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Research Article

Effectiveness of Abdominal Hollowing Exercises Versus Conventional Physical Therapy for Low Back Pain in Caregivers of Spinal Cord Injury Patients

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Abstract

This study aimed to compare the effectiveness of abdominal hollowing exercise (AHE) vs. conventional physical therapy for low back pain (LBP) in caregivers of spinal cord injury (SCI) patients. In this quasi-experimental study, 60 subjects with LBP were arbitrarily allocated into two groups via consecutive sampling: Group A (n=30), who received AHE, and Group B (n=30), who received conventional physical therapy for 4 weeks at the Paraplegic Centre, Peshawar. The primary outcome measures were functional disability score through the modified Oswestry Disability Index (mODI) and pain intensity using the visual analog scale (VAS) questionnaire. In terms of the mODI score and the VAS of caregivers with LBP, a comparison was made between the two groups at baseline and the end of a four-week treatment period. At baseline, comparable results were observed. However, after the treatment, a statistically significant difference was found in both VAS and ODI scores ($p<0.05$) between the two groups. The VAS scores within group A were significantly lower (3.23±1.61) compared to the baseline scores (4.93±0.78). Similarly, the ODI scores showed a significant improvement ($p=0.001$) in group A in the fourth week, as compared to group B ($p=0.719$). AHE demonstrated effectiveness in managing LBP among caregivers of patients with SCI, surpassing the outcomes observed in those who underwent conventional physiotherapy for LBP. Considering the context of chronic LBP in caregivers, it is recommended to integrate AHE into the treatment approach, as it can lead to substantial pain reduction and diminished disability among individuals caring for SCI patients.

Keywords: Spinal cord injury; caregiver; low back pain; lumber region; abdominal hollowing exercise (AHE); core stability exercise.

1. Introduction

Spinal cord injury (SCI) is a devastating and lifelong condition, the occurrence of which is increasing every year (Ghazwin et al. 2015). Globally, its estimated annual incidence ranges from 13-33 cases per million, whereas the prevalence ranges from 110 to 120 per million of the population (Wyndaele and Wyndaele 2006). SCI causes serious disabilities and such patients are usually dependent on help in the form of mobility in bed, transfer, and activities of daily living (ADL) from their caregivers (Bardak, Erhan, and Gündüz 2012). In order to provide care for these individuals, caregivers play an important role but this role makes them vulnerable to different disorders such as low back pain (LBP). Caregivers engage in activities that increase their susceptibility to LBP, including maintaining awkward static and dynamic postures, frequently bending and twisting, lifting heavy weights, and experiencing psychological stress (Pajeemas et al. 2018).

The prevalence of LBP in professional caregivers is around 58% while in non-professional caregivers it was observed to be 64.4%. Many

caregivers who do not report a back injury may still suffer from back pain. Data from over 80 studies reveal that back pain in caregivers has a worldwide prevalence of 40-50% and a lifetime prevalence of 35-80% (Hignett 1996).

Several occupational factors can predict back pain and injury. Manual handling is considered a major risk factor for a back injury (Da Costa and Vieira 2010, Kuiper et al. 1999). Heavy and repetitive lifting with a flexed lumbar spine puts individuals at a high threat of developing LBP and injury (Arjmand, Shirazi-Adl, and Bazrgari 2006, Marras et al. 1993). Limited experience in patient handling skills, as well as poor posture while lifting objects weighing more than 10 kilograms, have been reported as major contributors to LBP among caregivers (Mundt et al. 1993, Videman et al. 1989b). Utilizing more spine flexion also increases compression, torsion, and shear forces on the lumbar spine (McGill 1997, Skotte et al. 2002, Bauer, Paulus, and Keller 2015), and therefore significantly increases the chance of developing herniated discs and/or other tissue damage to the structures of the spine (Marshall and McGill 2010, Hadjipavlou et al. 2008, Plouvier et al. 2008).

Due to the numerous adverse effects associated with LBP, treatment should include a multidisciplinary approach because it has been argued that only one technique for LBP treatment would be ineffective (Koes et al. 2000). Conservative LBP treatment involves physical therapy, lifestyle changes, and medication. These techniques are intended to decrease pain, increase mobilization, and improve functional and psychological status (Şahin, Karahan, and Albayrak 2018, Waddell and Burton 2005). One of the main treatments used for LBP is exercising and has been shown to lessen the frequency and time of back pain (Liddle, Gracey, and Baxter 2007, van der Roer et al. 2008). Previous studies have revealed that physiotherapy modalities such as hot packs, diathermy, ice massages, ultrasound therapy, and TENS decrease inflammation, and relieve joint stiffness and musculoskeletal symptoms thereby, providing symptomatic relief (Şahin, Karahan, and Albayrak 2018, Nordin and Campello 1999, Choi et al. 2010, Shahbandar and Press 2005). Similarly, the effectiveness of abdominal hollowing exercise (AHE) in treating LBP has also been demonstrated. AHE is beneficial for patients with LBP. It not only helps to reduce pain but also improves muscle activation patterns and enhances functional outcomes (García-Jaén et al. 2020, Kim and Oh 2015). By incorporating AHE into their routine management, those with LBP can experience relief, improved muscle control, and better overall functionality. Keeping this in mind, this study is conducted to compare the effectiveness of AHE vs. conventional physical therapy for LBP among caregivers of SCI patients.

2. Methods & Materials

This quasi-experimental study was conducted at the Paraplegic Centre, Hayatabad, Peshawar. A total of 60 caregivers with LBP were selected using consecutive sampling. Both males and females with an age range of 18-50 years, non-professional caregivers of SCI patients, and caregivers with care time for more than two months were enrolled. Those having multiple sclerosis, TB spine, spinal tumor, fracture, pregnancy, previous surgery, structural abnormalities, osteoporosis, and severe cardiovascular and metabolic disease were excluded.

Of the total 60 caregivers, equal numbers were arbitrarily allocated into two treatment groups, A & B respectively. All the patients in group A received AHE in supine lying, quadruped position, and crook lying. All the patients in group B received conventional physiotherapy which included mat activities, stretching (single and double knee to chest exercise) and strengthening of the rectus-obliques muscles, bridging exercise for strengthening back extensor muscles, prone lying with a pillow with

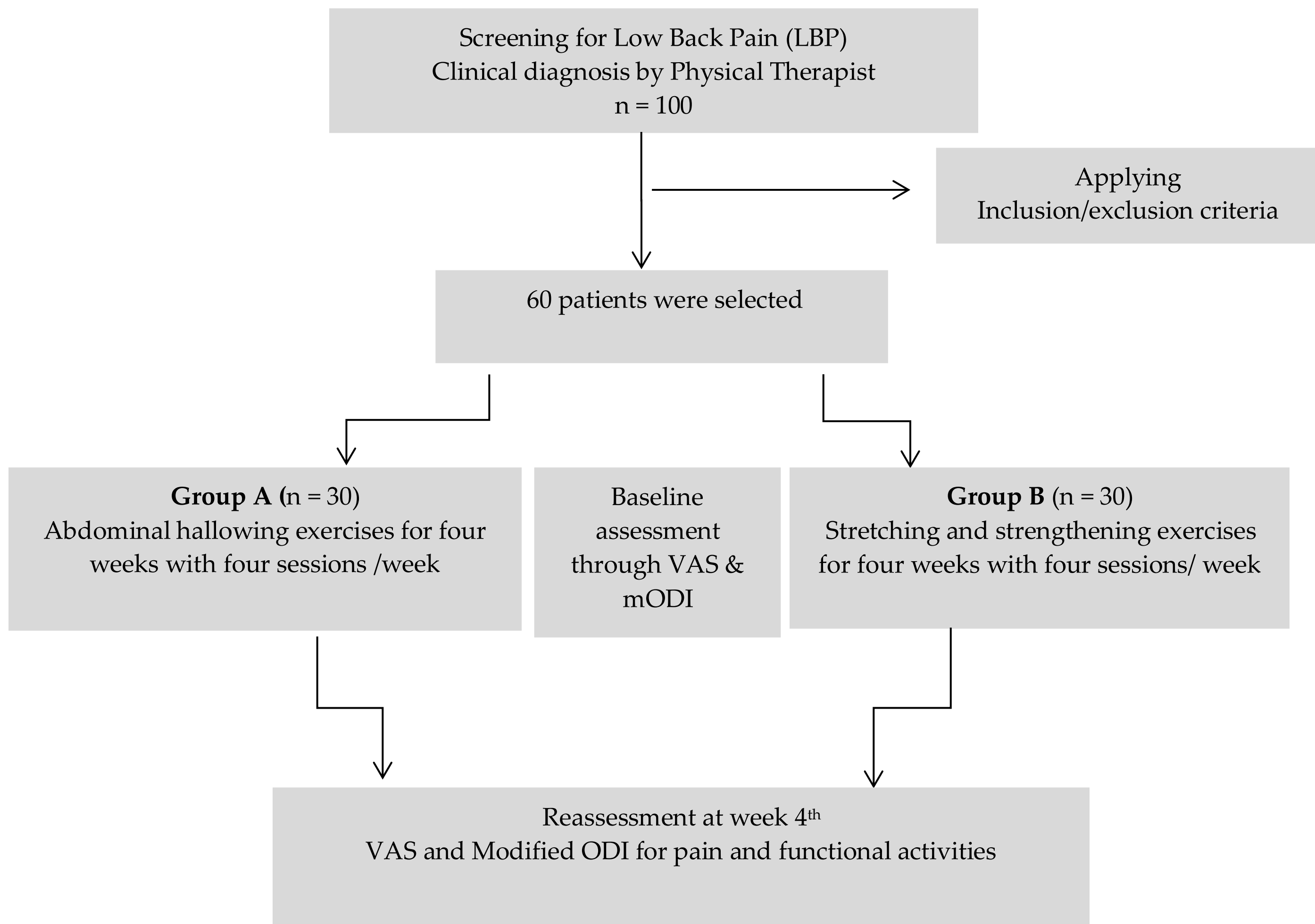

Figure 1: The figure shows the study design employed in this investigation.

one leg sliding, and cycling in supine. Both groups received treatment of four sessions per week for four weeks. The treatment was provided by a professional and qualified physical therapist. Data was collected at the start of the study (baseline) and the end of week 4, using the visual analog scale (VAS) and the modified Oswestry Disability Index (mODI) for pain and functional activities as outcome measures.

Data was collected from the participants after ethical approval from the Khyber Medical University ethical committee (Ref No: DIR/CPMR-PCP/26419, dated: 26/04/2019). Collected data was analyzed through SPSS version 22. Frequency and percentages were calculated for categorical data. Mean and SD were calculated for continuous variables like age, and BMI. An Independent sample t-test was used for numerical data (pain, functional disability) and a Chi-square test was used for categorical variables. Pre and Post differences were calculated using paired t-test. P value < 0.05 was taken as statistically significant.

3. Results

Of the total 60 participants, 45 (75.00%) were males. The mean (SD) age of the participants was

Table 1: Comparison of Socio-demographic, anthropometric, and clinical characteristics of the study group and control group.

Variable	Total	Groups		p-value
		Physiotherapy Group Mean ±SD, N (%)	Control Group Mean ±SD, N (%)	
Age	38.43±11.15	36.17±11.33	40.70±10.67	0.116
Gender				
Male	45(75)	23(76.7)	22(73.3)	0.766
Female	15(25)	07(23.3)	08(26.7)	
Marital status				
Single	18(30)	11(36.7)	7(23.3)	0.260
Married	42(70)	19(63.3	23(76.7)	
Education				
No formal education	12(20)	6(20.0)	6(20.0)	0.515
Primary	16(26.75)	8(26.7)	8(26.7)	
Middle	23(38.3)	12(40)	11(36.7)	
Secondary	3(5)	0(0.0)	3(10)	
Higher secondary	5(8.3)	3(10)	2(6.7)	
Graduation	1(1.7)	1(3.3)	0(0.0)	
Occupation				
No occupation	16(26.7)	6(20)	10(33.3)	0.251
Student	3(5)	2(6.7)	1(3.3)	
Civil & military Job	4(6.7)	4(13.3)	0(0.0)	
Private job	10(16.7)	5(16.7)	5(16.7)	
Others	27(45)	13(43.3)	14(46.7)	
Socioeconomic status				
Low	24(40)	14(46.7)	10(33.3)	0.304
Middle	35(58.3)	15(50)	20(66.7)	
High	1(1.7)	1(3.3)	0(0.0)	
History of smoking				1.00
Yes	20(33.3)	10(33.3)	10(33.3)	
No	40(66.7)	20(66.7)	20(66.7)	
History of regular exercise				0.688
Yes	53(88.3)	27(90)	26(86.7)	
No	7(11.17)	3(10)	4(13.3)	
Height (meter)	1.61±0.10	1.60(0.10)	1.61(0.10)	0.621
Weight (Kg)	63.78±6.33	63.73(7.81)	63.83(4.52)	0.952
BMI of the caregiver	24.92±3.60	25.07(3.90)	24.77(3.33)	0.756
Take care duration	14.52±15.81	9.20(10.36)	19.83(18.51)	**0.008**
Category of care duration (minutes)	107.43±22.38	96.83(26.73)	118.03(8.51)	**<0.001**

38.43±11.15 years. The majority were married and had completed middle school. The mean (SD) height, weight, and body mass index (BMI) of the caregiver were 1.61±0.10m, 63.78±6.33kg, and 24.92±3.6 respectively. The mean (SD) care duration for participants caring for their SCI patient was 14.52±15.81 months. Socio-demographic, and anthropometric characteristics of the study participants are depicted in Table 1.

Socio-demographic and anthropometric characteristics of the study participants were compared between two groups. No significant mean differences regarding age (p=0.116),

Table 2: Oswestry Disability Index (ODI) and visual analog scale (VAS) scores of those with low back pain both in the study group and control group [inter-group analysis].

Parameters	Groups		Mean difference	t(df)	p-value
	Physiotherapy Group Mean ± SD	Control Group Mean ± SD			
VAS at Baseline	4.93±0.78	4.73±0.78	0.20	0.99(58)	0.328
VAS 4th week	3.23±1.61	4.50±3.05	-1.27	-2.01(58)	**0.049**
ODI baseline	29.50±10.66	27.00±15.53	2.53	0.737(58)	0.464
ODI 4th week	19.40±10.91	25.67±10.91	1.66	-6.26 (58)	**0.030**

gender (p=0.766), marital status (p=0.260), education (p=0.515), occupation (p=0.251), socioeconomic status (p=0.304), smoking history (p=1.000), history of regular exercise (p=0.688) and BMI (p=0.756) was observed in either group. However, the mean differences regarding care duration [months] (p=0.008) and care duration in minutes for various activities (p <0.001) were found to be statistically significant between the two groups (Table 1). When the two groups were compared at baseline and the end of the four-week treatment, no significant difference in VAS between the groups at baseline was observed. However, the difference at the end of four weeks was statistically significant between the groups. Similar results were noted for mODI at baseline between the two groups (p=0.464) however, there was a statistically significant difference at the end of four weeks (p=0.030) as given in Table 2. As depicted in Table 3, the VAS scores after the therapy within group A were significantly lower (3.23±1.61) compared to baseline scores (4.93±0.78). Similarly, ODI scores showed a significant improvement (p=0.001) in group A in 4th week compared to group B (p=0.719).

4. Discussion

SCI patients may require caregivers for assistance with daily activities (Humaira Umme 2015). Caregivers have to cope with the overwhelming effects of SCI and LBP due to awkward posture, bending, twisting, lifting, and psychological stress, causing exhaustion and isolation (Humaira Umme 2015). Caregivers may face many musculoskeletal issues, and those looking for people with SCI have any major disability like LBP (Humaira Umme 2015). Ergonomics predicts back pain; manual handling is a major determinant (Da Costa and Vieira 2010, Kuiper et al. 1999). Repetitive lifting with a flexed lumbar spine increases the risk of lower back pain (Arjmand, Shirazi-Adl, and Bazrgari 2006, Marras et al. 1993). Limited experience in patient handling skills, as well as poor posture while lifting objects weighing more than 10 kilograms, have been reported as major contributors to LBP among caregivers (Mundt et al. 1993, Videman et al. 1989a). Utilizing more spine flexion also increases compression, torsion, and shear forces on the lumbar spine (McGill 1997, Skotte et al. 2002, Bauer, Paulus, and Keller 2015), and therefore significantly increases the chance of developing herniated discs and/or other tissue damage to the structures of the spine (Marshall and McGill 2010, Hadjipavlou et al. 2008, Plouvier et al. 2008). A multi-disciplinary approach is essential for LBP treatment due to the multiple negative effects and the ineffectiveness of one technique (Koes et al. 2000). Conservative LBP treatment involves physical therapy, lifestyle changes, and medication. Exercise is recommended for increasing back strength, flexibility, range of motion, fitness, mood, and reducing depression. However, the wide range of interventions, co-interventions, incoherent recommendations, and lack of data on specific exercise types make clinical implementation challenging. The benefits and role of exercise remain undetermined. Specific exercise aspects like stretching or supervision reduce pain and enhance

Table 3: Comparison of the outcomes of paired t-test of VAS and ODI [Intra-group analysis].

Parameter	Pre-mean (SD)	Post-mean (SD)	Paired mean difference	P value
Physiotherapy Group				
VAS	4.93 ± 0.78	3.23 ±1.61	1.70	<0.001
ODI	29.50 ± 10.66	19.40±10.91	10.10	0.001
Control (Conventional treatment) Group				
VAS	4.73 ±0.78	4.50 ± 3.05	0.23	<0.001
ODI	27.00±15.53	25.67±10.91	1.33	0.719

function in non-specific chronic LBP. There is no evidence to support the idea that one form of exercise is more effective than another. Stabilization exercises can normalize functional and morphological trunk changes, protecting spinal joints from microtrauma and degenerative changes (Choi et al. 2010, Abdulla et al. 2015).

Hollowing and bracing exercises are stabilization exercises with contrasting results in studies. Richardson et al. found that hollowing exercises provided better stability (Hodges and Richardson 1996), while Grenier and McGill suggested bracing exercises had better effects (Grenier and McGill 2007). Allison et al. found significant differences in transverse abdominis muscle activation between hollowing and bracing groups (Allison, Godfrey, and Robinson 1998). Bjerkefors et al. found that stabilization exercises, including hollowing exercises, led to increased electromyography in the transverse abdominis (Bjerkefors et al. 2010). Urquhart et al. found that hollowing exercises improved mODI scores and stabilized the spine (Urquhart et al. 2005).

A study by (Sahin et al. 2011), stated that in both groups, post-therapy VAS scores were significantly lower compared to pre-therapy scores, and the differences were found to be significant between pre-treatment and at three months post-treatment ($p<0.05$) (Şahin, Karahan, and Albayrak 2018). Interestingly in this study, the VAS score significantly reduced in the physiotherapy group after 4th week. Studies using the VAS have shown that AHE, designed to strengthen deep abdominal muscles, can help monitor LBP in caregivers of SCI patients. These exercises reduce stress and core stability, indicating better pain management.

AHE exercises improve mODI scores in caregivers of SCI patients with LBP, reducing functional impairment. These exercises improve core stability, and alignment, and reduce low back stress, while also boosting functional abilities, pain relief, and posture. These exercises may also improve caregivers' overall health and quality of life. In terms of ODI score, the two groups were comparable at baseline. However, ODI scores showed significant improvement in the physiotherapy group in the 4th week of follow-up compared to the control group. Our study results are consistent with the reported outcome of a study conducted by Nilay sahin et al in Turkey. They reported that compared to baseline values a significant improvement was observed in ODI score at two weeks and three months of follow-up ($p<0.05$) (Sahin, Ugurlu, and Karahan 2011). However, Ayşe Nur Bardak reported that two groups (study and control) were compared in terms of ODI scores, and no significant difference between groups was observed (Bardak, Erhan, and Gündüz 2012). This difference could be attributed to a number of factors such as incorrect technique, structural issues, inadequate core strength, insufficient exercise duration, and poor posture. Consulting a physical therapist is essential to developing a comprehensive treatment plan that addresses these factors and determines the most suitable

interventions for effective LBP management. The SCI caregiver disability scale lacks data on travel and social activities, indicating that the ODI scale is insufficient for evaluating disability due to LBP in certain groups. More sensitive scales are needed for special groups.

5. Conclusions

We conclude that AHE is clinically effective in the management of LBP among caregivers of SCI patients and significantly better than conventional physical therapy. Therefore, core stability exercises should be incorporated into the treatment approach for LBP to achieve better improvement in pain and reduce disability due to LBP in caregivers of SCI patients.

Conflict of interest
The authors declare that they have no conflicts of interest to disclose.

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Study Approval
The review board of the Paraplegic Center Peshawar, Pakistan, approved this study.

Consent Forms
Each participant signed a consent form. These forms are available with the authors.

Authors Contributions
IUH was responsible for the conception, data analysis, addition of contents to the initial version, review & editing. SU and RU drafted the initial version & language editing. MI and IR reviewed and organized the article. NI and AS added ideas and contents to the first version and reviewed the final manuscript. All authors read and approved the final version.

Data Availability
All the data related to this manuscript is available with the authors.

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