

Research Article

Feasibility and Preliminary Efficacy of Progressive Resistance Training as an Adjunct to Conventional Physiotherapy in Diabetic Adhesive Capsulitis: A Pilot Study

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ABSTRACT

Background: Adhesive capsulitis (AC) is a painful, progressively stiffening shoulder disorder that is more common in people with diabetes. Conventional physiotherapy centres on pain relief and mobilisation, and the added value of progressive resistance training (PRT) is uncertain. This pilot randomised controlled trial (RCT) assessed the feasibility of adding PRT to conventional physiotherapy in diabetic AC and explored its preliminary efficacy.

Methods: In this single-centre, assessor-blinded, two-arm parallel pilot RCT, 30 adults aged 40-65 years with type 2 diabetes and unilateral stage 1-2 AC were randomised 1:1, stratified by sex and baseline pain, to conventional physiotherapy plus PRT (Group A, n=15) or conventional physiotherapy alone (Group B, n=15). Both groups attended 18 supervised sessions (three per week for six weeks). Feasibility outcomes were retention, adherence, safety and acceptability. Secondary outcomes were pain (NPRS), goniometric active and passive range of motion (ROM), function (SPADI, DASH) and isometric strength (hand-held dynamometry), assessed at baseline, week 3 and week 6. Analyses followed the intention-to-treat principle (last observation carried forward) using baseline-adjusted ANCOVA, mixed-design ANOVA and Cohen's d.

Results: Retention was 96.7% (29/30; 95% CI 83.3-99.4). Mean session attendance was 90.7% (16.3 of 18 sessions), 96.7% of participants attended at least 80% of sessions, and mean acceptability was 4.5 of 5. Nine mild, transient adverse events occurred (Group A 4/15; Group B 5/15); none was serious or glycaemic. At week 6, Group A showed greater improvement than Group B in SPADI total (adjusted difference -6.7, 95% CI -8.6 to -4.8 points; d=-1.24), DASH (-5.6, 95% CI -7.7 to -3.5 points), active flexion (7.2°, 95% CI 4.5 to 9.8), external rotation strength (0.89 kg, 95% CI 0.75 to 1.04; d=1.09) and all other ROM and strength measures. Pain during activity favoured Group A modestly (-0.5, 95% CI -0.9 to -0.1 points), whereas pain at rest did not differ clearly (-0.3, 95% CI -0.5 to 0.0 points). Group × Time interactions were significant for 16 of 17 outcomes.

Conclusion: Adding PRT to conventional physiotherapy was feasible, acceptable and, within the limits of a small pilot, apparently safe in adults with diabetic AC. Preliminary estimates favoured the addition of PRT for mobility, function and strength, although between-group differences in pain and function were small relative to published minimal clinically important differences. A definitive, adequately powered, multicentre RCT with longer follow-up is warranted.

Keywords: Adhesive Capsulitis, Frozen Shoulder, Type 2 Diabetes Mellitus, Progressive Resistance Training, Physiotherapy, Pilot Randomised Controlled Trial, Feasibility.

INTRODUCTION

Adhesive capsulitis (AC), or frozen shoulder, is characterised by pain and a gradual, global loss of active and passive glenohumeral motion, with

external rotation usually the most restricted movement (Kelley et al., 2013; Ramirez, 2019). Diabetes mellitus is one of its strongest recognised associations. A meta-analysis

estimated that AC affects about 13% of people with diabetes, who are roughly five times more likely than controls to have the condition (Zreik et al., 2016), and a later systematic review reported pooled odds of 3.69 for developing frozen shoulder in diabetes (Dyer et al., 2023). Hospital-based data also link both obesity and diabetes with AC (Kingston et al., 2018), and the prevalence in type 2 diabetes has been reported at over one in five in a cross-sectional study that also found associations with autonomic neuropathy (Arkkila et al., 1996). Musculoskeletal complications of diabetes are common and reduce quality of life (Al-Homood, 2013).

Although AC was traditionally regarded as self-limiting, persistent functional limitation after long follow-up has challenged that view (Ramirez, 2019). A systematic review and network meta-analysis found that intra-articular corticosteroid gave the best short-term benefit, with home exercise and physiotherapy adding benefit in the mid term (Challoumas et al., 2020). Clinical practice guidelines emphasise patient education, stretching and mobilisation (Kelley et al., 2013), and randomised trials have examined mobilisation grades (Vermeulen et al., 2006) and supervised exercise formats (Russell et al., 2014). Conventional programmes therefore concentrate on capsular mobility and pain modulation, with relatively little attention to restoring the strength and dynamic control of the rotator cuff and scapular muscles that are likely to be compromised by pain, disuse and metabolic disease.

Resistance exercise is an established component of exercise guidance for people with type 2 diabetes (Colberg et al., 2016), yet clinicians may hesitate to load a painful, stiff shoulder, and safety concerns, particularly glycaemic excursions, are relevant in this population. Evidence for resistance training in diabetic AC is scarce. A recent pilot RCT reported that an eight-week resistance-band programme improved range of motion, pain and disability compared with a control group in adults with diabetes and AC (Moghadasli & Jafari, 2026). What remains unclear is whether a structured, criterion-based progression of resistance training adds benefit when delivered alongside conventional physiotherapy, and whether it can be delivered safely with glucose monitoring.

Pilot studies are intended to test the feasibility of trial procedures and the intervention before a definitive trial, and should not be judged on their power to detect treatment effects (Lancaster et al., 2004; Thabane et al., 2010; Eldridge et al., 2016). This pilot RCT therefore had a primary

feasibility aim, namely to assess recruitment, retention, adherence, safety and acceptability of PRT as an adjunct to conventional physiotherapy in adults with diabetic AC, and a secondary aim to explore preliminary effects on pain, range of motion, shoulder function and muscle strength.

MATERIALS AND METHODS

Study Design

This was a single-centre, assessor-blinded, parallel-group, two-arm pilot randomised controlled trial. Reporting follows the CONSORT 2010 extension for randomised pilot and feasibility trials (Eldridge et al., 2016). Participants were allocated 1:1 to Group A (PRT plus conventional physiotherapy) or Group B (conventional physiotherapy alone). Both groups received supervised sessions three times per week for six weeks (18 sessions in total). Outcomes were assessed at baseline, week 3 and week 6 (end of intervention); no 12-week follow-up data were collected.

Participants

Adults aged 40–65 years with type 2 diabetes mellitus and unilateral clinically diagnosed AC. Participants were assessed for eligibility by the treating clinician and provided written informed consent before baseline assessment.

Inclusion and Exclusion Criteria

Inclusion criteria were: age 40–65 years; type 2 diabetes mellitus (HbA1c $\geq 6.5\%$ or current antidiabetic medication); clinically diagnosed unilateral AC at stage 1 or 2 with restriction of passive external rotation of at least 50% relative to the contralateral side; pain of at least 3/10 on the Numeric Pain Rating Scale (NPRS); and symptom duration of 1–9 months. Exclusion criteria were: previous shoulder surgery or trauma on the affected side; neurological disorders affecting the upper limb; uncontrolled hypertension or cardiovascular disease contraindicating resistance exercise; corticosteroid injection to the shoulder within the previous three months; and severe retinopathy, nephropathy or autonomic neuropathy limiting safe exercise.

Sample Size

As this was a pilot study, no formal power calculation was performed. A target of 30–36 participants (15–18 per group) was set to allow estimation of feasibility parameters and preliminary effect sizes, with allowance for approximately 15–20% dropout. This target is consistent with published guidance on pilot trial sample sizes, which suggests about 15 per arm

when a medium standardised effect is anticipated in the main trial (Whitehead et al., 2016).

Randomisation, Allocation Concealment and Blinding

A computer-generated random sequence allocated participants 1:1, stratified by sex and baseline pain severity. Allocation was concealed in sealed opaque envelopes. The outcome assessor was blinded to group allocation; participants and treating therapists could not be blinded because of the nature of the interventions.

Interventions

Conventional physiotherapy (both groups).

Each supervised session comprised a moist heat pack (10 min); conventional-mode transcutaneous electrical nerve stimulation (TENS, 15 min); and passive and active-assisted joint mobilisation (Maitland grades I–III as tolerated) in flexion, abduction, and external and internal rotation (10–12 min). All participants also followed a home exercise programme of pendulum exercises, towel stretch, cross-body stretch and wall walk (two sets of 10 repetitions, twice daily).

Progressive resistance training (Group A only).

PRT was delivered under supervision after the conventional component using resistance bands and/or light dumbbells. Six exercises were prescribed: (1) shoulder external rotation (side-lying or standing with band); (2) shoulder internal rotation (band); (3) scapular retraction/rows; (4) shoulder abduction in the scapular plane; (5) shoulder flexion (forward raise); and (6) low-load external rotation at 90° abduction when ROM allowed. Load was progressed in three phases. In weeks 1–2, light resistance (yellow/red band or 0.5–1 kg) was used for two sets of 8–10 repetitions, emphasising form and pain-free range. In weeks 3–4, moderate resistance (green/blue band or 1–2 kg) was used for 2–3 sets of 10–12 repetitions. In weeks 5–6, higher resistance (black band or 2–3 kg) or increased sets/repetitions was used, provided pain remained $\leq 4/10$ during exercise and there was no compensatory movement. Load was increased only when the prescribed sets and repetitions were completed with good form and pain of $\leq 3-4/10$ in the last set. Rest between sets was 60–90 s. Capillary blood glucose was measured before and after each session, and the session was stopped if glucose was <100 mg/dL or >300 mg/dL.

Control (Group B). Group B received exactly the same conventional physiotherapy protocol without resistance training. Session duration was approximately matched by adding supervised active range-of-motion exercise and gentle stretching so that total contact time was similar between groups.

Outcome Measures

Feasibility outcomes (primary) were recruitment rate (proportion of eligible patients enrolled), retention/dropout rate, adherence (percentage of the 18 supervised sessions attended and self-reported percentage of prescribed home exercises completed), adverse events and safety (especially glycaemic events), and participant acceptability (single Likert item, 1 = very poor to 5 = excellent, at week 6).

Preliminary efficacy outcomes (secondary) were: pain at rest and during activity (NPRS, 0–10; Farrar et al., 2001); active and passive ROM of flexion, abduction, external rotation and internal rotation measured with a universal goniometer (degrees); shoulder function using the Shoulder Pain and Disability Index (SPADI; pain and disability subscales and total, 0–100; Roach et al., 1991) and the Disabilities of the Arm, Shoulder and Hand questionnaire (DASH, 0–100; Hudak et al., 1996), for both of which higher scores indicate greater disability; and isometric strength of the external rotators, internal rotators and abductors using a hand-held dynamometer (mean of three trials, kg), a method with good to excellent reliability for shoulder rotation strength (Cools et al., 2014). Participant characteristics recorded at baseline were age, sex, affected side, symptom duration, diabetes duration, HbA1c, AC stage and body mass index (BMI).

Ethical Considerations

The study protocol was approved by the Institutional Ethics Committee at the Department of rehabilitation. All participants provided written informed consent, and the study was conducted in accordance with the Declaration of Helsinki.

Statistical Analysis

Feasibility outcomes are reported descriptively with 95% confidence intervals (Wilson score intervals for proportions, Newcombe, 1998; t-based intervals for means). Baseline comparability is shown descriptively using independent t-tests and Fisher's exact tests; the associated p-values are not used to guide analysis (Lancaster et al., 2004). Preliminary efficacy followed the intention-to-treat principle, with all randomised participants analysed in their

allocated group. One participant had missing week-6 data, which were imputed by last observation carried forward (the week-3 value). Between-group differences at week 3 and week 6 were estimated with analysis of covariance (ANCOVA), including group as a fixed factor and the baseline value of the outcome as covariate (Vickers & Altman, 2001), and are reported as adjusted mean differences (Group A minus Group B) with 95% CIs. The standardised effect size was Cohen's *d*, calculated as the adjusted difference divided by the pooled baseline standard deviation with Hedges' small-sample correction (following Morris, 2008), with CIs obtained by scaling the CI of the adjusted difference; values of 0.2, 0.5 and 0.8 were taken as small, medium and large (Cohen, 1988). Effects of time and the Group $\times$ Time interaction were examined with a two-way mixed-design ANOVA (Group: A, B; Time: baseline, week 3, week 6) with Greenhouse–Geisser-corrected degrees of freedom and partial eta squared (η^2). Within-group change from baseline to week 6 was analysed with paired *t*-tests.

Residual normality was checked with the Shapiro–Wilk test. Sensitivity analyses comprised (i) a per-protocol ANCOVA of completers (*n*=29); (ii) an ANCOVA additionally adjusted for sex, AC stage and BMI; and (iii) the Mann–Whitney *U* test on baseline-to-week-6 change scores. A responder analysis used published minimal clinically important differences (MCIDs): 2 points for NPRS (Farrar et al., 2001), 8–13 points for SPADI (Roy et al., 2009; both 8 and 13 points were examined)

and 10.83 points for DASH (Franchignoni et al., 2014). Significance was set at two-sided α =0.05 with no adjustment for multiplicity; all efficacy analyses were exploratory, and emphasis is placed on estimates and confidence intervals rather than *p*-values (Lee et al., 2014). Analyses were performed in Python 3 (NumPy, SciPy, pandas) and figures were produced with Matplotlib.

RESULTS

Participant Flow and Baseline Characteristics

Thirty participants were randomised, 15 to each group, and all received the allocated intervention (Figure 1). One participant in Group B (a 57-year-old man with stage 2 AC) completed the week-3 assessment but did not complete the programme because he was unable to attend the remaining sessions (9 of 18 attended) and had no week-6 assessment. The remaining 29 participants completed all assessments, giving a retention rate of 96.7%. All 30 participants were included in the intention-to-treat analysis.

Baseline characteristics are shown in Table 1. Groups were similar in age, symptom duration, diabetes duration and HbA1c, and in baseline pain, function, ROM and strength (all *p*>.40). Group A contained proportionally more women (7/15 vs 4/15), more participants with stage 1 AC (10/15 vs 6/15) and a numerically higher BMI (29.4 vs 27.0 kg/m²; *p*=.053); none of these differences was statistically significant, but because the trial was small they were examined in a sensitivity analysis.

Table 1. Baseline characteristics of participants by group (mean $\pm$ SD unless stated).

Characteristic	Group A (n=15)	Group B (n=15)	<i>p</i>
Age, years	53.9 $\pm$ 5.6	54.6 $\pm$ 5.3	.741
Women/Men, <i>n</i>	7/8	4/11	.450
Affected side, R/L, <i>n</i>	8/7	7/8	1.000
AC stage 1/2, <i>n</i>	10/5	6/9	.272
Symptom duration, months	5.1 $\pm$ 1.7	4.7 $\pm$ 2.1	.564
Diabetes duration, years	10.7 $\pm$ 4.7	10.6 $\pm$ 4.3	.968
HbA1c, %	7.94 $\pm$ 0.94	7.75 $\pm$ 0.84	.572
BMI, kg/m ²	29.4 $\pm$ 3.4	27.0 $\pm$ 3.0	.053
NPRS at rest (0–10)	4.6 $\pm$ 1.2	4.3 $\pm$ 1.0	.405
NPRS during activity (0–10)	6.1 $\pm$ 1.2	6.3 $\pm$ 1.1	.526
SPADI total (0–100)	66.7 $\pm$ 6.5	67.2 $\pm$ 3.5	.823
DASH (0–100)	57.6 $\pm$ 8.6	57.1 $\pm$ 10.3	.879
Active flexion, °	85.5 $\pm$ 13.9	84.3 $\pm$ 11.3	.808
ER strength, kg	4.49 $\pm$ 0.77	4.43 $\pm$ 0.82	.838

AC, adhesive capsulitis; BMI, body mass index; ER, external rotation; NPRS, Numeric Pain Rating Scale; R/L, right/left. *p*-values: independent *t*-test or Fisher's exact test, shown descriptively.

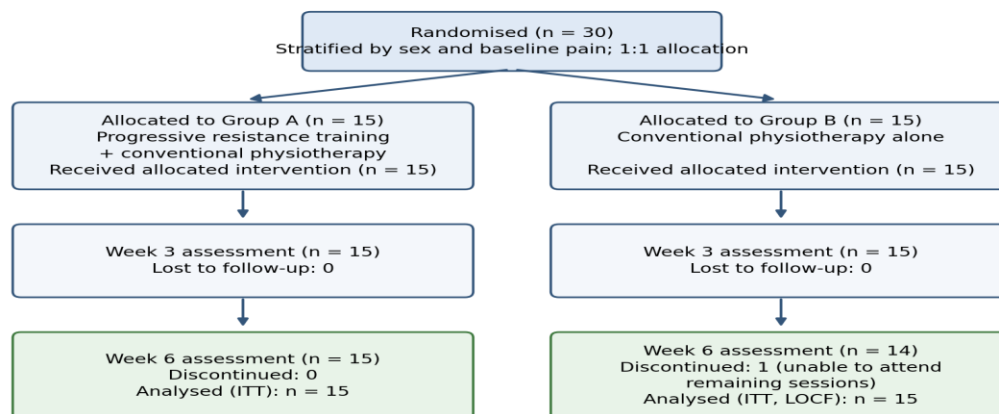


Figure 1. CONSORT-style flow diagram of participants through the pilot trial. ITT, intention-to-treat; LOCF, last observation carried forward.

Feasibility Outcomes

Feasibility results are summarised in Table 2 and Figure 2. patients assessed and all were eligible and 30 were enrolled, giving a recruitment rate of 100%; the minimum target of 30 participants was achieved. Retention was 100% in Group A and 93.3% in Group B (overall 96.7%, 95% CI 83.3–99.4). Mean attendance was 16.3 ± 1.8 of 18 supervised sessions (90.7%, 95% CI 87.1–94.4), with no meaningful difference between groups (Group A 91.1%, Group B 90.4%), and 29 of 30 participants (96.7%) attended at least 80% of sessions. Self-reported completion of the prescribed home exercises averaged 77.6% (95% CI 73.9–81.3), similar in both groups (Group A 78.7%, Group B 76.4%).

Nine participants (30.0%, 95% CI 16.7–47.9) reported an adverse event: four in Group A (three episodes of transient muscle soreness and one temporary increase in shoulder discomfort) and five in Group B (four temporary increases in shoulder discomfort and one episode of transient muscle soreness). All were mild and self-limiting, none led to discontinuation, none was serious, and none was related to glycaemic safety thresholds. Acceptability was high: all 29 participants who completed the questionnaire rated the programme as good (4) or excellent (5), with a mean score of 4.5 ± 0.5 (95% CI 4.3–4.7) and no difference between groups.

Table 2. Feasibility outcomes by group.

Feasibility outcome	Group A (n=15)	Group B (n=15)	Overall (n=30)
Participants randomised, n=	15	15	30
Recruitment rate (enrolled/eligible)	[to be inserted]	[to be inserted]	[to be inserted]
Completed week 6, n (% [95% CI])	15 (100 [79.6–100])	14 (93.3 [70.2–98.8])	29 (96.7 [83.3–99.4])
Sessions attended (of 18), mean $\pm$ SD [range]	16.4 ± 1.1 [15–18]	16.3 ± 2.3 [9–18]	16.3 ± 1.8 [9–18]
Session attendance, % (mean $\pm$ SD)	91.1 ± 6.2	90.4 ± 12.7	90.7 ± 9.8 (95% CI 87.1–94.4)
Attended $\geq 80\%$ of sessions, n (% [95% CI])	15 (100 [79.6–100])	14 (93.3 [70.2–98.8])	29 (96.7 [83.3–99.4])
Home exercise adherence, % (mean $\pm$ SD)	78.7 ± 9.7	76.4 ± 10.4	77.6 ± 9.9 (95% CI 73.9–81.3)
Participants with ≥ 1 adverse event, n (% [95% CI])	4 (26.7 [10.9–52.0])	5 (33.3 [15.2–58.3])	9 (30.0 [16.7–47.9])
Transient muscle soreness, n	3	1	4
Temporary increase in shoulder discomfort, n	1	4	5
Serious or glycaemic adverse events, n	0	0	0

Acceptability, Likert 1–5 (mean ± SD)	4.53 ± 0.52	4.50 ± 0.52	4.52 ± 0.51 (95% CI 4.32–4.71)
Rated good or excellent (≥4), n/N (%)	15/15 (100)	14/14 (100)	29/29 (100)

Confidence intervals for proportions are Wilson score intervals. Acceptability was not available for the participant who discontinued.

Bracketed, highlighted entries are to be completed from the screening log.

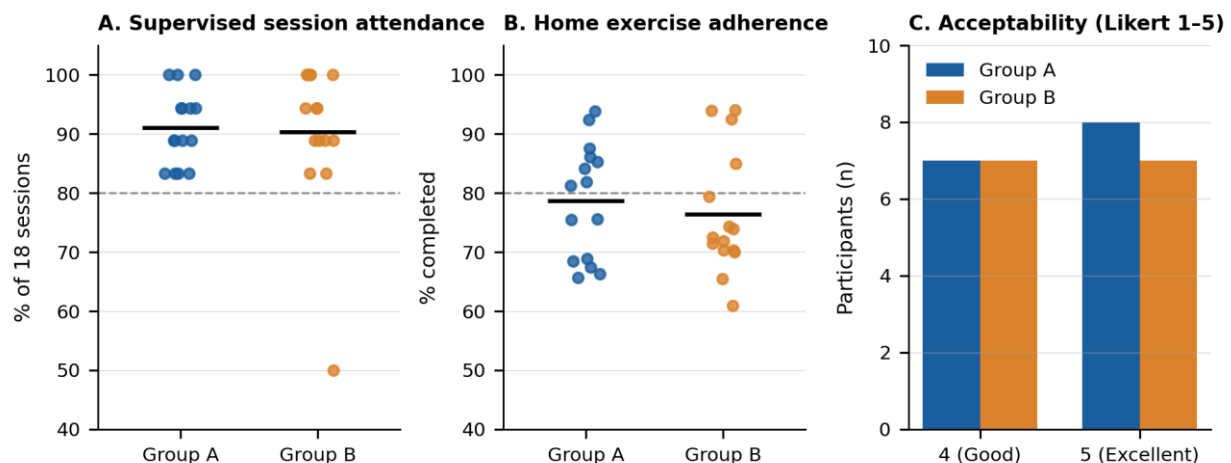


Figure 2. Feasibility outcomes. (A) Supervised session attendance and (B) self-reported home-exercise adherence for individual participants (horizontal bar = group mean; dashed line = 80% benchmark). (C) Participant-rated acceptability.

Pain

Pain decreased over time in both groups (Table 3, Figure 3). Pain during activity fell from 6.1 ± 1.2 to 4.1 ± 1.4 in Group A and from 6.3 ± 1.1 to 4.9 ± 1.3 in Group B. After adjustment for baseline, Group A had lower pain during activity at week 6 (adjusted difference -0.5 , 95% CI -0.9 to -0.1 points; $d = -0.44$ (-0.77 to -0.10)).

Pain at rest fell similarly in both groups (4.6 ± 1.2 to 3.5 ± 1.1 vs 4.3 ± 1.0 to 3.5 ± 1.1), and the adjusted difference at week 6 was small with a confidence interval touching zero (-0.3 , 95% CI -0.5 to 0.0 points; $p = .059$). The Group $\times$ Time interaction was significant for pain during activity ($F(1.4, 40.5) = 4.55$, $p = .026$) but not for pain at rest ($p = .347$).

Table 3. Pain and function outcomes at baseline, week 3 and week 6 by group (mean ± SD; ITT with LOCF, n=15 per group).

Outcome	A: Baseline	A: Week 3	A: Week 6	B: Baseline	B: Week 3	B: Week 6
NPRS at rest (0–10)	4.6 ± 1.2	4.1 ± 1.3	3.5 ± 1.1	4.3 ± 1.0	3.9 ± 1.1	3.5 ± 1.1
NPRS during activity (0–10)	6.1 ± 1.2	5.0 ± 1.1	4.1 ± 1.4	6.3 ± 1.1	5.8 ± 1.2	4.9 ± 1.3
SPADI pain (0–100)	66.3 ± 8.7	57.2 ± 10.2	48.3 ± 8.5	68.8 ± 8.0	62.5 ± 7.7	57.4 ± 7.8
SPADI disability (0–100)	67.1 ± 7.4	59.4 ± 8.2	50.1 ± 7.1	65.5 ± 8.8	60.2 ± 9.3	55.2 ± 10.4
SPADI total (0–100)	66.7 ± 6.5	58.3 ± 7.4	49.2 ± 6.3	67.2 ± 3.5	61.4 ± 3.7	56.3 ± 5.4
DASH (0–100)	57.6 ± 8.6	49.6 ± 8.7	41.4 ± 9.7	57.1 ± 10.3	51.7 ± 11.0	46.5 ± 10.1

A, Group A (PRT + conventional physiotherapy); B, Group B (conventional physiotherapy). NPRS, Numeric Pain Rating

Scale; SPADI, Shoulder Pain and Disability Index; DASH, Disabilities of the Arm, Shoulder

and Hand. Lower scores indicate less pain or disability.

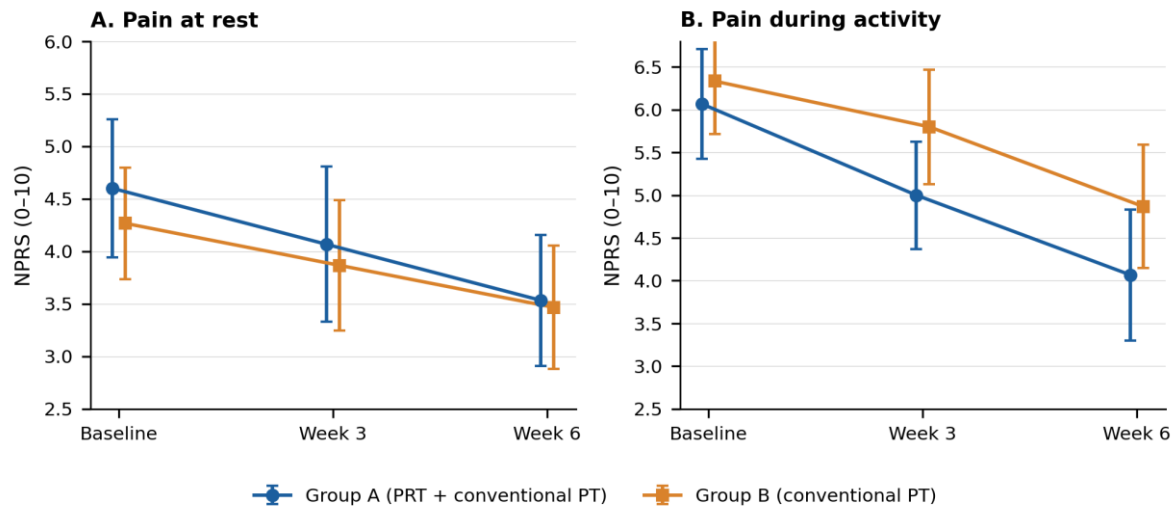


Figure 3. Pain at rest (A) and during activity (B) at baseline, week 3 and week 6. Points are group means with 95% confidence intervals (ITT, LOCF). Lower scores indicate less pain.

Range of Motion

All eight ROM measures improved in both groups, with larger gains in Group A (Table 4, Figures 4 and 5). Active flexion rose by 19.0° in Group A and 11.8° in Group B, and the adjusted difference at week 6 was 7.2°, 95% CI 4.5 to 9.8 ($d=0.55$). Corresponding adjusted differences for the other active movements were 4.7°, 95% CI 2.3 to 7.1 for abduction, 3.1°, 95% CI 2.0 to 4.1 for external rotation and 4.4°, 95% CI 2.7 to 6.1 for internal

rotation. For passive movements the adjusted differences were 4.5°, 95% CI 2.6 to 6.4 for flexion, 7.6°, 95% CI 5.8 to 9.3 for abduction, 3.1°, 95% CI 1.9 to 4.3 for external rotation and 3.2°, 95% CI 1.6 to 4.7 for internal rotation. At week 3, between-group differences were already evident for active abduction, active internal rotation, passive abduction and passive external rotation, whereas confidence intervals for the remaining measures included zero (Table 6).

Table 4. Active and passive range of motion at baseline, week 3 and week 6 by group (mean $\pm$ SD, degrees; ITT with LOCF).

Outcome	A: Baseline	A: Week 3	A: Week 6	B: Baseline	B: Week 3	B: Week 6
Active ROM (degrees)						
Flexion	85.5 $\pm$ 13.9	94.5 $\pm$ 14.2	104.5 $\pm$ 14.8	84.3 $\pm$ 11.3	91.5 $\pm$ 12.3	96.1 $\pm$ 11.8
Abduction	72.4 $\pm$ 11.8	84.0 $\pm$ 12.3	89.5 $\pm$ 12.4	75.9 $\pm$ 12.5	83.0 $\pm$ 13.0	88.1 $\pm$ 11.9
External rotation	26.1 $\pm$ 6.7	29.9 $\pm$ 6.6	34.4 $\pm$ 6.0	25.0 $\pm$ 6.6	28.4 $\pm$ 6.6	30.3 $\pm$ 6.9
Internal rotation	34.1 $\pm$ 5.5	39.9 $\pm$ 5.5	43.7 $\pm$ 5.7	32.7 $\pm$ 6.0	35.5 $\pm$ 6.0	37.9 $\pm$ 6.1
Passive ROM (degrees)						
Flexion	103.9 $\pm$ 14.3	113.1 $\pm$ 15.0	121.5 $\pm$ 15.0	102.6 $\pm$ 11.5	109.8 $\pm$ 10.1	115.6 $\pm$ 11.6
Abduction	91.7 $\pm$ 14.1	102.0 $\pm$ 13.9	111.5 $\pm$ 15.0	95.3 $\pm$ 13.9	101.7 $\pm$ 13.9	107.5 $\pm$ 13.1
External rotation	35.1 $\pm$ 8.1	39.5 $\pm$ 8.9	43.5 $\pm$ 7.9	37.3 $\pm$ 6.0	39.3 $\pm$ 6.2	42.5 $\pm$ 6.2
Internal rotation	44.7 $\pm$ 7.6	49.2 $\pm$ 9.1	54.5 $\pm$ 7.8	43.7 $\pm$ 6.4	46.7 $\pm$ 6.9	50.3 $\pm$ 6.9

ER, external rotation; IR, internal rotation. Measured with a universal goniometer.

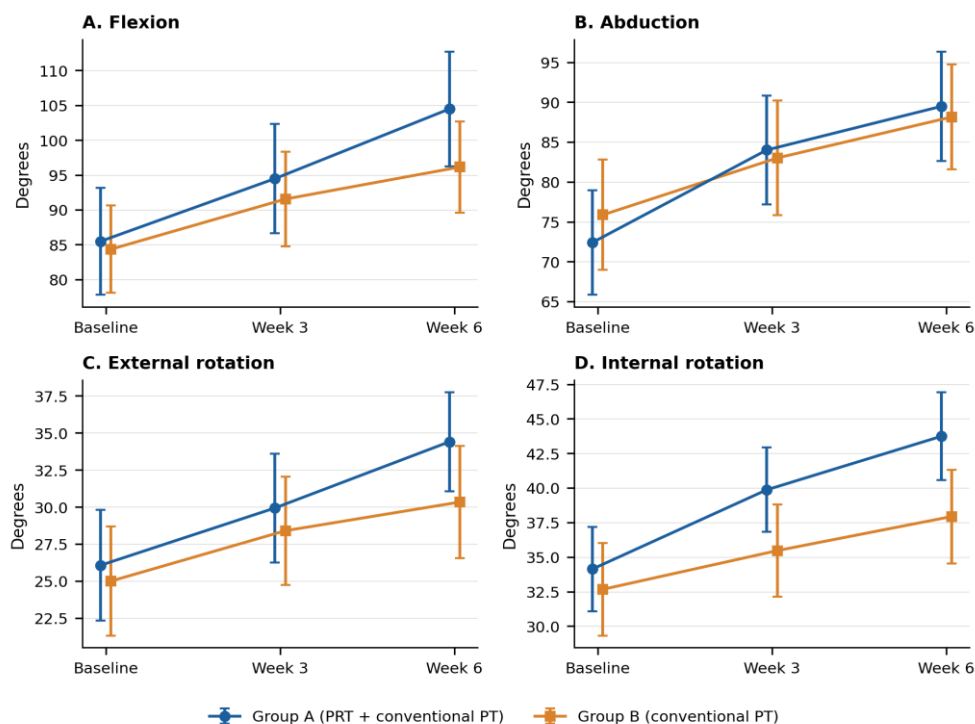


Figure 4. Active range of motion: (A) flexion, (B) abduction, (C) external rotation and (D) internal rotation. Means with 95% confidence intervals (ITT, LOCF).

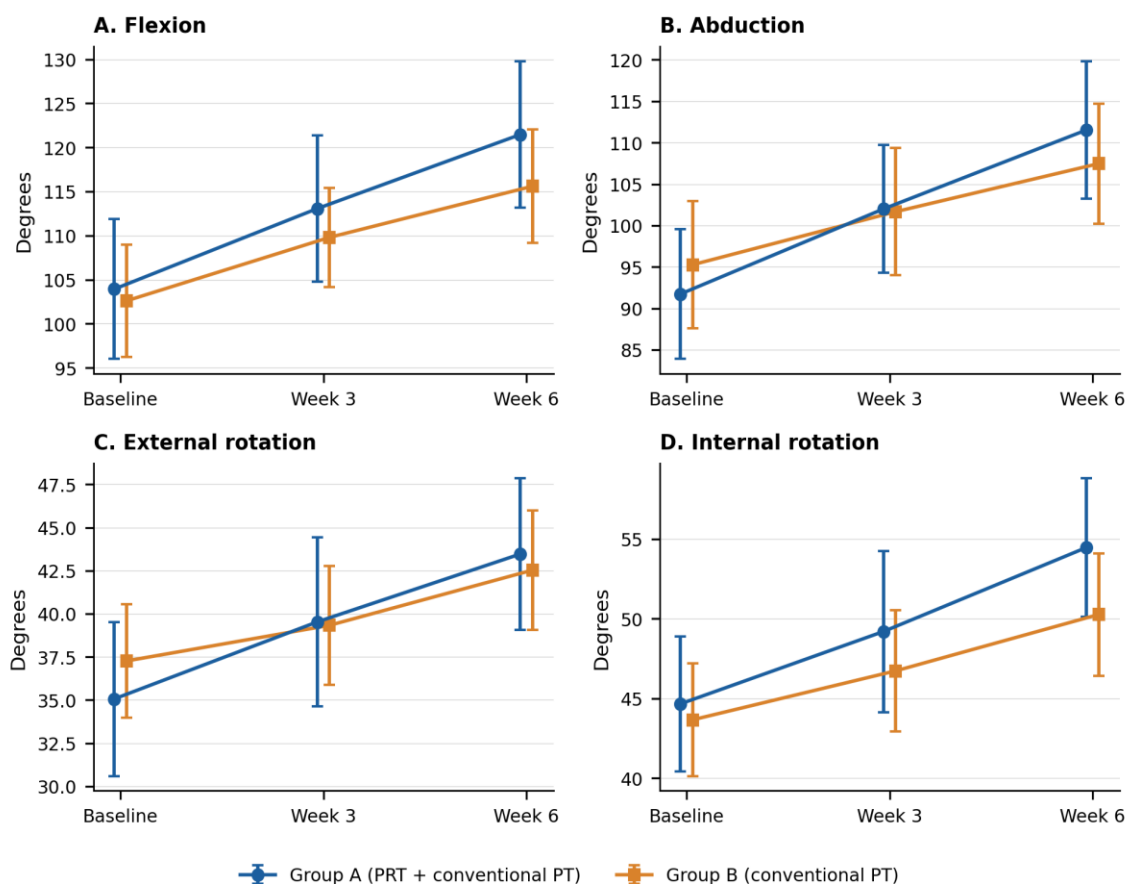


Figure 5. Passive range of motion: (A) flexion, (B) abduction, (C) external rotation and (D) internal rotation. Means with 95% confidence intervals (ITT, LOCF).

Shoulder Function

Both groups improved on all function measures, with greater improvement in Group A (Table 3, Figures 6 and 7). SPADI total fell by 17.5 points in Group A (66.7 to 49.2) and by 10.8 points in Group B (67.2 to 56.3), an adjusted week-6 difference of -6.7 , 95% CI -8.6 to -4.8 points ($d=-1.24$ (-1.59 to -0.88)). Differences were similar for the SPADI pain subscale (-6.9 , 95% CI -9.2 to -4.5) and disability subscale (-6.8 ,

95% CI -8.7 to -4.9). DASH fell from 57.6 to 41.4 in Group A and from 57.1 to 46.5 in Group B (adjusted difference -5.6 , 95% CI -7.7 to -3.5 points; $d=-0.58$ (-0.79 to -0.36)). The standardised difference for SPADI total is larger than for its two subscales because the baseline SD of the total score is smaller; it should be read alongside the raw differences. Individual trajectories (Figure 7) show that SPADI scores fell in every participant in both groups.

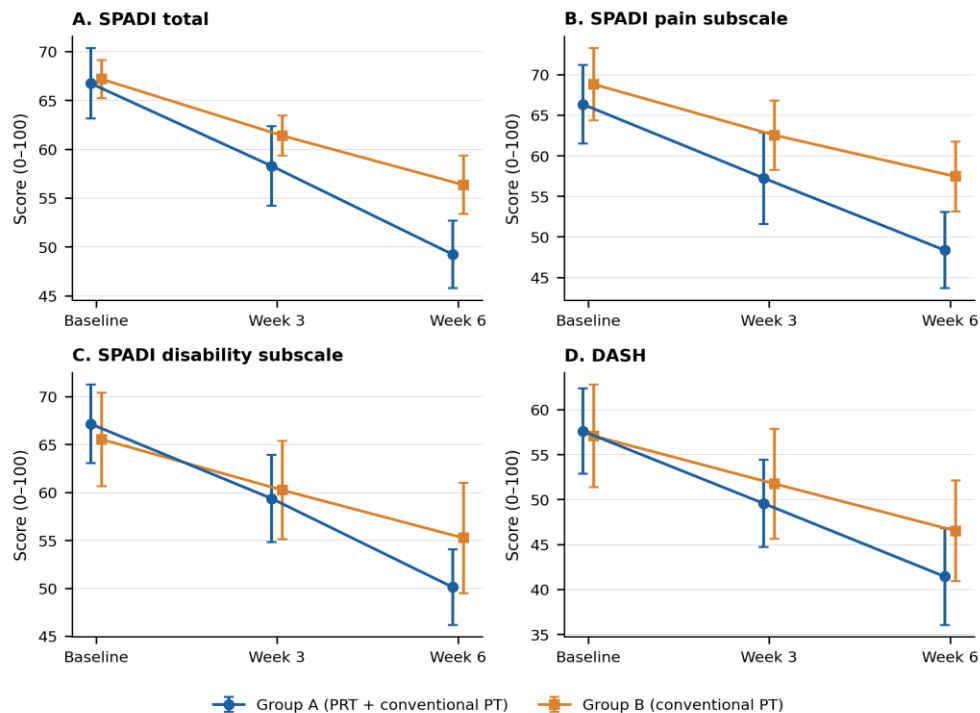


Figure 6. Shoulder function: (A) SPADI total, (B) SPADI pain subscale, (C) SPADI disability subscale and (D) DASH. Means with 95% confidence intervals (ITT, LOCF). Lower scores indicate less disability.

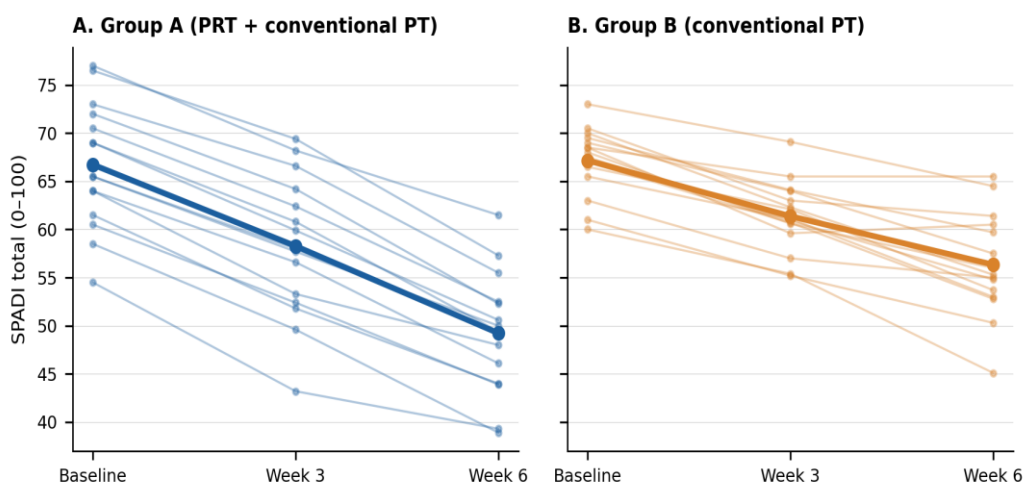


Figure 7. Individual participant trajectories of SPADI total score in Group A (A) and Group B (B). Thin lines are individual participants; thick lines are group means.

Muscle Strength

Isometric strength increased in both groups, but gains were greater in Group A (Table 5, Figure 8).

External rotation strength rose from 4.49 to 6.07 kg in Group A (+1.59 kg) and from 4.43 to 5.12 kg in Group B (+0.69 kg), with an adjusted week-6 difference of 0.89 kg, 95% CI 0.75 to 1.04 (d=1.09). Adjusted differences were 0.80 kg, 95% CI 0.68 to 0.93 for internal rotation strength

(d=0.83) and 0.69 kg, 95% CI 0.55 to 0.83 for abduction strength (d=0.84). Strength was the trained quality in Group A, so larger gains in this domain were expected; the clinical interest lies in whether they translate into better mobility and function.

Table 5. Isometric shoulder strength at baseline, week 3 and week 6 by group (mean $\pm$ SD, kg; ITT with LOCF).

Outcome	A: Baseline	A: Week 3	A: Week 6	B: Baseline	B: Week 3	B: Week 6
External rotation	4.49 $\pm$ 0.77	5.25 $\pm$ 0.74	6.07 $\pm$ 0.71	4.43 $\pm$ 0.82	4.83 $\pm$ 0.78	5.12 $\pm$ 0.90
Internal rotation	5.83 $\pm$ 0.84	6.61 $\pm$ 0.92	7.33 $\pm$ 0.89	5.64 $\pm$ 1.04	5.93 $\pm$ 1.05	6.33 $\pm$ 1.05
Abduction	5.33 $\pm$ 0.74	6.05 $\pm$ 0.72	6.69 $\pm$ 0.78	5.61 $\pm$ 0.85	5.99 $\pm$ 0.85	6.27 $\pm$ 0.83

Hand-held dynamometry, mean of three trials.

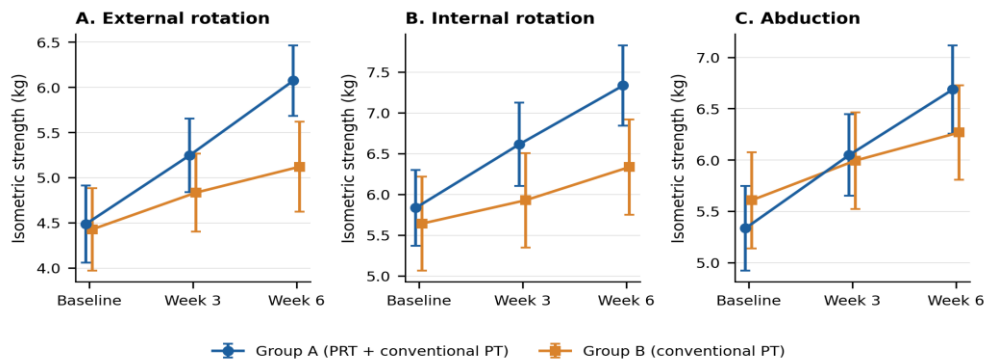


Figure 8. Isometric strength of the shoulder (A) external rotators, (B) internal rotators and (C) abductors. Means with 95% confidence intervals (ITT, LOCF).

Between-Group Effects and Mixed ANOVA

Table 6 combines the baseline-adjusted between-group estimates with the mixed ANOVA results, and Figure 9 shows the standardised week-6 differences for all outcomes. A significant main effect of Time ($p < .001$) was found for every outcome. The Group main effect was not significant for any outcome, as expected given comparable baselines and the divergence of the groups over time. The Group $\times$ Time interaction was significant for 16 of 17 outcomes (the exception was pain at rest), with partial eta squared values from 0.14 to 0.76; the largest

interactions were for strength ($\eta^2 = 0.59-0.76$), passive abduction (0.52) and SPADI total (0.52). Using Cohen's benchmarks, standardised week-6 differences were large for strength (d=0.83–1.09) and SPADI (d=0.80–1.24), medium for DASH, active flexion and passive abduction, small-to-medium for the remaining ROM measures, and small for pain, where the interval for pain at rest included zero (Figure 9). Confidence intervals were fairly narrow, reflecting the consistency of individual change within this small sample.

Table 6. Baseline-adjusted between-group differences (Group A minus Group B) and Group $\times$ Time interaction from the mixed ANOVA.

Outcome	Week 3 adjusted difference (95% CI)	Week 6 adjusted difference (95% CI)	p (Week 6)	Cohen's d (95% CI)	Group $\times$ Time F (df)	p	η^2
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NPRS rest	-0.1 (-0.5 to 0.2)	-0.3 (-0.5 to 0.0)	.059	-0.23 (-0.47 to +0.01)	1.02 (1.4, 40.1)	.347	0.035
NPRS activity	-0.5 (-0.9 to -0.2)	-0.5 (-0.9 to -0.1)	.014	-0.44 (-0.77 to -0.10)	4.55 (1.4, 40.5)	.026	0.140
Active flexion	+1.8 (-0.3 to 3.8)	+7.2 (4.5 to 9.8)	<.001	+0.55 (+0.35 to +0.76)	15.90 (1.5, 43.0)	<.001	0.362
Active abduction	+4.5 (2.3 to 6.7)	+4.7 (2.3 to 7.1)	<.001	+0.37 (+0.18 to +0.56)	9.50 (1.7, 47.1)	<.001	0.253
Active ER	+0.5 (-0.7 to 1.8)	+3.1 (2.0 to 4.1)	<.001	+0.45 (+0.29 to +0.60)	11.30 (1.5, 40.9)	<.001	0.287
Active IR	+3.1 (1.2 to 4.9)	+4.4 (2.7 to 6.1)	<.001	+0.74 (+0.45 to +1.03)	8.79 (1.4, 38.4)	.002	0.239
Passive flexion	+2.0 (-0.0 to 4.0)	+4.5 (2.6 to 6.4)	<.001	+0.34 (+0.19 to +0.48)	8.51 (1.6, 43.8)	.002	0.233
Passive abduction	+3.8 (1.8 to 5.7)	+7.6 (5.8 to 9.3)	<.001	+0.53 (+0.41 to +0.65)	30.87 (1.8, 49.1)	<.001	0.524
Passive ER	+2.5 (1.6 to 3.5)	+3.1 (1.9 to 4.3)	<.001	+0.42 (+0.26 to +0.59)	12.24 (1.3, 35.4)	<.001	0.304
Passive IR	+1.4 (-0.4 to 3.2)	+3.2 (1.6 to 4.7)	<.001	+0.44 (+0.23 to +0.66)	5.22 (1.4, 40.1)	.017	0.157
SPADI pain	-2.7 (-4.6 to -0.8)	-6.9 (-9.2 to -4.5)	<.001	-0.80 (-1.07 to -0.53)	18.61 (1.8, 50.9)	<.001	0.399
SPADI disability	-2.5 (-4.3 to -0.8)	-6.8 (-8.7 to -4.9)	<.001	-0.82 (-1.04 to -0.59)	21.06 (1.5, 41.1)	<.001	0.429
SPADI total	-2.6 (-3.7 to -1.5)	-6.7 (-8.6 to -4.8)	<.001	-1.24 (-1.59 to -0.88)	30.46 (1.4, 40.0)	<.001	0.521
DASH	-2.7 (-4.5 to -0.9)	-5.6 (-7.7 to -3.5)	<.001	-0.58 (-0.79 to -0.36)	14.46 (1.7, 47.6)	<.001	0.340
ER strength	+0.36 (0.24 to 0.48)	+0.89 (0.75 to 1.04)	<.001	+1.09 (+0.91 to +1.27)	87.38 (1.9, 53.5)	<.001	0.757
IR strength	+0.49 (0.37 to 0.60)	+0.80 (0.68 to 0.93)	<.001	+0.83 (+0.70 to +0.95)	72.76 (1.5, 43.2)	<.001	0.722
Abduction strength	+0.32 (0.18 to 0.45)	+0.69 (0.55 to 0.83)	<.001	+0.84 (+0.67 to +1.01)	39.96 (1.5, 41.6)	<.001	0.588

Differences are expressed in the units of each outcome (points for NPRS, SPADI and DASH; degrees for ROM; kg for strength). For NPRS, SPADI and DASH, negative values favour Group A (lower pain/disability); for ROM and strength,

positive values favour Group A. Degrees of freedom are Greenhouse–Geisser-corrected. ANCOVA adjusted for baseline value; ITT with LOCF.

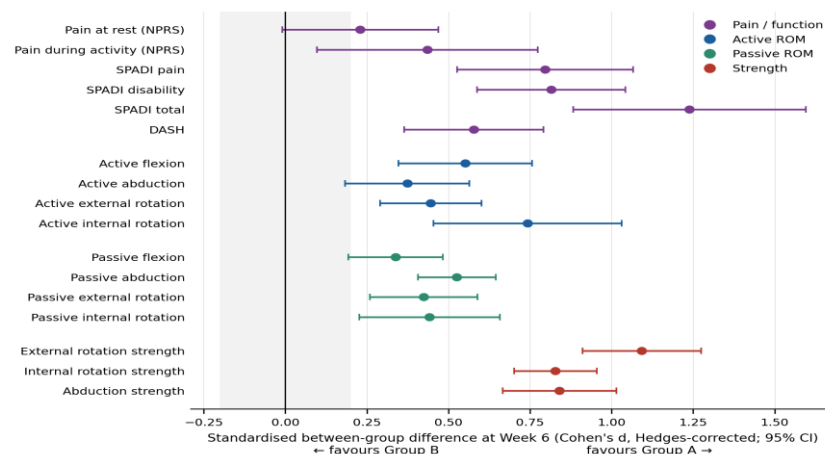


Figure 9. Forest plot of standardised between-group differences at week 6 (Cohen's d, Hedges-corrected, with 95% CI). Signs are aligned so that positive values favour Group A. The shaded band marks $|d| < 0.2$.

Within-Group Change, Responder and Sensitivity Analyses

Within-group changes from baseline to week 6 were statistically significant for every outcome in both groups (Table 7). Within-group standardised effects (dz) were very large (range 1.9–11.4) because individual change scores varied little around their means; these values describe the consistency of change in this sample and should not be taken as estimates of the effect that would be seen in a larger, more heterogeneous population.

Responder analyses using published MCIDs are shown in Table 8. A reduction of at least 2 points in pain during activity was reached by 13/15 (86.7%) participants in Group A and 7/15 (46.7%) in Group B. A SPADI improvement of at least 13 points, the upper bound of the reported MCID range, was achieved by all 15 Group A

participants and 3 of 15 in Group B ($p < .001$), whereas the lower bound of 8 points was reached by nearly everyone in both groups. A DASH improvement of at least 10.83 points was reached by 15 of 15 and 7 of 15 participants, respectively ($p = .002$).

Results were robust to the sensitivity analyses (Table 9). Per-protocol estimates were similar to the primary analysis, and additional adjustment for sex, AC stage and BMI changed the adjusted differences only slightly (for example SPADI total -6.1 vs -6.7 points). Residuals departed from normality (Shapiro–Wilk $p < .05$) for five outcomes (pain at rest, active flexion, active external rotation, and external rotation and abduction strength); non-parametric tests on change scores gave the same conclusions, with pain at rest remaining borderline (Mann–Whitney $p = .049$ vs ANCOVA $p = .059$).

Table 7. Within-group change from baseline to week 6 (mean change, 95% CI; paired t-test).

Outcome	Group A: change (95% CI)	p	Group B: change (95% CI)	p
NPRS rest	−1.1 (−1.2 to −0.9)	<.001	−0.8 (−1.0 to −0.6)	<.001
NPRS activity	−2.0 (−2.3 to −1.7)	<.001	−1.5 (−1.8 to −1.2)	<.001
Active flexion	+19.0 (17.3 to 20.7)	<.001	+11.8 (9.7 to 13.9)	<.001
Active abduction	+17.1 (15.8 to 18.3)	<.001	+12.3 (10.2 to 14.4)	<.001
Active ER	+8.3 (7.5 to 9.2)	<.001	+5.3 (4.6 to 6.0)	<.001
Active IR	+9.6 (8.3 to 10.9)	<.001	+5.3 (4.1 to 6.4)	<.001
Passive flexion	+17.5 (16.6 to 18.5)	<.001	+13.0 (11.3 to 14.7)	<.001
Passive abduction	+19.8 (18.4 to 21.2)	<.001	+12.2 (11.2 to 13.2)	<.001
Passive ER	+8.4 (7.6 to 9.2)	<.001	+5.3 (4.4 to 6.2)	<.001
Passive IR	+9.8 (8.7 to 10.9)	<.001	+6.6 (5.4 to 7.8)	<.001
SPADI pain	−18.0 (−19.5 to −16.5)	<.001	−11.4 (−13.3 to −9.4)	<.001
SPADI disability	−17.0 (−17.8 to −16.2)	<.001	−10.3 (−12.1 to −8.5)	<.001
SPADI total	−17.5 (−18.4 to −16.6)	<.001	−10.8 (−12.6 to −9.1)	<.001
DASH	−16.2 (−17.6 to −14.7)	<.001	−10.6 (−12.1 to −9.0)	<.001
ER strength	+1.59 (1.51 to 1.67)	<.001	+0.69 (0.56 to 0.82)	<.001

IR strength	+1.50 (1.40 to 1.60)	<.001	+0.69 (0.61 to 0.77)	<.001
Abduction strength	+1.35 (1.26 to 1.44)	<.001	+0.66 (0.55 to 0.77)	<.001

ITT with LOCF (n=15 per group). Units as in Table 6.

Table 8. Responder analysis based on published minimal clinically important differences (MCIDs), n (%) of participants.

Responder criterion	Group A (n=15)	Group B (n=15)	p (Fisher)
NPRS during activity, reduction ≥ 2 points	13/15 (86.7)	7/15 (46.7)	.050
SPADI total, improvement ≥ 8 points	15/15 (100.0)	14/15 (93.3)	1.000
SPADI total, improvement ≥ 13 points	15/15 (100.0)	3/15 (20.0)	<.001
DASH, improvement ≥ 10.83 points	15/15 (100.0)	7/15 (46.7)	.002

MCID sources: NPRS 2 points (Farrar et al., 2001); SPADI 8–13 points (Roy et al., 2009); DASH 10.83 points (Franchignoni et al., 2014).

Table 9. Sensitivity analyses: week-6 adjusted differences (Group A minus Group B) under alternative analytic approaches.

Outcome	Primary: ITT, LOCF (n=30)	Per-protocol (n=29)	Adjusted for sex, stage and BMI (n=30)	Mann– Whitney p (change score)
NPRS rest	−0.3 (−0.5 to 0.0)	−0.3 (−0.5 to 0.0)	−0.3 (−0.6 to 0.0)	.049
NPRS activity	−0.5 (−0.9 to −0.1)	−0.5 (−0.9 to −0.1)	−0.6 (−1.0 to −0.2)	.013
Active flexion	+7.2 (4.5 to 9.8)	+6.5 (4.2 to 8.8)	+7.3 (4.4 to 10.3)	<.001
Active abduction	+4.7 (2.3 to 7.1)	+4.2 (2.1 to 6.3)	+4.6 (1.9 to 7.2)	<.001
Active ER	+3.1 (2.0 to 4.1)	+3.0 (1.9 to 4.2)	+3.1 (1.8 to 4.3)	<.001
Active IR	+4.4 (2.7 to 6.1)	+4.2 (2.5 to 6.0)	+3.7 (1.9 to 5.6)	<.001
Passive flexion	+4.5 (2.6 to 6.4)	+4.1 (2.3 to 5.9)	+4.1 (2.0 to 6.2)	<.001
Passive abduction	+7.6 (5.8 to 9.3)	+7.3 (5.6 to 9.0)	+7.3 (5.5 to 9.1)	<.001
Passive ER	+3.1 (1.9 to 4.3)	+3.0 (1.8 to 4.2)	+3.1 (1.7 to 4.5)	<.001
Passive IR	+3.2 (1.6 to 4.7)	+3.1 (1.5 to 4.8)	+2.8 (1.1 to 4.5)	<.001
SPADI pain	−6.9 (−9.2 to −4.5)	−6.1 (−8.1 to −4.1)	−6.5 (−9.2 to −3.9)	<.001
SPADI disability	−6.8 (−8.7 to −4.9)	−6.3 (−8.1 to −4.5)	−6.3 (−8.3 to −4.3)	<.001
SPADI total	−6.7 (−8.6 to −4.8)	−6.1 (−7.7 to −4.5)	−6.1 (−8.2 to −4.1)	<.001
DASH	−5.6 (−7.7 to −3.5)	−5.1 (−7.0 to −3.2)	−5.5 (−7.9 to −3.1)	<.001
ER strength	+0.89 (0.75 to 1.04)	+0.85 (0.73 to 0.97)	+0.82 (0.66 to 0.98)	<.001
IR strength	+0.80 (0.68 to 0.93)	+0.79 (0.67 to 0.92)	+0.81 (0.66 to 0.95)	<.001
Abduction strength	+0.69 (0.55 to 0.83)	+0.66 (0.52 to 0.81)	+0.66 (0.48 to 0.83)	<.001

Estimates are adjusted differences (95% CI) from ANCOVA including the baseline value; units as in Table 6.

DISCUSSION

This pilot RCT showed that adding a criterion-based progressive resistance programme to conventional physiotherapy is feasible and acceptable in adults with diabetic AC, with high retention and attendance, mild and infrequent adverse events, and uniformly favourable

acceptability ratings. Exploratory efficacy analyses favoured the addition of PRT for ROM, function and strength, while differences in pain were small. These findings justify progression to a definitive trial but cannot establish efficacy. Retention (96.7%) and session attendance (90.7%) comfortably exceeded the 80% level

that is commonly used as a working benchmark in pilot studies, although no formal progression criteria were specified in advance, and they did not differ between arms, suggesting that the additional resistance component did not burden participation. Self-reported home exercise adherence was lower (77.6%), which is typical of unsupervised components and is subject to recall bias. Recruitment could not be evaluated beyond reaching the minimum target of 30 participants, and the screening figures should be reported in full (see Section 3.2). Adverse events were mild, similar in frequency between groups (26.7% vs 33.3%), and consistent with the muscle soreness and symptom flare that can follow exercise. No glycaemic event was recorded, which supports the practicability of pre- and post-session glucose monitoring with safety stops at <100 and >300 mg/dL, in line with general guidance on exercise and glycaemic management in diabetes (Colberg et al., 2016). Because the trial excluded people with severe retinopathy, nephropathy or autonomic neuropathy, and was too small to detect uncommon harms, these safety observations apply only to the screened population studied.

Both groups improved substantially over six weeks, consistent with the benefits of conventional physiotherapy and home exercise in AC (Challoumas et al., 2020; Russell et al., 2014; Vermeulen et al., 2006) and with the stage 1–2 and relatively short symptom duration of this cohort. Without a no-treatment arm, part of the improvement in both groups may reflect natural history (Ramirez, 2019), so improvements cannot be attributed wholly to treatment. The difference between groups is the relevant contrast: Group A achieved larger gains in every ROM measure, in SPADI and DASH, and in strength. The direction of these results agrees with the recent pilot trial of resistance-band exercise in diabetic AC, which found greater improvement in ROM, pain and disability than in a control group (Moghadasli & Jafari, 2026). The present design adds an active comparator and a criterion-based progression, isolating the incremental contribution of resistance work to a conventional programme. Several mechanisms could explain why PRT contributed to mobility beyond stretching and mobilisation. Loaded, pain-limited movement through available range may improve neuromuscular control of the rotator cuff and scapular stabilisers, reduce protective muscle guarding and increase the active range that patients can use. The week-3 data, in which

active abduction and internal rotation already differed between groups, are compatible with an early neuromuscular contribution, whereas gains in several other measures emerged later. These explanations are hypotheses; this trial did not measure muscle activation, capsular properties or pain-related inhibition. The larger strength gains in Group A were expected from training specificity and are not in themselves evidence of functional benefit, but the concurrent improvement in SPADI and DASH is encouraging. A further consideration is that Group A performed more loaded work within sessions of matched duration, so effects of exercise dose and of attention cannot be fully separated from those of the resistance component.

The clinical importance of the incremental effect needs careful interpretation. Within-group improvements in Group A in SPADI (17.5 points), DASH (16.2 points) and pain during activity (2.0 points) exceeded published MCIDs (Farrar et al., 2001; Roy et al., 2009; Franchignoni et al., 2014), but the adjusted between-group differences (SPADI –6.7 points, DASH –5.6 points, pain during activity –0.5 points) were smaller than these thresholds, and the ROM differences of about 3–8° are modest. At the same time, the proportion of participants exceeding the upper SPADI threshold was 100% in Group A compared with 20% in Group B. Following recommendations for pilot trials, we therefore emphasise estimates and confidence intervals over significance testing, and treat the effects as signals to be tested rather than as demonstrated benefit (Lee et al., 2014). The narrow confidence intervals and very large within-group effect sizes reflect the uniformity of change across participants in this sample and may overstate the precision that a larger, more heterogeneous population would show.

Clinical Implications

If confirmed, the findings suggest that physiotherapists treating diabetic AC at stage 1–2 may consider adding graded resistance exercise to conventional care once pain allows, using low loads with criterion-based progression (completion of the prescribed sets and repetitions with good form and pain of $\leq 3-4/10$), supervised delivery, and screening for diabetic complications that limit safe exercise. Capillary glucose measured before and after sessions, with clear stop thresholds, appears practicable in routine outpatient settings. Until a definitive trial reports, PRT should be

regarded as a promising, low-risk adjunct rather than an established standard of care.

Limitations and Future Research

The main limitation is the small sample from a single centre, which, as is appropriate for a pilot, was not powered to test efficacy; all efficacy results are exploratory and are not adjusted for multiplicity across 17 outcomes. Participants and therapists were not blinded, and although assessor blinding reduces detection bias, self-reported outcomes (NPRS, SPADI, DASH) remain susceptible to expectation effects. The groups differed numerically in sex, AC stage and BMI despite stratified randomisation, although covariate-adjusted analyses gave similar results. One participant's week-6 data were imputed by last observation carried forward, a simple method that may bias estimates, although the per-protocol analysis agreed with the primary analysis. The follow-up of six weeks does not allow assessment of durability, and the natural history of AC means that longer follow-up is needed to determine whether PRT shortens recovery. Home exercise adherence was self-reported. The study enrolled only people with type 2 diabetes aged 40–65 years at early stages of AC and excluded those with severe complications, which limits generalisability.

Future work should be a multicentre, adequately powered RCT with a sample size derived from the variability observed here and a prespecified primary outcome (for example SPADI total). Trials should include 12-week and longer follow-up, objective load and progression records to verify fidelity, glycaemic outcomes including HbA1c, assessment of capsular and muscle characteristics, formal progression criteria for feasibility, and qualitative evaluation of acceptability. Dose-comparison and cost-effectiveness analyses, and extension to people with type 1 diabetes and later-stage disease, would also be valuable.

CONCLUSION

In this pilot RCT, adding progressive resistance training to conventional physiotherapy was feasible, well accepted and associated with only mild, transient adverse events in adults with type 2 diabetes and stage 1–2 adhesive capsulitis. Preliminary estimates favoured the combined programme for range of motion, shoulder function and strength, with smaller differences for pain. Differences between groups in pain and function were smaller than published MCIDs, so their clinical importance remains uncertain. These results support proceeding to a definitive randomised trial with longer follow-up to establish whether PRT provides clinically meaningful added benefit.

Supplementary Table S1. Participant-level data for key outcomes (complete data set is held in the study master chart).

I D	G rp	A ge	S ex	Sta ge	Se ss.	SPA DI BL	SPA DI W3	SPA DI W6	DA SH BL	DA SH W6	NP RS- A BL	NP RS- A W6	AFI ex BL	AFI ex W6	E R s tr B L	E R s tr W 6
A 0 1	A	53	M	2	17	61.5	51.8	44.0	48. 0	28. 2	5	3	101	121	5. 3	6. 9
A 0 2	A	59	F	1	17	77.0	68.2	61.5	73. 0	56. 8	5	4	66	80	4. 7	6. 3
A 0 3	A	53	M	2	18	64.0	53.3	48.0	56. 0	41. 4	8	6	94	110	5. 7	7. 3
A 0 4	A	56	M	1	18	58.5	49.6	38.9	52. 0	38. 5	5	2	70	85	3. 2	5. 0
A 0 5	A	62	M	1	16	65.5	58.0	49.1	50. 0	30. 0	5	3	90	107	4. 0	5. 6

A 0 6	A	43	F	1	15	73.0	66.6	55.5	56. 0	36. 1	5	3	100	121	4. 9	6. 6
A 0 7	A	51	F	2	16	76.5	69.4	57.3	73. 0	60. 4	8	7	96	119	4. 8	6. 4
A 0 8	A	44	M	1	18	60.5	52.4	43.9	67. 0	51. 6	7	5	67	83	3. 6	5. 1
A 0 9	A	50	M	1	16	65.5	57.7	50.0	56. 0	43. 6	7	5	88	111	5. 0	6. 4
A 1 0	A	58	F	1	15	69.0	59.9	50.6	47. 0	29. 8	5	3	91	109	4. 8	6. 3
A 1 1	A	56	F	2	15	64.0	56.6	46.1	62. 0	45. 2	6	3	66	88	3. 8	5. 5
A 1 2	A	52	F	2	17	69.0	60.8	49.4	54. 0	36. 1	5	3	92	113	5. 3	6. 5
A 1 3	A	59	M	1	15	54.5	43.2	39.3	52. 0	38. 8	6	4	88	109	4. 6	6. 2
A 1 4	A	52	M	1	17	70.5	62.4	52.5	52. 0	36. 1	7	5	104	120	4. 4	6. 1
A 1 5	A	61	F	1	16	72.0	64.2	52.3	66. 0	48. 8	7	5	69	91	3. 2	4. 9
B 0 1	B	58	M	2	17	70.0	62.3	55.3	75. 0	62. 6	6	4	87	103	4. 1	5. 1
B 0 2	B	55	F	1	17	67.5	60.9	54.8	72. 0	58. 5	6	5	66	79	4. 9	5. 7
B 0 3	B	55	M	1	16	73.0	69.1	64.5	50. 0	41. 2	5	4	92	106	5. 1	5. 8
B 0 4	B	59	M	2	18	66.5	62.1	53.7	49. 0	36. 0	8	7	84	95	3. 7	4. 5
B 0 5	B	46	F	1	15	69.0	64.0	57.5	55. 0	45. 8	5	3	66	79	3. 5	4. 3
B 0 6	B	50	F	2	15	65.5	61.1	53.0	50. 0	42. 6	5	4	101	110	5. 3	6. 2
B 0 7	B	52	M	2	18	70.5	63.0	61.4	56. 0	42. 8	7	5	95	106	4. 9	5. 7
B 0 8	B	64	M	2	17	67.0	60.7	52.8	46. 0	35. 3	6	4	95	108	3. 5	4. 0

B 0 9	B	52	M	2	16	69.5	64.1	59.7	55. 0	43. 2	7	6	92	104	3. 4	3. 9
B 1 0	B	53	M	1	18	68.0	60.6	56.0	52. 0	38. 4	6	4	77	85	4. 4	5. 3
B 1 1	B	63	M	2	16	68.5	59.6	60.5	48. 0	39. 8	6	5	92	107	5. 7	6. 2
B 1 2	B	52	M	1	16	63.0	57.0	55.0	63. 0	54. 1	8	6	74	90	4. 1	5. 0
B 1 3	B	46	F	2	18	60.0	55.4	45.1	73. 0	59. 0	7	6	76	92	5. 9	6. 6
B 1 4	B	57	M	1	18	61.0	55.2	50.3	45. 0	35. 4	5	3	94	102	4. 1	4. 6
B 1 5	B	57	M	2	9	68.5	65.5	–	67. 0	–	8	–	74	–	3. 8	–

BL, baseline; W3/W6, week 3/6; Grp, group; Sess., supervised sessions attended (of 18); SPADI total; NPRS-A, NPRS during activity; AFlex, active flexion (°); ER str, external rotation strength (kg). B15 discontinued after week 3; week-6 values shown as “–” were imputed by LOCF (week-3 value) in the ITT analysis.

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