Impact of Circuit-based Exercise in Breast Cancer Survivorship

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Abstract

Adjuvant chemotherapy (AdjCTx) often induces muscle weakness and functional decline in breast cancer patients. This study evaluated the feasibility and functional outcomes of a supervised circuit-based exercise (CBE) program incorporating eccentric resistance in postoperative patients with or without concurrent AdjCTx.

Forty participants completed at least two months of training using the Milon® system, integrating aerobic and eccentric resistance exercises at ~60% 1RM. Both groups showed significant strength improvements over time (F = 10.75–12.34, P < 0.001). While the AdjCTx (–) group achieved greater gains, the AdjCTx (+) group demonstrated steady functional maintenance without regression. Gait speed improved in both groups, and BMI decreased significantly.

These findings suggest that CBE is feasible and well tolerated during chemotherapy and can preserve lower-limb strength and mobility, supporting its use as an early rehabilitation strategy in survivorship care.

Introduction

Adjuvant chemotherapy (AdjCTx) in breast cancer patients is associated with muscle weakness, fatigue, and functional decline that may persist into survivorship. While exercise is recognized as a supportive intervention, the role of circuit-based exercise (CBE) during active chemotherapy remains underexplored. This study investigated the feasibility and functional outcomes of a supervised CBE program in breast cancer patients with or without concurrent AdjCTx.

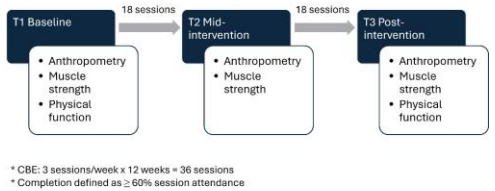


Figure 1. Study timeline and assessment schedule

Methods and Materials

This study included 40 postoperative breast cancer patients who participated in a supervised circuit-based exercise (CBE) program between June 2020 and April 2023. Participants were stratified into AdjCTx (+) (n = 20) and AdjCTx (–) (n = 20) groups according to whether they were undergoing adjuvant chemotherapy.

The CBE protocol, delivered using the Milon® system, combined aerobic and eccentric resistance exercises performed at approximately 60% of one-repetition maximum. Each session was completed twice weekly under professional supervision for at least two months (Figure 1).

Functional outcomes included:

- Isokinetic knee extensor strength (peak torque)
- Gait speed via the 10-meter walk test
- Balance using the Berg Balance Scale (BBS)
- Mobility assessed by the Timed Up and Go (TUG) test

Body composition (BMI, body fat percentage, appendicular lean mass index [ALMI]) was measured using bioelectrical impedance analysis. Within- and between-group changes were evaluated using repeated-measures ANOVA and paired t-tests.

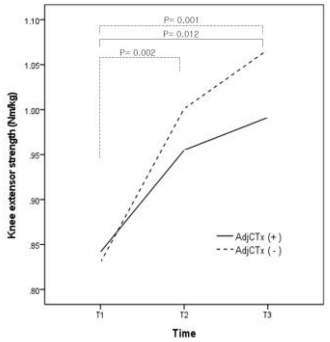


Figure 2. Serial change of knee extensor strength (mean knee extensor peak torque at 60°/sec relative to body weight (Nm/kg)) between groups. Time 1, baseline; Time 2, first follow-up about 2 months of CBE; Time 3, second follow-up about 4.7 months of CBE.

Results

Both groups showed significant improvement in isokinetic knee extensor strength over time (F = 10.75–12.34, P < 0.001). The AdjCTx (–) group demonstrated greater absolute strength gains, whereas the AdjCTx (+) group showed steady, progressive improvement without regression during chemotherapy (Figure 2).

BMI decreased significantly in both groups (P < 0.001), while body fat percentage and ALMI remained stable. Functional gains in TUG and BBS were observed only in the AdjCTx (–) group (P < 0.05), suggesting enhanced post-treatment balance and mobility. In contrast, the AdjCTx (+) group maintained baseline function, reflecting functional preservation despite ongoing chemotherapy (Table 1).

Both groups exhibited significant improvement in gait speed, with a greater relative increase in the AdjCTx (+) group (P = 0.022).

Overall, the findings demonstrate that supervised CBE incorporating eccentric resistance is safe, feasible, and effective in maintaining or improving physical performance in breast cancer patients, irrespective of chemotherapy status.

Table 1. Changes in knee extensor strength and body composition over time in participants with or without adjuvant chemotherapy

Outcomes	Outcome Measure	Group	T1	T2	T3	Intragroup	Time effect	Time*Group effect
			Baseline	Midpoint	Post-intervention	p-value	(F, p)	(F, p)
Knee extensor strength	KEPT (Nm)	AdjCTx (-)	49.0±17.4	57.8±17.9†	59.9±18.4†	0.029*	10.75, <0.001**	0.32, 0.67
		AdjCTx (+)	46.8±16.9	52.2±16.6†	55.4±16.9†	0.001**		
	KEPTBW (Nm/kg)	AdjCTx (-)	0.85±0.29	1.02±0.35†	1.06±0.34†	0.021*	12.34, <0.001**	0.38, 0.64
		AdjCTx (+)	0.83±0.26	0.93±0.26	1.00±0.28†	<0.001**		
Body composition	BMI (kg/m²)	AdjCTx (-)	24.2±5.6	23.1±3.7	23.0±3.7	<0.001**	64.43, <0.001**	0.82, 0.40
		AdjCTx (+)	22.8±4.0	22.6±4.2	22.4±4.2	<0.001**		
	Body fat (%)	AdjCTx (-)	32.0±9.0	31.7±8.7	31.9±7.9	0.96	0.181, 0.83	0.23, 0.79
		AdjCTx (+)	30.2±8.6	30.3±8.3	29.4±8.2	0.49		
	ALMI (kg/m²)	AdjCTx (-)	6.3±1.1	6.3±1.0	6.3±1.0	0.60	0.38, 0.63	0.61, 0.5
		AdjCTx (+)	6.1±0.76	6.0±0.65	6.0±0.6	0.53		

Values are mean ± standard deviation.

*P<0.05, **P<0.01 by two-way repeated measures ANOVA

†P<0.05 indicates a difference from baseline (T1) within the same group.

KEPT, knee extensor peak torque at 60°/sec; KEPTBW, knee extensor peak torque relative to body weight; BMI, Body Mass Index; ALMI, Appendicular Lean Mass Index

Discussion

This study demonstrates that circuit-based exercise (CBE) integrating eccentric resistance is both feasible and beneficial during adjuvant chemotherapy.

Despite the physiological stress of ongoing treatment, participants in the AdjCTx (+) group maintained muscle strength and mobility, suggesting a protective effect of structured, supervised exercise. The absence of functional regression is particularly meaningful in this population, where fatigue and deconditioning are common.

Eccentric resistance likely contributed to greater mechanical efficiency and lower perceived exertion, enabling consistent training adherence. The CBE format further facilitated safety and progression through automated resistance control and balanced aerobic–strength integration.

Patients not receiving chemotherapy (AdjCTx –) demonstrated broader gains in strength, balance, and mobility, likely reflecting enhanced recovery capacity once systemic treatment stress was removed.

Together, these findings extend the evidence supporting early exercise intervention during cancer therapy, highlighting that individualized, supervised CBE can mitigate treatment-related decline and sustain physical function throughout survivorship.

Conclusions

CBE incorporating eccentric resistance is a safe, feasible, and effective rehabilitation strategy for breast cancer patients, including those undergoing adjuvant chemotherapy.

It preserves lower-limb strength, mobility, and overall functional capacity, preventing treatment-related physical decline.

Early integration of supervised CBE during chemotherapy may help maintain independence and quality of life, bridging the gap between active treatment and survivorship.

These findings support incorporating structured, individualized CBE into standard oncology rehabilitation programs.

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