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Comparison of the Effect of Pilates Exercises and Back Rehabilitation Protocol on Pain, Core Strength and Functional Status in Patients with Lumbar Disc Herniation

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Abstract:

- ***Aim***

To compare the effectiveness of Pilates exercises and Back rehabilitation protocol on pain, core strength and functional status in low back pain patients with lumbar disc herniation.

- ***Methodology***

Thirty-nine subjects were included in the study and allocated in two groups Pilates and Back rehabilitation group. They were given supervised intervention for 2 weeks followed by 2 weeks of home exercise program. Hot fomentation and ergonomic advice were given to patients in both the groups. Outcome measures used were Visual Analogue Scale, Pressure biofeedback unit and Oswestry disability index to assess pain, core strength, and disability respectively pre-treatment at week 0 and post 4-week intervention.

- ***Results***

Statistical analysis was done using SPSS version 24. There was a significant difference on an intra-group analysis in outcome measures in Pilates and Back rehabilitation group, however, a non-significant difference existed on an inter-group comparison between the two groups.

- ***Conclusion***

Both the intervention techniques that is Pilates exercises and Back rehabilitation protocol were equally effective in reducing pain, increasing core strength and reducing disability over a period of 4 weeks in low back pain patients with lumbar disc herniation.

Keywords- *Pilates Exercises, Back Rehabilitation, Low Back Pain, Lumbar Disc Herniation.*

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I. INTRODUCTION

Low back pain is one of the most common symptoms affecting almost 80% of individuals during their lifetime [1]. Advancing age, trauma, sudden jerk, postural faults, improper working habits like bending, lifting etc. are some factors affecting the spine mostly in young and middle-age. These spinal deviations occur because of the imbalance between the social demands and physical capabilities of the individual altering the lumbar spine and tissues surrounding it. Lumbar disc herniation being one of the most common problems occurring in adult population due to these increased demands [2]. Symptomatic lumbar disc herniation affects almost 1-2% of the general population [3].

During the initial course of disc herniation, there is a mild localized displacement of disc material beyond the normal margins of the intervertebral disc space resulting in back pain with or without unilateral or bilateral radicular leg pain, weakness or numbness in myotomal or dermatomal distribution [3]. It worsens posture with a loss in natural lumbar curvature along with reduced core muscle strength causing pain and disability which affects individual's daily activities. Therefore, a treatment method which focuses on all these clinical features would prove to be more effective for treatment of mild lumbar disc herniation apart from surgical interventions. Moreover, research has demonstrated that non-surgical methods for treating lumbar disc herniation were as effective as surgical interventions over the long term. Hence conservative treatment in the form of various physiotherapy interventions was recommended for those with lesser duration of onset of symptoms mostly less than 6 months [4].

In various studies, authors demonstrated reduced core muscle strength in low back pain patient and core stability exercises have proven to be more effective in decreasing their pain and improving physical function [5]. Core strengthening improves spinal stability and was found to be performance-enhancing program for various lumbar spine disorders [6]. Many studies have proved the effectiveness of lumbar stabilization exercises in reducing pain and improving the functional status of low back pain patients [7]

Pilates exercises are effective treatment method to recruit core muscles in patients with low back pain. It is a form of mind-body exercise focusing on controlled movement, posture, and breathing. It works on 6 principles: centering, concentration, control, precision, flow, and breathing. The principle of centering is based on the concept that all movements of the human body emanate from the centre or core of the body as per Joseph Pilates [6] and hence core strengthening is primary goal in Pilates. Various studies have shown its effectiveness for treating nonspecific low back pain where modification of exercises was done to adapt specific health conditions of the patients [8].

Therefore, the present study aimed at evaluating the effectiveness of Pilates Exercises in addition to moist heat and ergonomic advice on pain, core strength and functional disability in low back pain patients with lumbar disc herniation. This study hypothesized that Pilates exercises protocol is more beneficial than conventional Back rehabilitation protocol in the management of low back pain patients with lumbar disc herniation.

II. METHODOLOGY

This Experimental study was conducted in Outpatient department set up of tertiary care centers for 18 months duration after approval by the institutional ethical committee. Low back pain patients who were diagnosed with lumbar disc herniation by the spine consultants were included. A written informed consent including detailed explanation about the purpose and procedure of the study was taken from all the patients before beginning the intervention. Patient confidentiality was maintained. Out of 91 subjects (males and females) screened, 42 patients were included in the study depending on their fulfillment of the inclusion criteria mentioned below. Demographic data, medical history, and low back pain history were documented.

➢ *Inclusion Criteria:*

Diagnosed patients of lumbar disc herniation (Grade I and II) [9] Christian W and Boos N 2004, confirmed on MRI scan of both gender between the age group of 20-55 years (38.89 +/- 6.14 for pilates group and 32.95 +/- 6.81 for back rehabilitation group); symptomatically in sub-acute or chronic stage (4 weeks – 6 months)[10] of low back pain with or without lower limb radiation and pain intensity level on visual analogue scale between 3-7/10 [2,4]

➢ *Exclusion Criteria:*

Patients with Sequestered disc, Spinal cord injury-fracture or instability; Infection, Space occupying lesions (SOL) or Systemic diseases like Rheumatoid arthritis, Progressive neurological disorder; those having a history of spinal surgery or pain block were excluded from the study.

- *Patient Allocation*

Patients included in the study were divided into two groups - Group A and Group B by simple random sampling.

- *Outcome Measures*

The outcome measures used were Visual Analogue Scale [11] for pain intensity, Pressure biofeedback unit (Chittanooga) [12] for core strength and Oswestry disability index [13] for low back function. Assessment of outcome measures was done prior at week 0 and after 4 weeks of intervention.

➢ *Intervention*

Patients in Group A were treated with Pilates exercises and patients in Group B were treated with Conventional Back rehabilitation protocol. Patients in both the groups were given hydro collator packs for 10-15 min prior to each exercise session [14, 15]

➢ *Group A: Pilates Exercises.*

All the patients in this group were treated with modified Pilates exercises. The first session involved teaching basic principles of Pilates exercise [16]. Protocol included attaining neutral spine position, learning breathing control and

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recruiting core muscles during all exercises. Modified Pilates exercise program given to patients included Hundreds (patient specific), Shoulder bridge, Double arm stretch and Single leg circles in the first week and progressed with Side kick, Single leg kick and Swimming exercises in the second week along with exercises taught in the first week [17,18]. Repetitions given were specific to the individual as per effective performance of the exercise considering principles of pilates but a maximum of 10 repetitions was given for each exercise.

- *Group B: Back Rehabilitation Protocol*

Patients were given traditional core strengthening exercises along with low back and hip muscles strengthening exercises. Exercises given were Core activation, Pelvic tilts, Bridging with a neutral spine, Prone on the elbow in the first week and progressed with Core with straight leg lift, Prone leg lift and Alternate hand and leg extension in prone in the second week along with exercises taught in the first week [19].10 repetitions were given for each exercise.

Both exercise protocols were done for 5 days/week for 30- 45 min under supervision for two weeks [18]. From third week onwards, patients were advised to perform exercises from their respective protocol as a home exercise program for next two weeks. Total intervention period being 4 weeks [20]. Postural education and ergonomic advice were given to patients in both the groups prior to every intervention [21]. Reassessment of the outcome scores was done after 4 weeks of intervention.

III. RESULTS - STATISTICAL ANALYSIS

The data was analyzed using Statistical Package for Social Sciences (SPSS) version 24. For Parametric data, within group analysis for core strength was done using paired T-test and between two groups (A and B) was done using unpaired T test. For nonparametric data, within group analysis for visual analogue scale and functional disability was done using the Wilcoxons signed rank test and between both groups (A and B) was done using Mann-Whitney U-test.

The level of significance was set at $p \leq 0.05$.

Statistical analysis was done on 37 patients (18 in Pilates group and 19 in Back rehabilitation group) who completed the study out of 42 included patients.

TABLES

Table 1- Demographic Characteristics:

Sr. No	Demographic data	Pilates Group (n=18) Mean +/-SD	Back Rehabilitation Protocol Group (n= 19) Mean +/- SD	P value
1	Age (years)	38.89 +/- 6.14	32.95 +/- 6.81	0.84
2	B.M.I (kg/m^2)	27.04 +/- 3.74	27.60 +/- 2.10	0.13
3	Duration of symptoms(months)	3.5 +/- 1.53	3.89 +/- 1.72	0.44

Table 2- Baseline Parameters

Baseline values	Pilates Group (Mean +/- SD)	Back Rehabilitation Protocol Group (Mean +/- SD)	P value
Pain	5.64 +/- 0.63	5.33 +/- 0.859	0.19
Core strength	67.44 +/- 1.14	68 +/- 1.15	0.15
ODI score	15.5 +/- 4.79	14.42 +/- 5.89	0.46

According to table 1 and 2, P value for demographic data and for baseline outcome parameters between the two groups was found to be non-significant (>0.05) indicating baseline matching.

Table 3 – Within Group Analysis of Pain, Core Strength and ODI Score in Pilates Group.

Outcome measure	Pre Rx (Mean +/- SD)	Post Rx (Mean +/- SD)	P value
Pain	5.64 +/- 0.63	2.46 +/- 0.82	0.00*
Core strength	67.44 +/- 1.14	65 +/- 1.41	0.00*
ODI score	15.5 +/- 4.79	8.94 +/- 3.55	0.00*

Table 4 – Within Group Analysis of Pain, Core Strength and ODI Score in Back Rehabilitation Protocol Group

Outcome measure	Pre Rx (Mean +/- SD)	Post Rx (Mean +/- SD)	P value
Pain	5.33 +/- 0.85	2.37 +/- 0.76	0.00*
Core strength	68 +/- 1.15	66.10 +/- 1.04	0.00*
ODI score	14.42 +/- 5.89	7.73 +/- 2.68	0.00*

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Table 3 and table 4 suggests that pre and post treatment p value for Pain, Core strength and Oswestry disability index was found to be significant (<0.05) within Pilates group and Back Rehabilitation group.

Table 5 – Between Two Group Analysis of Pain, Core Strength and ODI Score (Post Treatment)

Outcome measure	Pilates group (post treatment) (Mean +/- SD)	Back Rehab group (post treatment) (Mean +/- SD)	P value
Pain	2.46 +/- 0.82	2.37 +/- 0.76	0.39
Core strength	65 +/- 1.41	66.10 +/- 1.04	0.16
ODI score	8.94 +/- 3.55	7.73 +/- 2.68	0.96

Above table suggests that p value for pain, core strength and ODI score within both the groups was found to be non-significant (<0.05) indicating that there was no significant difference between the outcome measures of both the treatment protocols.

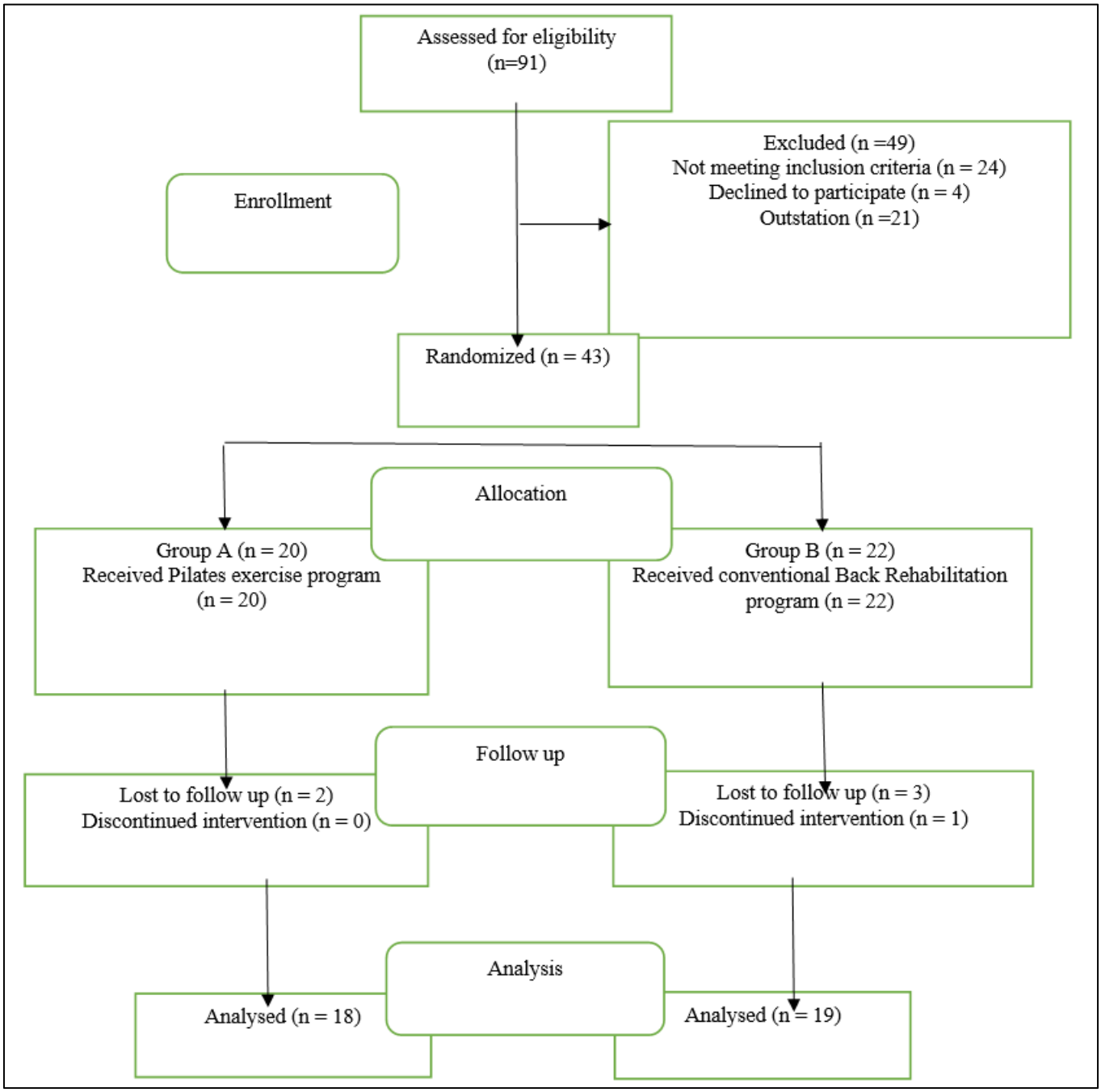

Fig 1 Project Flow Chart (As Per Consort Guidelines)

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IV. DISCUSSION

This experimental study was performed to compare the effects of Pilates exercises and routine Back rehabilitation protocol on pain, core strength and functional disability in low back pain patients with lumbar disc herniation. Subject matching was done based on age, BMI, duration of symptoms and all outcome parameters at baseline in between two groups for 37 patients who completed the study out of 42 recruited. There were total 5 drop outs in the study.

Results of the present study demonstrated a significant improvement in all the three outcome measures in low back pain patients with lumbar disc herniation treated with two different treatment protocols post 4 weeks of intervention. On intergroup comparison, a non-significant difference was observed in terms of all the outcome parameters suggesting their equal effectiveness in low back pain patients with lumbar disc herniation.

- *Intra-Group Comparison- Pilates Protocol:*

One group of the study population was treated with modified Pilates exercises along with moist heat and ergonomic advice. Our statistical analysis revealed that 4 weeks of Pilates exercise protocol was effective in reducing pain by 56% and functional disability by 43% in these patients. This statistical difference in pain and disability can be considered as a significant change as shown by Smeets (2011) [22] and Hawker (2011) [23] where 30% change in disability and 1.1 to 1.9(10%) cm change in VAS respectively was concluded to be minimal detectable change.

Findings of the study were also supported by RCT carried out by Miyamoto et al (2013) [17] where modified pilates exercises with educational booklet exhibited significant improvement in pain and disability post 6 weeks of intervention. Similar results were found by Bryan and Hawson (2003) with respect to pain reduction on VAS and functional improvement on ODI [24]. In another RCT by Da Luz et al (2013) on chronic nonspecific low back pain, equipment based pilates exercises were found to be more effective than mat Pilates exercises at 6 weeks and at six months follow-up in improving functional disability and reducing kinesiophobia but not with respect to pain intensity and global perceived effects [25].

Like pain and disability, the third outcome measure core muscle strength also showed a significant improvement post 4 weeks (p-value < 0.05). Critchley et al (2011) and Sekendiz et al (2007) also documented positive effects of Pilates on increasing transversus abdominis activity, back extensor muscle strength, endurance, and posterior trunk flexibility [26,27].

Therefore present findings of the study justified the role of Pilates protocol in neutralizing the spine. It changes the pelvis and lumbar spine posture, transforming the hypolordotic curve to a normal lordotic curve enhancing effective functioning of lumbopelvic rhythm. Pilates also initiates lumbar extension along with strengthening major core muscles- abdominals, spinal extensors, hip flexors, and hip extensors. This must have reduced the intradiscal pressure altering annulus fibrosus structure, pushing nucleous anteriorly reducing pain and disability in patients of this group [28, 7]. Pilates also focusses on coordinating breathing pattern with core activation. Deep inhalation drops the diaphragm down causing more rush of air in lungs increasing pneumatic pressure within the thoracic cavity activating deep muscles enhancing core stability after 4 weeks of Pilates training [7]

- *Intragroup Comparison- Back Rehabilitation Protocol:*

Other group was treated with Back Rehabilitation Protocol including core stabilization exercises along with hot fomentation and ergonomic advice for 4 weeks. Pain and functional disability showed significant difference in this group as well. There was 55% improvement in pain whereas disability showed 40% improvement post intervention which is a clinically significant detectable difference as shown by Smeets and Hawker in their studies [22, 23]. Kaul et al (2007) obtained similar results with respect to pain and disability on comparing extension exercises with core stabilization exercises in chronic disc prolapse in farmers post 4-week intervention [19]. Bakhtiary et al and Goldby et al (2005-2006) in their studies also concluded spinal stabilization to have beneficial effect in reducing pain and disability [7, 29].

Core strength was the third outcome measure which showed statistically significant difference on intra-group comparison post 4 weeks in group B. Akuthota and Nadler (2004) in a review article concluded core strengthening to be a performance enhancing program for various lumbar spine and musculoskeletal injuries apart from its preventive role [30]. Richardson et al studied muscle pattern of Transversus Abdominus (TrA) contraction independently and in combination with other abdominal muscle [31]. He concluded independent TrA contraction to be useful in treatment of low back pain patients supporting findings of present study. Hodges et al found that delayed TA contraction was considered to be a motor control deficit resulting in inefficient muscular spinal stabilization, concluding core activation and strengthening to be an important part of lumbopelvic stability in low back pain rehabilitation [32].

Core stabilization exercises given in back rehabilitation protocol targeted the same group of muscles for core strengthening as in Pilates protocol with mechanism of work however principles of Pilates and the concept of breathing control was absent. It works towards optimizing the function of three subsystems (muscles, ligaments, neural structures) of core to control the position and motion of trunk over pelvis and leg to allow for proper production and transfer of forces to terminal segment in integrated kinetic chain activities. Thus back rehabilitation protocol helped to reduce pain, increase core strength and reduce functional disability [33].

- *Inter Group Comparision:*

The main objective of this study was to compare effectiveness of both protocols in treatment of low back pain patients with lumbar disc herniation where no significant difference was observed in all three outcome parameters suggesting similar effectiveness.

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Firstly, patients in both groups were given hot fomentation prior to each exercise session. Superficial heating brings about an elevation in the temperature, increase in soft tissue flexibility, and better contraction of smooth muscles improving motor function of muscles inhibiting pain signals. Simon et al. in a review have mentioned moderate evidence of heat in reducing pain and disability in low back pain patients having symptoms for up to 3 months [34].

Secondly, exercises included in both the protocols were designed to initiate spinal extension along with core activation. Hahne(2006) in a case study on a 26-year-old female child worker having chronic lumbar disc extrusion with radiculopathy obtained functional restoration of disc extrusion on MRI did post 9-week intervention proving effectiveness of extension exercises in patients with prolapsed disc [35].

Thirdly ergonomic advice was given to all the patients of both the groups. Veres et al (2010) reported activities like flexion, flexion-rotation, heavy weight lifting, unsupported sitting etc. to increase intradiscal pressure stressing annular fibers causing disc protrusion [36]. Avoiding these activities also have potential benefits and prevent further worsening of the condition. Parekh (2014) also documented effectiveness of ergonomic intervention along with physical therapy to cause greater improvement in pain and functional performance in farmers with chronic low back pain [21].

In a systemic review with meta-analysis Pereira et al (2012) demonstrated significant intra-group analysis but non-significant inter-group analysis on comparison of Pilates exercises with no treatment or lumbar stabilization exercise program on pain and functionality in chronic nonspecific low back pain [37]. Marcelo et al (2014) in another systemic review concluded that Pilates had similar effects like traditional exercises with better strengthening of TA muscle [38]. Lim et al (2011) concluded in a systemic review that Pilates exercises are no more effective than minimal intervention or other exercise interventions to reduce disability related to chronic low back pain [20].Also after 2 weeks of supervised training, 2 weeks of unsupervised exercises was given which could have cause similar effectiveness if not better results with pilates than Back rehabilitation protocol. If supervised intervention was continued for all four week, pilates could have had better results post intervention.

The limitation of the study however was that 2 weeks of supervised intervention was given followed by 2 weeks of unsupervised intervention; Effects of medications were not considered which could have altered the outcomes of our study; Treatment protocols were rigid and patient specific alterations were not done within 4 weeks of intervention; Occupational differences were not considered.

V. CONCLUSION

Pilates exercises and Back rehabilitation protocol were equally effective in reducing pain, increasing core strength and improving functional status at 4 weeks in patients with lumbar disc herniation. Thus we recommend implementation of Pilates exercise protocol safely in patients with grade 1 and 2 lumbar disc herniation as an alternative to routine Back rehabilitation protocol.

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