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LONG-TERM EFFECT OF STRENGTHENING EXERCISE VERSUS STRETCHING EXERCISE COMBINED WITH SHOCK WAVE THERAPY ON PAIN AND DISABILITY IN PATIENTS WITH CERVICAL RADICULOPATHY: A 12-MONTH FOLLOW-UP RANDOMIZED CONTROLLED TRIAL

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KEYWORDS

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Abstract

Background: Cervical radiculopathy (CR) is diagnostically distinct from non-specific mechanical neck pain, has a dual mechanical-chemical physiopathology, and a natural history that is longer and more prone to recurrence than commonly assumed. No previous trial had directly compared strengthening versus stretching exercise with a constant background of extracorporeal shock wave therapy (ESWT) in a diagnostically confirmed population of radicular patients over a clinically relevant time period.

Objective: To compare the long-term effect of strengthening exercise compared to stretching exercise and both in combination with ESWT for reducing pain intensity and disability in patients with cervical radiculopathy over 12 months.

Methods: A Prospective, randomized, parallel group, assessor-blinded, two arm RCT was conducted in the Department of Physiotherapy with the Department of Orthopaedics teaching hospital at Malwanchal University, Indore. Two hundred patients aged 25–55 years with physician-diagnosed cervical radiculopathy were randomly assigned to Group A (strengthening + ESWT, n=100) and Group B (stretching + ESWT, n=100) with equal ESWT protocol and exercise dosage for 8 weeks supervised phase.

Outcome measures: Numeric Pain Rating Scale (NPRS) and Neck Disability Index (NDI) recorded at baseline, at end of intervention and at 3, 6, and 12 months.

Results: There were no significant differences between the groups at baseline. Mean NPRS at 12 months was 1.39 ± 0.6 in Group A versus 5.1 ± 0.79 in Group B ($p<0.001$). Mean NDI at 12 months was 12.13 ± 3.7% versus 42.97 ± 5.2% ($p<0.001$). Group A continued to improve over time, while Group B improved during active treatment, but regressed to near-baseline values over time.

Conclusion: Strengthening exercise combined with ESWT produces significantly better and more durable pain and disability outcomes than stretching exercise combined with ESWT over 12 months in cervical radiculopathy.

1. INTRODUCTION

1.1 Anatomy, Biomechanics, and Pathophysiology

The cervical spine allows multiplanar movement while protecting the space for the nerve roots to exit through the narrow intervertebral foramina[1]. These foramina which have the uncovertebral and facet joints are narrow enough that modest degenerative change can comprise the space available to the exiting nerve root[1,2]. Which give rise to the classic dermatomal and myotomal patterns of clinical diagnosis; most cervical radiculopathy (CR) presentations occur at the C6 and C7 segments, due to the mechanical stresses of activity on these lower levels of the cervical spine.[2]

CR produces dermatomal pain, paraesthesias, and loss of deep tendon reflexes, which are all different from those found in simple mechanical neck pain.[2] It arises through two pathways: a mechanical pathway which happens when disc material, osteophyte or hypertrophied joint compresses the nerve root and a chemical pathway which occurs when substances released from the degenerating disc (TNF-α, IL-6 and matrix metalloproteinases) trigger local inflammation independent of mechanical compression.[2] Mechanical decompression alone may not be enough to resolve radicular symptoms if there is also a chemical component, and there is no direct relationship between reported and radiological severity.[3] The present trial design uses exercise-based loading normalisation combined with ESWT is largely local biological and neurochemical rather than decompressive – is positioned to address both components simultaneously.

1.2 Epidemiology and Diagnosis

The incidence rate of CR has been estimated at 0.8-1.79 cases per 1000 person years, and prevalence at 1.21-5.8 per 1000,variation likely reflecting differing diagnostic criteria.[4] A systematic review reported that the burden of CR on mental health and functioning is relatively under-characterised when compared with non-specific neck pain.[4] Diagnosis is made by history combined with provocative testing; the sensitivity and specificity of the Spurling test varies between 0.38–0.97 and 0.89-1.00 respectively, across studies, and it is

important to note that none of these tests is individually diagnostic, but a consistent history and positive Spurling test plus additional provocative tests significantly increases diagnostic confidence.[5]

This directly informed the present trial's diagnostic protocol — a cluster of provocative tests plus mandatory physician confirmation — since provocative testing alone risks misclassifying peripheral nerve pathology (posterior interosseous nerve syndrome, carpal tunnel syndrome, both of which can mimic C6/C7 radiculopathy) as CR.[3]

1.3 Natural History and Conservative Management

In a prospective cohort study of conservatively managed CR, symptom resolution was around 55% at 6 and 12 months, and a longer symptom duration and higher baseline level of disability were associated with a poorer outcome; the majority of symptom resolution occurred in the first 6 months, with a large number of subjects remaining symptomatic at 12 months.[6] This direct motivate the present trial's 12-month follow-up and explicit recurrence outcome as the time frame could be so brief that patients would be considered "recovered" when they are continuing along a slow trajectory or could be at risk of recurrence. Conservative management is the first line of management; surgery should be reserved for progressive neurological deficit or an failed conservative trial.[1] A systematic review of manual therapy trials supported intervention benefits in all included trials regardless of technique, but heterogeneity of diagnostic criteria limited pooled conclusion[7] - further supporting the need for the explicit diagnostic criteria used here.

1.4 Risk Factors and Psychosocial Burden

Sustained forward head posture from prolonged device use is significantly associated with neck pain severity[8], in a dose-dependent manner, and occupational exposure (ie, >6 hours per day of computer use, fear of avoidance beliefs, and lack of cervical flexion) is independently associated with neck pain among office workers[9], both of which are applicable to the present trial's 25-55 year old, mostly occupationally exposed, sample. Kinesiophobia, or fear of movement, is consistently associated with greater pain, disability, and reduced quality of life in chronic musculoskeletal pain and exercise is one of the most evidence-based treatments for kinesiophobia.[10] Due to the lack of formal measurement of

kinesiophobia at baseline, between-group differences should be interpreted with the assumption that differential engagement with the assigned exercise type could also account for outcomes, in addition to the described mechanisms of neuromuscular and tissue-extensibility.

1.5 Strengthening Exercise in Cervical Radiculopathy

In a meta-analysis of 10 RCTs, and 871 CR participants, a significant reduction in pain was observed with exercise alone or in combination with conventional treatment, but the specific type or dose of exercise could not be determined to be the most effective.[11] Strengthening exercises for deep cervical flexors, extensors and scapular stabilisers are used as the focus of strengthening, incorporating a systematic review that showed only deep cervical flexor (DCF) training reliably was shown to alter cervical neuromuscular activation compared to other exercises.[12] Evidence also indicates that strengthening of deep (rather than superficial) flexors is the more clinically responsive strengthening target.[13]

A trial of 32 confirmed CR patients found structured stabilisation training produced greater postural-alignment and grip-strength gains than unsupervised home exercise,[14] though its comparator was not mechanistically distinct and its 3-month follow-up too short to reveal durability — the specific gap the present trial addresses. DCF training elsewhere produced greater pressure-pain-threshold and disability gains than superficial training,[15] benefited an occupational teacher population,[16] and produced gains sustained at 3-month follow-up in chronic mechanical neck pain.[17] A dose-response meta-regression found more frequent, longer sessions produce correspondingly larger effects for resistance exercise in chronic neck pain,[18] directly informing this trial's full eight-week, high-frequency strengthening dosage.

1.6 Rationale

Cervical radiculopathy is diagnostically distinct from non-specific neck pain, its natural history is longer and more likely to relapse than is often believed, the evidence to support the effectiveness of any specific exercise program is underdeveloped, and diagnostic rigor at enrolment is a substantive rather than peripheral determinant of trial validity. No previous trial had directly compare strengthening with stretching as primary interventions, while keeping ESWT constant across arms, and to follow

participants for up to 1 year with a pre-specified outcome of recurrence in a diagnostically confirmed sample of people with radicular symptoms. This paper presents the results of the pain (NPRS) and disability (NDI) measures from a trial designed to address this gap.

Aim and objectives. To compare the long-term effects of strengthening exercise versus stretching exercise both combined with ESWT on pain intensity and disability in patients with cervical radiculopathy over 12 months.

2. MATERIAL AND METHOD

Research Design: Prospective, randomized, parallel-group, assessor-blinded, two-arm RCT.

Study Setting: Department of Physiotherapy, in collaboration with the Department of Orthopaedics, teaching hospital attached to Malwanchal University, Indore.

Study Population: Male and female patients aged 25-55 years who had neck pain with radiating arm pain that fulfilled diagnostic criteria for CR, and were identified as having a positive combination of provocation tests (Spurling's, upper limb tension, cervical distraction) and independent confirmation by physician/orthopaedician.

Sample Size: Sample size was calculated using Cohen's d ($d \approx 0.42$, $\alpha = 0.05$ two-tailed, power = 0.80): $n = 2 \times [(1.96 + 0.84) / 0.42]^2 = 88.9 \approx 89$ per group. Allowing for 10% anticipated attrition ($89 / 0.90 = 98.9$), the sample was rounded up to 100 per group ($N = 200$).

Sampling Technique: Purposive (consecutive) sampling, followed computer-generated block randomization with

randomly varying block size and allocation concealment using sequentially numbered, opaque and sealed envelopes (SNOSE).

SELECTION CRITERIA.

Inclusion criteria:

- Age 25–55 years, both sexes
- Clinical diagnosis of CR with positive Spurling's, cervical distraction, and upper limb tension tests, dermatomal radicular pain, confirmed by physician/orthopaedician
- Symptom duration ≥4 weeks
- Baseline NPRS ≥4/10
- Informed consent and willingness to complete full 12 month follow-up

Exclusion criteria:

- Progressive neurological deficit or cervical myelopathy that requires surgery
- Previous spinal surgery in the cervical region
- Fracture, tumour, infection or inflammatory arthropathy.
- Bleeding disorders or pacemakers, or other contraindications to ESWT
- Pregnancy
- Uncontrolled systemic disease precluding exercise

Reliability and Pilot. In neck-pain population, NPRS and NDI have been found reliable and have established the MCID thresholds[19] however, in a pilot of 20 participants (10 each), these were not included in final analysis, the feasibility of recruitment, tolerability of the protocol and clarity of the form were assessed.

Ethics. Clearance from the Institutional Ethics Committee of Malwanchal University; CTRI registration; performed according to the Declaration of Helsinki.

PROCEDURE.

Common adjunct — ESWT (both groups): Applied to paracervical musculature and myofascial trigger points once weekly for 6 weeks, (0.10-0.25 mJ/mm2, 1,500-2,000 impulses/session)

Group A (n=100): Strengthening (8 weeks, 3 sessions/week): Phase 1 (Weeks 1-2): biofeedback-guided craniocervical flexion isometrics, isometric extensor/rotator holds, scapular retraction. Phase 2 (Weeks 3 to 5): Theraband resisted strengthening in multiplanar, isotonic strengthening of trapezius, levator scapulae and rhomboid.

Phase 3 (Weeks 6-8): Dynamic resisted functional range exercise, task specific loading, moving to independent exercise management.

Group B (n=100) — Stretching (8 weeks, 3 sessions/week): Phase 1: Static stretching of upper trapezius, levator scapulae, SCM, scalenes and active-assisted AROM. Phase 2: Pectoral /thoracic stretching, self administered traction, diaphragmatic-breathing-assisted stretches. Phase 3: full active AROM all planes, stretch, hold/relax, transition to independent management.

Outcome Measures. (a) NPRS — an 11-point self-report scale (0–10). (b) NDI — a 10-item questionnaire (0-5 points each, total expressed as percentage). Both measured at baseline, at week 8, 3, 6 and 12 months.

Statistical Analysis. Data analyses were done using SPSS v26.0 or above. Normality was assessed using the Shapiro–Wilk test. The within-group change was analyzed using repeated-measures ANOVA or Friedman test, depending on the distribution, and the between-group change was analyzed using the independent-samples t-test. The level of statistical significance was defined as $p<0.05$ (two-tailed).

3. DATA ANALYSIS AND RESULTS

All 200 randomised participants completed 12-month follow-up with no loss to follow-up.

TABLE 1. Group-wise Distribution of Participants

Group	Intervention	n	%	Female n (%)	Male n (%)
A	Strengthening + ESWT	100	50.0%	33 (33.0%)	67 (67.0%)
B	Stretching + ESWT	100	50.0%	31 (31.0%)	69 (69.0%)

Total	—	200	100%	64 (32.0%)	136 (68.0%)

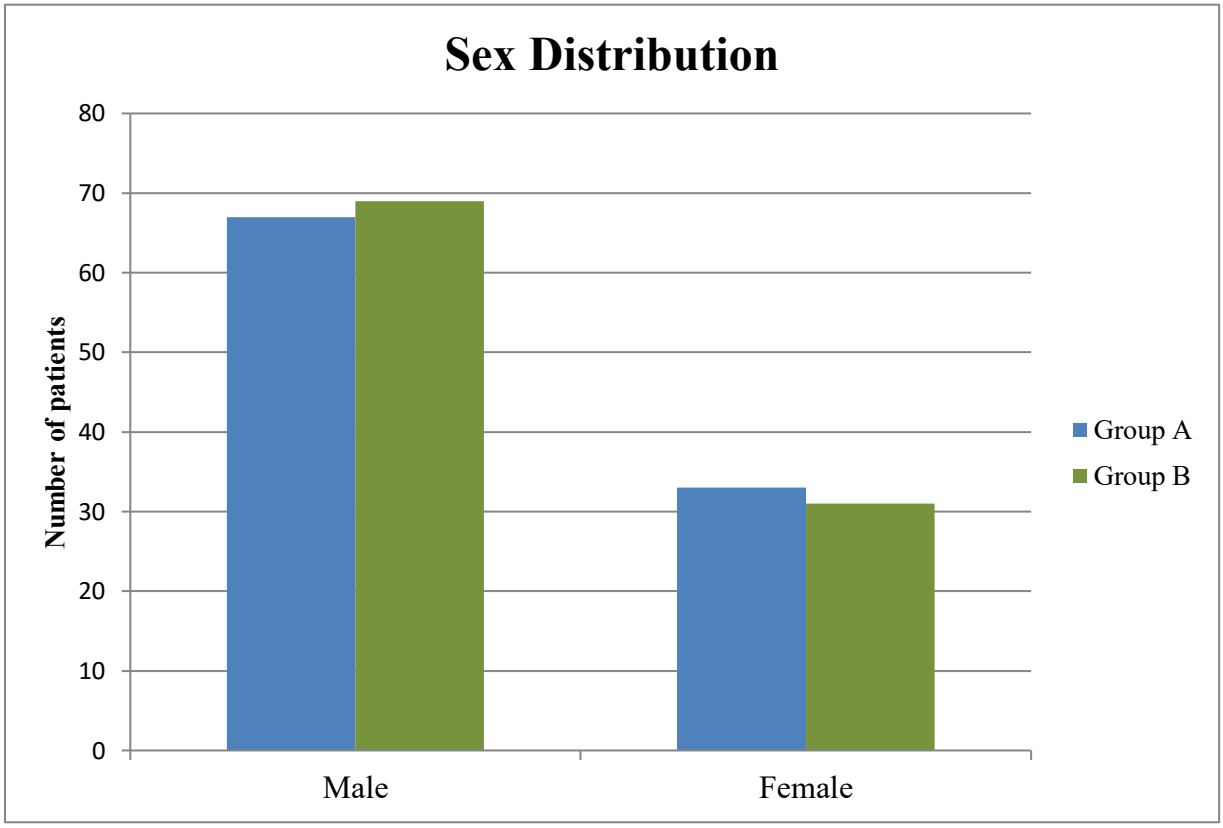


Figure 1 — Group-wise Sex Distribution of Participants

TABLE 2. Demographic Characteristics of the Study Population

Variable	Group A (n=100)	Group B (n=100)	Total (n=200)	p-value	Interpretation
Age — Mean ± SD (years)	39.58 ± 9.7	39.6 ± 9.39	39.6 ± 9.5	0.976	Not significant
Symptom duration — Mean ± SD (weeks)	30.76 ± 13.20	31.46 ± 13.8	31.11 ± 13.50	0.715	Not significant

Male — n (%)	67 (67.0%)	69 (69.0%)	136 (68.0%)	0.880	Not significant
Female — n (%)	33 (33.0%)	31 (31.0%)	64 (32.0%)	0.880	Not significant

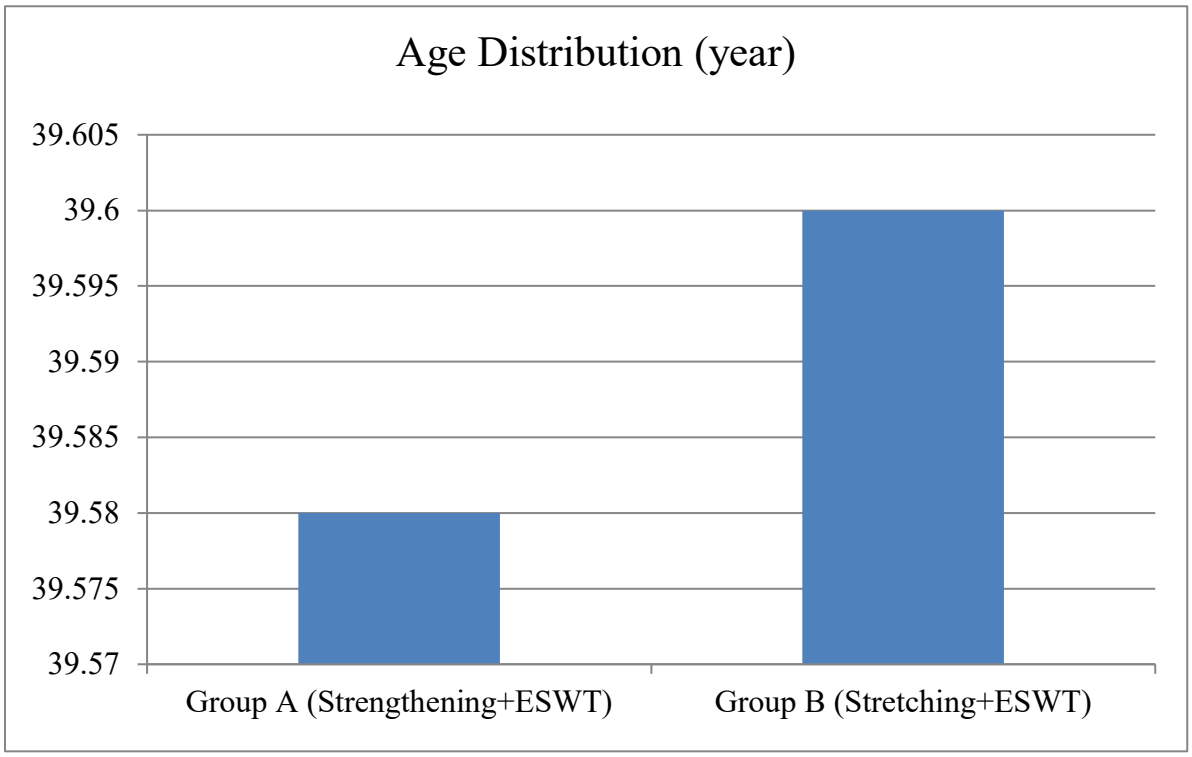


Figure 2 — Group-wise Age Distribution of Participants

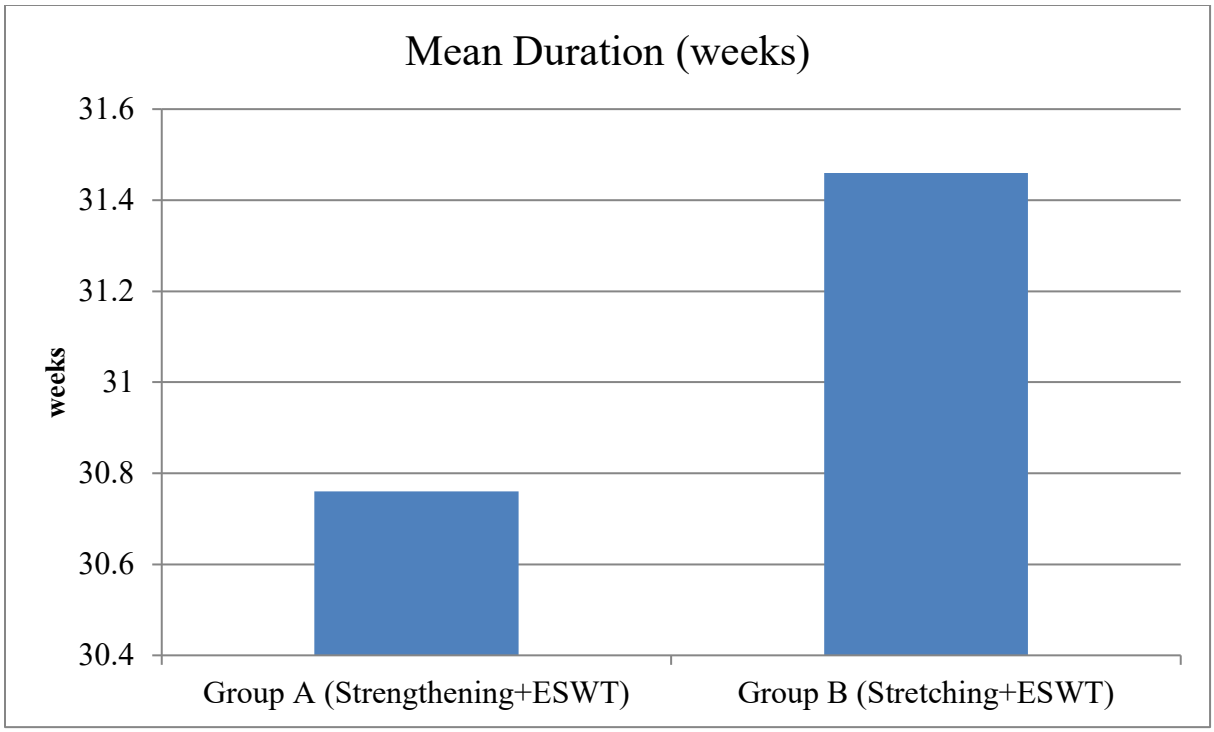


Figure 3 — Group-wise Mean duration of Participant

TABLE 2.1. Clinical Characteristics by Group

Variable	Group A	Group B	Chi-square, p
Affected side — Right	63	69	0.455, NS
Affected side — Left	37	31	
Disc level — C5–C6	51	51	0.831, NS
Disc level — C6–C7	28	25	
Disc level — C7–T1	21	24	

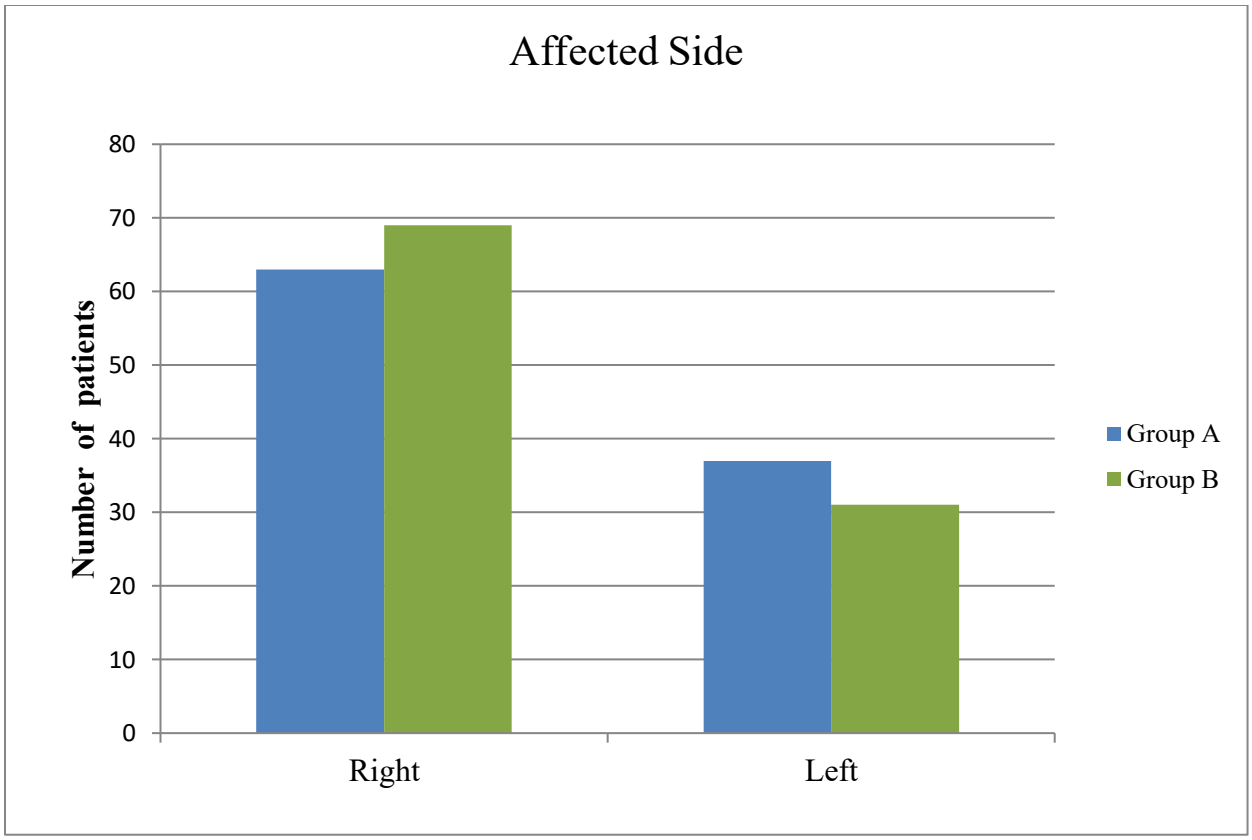


Figure 4 – Affected side distribution by side

TABLE 2.2. Age Distribution by Group

Age Band	Group A n (%)	Group B n (%)	Total n (%)
25–34 years	39 (39.0%)	37 (37.0%)	76 (38.0%)
35–44 years	24 (24.0%)	28 (28.0%)	52 (26.0%)
45–49 years	14 (14.0%)	15 (15.0%)	29 (14.5%)
50–55 years	23 (23.0%)	20 (20.0%)	43 (21.5%)
Total	**100 (100.0%)**	**100 (100.0%)**	**200 (100.0%)**

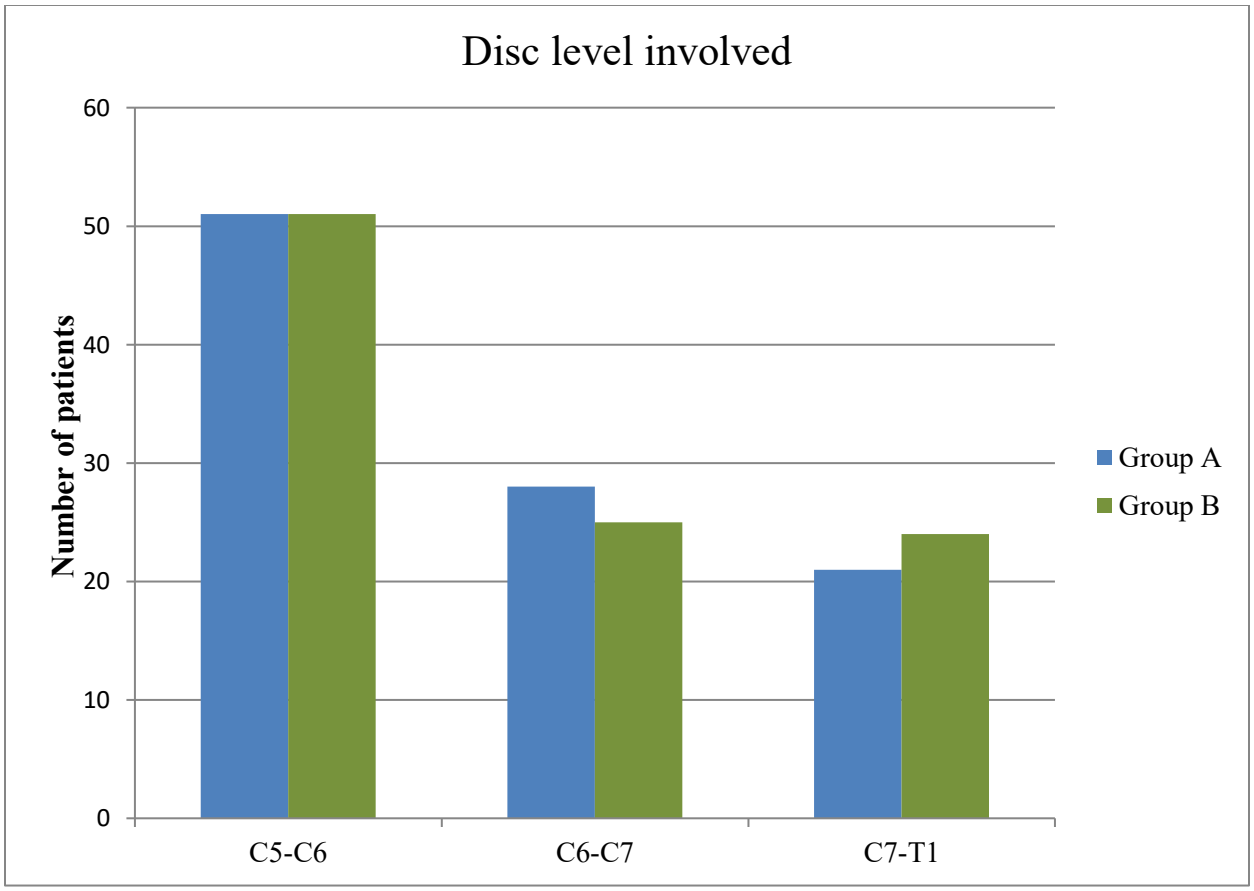


Figure 5 – Disc level involved distribution

TABLE 2.3. Baseline Outcome Scores — Between-Group Comparison

Outcome	Group A (Mean ± SD)	Group B (Mean ± SD)	t-test p-value	Inference
NPRS (0–10)	6.3 ± 0.96	6.1 ± 0.96	0.162	NS
NDI (0–100%)	46.2 ± 6.3	45.7 ± 7.15	0.557	NS
PSFS (0–10)	3.18 ± 0.86	3.2 ± 0.61	0.776	NS

ROM Flexion (°)	27.9 ± 4.1	27.6 ± 4.38	0.631	NS
ROM Extension (°)	31.5 ± 5.16	32.3 ± 4.97	0.254	NS
ROM Lateral Flexion – L (°)	22.15 ± 3.79	21.5 ± 4.59	0.291	NS
ROM Lateral Flexion – R (°)	22.2 ± 4.09	22.2 ± 3.99	1.00000	NS
ROM Rotation – L (°)	48.2 ± 6.08	48.3 ± 5.08	0.949	NS
ROM Rotation – R (°)	48.0 ± 6.20	47.9 ± 5.59	0.942	NS

TABLE 3. NPRS Mean ± SD at All Time Points and Between-Group Comparison

Time Point	Group A (n=100)	Group B (n=100)	p-value	Interpretation
Baseline	6.3 ± 0.96	6.12 ± 0.96	0.169	Not significant
Post-8Wk	3.06 ± 0.75	3.93 ± 0.7	<0.001	Significant, favours Group A
3-Month	2.35 ± 0.66	4.47 ± 0.78	<0.001	Significant, favours Group A
6-Month	1.87 ± 0.6	4.75 ± 0.79	<0.001	Significant, favours Group A

12-Month	1.39 ± 0.6	5.1 ± 0.79	<0.001	Significant, favours Group A

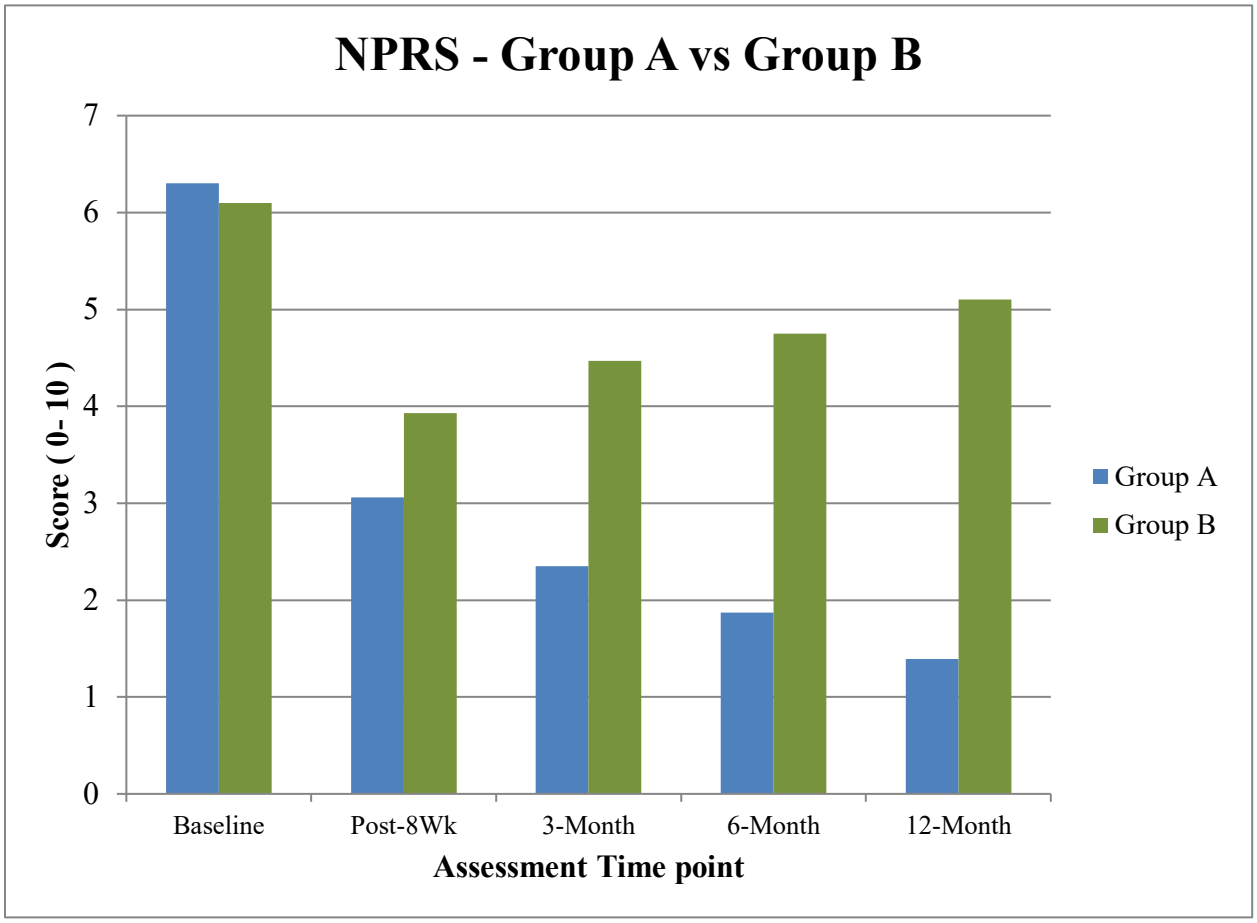


Figure 6 - NPRS Mean Trend Across Five Time Points (Group A vs. Group B)

TABLE 3.1. NPRS Category Distribution — Baseline vs. 12-Month Follow-Up

NPRS Category	Group A Baseline	Group A 12-Month	Group B Baseline	Group B 12-Month
No pain (0)	0 (0.0%)	3 (3.0%)	0 (0.0%)	0 (0.0%)
Mild (1–3)	0 (0.0%)	97 (97.0%)	0 (0.0%)	7 (7.0%)

Moderate (4–6)	75 (75.0%)	0 (0.0%)	80 (80.0%)	92 (92.0%)
Severe (7–10)	25 (25.0%)	0 (0.0%)	20 (20.0%)	1 (1.0%)

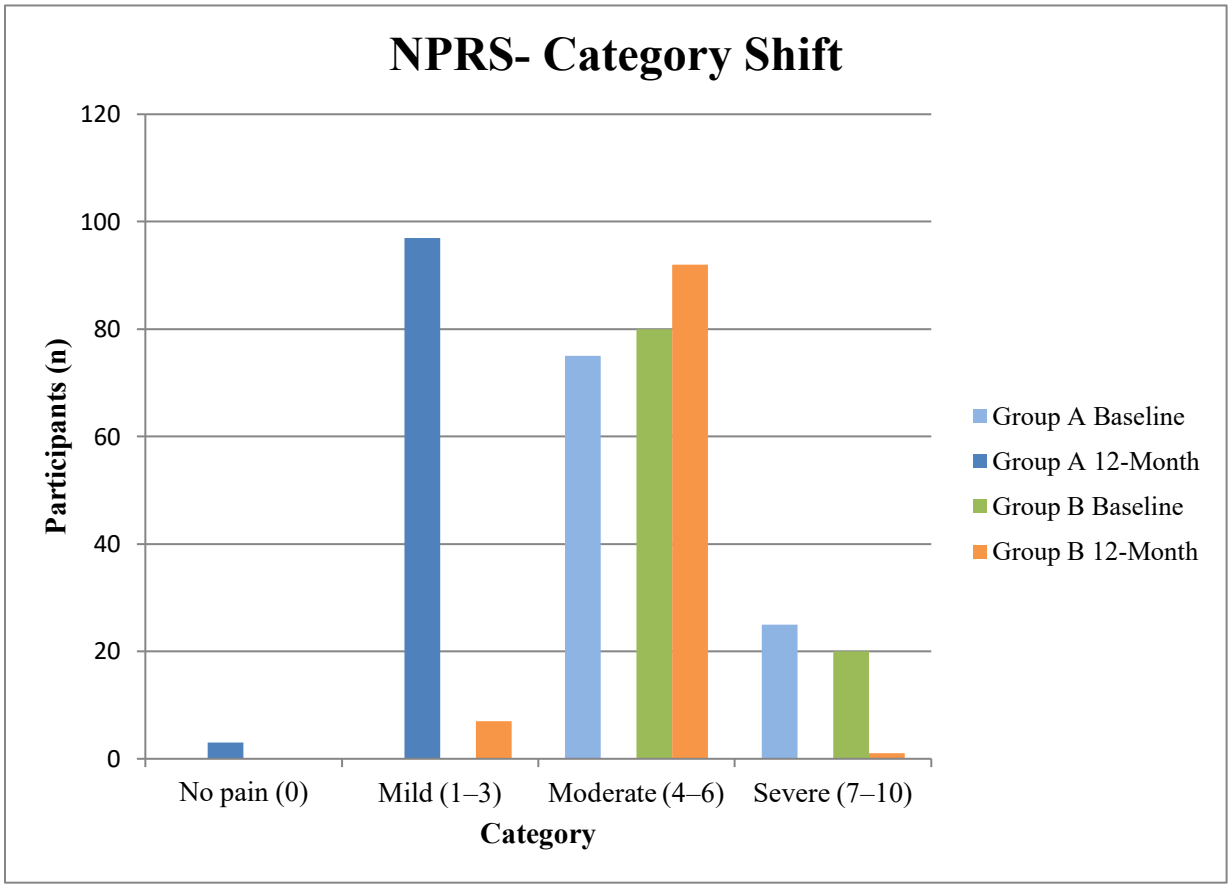


Figure 7 - NPRS Category Distribution — Baseline vs. 12-Month

TABLE 4. NDI Mean ± SD at All Time Points and Between-Group Comparison

Time Point	Group A (n=100)	Group B (n=100)	p-value	Interpretation
Baseline	46.27 ± 6.3	45.71 ± 7.15	0.555	Not significant
Post-8Wk	25.77 ± 4.8	36.5 ± 4.7	<0.001	Significant, favours Group A
3-Month	20.25 ± 3.72	38.45 ± 4.42	<0.001	Significant, favours Group A

6-Month	15.2 ± 3.83	41.66 ± 5.0	<0.001	Significant, favours Group A
12-Month	12.13 ± 3.7	42.97 ± 5.2	<0.001	Significant, favours Group A

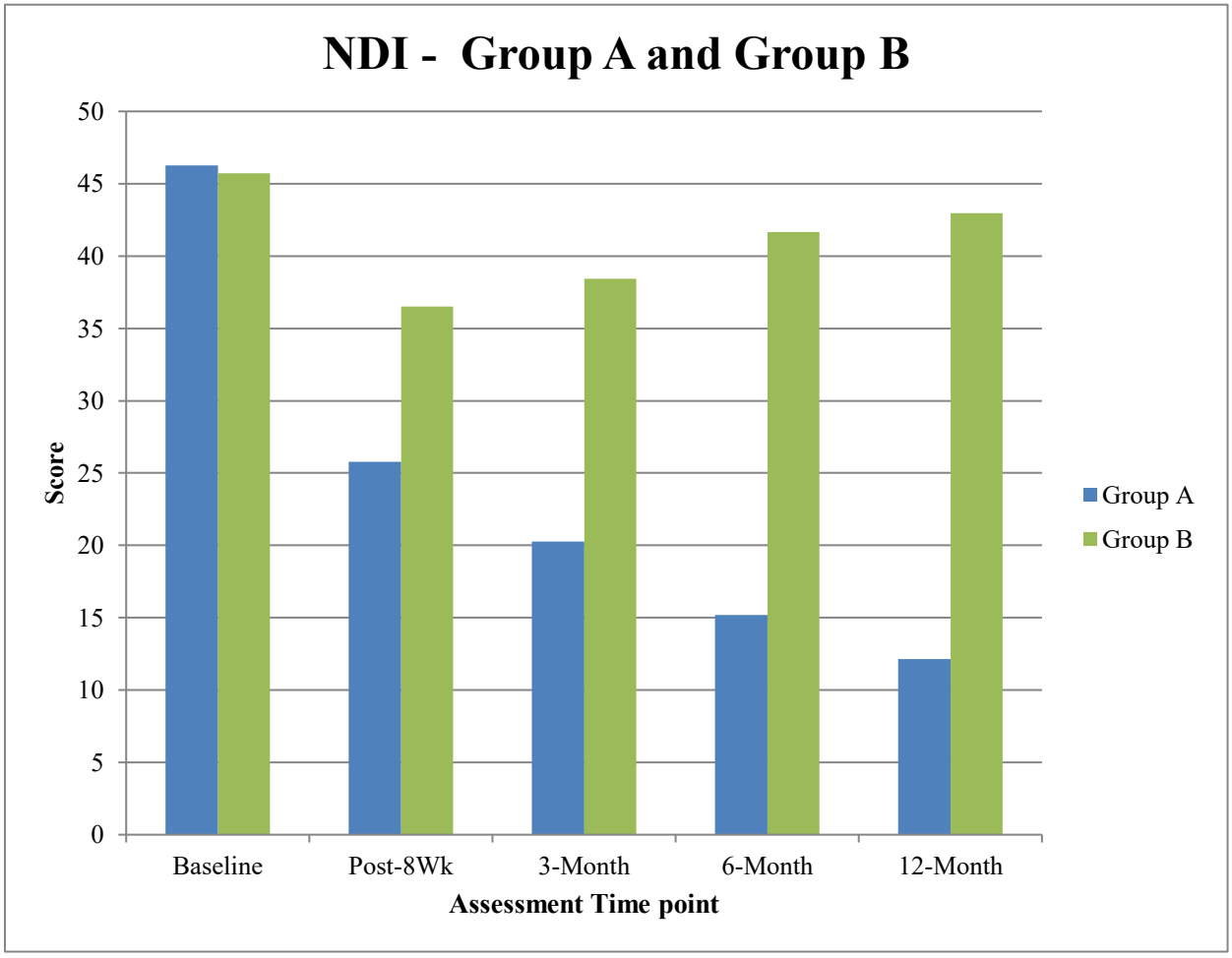


Figure 8 - NDI Mean Trend Across Five Time Points (Group A vs. Group B)

TABLE 4.1. NDI Category Distribution — Baseline vs. 12-Month Follow-Up

NDI Category	Group A Baseline	Group A 12-Month	Group B Baseline	Group B 12-Month
No disability (0–8%)	0 (0.0%)	29 (29.0%)	0 (0.0%)	0 (0.0%)

Mild (10–28%)	0 (0.0%)	71 (71.0%)	0 (0.0%)	0 (0.0%)
Moderate (30–48%)	69 (69.0%)	0 (0.0%)	70 (70.0%)	89 (89.0%)
Severe (50–68%)	31 (31.0%)	0 (0.0%)	30 (30.0%)	11 (11.0%)

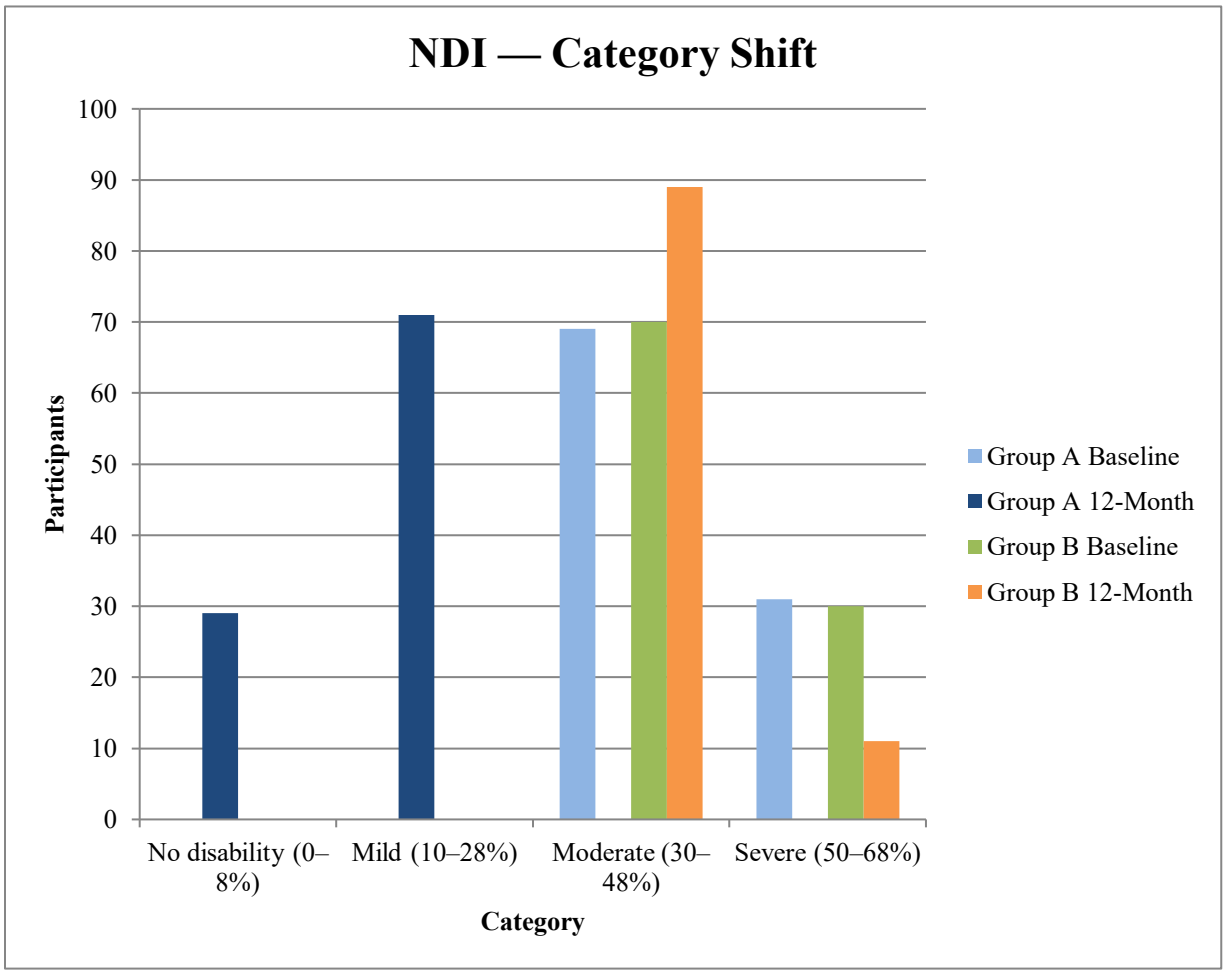


Table 10 — NDI Category Distribution: Baseline vs. 12-Month Follow-up

4. DISCUSSION

4.1 Pain Intensity (NPRS)

Groups were equivalent at baseline, and demonstrated a significant improvement during active treatment, which is consistent with the general short-term analgesic properties of exercise in CR.[11] The current

results contradict that literature with regard to the outcome after supervision ended: In Group A, the outcome increased, from 3.06 at Week 8 to 1.39 at 12 months; in Group B, the outcome improved, peaking at 3.93 at Week 8, but worsened to 5.1 at 12 months. A treatment that continues improving for a year after supervised sessions end suggests the physiological adaptation matures and generalises to daily movement — the signature of a motor-control model of deep flexor and scapular stabiliser retraining.[12],[13] The tissue-extensibility model predicts stretching gains require continued practice to maintain, with greater vulnerability to relapse once supervision stops[20] — precisely the pattern Group B exhibited. These findings extend Akkan and Gelecek's[14] 3-month strengthening evidence in confirmed CR to a substantially longer window, and suggest apparent short-term equality between exercise philosophies reported elsewhere may not hold once observation is meaningfully extended.[21] The 12-month gap (1.39 vs. 5.1) represents the difference between pain unlikely to limit daily activity and pain still expected to do so.

4.2 Disability (NDI)

There was no difference between the baseline NDIs (both moderate to severe). Group A's NDI dropped steadily from 25.77% at Week 8 to 12.13% at 12 months, while Group B's NDI improved to 36.5% at Week 8, but then deteriorated progressively to 42.97% at 12 months - which was the Group B baseline. This late-stage regression is perhaps the most clinically relevant: functionally , as reflected in the Group B participants report difficulties they experienced with lifting, reading, concentration, work, driving, sleeping and recreation, showed no difference between the patients' responses at 12 months and at pre-treatment, despite 8 weeks of supervised care and matched ESWT. This directly confirms Sleijser-Koehorst et al. (2012) results that most of the CR improvement is seen in an early window and that the CR improvement outside of this window is either partial or non-durable. Since both arms were matched in frequency, duration, and contact time,[18] it is unlikely that this differential is due to dosage imbalance between the two and more likely represents a real difference in the mechanisms of neuromuscular and connective-tissue adaptation pathways.

4.3 Biopsychosocial Considerations and Clinical Implications

Kinesiophobia has been shown to significantly predict chronic disability trajectories [22] and to be associated with decreased proprioceptive accuracy. [23] That Group A showed near-universal responders rates (companion paper), may be because of lack of kinesiophobia as a significant limiting factor here — or perhaps because of the graded strengthening progression' that served as an incremental exposure. This is speculative but a plausible alternate explanation.

The direct clinical implication: exercise strengthening should be recommended as a first line treatment if long-term (12-month) pain and disability outcomes are the treatment target, rather than short-term pain relief. Diagnostic rigor at enrolment provocative-test cluster plus physician confirmation,[3,4,5] – likely contributed to this trial's larger than typical effect sizes, compared with trials in broadly defined, non-radicular samples.

4.4 Limitations

Complete blinding was not feasible due to the hands-on nature of both interventions. This trial is single-setting, and is to be replicated at multiple centres before its magnitude is assumed to represent a general pattern. The 25-55 year-old, diagnostically selected sample may not be generalisable to older, myelopathic, and unconfirmed-radiculopathy populations. Kinesiophobia was not formally measured[22,23]. Because ESWT was held constant rather than varied factorially, this design cannot formally rule out a differential ESWT exercise interaction[24].

5. CONCLUSION

This randomized controlled trial aimed to investigate whether the strength or stretching exercise group, each delivered against a constant extracorporeal shock wave therapy (ESWT) background, leads to superior long-term pain and disability outcomes in patients with a diagnostically confirmed cervical radiculopathy. A total of 200 participants between the ages of 25 and 55 were randomly assigned to Group A (strengthening exercise + ESWT, n=100) and Group B (stretching exercise + ESWT, n=100) and the arms were matched as closely as possible with respect to ESWT parameters, frequency, duration, and total therapist contact time across the 8-week

supervised intervention period, and assessed at 3, 6, and 12 months.

At baseline the two groups were statistically similar for every demographic and clinical parameter evaluated - age, duration of symptoms, male to female, dominant versus nondominant side, disc level, and both outcome measures, ensuring that the randomisation was truly equivalent and any subsequent between groups difference could not attributed to an imbalance on who was allocated to which arm.Both groups showed a significant improvement over the 8-week active treatment period, which is consistent with the overall literature demonstrating that exercise, either of type, results in short term relief of pain in cervical radiculopathy. The results of this trial differ significantly from this general literature in what happened following supervised treatment. Group A's Numeric Pain Rating Scale (NPRS) score also continued to decrease at the subsequent follow-up measurement with a mean score of 1.39 (mild pain) at 12-month follow-up, which was similar to the parallel decrease in their Neck Disability Index (NDI) score 12.13% in the mild disability band. In contrast, Group B experienced a material improvement during active treatment and a reversal afterwards with its NPRS increasing from its Week-8 lowest point of 3.93 to 12-month mean of 5.1, and its NDI increasing from 36.5% at Week 8 to 42.97% at 12 months, which was essentially the same as the treatment group's own pre-treatment baseline of 45.71%. The differences between groups were highly statistically significant at 12 months, both on the NPRS ($p<0.001$) and on the NDI ($p<0.001$), and the magnitude of these differences, a gap of more than three and a half points on a 10-point pain scale and more than thirty percentage points on a 100-point disability index is a difference of clear clinical, not merely statistical, consequence.

The central conclusion that follows from these findings is that strengthening exercise in combination with ESWT, the resulting pain and disability outcomes are not just statistically superior to combination with stretching exercise and ESWT, but also persist throughout a full year after therapy was completed, while stretching exercise and ESWT yield an early, partially reversible benefit that rapidly diminishes once active supervision is withdrawn. Because both exercise arms were matched precisely on dosage, session frequency, contact time, and adjunctive ESWT

treatment, this divergence cannot be attributed to an imbalance in how much treatment either group received; it is better explained by a genuine mechanistic difference between the two exercise philosophies — a motor-control, load-tolerance-restoring adaptation pathway engaged by strengthening exercise, against a more readily reversible, continued-practice-dependent connective-tissue adaptation pathway engaged by stretching exercise.

These findings have direct clinical implications and practical application to clinical decision making. In the case of a treatment objective that requires long-term symptom control rather than short-term alleviation, strengthening exercise along with ESWT should be considered the treatment of choice as the exercise component to conservative care for cervical radiculopathy. This recommendation may be particularly relevant to the outpatient physiotherapy setting, including the setting in which this trial was conducted, where stretching-dominant protocols are often chosen as they are less physically demanding, simpler patient education requirements, and might be perceived as having a lower risk of early exacerbation of symptoms. The present findings indicated that this common attitude, if unchallenged, may bias towards a less beneficial exercise philosophy that is materially less likely to result in a long-term benefit in this particular population, and that any tolerability advantage that an early treatment adherence to exercise may provide should be explicitly considered, and discussed with the patient, against the substantially poorer twelve-month trajectory.At the same time, this conclusion should not be read as a categorical dismissal of stretching exercise as a therapeutic tool, nor as license to apply the strengthening protocol tested here, unmodified, to every presentation of cervical radiculopathy regardless of acuity or irritability; clinicians managing patients in a more acutely symptomatic phase than the population enrolled here should continue to apply individualised clinical judgement regarding the pace of exercise progression.

Lastly, this conclusion should be interpreted within the limits set in the trial because of its design: single-centre, a limited age range of 25-55 years, fixed dose parameters for exercise, ESWT, and lack of full blinding of the nature of comparing two physically active, hands-on interventions.

Finally, this conclusion should be understood within the bounds the trial's own

design establishes: a single-centre setting, a defined 25–55-year age band, fixed exercise and ESWT dosing parameters, and the absence of full blinding inherent to comparing two active, hands-on physical interventions. None of these limitations individually or collectively undermines the central finding reported here, but each defines the specific conditions under which this finding should presently be understood to hold, and each points toward a corresponding direction — multi-centre replication, dose-response investigation, and factorial ESWT-exercise testing among them — for future research seeking to extend these findings beyond the population and setting in which they were obtained.

DECLARATIONS

Ethical approval: Obtained from the Institutional Ethics Committee, Malwanchal University, prior to commencement; registered with the Clinical Trials Registry of India (CTRI) [registration number to be inserted].

Informed consent: Written informed consent was obtained from all participants prior to enrolment.

Conflict of interest: The authors declare no conflict of interest.

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Data availability: Data are available from the corresponding author on reasonable request.

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