionality, by decreasing shoulder pain. In this study we compared the effects of 2 different resistance training programmes to find out which one is more effective in reducing shoulder pain and improving upper extremity function and strength among paraplegic patients.

30 subjects were selected on the basis of inclusion and exclusion criteria, then divided equally into two groups, Group A and Group B. Each group consists of 15 subjects. Group A received conventional therapy along with circuit resistance training 1 hour a day, 3 times /week for 8 weeks. Group B received conventional therapy along with progressive resistance exercises 1 hour a day 3 times /week for 8 weeks. Pre-test and post-test were done before and after the intervention. The outcome measures used are DASH questionnaire, Wheelchair User's Shoulder Pain Index and

Handheld Dynamometer. Student 't' test was used for the statistical analysis. Paired 't' test was used for the intra group comparison of pre and post test results. Independent 't' test was used for the inter group comparison. Significance level kept p value <0.05.

In comparison of Pre-Test and Post-Test differences of disability in group A and group B, the calculated value is 3.687 which is greater than the table value 2.04, with the p< 0.05. Result shows improvement in both groups. Even though both groups showed improvement, more significant improvement in function was shown by the CRT group. The improvement of upper limb function in the patients from the CRT group in the present study was a statistically significant as well as clinically important finding. Nash M S et al, reported that CRT improves cardiovascular efficiency and endurance because the participant was able to obtain higher VO2 values with a lower HR at each workload throughout the protocol. These changes may lead to greater ease in functioning and possibly an inclination to become more active if physical activity becomes easier [10].

Exercise training is an adaptive process. The body will adapt to the stress of exercise with increased fitness. An interesting aspect of skeletal muscle is its adaptability. If a muscle is stressed, it adapts and improves its function. The nature of the adaptive response must always be considered when designing the training program. The improvement in function may also be related due to reduction in pain by the resisted exercises.This study also found improvement with regard to the abduction ROM. This demonstrates that such movement is considerably compromised in shoulder injuries and can be improved with exercise [11].

In comparison of Pre-Test and Post-Test differences of pain in group A and group B, the calculated value for pain is 2.048 which is equal to the table value 2.04 with p = 0.05. Both CRT and PRE group shows improvement in shoulder pain. And CRT group shows more improvement. But there is no much significant difference for CRT when compared between groups. Both treatment protocols emphasized stretching of the anterior chest accompanied by strengthening of the shoulder joint complex and mobilization of the scapula thoracic articulation, have been noted to reduce shoulder joint pain in wheelchair users. This improvement has occurred due to scapula humeral stability.
Exercises for strengthening the muscles of the rotator cuff stabilize the shoulder joint. The aim of the training program in the present study was to strengthen the musculature of the rotator cuff, thereby promoting stability in the joint, which is one of the factors that leads to the improvement of pain.

In comparison of Pre-Test and Post-Test differences of strength in group A and group B, the calculated value for strength on left side is 4.69 which is greater than the table value 2.04 with p< 0.05. And the calculated value for strength on right side is 3.15 which is greater than the table value 2.04 with p<0.05. So, CRT group shows more significant in improving strength. The result shows, improvement in both groups. Even though both groups showed improvement, more significant improvement in strength was shown by the CRT group. And there is no significant difference in pain when compared between groups.

Resistance training is identified as the most effective method for maintaining and increasing body mass and improving both muscular strength and endurance. Muscles increase their strength and size when they are forced to contract at tensions close to their maximum. Muscles must be overloaded to hypertrophy and improves strength [12].

The study revealed that Circuit Resistance Training demonstrated a significant improvement in upper limb function and strength. And both CRT and PRE group shows reduction in shoulder pain among paraplegic wheelchair users.

6. Conclusion

Exercise is a feasible, conservative and therapeutic intervention for the treatment of shoulder pain among wheelchair users. Even though both CRT and PRE groups showed improvement, more significant improvement in function and strength was shown by the CRT group. Both CRT and PRE group shows reduction in shoulder pain among paraplegic wheelchair users.

7. Future Scope

- The duration of study should be increased. It may lead to better and valuable result.
- Future investigations can be conducted in different population and age groups.
- The sample size of subjects should be increased for a more reliable outcome.
- A follow up study could ensure the long term effect of the treatment programme.
- Future studies can be done with large group and longer follow up.

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