

Effects of Task-Specific Trunk Control and Postural Endurance Training On Functional Movement Adaptability and Disability Following Lumbar Spine Fusion: A Randomized Controlled Trial

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Abstract

Background: Functional limitations may persist following lumbar spine fusion despite successful surgical management. Reduced trunk control and postural endurance can interfere with functional recovery and activities of daily living. Task-specific rehabilitation may help restore efficient movement patterns and improve postoperative function. The aim is to evaluate the effects of task-specific trunk control and postural endurance training on functional movement adaptability and disability in patients following lumbar spine fusion surgery. **Material and Methods:** A prospective interventional study was conducted at Hi-Tech Hospital, Gandhinagar, Gujarat, from January 2021 to January 2022. A total of 75 patients who had undergone lumbar spine fusion and were referred for postoperative physiotherapy rehabilitation were included. Participants underwent a structured programme consisting of task-specific trunk control exercises and postural endurance training. Functional movement adaptability and disability using the Oswestry Disability Index (ODI) were assessed before and after the intervention. A p-value <0.05 was considered statistically significant. **Results:** The mean age of participants was 48.6 ± 9.7 years, and 57.3% were male. Functional movement adaptability improved significantly from 42.7 ± 8.6 before intervention to 61.9 ± 9.1 after intervention ($p < 0.001$). The mean ODI score decreased significantly from 41.8 ± 10.3 to 25.6 ± 9.2 ($p < 0.001$). Improvement in functional movement adaptability showed a moderate positive correlation with reduction in disability ($r = 0.58$, $p < 0.001$). **Conclusion:** Task-specific trunk control and postural endurance training was associated with improved functional movement adaptability and reduced disability following lumbar spine fusion. This approach may be a useful component of postoperative physiotherapy rehabilitation.

Keywords: Lumbar spine fusion, Task-specific training, Trunk control, Postural endurance, Functional movement, Oswestry Disability Index, Physiotherapy rehabilitation.

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INTRODUCTION

Low back pain (LBP) affects more than half a billion people worldwide and remains one of the leading causes of disability across different age groups and income levels.^[1,2] Although LBP follows a relatively benign course in most individuals, a proportion of patients develop chronic low back pain (CLBP), which can considerably affect daily activities, quality of life, healthcare utilization, and work productivity. For patients with persistent symptoms who do not respond adequately to conservative management, lumbar spinal fusion (LSF) is commonly performed with the aim of reducing pain and improving functional ability.^[3,4] Over the past few decades, the use of LSF for the management of chronic low back pain has increased substantially.^[4]

Lumbar spinal fusion is frequently performed for conditions such as degenerative spinal disorders, spinal stenosis, and spondylolisthesis. Despite advances in surgical techniques, recovery after surgery is not always complete, and approximately 10–40% of patients may experience unsatisfactory outcomes. Persistent pain, motor deficits, reduced functional capacity, and difficulty returning to

work are among the commonly reported problems following surgery.^[5,6]

Recovery may also be influenced by psychological and behavioural factors. Fear of movement has been reported in a considerable proportion of patients undergoing spinal surgery and may interfere with postoperative rehabilitation. Fear-avoidance behaviour, negative affect, and depression have been associated with persistent pain and reduced functional ability for several years following spine surgery. These factors may restrict normal movement and contribute to delayed functional recovery.^[7-10]

In addition, reduced strength and postoperative atrophy of the

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trunk and back muscles may contribute to persistent functional limitations. Traditionally, strengthening and functional rehabilitation have often been initiated several weeks to months after lumbar fusion. However, growing evidence suggests that appropriately supervised trunk muscle conditioning may be introduced earlier in selected patients. Improving trunk muscle strength, control, and endurance may help minimize muscle deconditioning, enhance functional performance, reduce disability, and improve quality of life following surgery.^[11]

Task-specific training offers a functional approach to postoperative rehabilitation. It involves repeated practice of meaningful functional tasks, or components of those tasks, to develop efficient and adaptable movement strategies. Rather than focusing solely on isolated muscle strengthening, task-specific training encourages patients to practise different movement patterns according to the demands of the task and environment.^[12] This approach may help reduce stereotyped or guarded movement patterns and improve the ability to adapt trunk movements during everyday activities.^[13,14]

Postural endurance is another important component of functional recovery after lumbar fusion. Adequate endurance of the trunk musculature is required to maintain postural control during prolonged sitting, standing, walking, and other activities of daily living. Therefore, combining task-specific trunk control exercises with postural endurance training may provide a more comprehensive rehabilitation strategy by addressing both movement control and the ability to sustain functional postures.^[15]

Previous studies have shown that structured rehabilitation following lumbar fusion can improve functional ability and may provide clinically meaningful benefits compared with usual postoperative care. However, evidence regarding rehabilitation programmes specifically combining task-specific trunk control with postural endurance training remains limited.^[16] So, Present study was conducted with aim to evaluate the effects of task-specific trunk control and postural endurance training on functional movement adaptability and disability in patients following lumbar spine fusion surgery.

MATERIALS AND METHODS

A prospective interventional study was conducted at Hi-Tech Hospital, Gandhinagar, Gujarat, India, from January 2021 to January 2022 after ethical permission of IEC. A

total of 75 patients who had undergone lumbar spine fusion surgery and were referred for postoperative physiotherapy rehabilitation were included in the study. The purpose and procedure of the study were explained to all participants before enrolment, and written informed consent was obtained. Inclusion criteria were cases had undergone lumbar spine fusion surgery, were clinically stable and eligible to participate in postoperative physiotherapy rehabilitation, were able to understand and follow instructions, were able to participate in the prescribed exercise programme and provided written informed consent for participation. Exclusion criteria were cases had significant postoperative complications contraindicating active rehabilitation, had severe neurological deficits substantially affecting functional mobility and had other significant musculoskeletal or neurological disorders affecting trunk control or functional performance. All participants received a structured physiotherapy rehabilitation programme comprising task-specific trunk control exercises and postural endurance training. Task-specific trunk control training was designed to improve coordinated activation and control of the trunk musculature during functional movements. The exercises emphasized appropriate lumbopelvic control during movements and functional activities. Exercise difficulty was progressively increased according to each participant's functional capacity and tolerance.

Postural endurance training focused on improving the ability of the trunk musculature to maintain appropriate postural alignment during sustained and repetitive activities. The duration and intensity of exercises were gradually progressed according to individual tolerance and clinical improvement. The exercise programme was administered under the supervision of a qualified physiotherapist. Particular attention was given to correct exercise technique, maintenance of appropriate trunk alignment, controlled movement, patient safety, and gradual progression of functional activities.

Demographic and clinical information, including age, sex, relevant clinical history, details related to lumbar spine fusion, and baseline functional status, was recorded using a structured data collection form. Pre-intervention and post-intervention outcome measurements were recorded for each participant.

The collected data were entered into a database and analyzed using appropriate statistical methods. Continuous variables were presented as mean and standard deviation, whereas categorical variables were expressed as frequency and percentage. A p-value of <0.05 was considered statistically significant.

RESULTS

Table 1: Socio-clinical characteristics of study participants [N=75]

Parameters	Number (%)
Age (years) (Mean $\pm$ SD)	48.6 $\pm$ 9.7
Male (n) (%)	43 (57.3%)
Female (n) (%)	32 (42.7%)
BMI (kg/m ²) (Mean $\pm$ SD)	26.8 $\pm$ 3.4
Single-level lumbar fusion (n) (%)	48 (64.0%)
Multi-level lumbar fusion (n) (%)	27 (36.0%)
Duration since surgery (weeks) (Mean $\pm$ SD)	7.2 $\pm$ 1.6

[Table 1] shows that the mean age of the study participants

was 48.6 $\pm$ 9.7 years. Of the total 75 participants, 57.3%

were male and 42.7% were female. The mean BMI of the participants was 26.8 ± 3.4 kg/m². Regarding the type of lumbar fusion, 64.0% of participants underwent single-level

lumbar fusion and 36.0% underwent multi-level lumbar fusion. The mean duration since surgery was 7.2 ± 1.6 weeks.

Table 2: Comparison of functional movement adaptability before and after intervention (n=75)

.	Pre-intervention (Mean $\pm$ SD)	Post-intervention (Mean $\pm$ SD)	Mean Change	p-value
Functional movement adaptability score*	42.7 $\pm$ 8.6	61.9 $\pm$ 9.1	+19.2	<0.001

[Table 2] shows the comparison of functional movement adaptability scores before and after the intervention. The mean functional movement adaptability score increased from 42.7 ± 8.6 before intervention to 61.9 ± 9.1 after

intervention, with a mean improvement of 19.2 points. The difference between pre- and post-intervention scores was statistically significant ($p < 0.001$),

Table 3: Comparison of disability before and after intervention (n=75)

Outcome	Pre-intervention (Mean $\pm$ SD)	Post-intervention (Mean $\pm$ SD)	Mean Reduction	p-value
Oswestry Disability Index (ODI)	41.8 $\pm$ 10.3	25.6 $\pm$ 9.2	16.2	<0.001

[Table 3] shows the comparison of disability before and after the intervention using the Oswestry Disability Index (ODI). The mean ODI score decreased from 41.8 ± 10.3

before intervention to 25.6 ± 9.2 after intervention, with a mean reduction of 16.2 points. This reduction was statistically significant ($p < 0.001$).

Table 4: Distribution of participants according to ODI disability category before and after intervention (n=75)

ODI Category	Pre-intervention n (%)	Post-intervention n (%)
Minimal disability	4 (5.3%)	21 (28.0%)
Moderate disability	30 (40.0%)	39 (52.0%)
Severe disability	34 (45.3%)	14 (18.7%)
Crippled	7 (9.3%)	1 (1.3%)
Bed-bound/exaggerating symptoms	0	0

[Table 4] shows the distribution of study participants according to ODI disability categories before and after the intervention. Before the intervention, 5.3% of participants had minimal disability, 40.0% had moderate disability, 45.3% had severe disability, and 9.3% were in the crippled

category. After the intervention, the proportion of participants with minimal disability increased to 28.0%, while 52.0% had moderate disability, 18.7% had severe disability, and only 1.3% remained in the crippled category.

Table 5: Association between improvement in functional movement adaptability and reduction in disability

Variables	Correlation coefficient (r)	p-value
Improvement in functional movement adaptability vs. reduction in ODI	0.58	<0.001

[Table 5] shows the association between improvement in functional movement adaptability and reduction in disability. A moderate positive correlation ($r = 0.58$) was observed between improvement in functional movement adaptability and reduction in ODI score. This correlation was statistically significant ($p < 0.001$).

DISCUSSION

The study participants were predominantly middle-aged, with a mean age of 48.6 years, and males were slightly more represented than females. The mean BMI was 26.8 kg/m², indicating that the participants were, on average, in the overweight category. Most had undergone single-level lumbar fusion, while approximately one-third had undergone multi-level fusion.

A significant improvement in functional movement adaptability was observed following task-specific trunk control and postural endurance training. The mean score increased from 42.7 before the intervention to 61.9 after the intervention, indicating better ability to perform and adapt to functional movements after completing the rehabilitation

programme. Similar findings were reported by Kernc et al,^[17] (2018), who evaluated an early strength-training-based rehabilitation programme following lumbar spine fusion and found improvement in trunk muscle function and functional performance. Likewise, Huang et al,^[18] (2023) reported that an early aquatic exercise programme after lumbar fusion improved several aspects of trunk function and functional recovery. These findings are in line with the present study and support the role of structured trunk-focused rehabilitation in improving functional recovery after lumbar fusion.

Disability also improved significantly following the intervention. The mean ODI score decreased from 41.8 to 25.6, with an overall reduction of 16.2 points. This change suggests that the improvement was not limited to functional movement alone but was also reflected in the participants' ability to carry out activities of daily living. Huang et al,^[18] (2023) reported a similar reduction in ODI following a six-week aquatic rehabilitation programme after lumbar fusion, further supporting the beneficial role of structured postoperative rehabilitation in reducing disability.

The change in ODI categories provides further support for this

improvement. Before rehabilitation, a substantial proportion of participants were classified as having severe disability. Following the intervention, more participants moved into the minimal and moderate disability categories, with fewer remaining in the severe disability group. This shift towards lower levels of disability suggests a meaningful improvement in the overall functional status of the participants after rehabilitation.

Another important finding was the moderate positive correlation between improvement in functional movement adaptability and reduction in disability ($r=0.58$, $p<0.001$). Participants who showed greater improvement in functional movement adaptability also tended to experience a greater reduction in disability. This suggests that improving the ability to control and adapt trunk movements during functional activities may be closely related to better overall functional recovery after lumbar fusion.

Similar improvements in functional disability have been reported by Abbott AD et al,^[19] (2010). In their randomized controlled trial involving 107 patients following lumbar fusion, psychomotor rehabilitation focusing on cognition, behaviour, and motor relearning resulted in greater improvement in functional disability than conventional exercise therapy at several follow-up assessments. Their findings suggest that rehabilitation after lumbar fusion should not be limited to improving muscle strength alone. Relearning appropriate movement patterns and developing confidence during functional activities may also be important components of recovery. This is particularly relevant to the task-specific approach used in the present study.

The timing of rehabilitation following lumbar fusion may also influence recovery. Oestergaard et al,^[20] (2012) compared rehabilitation initiated at six weeks with rehabilitation initiated at twelve weeks after instrumented lumbar fusion. Interestingly, greater improvement in ODI was observed in patients who started rehabilitation at twelve weeks. This suggests that starting rehabilitation earlier does not necessarily result in better outcomes and that the timing, intensity, and progression of rehabilitation should be considered according to the patient's postoperative condition.

Despite the favourable outcomes reported in several individual studies, there is still no clear consensus regarding the optimal rehabilitation programme following lumbar fusion. Rushton et al,^[6] (2012), in a systematic review and meta-analysis of randomized controlled trials, found that the available evidence was limited and generally of low quality, with considerable variation in rehabilitation interventions, outcome measures, and follow-up periods. This highlights the need for further well-designed studies to establish the most appropriate rehabilitation strategies for patients undergoing lumbar fusion.

Limitations: The study was conducted at a single centre with a relatively small sample size, which may limit the generalizability of the findings. In addition, the absence of a control group and long-term follow-up makes it difficult to determine how much of the observed improvement was specifically related to the intervention and whether these

benefits were maintained over time.

CONCLUSION

The present study showed that task-specific trunk control and postural endurance training was associated with improved functional movement adaptability and reduced disability in patients following lumbar spine fusion surgery. Participants demonstrated better functional performance and lower levels of disability after completing the structured physiotherapy programme. The improvement in movement adaptability was also associated with a reduction in disability, suggesting that better trunk control and postural endurance may contribute to functional recovery after lumbar fusion. Task-specific exercises may help patients perform everyday activities with greater control and confidence, while endurance training may improve their ability to maintain appropriate posture during sustained activities. Overall, these findings support the use of trunk control and postural endurance exercises as useful components of postoperative physiotherapy rehabilitation following lumbar spine fusion.

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Conflicts of interest

There are no conflicts of interest.

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