

# Effect of Core Stability And Functional Mobility Exercises on Muscle Strength after Lumbar Spinal Cord Injury

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## Abstract

**Background:** Many studies suggest that when people are confined to wheelchair, central neuropathies such as spinal cord injury usually reduce strength of core muscles and corresponding functional abilities for standing and reaching. Studies that have aimed to compare different strategies to improve functional capacity or stability have produced controversial results. Furthermore such studies have focused solely on individual component. In contrast, the present study describes the effect of core stability as well as functional mobility exercises on muscle strength after lumbar spinal cord injury.

**Aim:** To analyze the effect of core stability and functional mobility exercises on muscle strength after lumbar spinal cord injury.

**Methodology:** 25 patients with lumbar spinal cord injury were recruited on a volunteer basis. Ethics approval was obtained from Institutional ethical committee, KIMSUDU. The purpose and procedure of the study was explained to each participant before giving their consent to participate in the study. Neurological levels and impairment scales were determined according to the American Spinal Injury Association (ASIA) standards. Descriptive statistics such as percentages, mean, and standard deviation were used for data analysis.

**Result:** The p-value for each component is  $<0.0001$  and is extremely significant. For each variable of the study (muscle groups) the post assessment values were more than pre assessment values. The intervention used in this study produced significant improvement in core strength and lower extremity strength of participants after lumbar spinal cord injury.

**Conclusion:** Core stability and functional mobility exercises improve muscle strength in lumbar spinal cord injury patients.

**Keywords:** Lumbar spinal cord injury, core stability, functional mobility, physiotherapy.

## Introduction

The spine is an inherently unstable structure as the osteoligamentous lumbar spine buckles under small compressive loading.<sup>1</sup> Paralysis of the muscles below the level of the injury can lead to limited and altered mobility, self care, and ability to participate in valued social activities.<sup>2</sup> Disabilities related to spinal cord injury vary according to the degree of damage, and the damaged spinal segments or nerve fibers.<sup>3</sup> Mechanism of the injury that can cause damage to the vertebrae with a resultant damage to the cord is usually a hyper flexion with rotation movement. Extension with rotation is less likely to cause damage to the cord.<sup>4</sup> Injury

to the lumbar spine usually results in paraplegia or paraparesis.<sup>5,6</sup> Spinal cord injuries are typically divided into 2 categories: complete injuries and incomplete injuries. The international standards for neurological classification of spinal cord injury (ISNCSCI) defines a complete injury as having no sensory or motor function in the lowest sacral segments (S4 and S5). An incomplete injury is classified as having no motor and/or sensory function below neurological level including sensory and/or motor function at S4 and S5.<sup>7</sup>

Immediately following an acute injury to the spinal cord there is a stage of spinal shock. After the stage of

spinal shock has passed the various neurological deficits starts manifesting which commonly consists of the following: motor and sensory deficits, spasticity usually increases during first six months after spinal injury and reaches a plateau by the end of first year.<sup>8</sup>

A critical role of spine musculature is to stiffen the spine in all potential modes of instability. Active control of spinal stability is achieved through the regulation of force in surrounding muscles. Trunk extensors, flexors, and lateral flexors provide spinal stability during every dynamic movement. So, there is an important need to have balanced muscular control.<sup>9</sup> Proper timing and coordinated efforts of these muscles are important for spinal stability.<sup>10</sup>

Core stability describes the ability to control the position and movement of the central portion of the body to allow optimum production, transfer and control of force and motion to the terminal segments in the integrated activities.<sup>11</sup> Functional capacity has been studied as one important aspect of activity of daily living. Different functional training methods have been assessed for their effectiveness in improving functional capacity;<sup>12,13</sup> however, no definitive conclusions have been reached with regard to the type of functional training that is most effective.<sup>13</sup> Some studies have found that strength training can increase functional capacity,<sup>14,15</sup> even with only modest gains<sup>16</sup> or gains in a few measures.<sup>17</sup> Nevertheless, most studies that have been conducted focuses only on singular elements i.e. few studies that have been conducted focuses only on core stability while other studies focuses only on functional mobility for improving functional capacity in patients with spinal cord injury. Studying the effectiveness of combination of two elements i.e. core stability and functional mobility exercises in lumbar spinal cord injury patients could provide different interpretation about the utility of core stability and functional mobility exercises to improve strength and functional capacity.<sup>18</sup> Therefore, the purpose of this study is to evaluate the effectiveness of core stability and functional mobility exercises on muscle strength in lumbar spinal cord injury patients.

## Material and Methodology

This study aimed to evaluate the effect of core stability and functional mobility exercises on muscle strength after lumbar spinal cord injury. This was an experimental study. The study was conducted in Krishna institute of medical sciences 'Deemed to be' University, Karad. 25 patients with lumbar spinal cord injury were recruited on a volunteer basis. Sample size was calculated with the help of formula  $N=4SD^2/(x \times \epsilon)^2$ . Ethics approval was obtained from Institutional ethical committee. The participants were recruited according to the inclusion and exclusion criteria. The criterion for inclusion in the study was 1. Patients with history of American spinal Injury impairment scale (AIS) grade C and D SCI. 2. Both male and female participants. The exclusion criterion from the study was neurological illness other than lumbar spinal cord lesion. A written consent was taken from each participant to voluntarily participate in the study. Each participant was explained about the purpose and procedures of the study. Once the informed consent was taken, detailed information was gathered, assessments were done with appropriate outcome measure and pre test was done. Depending on pre assessment evaluated strength, a six week core muscle strengthening exercise protocol was given and follow-up for progression was done after 2, 4 and 6 weeks. Later again post test was done and descriptive statistics such as percentages, mean, standard deviations and paired t test were used for data analysis and were recorded in order to derive the conclusion. All statistical analyses were performed with instat software.

## Statistical Analysis and Result

Descriptive statistics were performed for all variables (i.e., muscle strengths). Pre and post assessments of the selected participants were done. Arithmetic mean, standard deviations, paired t –test and p-value were calculated for each outcome measure.

**Table no.1 Strength of muscle post intervention:.**

| Sr. no. | Muscle groups         | Mean  |       | SD     |        | Paired t-value | p-value | Interference          |
|---------|-----------------------|-------|-------|--------|--------|----------------|---------|-----------------------|
|         |                       | Pre   | Post  | Pre    | Post   |                |         |                       |
| 1.      | Hip flexors           | 2.280 | 4.440 | 0.8907 | 1.261  | 8.035          | <0.0001 | Extremely significant |
| 2.      | Hip extensors         | 2.480 | 3.920 | 1.112  | 1.288  | 4.793          | <0.0001 |                       |
| 3.      | Hip abductors         | 2.400 | 3.640 | 1.000  | 1.075  | 4.656          | <0.0001 |                       |
| 4.      | Hip adductors         | 2.480 | 3.920 | 0.8718 | 1.152  | 5.192          | <0.0001 |                       |
| 5.      | Knee flexors          | 3.200 | 4.560 | 0.8699 | 0.9129 | 5.283          | <0.0001 |                       |
| 6.      | Knee extensors        | 3.080 | 4.840 | 0.7024 | 0.9434 | 9.508          | <0.0001 |                       |
| 7.      | Ankle dorsiflexors    | 2.120 | 3.480 | 0.8327 | 0.9626 | 6.834          | <0.0001 |                       |
| 8.      | Ankle plantar flexors | 2.680 | 3.800 | 0.4761 | 0.7071 | 7.716          | <0.0001 |                       |
| 9.      | Great toe extensors   | 2.160 | 3.520 | 0.8505 | 1.085  | 5.911          | <0.0001 |                       |
| 10.     | Trunk flexors         | 1.680 | 3.200 | 0.6272 | 0.7638 | 14.905         | <0.0001 |                       |
| 11.     | Trunk extensors       | 1.560 | 3.200 | 0.5066 | 0.7638 | 14.421         | <0.0001 |                       |
| 12.     | Side flexors          | 1.880 | 3.560 | 0.5831 | 0.6000 | 15.087         | <0.0001 |                       |
| 13.     | Trunk rotators        | 1.640 | 3.160 | 0.5686 | 0.6245 | 14.905         | <0.0001 |                       |

The post assessment values of each study variable (muscle groups) are more than the pre assessment values. The mean difference of pre assessment values is -1.508. The mean difference of post assessment values is -0.172

**Table no.02 : strength of lower extremity muscles and core muscles of body in male subjects.**

| Males | Mean  | SD     | Paired t-value | p-value | Interference          |
|-------|-------|--------|----------------|---------|-----------------------|
| Pre   | 2.098 | 0.2762 | 15.489         | <0.0001 | Extremely significant |
| Post  | 3.331 | 0.4612 |                |         |                       |

The post assessment values of mean and SD of overall core and lower extremity strength of male participants are more than the pre assessment values. The mean difference is -1.234.

**Table no.03 : strength of lower extremity muscles and core muscles of body in female subjects.**

| Females | Mean  | SD     | Paired t-value | p-value | Interference          |
|---------|-------|--------|----------------|---------|-----------------------|
| Pre     | 1.852 | 0.2969 | 6.891          | <0.0001 | Extremely significant |
| Post    | 3.409 | 0.6149 |                |         |                       |

The post assessment values of mean and SD of overall core and lower extremity strength of female participants are more than the pre assessment values. The mean difference is -1.558.

## Discussion

This study aimed to analyze the effect of core stability and functional mobility exercises on muscle strength after lumbar spinal cord injury. Core stability is the ability of lumbopelvic hip complex to prevent buckling and to return to equilibrium after perturbation.<sup>19</sup> Functional mobility is the manner in which people are able to move around in the environment in order to participate in the activities of daily living.<sup>20</sup> Weakness is the most obvious impairment that inhibits people with SCI from performing motor tasks.<sup>21</sup>

In this study 25 patients were recruited according to the inclusion and exclusion criteria, in which 13 were male participants and 12 were female participants. Manual muscle test was performed on each subject for thirteen muscle groups (hip flexors, hip extensors, hip abductors, hip adductors, knee flexors, knee extensors, ankle dorsiflexors, ankle plantar flexors, great toe extensor, trunk flexors, trunk extensors, side flexors and trunk rotators) in standardized position.<sup>22</sup> Muscle strength was graded on a scale from zero to five using six weeks of interval.<sup>23</sup> We evaluated the pre test and post test assessment values for manual muscle testing in the selected participants.

Depending on the pre assessment values a six week core stability and functional mobility exercise protocol was given and follow up for progression was done after 2, 4, 6 weeks interval. In the initial phase of treatment galvanic current was given to trunk and lower extremity muscles with the frequency as tolerated and passive range of motion exercises to trunk and lower extremity muscles which initiated flicker of contractions.<sup>24</sup> Denervated muscles are incapable of contraction except by direct stimulation of the muscle fibers by suitable electrical means.<sup>25</sup> Once the initiation of contractions was achieved electrical stimulation with the help of

faradic current to motor nerves of spine and lower extremity was used. Innervated muscles contract in response to a demand for activity provided the demand is sufficient.<sup>24</sup> Once the patient was able to do active contractions, active assisted range of motion exercises were initiated. Once the power of contraction has been regained, the muscles were strengthened progressively until maximum function was obtained.<sup>25</sup> Strengthening of trunk and lower extremity muscles was done with isometric strengthening program. A person requires a progressive resistance training program in which the load is appropriately and progressively increased. Such training is often best performed within the context of a functional skill, provided the principles of progressive resistance training can be maintained.<sup>26</sup> Varieties of methods which were used for providing resistance are pulleys, free weights, weight cuffs and theraband.<sup>25</sup> Resistance training increases muscle strength by making muscles work against a weight or force.<sup>27</sup> Bed mobility exercises were used to improve functional mobility of the participants.<sup>25</sup> After all this procedure the post test assessment values were evaluated.

Richardson et al. proposed that lumbar stabilization exercise increased the stability of the spine and posture while performing functional postures and movements.<sup>28</sup> Panjabi reported that lumbar stabilization exercise, a muscle strengthening exercise for the deep muscle group, plays an important role in providing dynamic stabilization in the segments stability, and useful for decrease in spinal functional disorder.<sup>29</sup> Specific transverse abdominal muscle strengthening along with the conventional treatment shows speedy recovery than the only conventional therapy when given at the acute and sub-acute stages of traumatic spinal cord injury.<sup>30</sup> The present study also found improvements in lower extremity muscle strength as well as functional capacity after performing core stability and functional

mobility exercises. The post test results derived that the stabilization exercises used in this study produced significant improvement in muscle strength in the lumbar area thereby improving functional capacity and muscle strength in the lower extremity.

### Conclusion

Core stability and functional mobility exercises improve muscle strength in lumbar spinal cord injury patients.

**Ethical Clearance** - Obtained from INSTITUTIONAL ETHICAL COMMITTEE, KIMSDU, Karad.

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**Conflict of Interest** - Nil.

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