Effect of Exercise on Upper Extremity Pain and Dysfunction in Head and Neck Cancer Survivors

A Randomized Controlled Trial

Margaret L. McNeely, PhD[1]
Matthew B. Parliament, MD[2,3]
Hadi Seikaly, MD[4,5]
Naresh Jha, MD[2,3]
David J. Magee, PhD[6]
Mark J. Haykowsky, PhD[6]
Kerry S. Courneya, PhD[1]

[1] Faculty of Physical Education and Recreation, University of Alberta, Edmonton, Alberta, Canada.

[2] Department of Radiation Oncology, Cross Cancer Institute, Edmonton, Alberta, Canada.

[3] Department of Radiation Oncology, University of Alberta, Edmonton, Alberta, Canada.

[4] Department of Surgery, Capital Health Authority, Edmonton, Alberta, Canada.

[5] Department of Surgery, University of Alberta, Edmonton, Alberta, Canada.

[6] Department of Physical Therapy, University of Alberta, Edmonton, Alberta, Canada.

Supported in part by a Research Award from the Physiotherapy Foundation of Canada.

Dr. McNeely was supported by a Full Time Health Research Studentship from the Alberta Heritage Foundation for Medical Research.

Dr. Courneya is supported by the Canada Research Chairs Program and a Research Team Grant from the National Cancer Institute of Canada with funds from the Canadian Cancer Society and the Sociobehavioural Cancer Research Network.

We gratefully acknowledge Diane Cook, Jorge Fuentes, Aliya Ladha, Lisa Workman, and Erica Mueller for their assistance in exercise supervision, testing, and data management.

Address for reprints: Margaret L. McNeely, PhD, Faculty of Physical Education and Recreation, University of Alberta, E-488 Van Vliet Center, Edmonton, Alberta, Canada, T6G 2H9; Fax: (780) 492-8003; E-mail: mmcneely@ualberta.ca

Received November 5, 2007; revision received February 13, 2008; accepted February 15, 2008.

BACKGROUND. Shoulder pain and disability are well recognized complications associated with surgery for head and neck cancer. This study was designed to examine the effects of progressive resistance exercise training (PRET) on upper extremity pain and dysfunction in postsurgical head and neck cancer survivors.

METHODS. Fifty-two head and neck cancer survivors were assigned randomly to PRET (n = 27) or a standardized therapeutic exercise protocol (TP) (n = 25) for 12 weeks. The primary endpoint was change in patient-rated shoulder pain and disability from baseline to postintervention. Secondary endpoints were upper extremity strength and endurance, range of motion, fatigue, and quality of life.

RESULTS. Follow-up assessment for the primary outcome was 92%, and adherence to the supervised PRET and TP programs were 95% and 87%, respectively. On the basis of intention-to-treat analyses, PRET was superior to TP for improving shoulder pain and disability (−9.6; 95% confidence interval [95% CI], −16.4 to −4.5; $P = .001$), upper extremity strength (+10.8 kg; 95% CI, 5.4–16.2 kg; $P < .001$), and upper extremity endurance (+194 repetitions × kg; 95% CI, 10–378 repetitions × kg; $P = .039$). Changes in neck dissection impairment, fatigue, and quality of life favored the PRET group but did not reach statistical significance.

CONCLUSIONS. The PRET program significantly reduced shoulder pain and disability and improved upper extremity muscular strength and endurance in head and neck cancer survivors who had shoulder dysfunction because of spinal accessory nerve damage. Clinicians should consider the addition of PRET in the rehabilitation of postsurgical head and neck cancer survivors. ***Cancer* 2008;113:214–22.** © *2008 American Cancer Society.*

KEYWORDS: head and neck cancer, spinal accessory nerve, shoulder, pain, quality of life, exercise, physical therapy.

Shoulder dysfunction is a well recognized complication after neck dissection procedures and a major concern in the long-term quality of life of head and neck cancer (HNC) survivors. It is believed that impairment in shoulder function results from damage to or resection of the spinal accessory nerve and the ensuing denervation of the trapezius muscle.[1] Although neck dissection procedures that preserve the spinal accessory nerve currently are more common, a variable degree of shoulder dysfunction still occurs in 20% to 60% of patients.[2] More recent evidence suggests that shoulder pain and dysfunction cannot be attributed solely to spinal accessory neurapraxia and neurotmesis.[3] Symptoms that occur after nerve-sparing procedures may be complicated by neuropathic pain in the neck and by the presence of secondary effects in the shoulder, such as adhesive capsulitis, and

DOI 10.1002/cncr.23536
Published online 5 May 2008 in Wiley InterScience (www.interscience.wiley.com).

myofascial pain in the upper trapezius, levator scapulae, and rhomboid muscles.[3,4]

HNC survivors who have undergone neck dissection have increased risk for disability from their cancer and/or cancer treatment.[5] To our knowledge to date, however, few physical therapy intervention studies have been performed with the intent to reduce pain and disability in HNC survivors. In 2002, we conducted a pilot study to evaluate the feasibility of progressive resistance exercise training (PRET) for shoulder dysfunction because of spinal accessory neurapraxia/neurectomy in patients with HNC.[6] The pilot study demonstrated a high rate of follow-up assessment (85%) and excellent adherence to the PRET program (93%) with preliminary evidence of an efficacy benefit for patient-rated shoulder pain and disability.

Here, we report the results of our efficacy trial comparing a PRET program with a standardized therapeutic exercise protocol (TP) for upper extremity pain and dysfunction in postsurgical HNC survivors. We hypothesized that the PRET program would enhance muscular strength and endurance of the scapular muscles and reduce patient-rated shoulder pain and disability compared with TP.

MATERIALS AND METHODS

Setting and Participant

The trial was conducted at the Cross Cancer Institute and University of Alberta in Edmonton, Canada. Approval for the study was received from the Health Research Ethics Board of the University of Alberta and the Research Ethics Committee of the Alberta Cancer Board. All participants were diagnosed with carcinoma in the head and neck region that had been managed by definitive surgical resection. Eligibility criteria also included 1) surgical treatment, including radical neck dissection, modified radical neck dissection, and other variants of selective neck dissection; 2) Karnofsky performance status $\geq$60%[7,8]; 3) no evidence of residual cancer in the neck and no distant (M0) metastasis; and 4) completion of adjuvant HNC treatment. Participants also were required to present with symptoms of shoulder dysfunction attributed to spinal accessory nerve damage. Shoulder dysfunction because of spinal accessory nerve dysfunction was assumed if the participant presented with $\geq$3 of the following signs: atrophy of the upper trapezius muscle, shoulder droop, scapular malalignment (including lateral drift and rotation of the scapula), winging of the scapula with elevation of the arm, and limitation in shoulder abduction range of motion (ROM).

Participants were ineligible if they presented with 1) a history of shoulder or neck pathology unrelated to cancer treatment or 2) comorbid medical illness or psychiatric illness that would prevent completion of treatment or interfere with follow-up. Eligible participants were required to provide informed consent.

Experimental Design and Recruitment

The study was a prospective, randomized, controlled trial. Potential participants were recruited by using 2 methods. The Alberta Cancer Registry identified HNC survivors who lived within the region. The survivor's oncologist or surgeon was contacted to approve the survivor for potential participation in the study. A recruitment letter was mailed to the approved survivor that invited them to participate in the study. Potential participants also were identified by their surgeon or oncologist through otolaryngology head and neck follow-up clinics.

Randomization and Blinding

Eligible participants were stratified by tumor location (oral/oropharynx vs hypopharynx/larynx vs thyroid) and type of neck dissection (radical neck dissection vs modified radical neck dissection/variants of selective neck dissection) to control for potential differences in quality of life and recovery among HNC survivors. Participants were assigned randomly to TP or PRET after baseline testing. An independent researcher generated the allocation sequence by using a computer-generated code. A block permutation procedure was used to generate the allocation sequence within each stratum. The allocation sequence and contents of the envelopes were enclosed in sequentially numbered and sealed (opaque) envelopes. The allocation sequence and contents of the envelopes were concealed from all study personnel. Independent assessors who were blinded to group assignment performed the ROM and strength and endurance tests.

Interventions

All participants were asked to attend a minimum of 2 supervised sessions per week (with the option of a third session at the center or at home) for the 12-week intervention period. Both TP and PRET sessions took place at the Behavioral Medicine Fitness Centre at the University of Alberta and were administered by a physical therapist with experience working with HNC survivors (M.L.M.).

Standardized Therapeutic Exercise Group

Participants who were randomized to the TP group were provided with a therapeutic exercise treatment protocol for the 12-week period. TP was used as the comparison intervention in this study, because it represents the current standard of care at our center. The therapeutic exercise protocol consists of supervised active and passive ROM/stretching exercises, postural exercises, and basic strengthening exercises with light weights (1–5 kg) and elastic resistance bands. The specific strengthening exercises focused on the following muscle groups: rhomboids/middle trapezius; levator scapula/upper trapezius; biceps; and triceps, deltoid, and pectoralis major. For participants who had recovery of active trapezius muscle function, specific exercises to target the trapezius muscle were introduced between Weeks 6 and 8 of the intervention.

Progressive Resistance Exercise Training Group

Participants who were randomized to the PRET group received the same active and passive ROM/stretching exercises and postural exercises as the TP group. The PRET program replaced the basic strengthening exercises of the TP protocol and was performed for the same muscle groups as the TP protocol. However, the PRET protocol was tailored to each survivor based on baseline testing results and was prescribed with the intent to provide progressive overload to the specific muscle groups. The program consisted of 2 sets of 10 to 15 repetitions of 5 to 8 exercises, starting at 25% to 30% of their 1-repetition maximum (1-RM) strength and slowly progressing to 60% to 70% of their 1-RM strength by the end of the intervention period. Guidelines for exercise performance included maintenance of proper posture and scapular stability (eg, no winging of scapula) and a rating of perceived exertion on the Borg scale of no greater than 13 to 15 of 20 (described as "somewhat hard" to "hard").[9] The response to exercise in terms of postexercise pain and muscle soreness was recorded on the training log at the subsequent exercise session, and the prescription was modified as necessary. The resistance weight was increased by 1 kg to 2.5 kg once the participant was able to complete 2 sets of 15 repetitions with proper form. Details of the PRET protocol have been published previously.[6]

Assessment of Primary and Secondary Endpoints

Patient-rated and objectively measured outcomes were assessed at baseline and postintervention. The primary outcome was change in patient-rated shoulder pain and disability from baseline to postintervention using the Shoulder Pain and Disability Index (SPADI),[10] which is a valid and reliable instrument that reflects the pain and disability associated with the clinical syndrome of a painful shoulder.[11] Scores for the pain and disability subscales range from 0 to 100, with higher scores indicating greater impairment. The total SPADI score is calculated by averaging the Pain and Disability subscale scores.

Muscular strength of the upper extremity was assessed by a 1-RM test for the seated row and the chest press. Each upper extremity (right and left) was tested individually (1-arm test) followed by testing of both extremities (2-arm test). If participants presented with impairments in both shoulders as a result of undergoing bilateral neck dissection, then they were asked to identify their most 'problematic shoulder' for the purpose of analyzing shoulder outcomes. Muscular endurance was assessed by using a submaximal seated row test. The weight for this test was set at 50% of the individual's baseline 1-RM weight, and the test was performed at a cadence of 22 repetitions per minute (set by a metronome). The maximum number of repetitions performed before falling behind the required cadence was recorded. The same resistance weight (50% of baseline 1-RM) was used for the endurance test at the postintervention test. Muscular endurance scores were calculated by multiplying the weight in kilograms by the number of repetitions completed.

The measurement of shoulder ROM was performed by using a universal goniometer according to standardized procedures.[12] Active shoulder movements included forward flexion, abduction, and external rotation. Passive shoulder movements included forward flexion, abduction, external rotation, and horizontal abduction.

Quality of life and fatigue were assessed by using the Functional Assessment of Cancer Therapy-Anemia (FACT-An) scale.[13,14] The FACT-An is a valid and reliable cancer-specific quality-of-life instrument that consists of a 27-item core to which a 20-item fatigue- and anemia-specific subscale is added. The Neck Dissection Impairment Index (NDII) was used to assess treatment-specific quality of life. The NDII is a valid and reliable instrument for assessing neck dissection impairment. Individual items from the 10-question NDII are scored from 1 (a lot) to 5 (not at all), and higher scores represent less impairment.[15] The total NDII score is scaled to a 100-point cumulative score.

Covariates, Adherence, and Adverse Events

Demographic and behavioral data were collected by self-report, and medical data were abstracted from

records. The physical therapist monitored adherence and adverse events.

Sample Size

The sample size was calculated based on the mean difference between groups in change scores from baseline to postintervention on the primary outcome. The effect size was determined from the results of the pilot study, in which the mean difference between PRET and TP groups in the SPADI score was 14.5 with a standard deviation of 20 (effect size, 0.73). The required sample size for the study was approximately 60 participants or 30 participants per group to detect a moderate to large standardized difference (effect size, 0.75) in the primary outcome.

Analysis Plan

Baseline characteristics and adverse events of the 2 groups were compared by using the independent-samples Student *t* test for continuous data and the Pearson chi-square test for categoric data. Primary analysis used the independent samples *t* test to compare change scores between groups in outcomes from baseline to postintervention. Intention-to-treat analyses were conducted on all randomized participants by using baseline-observation-carried-forward analysis. Adjusted analyses controlled for baseline values of the outcome, age, sex, cancer stage, time since surgery, neck dissection type, and pain medication use. Probability levels $<.05$ (2-tailed) were accepted as significant.

RESULTS

Recruitment began October 1, 2005 and ended October 31, 2006 (Fig. 1). Fifteen of 45 eligible participants (33%) were recruited through the mailed letter of invitation. The estimated accrual rate from otolaryngology/head and neck follow-up clinics was 37 of 65 potentially eligible participants (57%). Of the patients who contacted the study coordinator, the most common reason for refusal was too busy (n = 5 participants). Recruitment of patients was stopped early at 52 participants to allow completion of the trial within the funding period.

The groups were balanced at baseline (Table 1). There was a wide range in the time from surgery to entry into the study (range, 2–180 months), and 3 participants were long-term survivors (>60 months). However, there were no significant differences between the groups in the time from surgery ($P = .384$). Full 12-week data were obtained on 46 of 52 participants (88%) and did not differ by group ($P = .995$). One participant in the PRET group withdrew because of a soft-tissue injury as a result of exercise participation. One participant (PRET group) was hospitalized for acute cholecystitis and, while hospitalized, suffered a stroke (unrelated to exercise participation). Two participants in the TP group withdrew because of cancer recurrence. Two participants were unable to perform the physical testing component at the end of the intervention period because of health concerns unrelated to study participation (1 participant in the PRET group underwent abdominal surgery for colon cancer and 1 participant in the TP group was under evaluation for cardiac disease). The TP group and the PRET group attended 87% and 95% of their 24 supervised physical therapy sessions, respectively. Three participants in the TP group continued with their usual exercises at home during the 12-week intervention period.

Changes in Patient-rated Outcomes

The overall SPADI score decreased by 14.1 in the PRET group compared with a decrease of 4.8 in the TP group (adjusted: −9.6; 95% confidence interval [95% CI], −16.4 to −4.5; $P = .001$) (Fig. 2). Scores on the Pain subscale decreased by 16.4 in the PRET group and by 2.2 in the TP group (adjusted: −16.4; 95% CI, −21.3 to −4.4; $P = .004$) (Fig. 3). The Disability score decreased by 11.8 in the PRET group and by 7.4 in the TP group and was statistically significant after adjusting for relevant baseline variables (−9.6; 95% CI, −13 to −2.5; $P = .005$) (Table 2). All other changes in patient-rated outcomes favored the PRET group but did not reach statistical significance (Table 2).

Changes in Objectively Measured Outcomes

PRET was superior to TP for all strength endpoints (Table 3). Muscular endurance, as assessed by a standard load test, was improved significantly in the PRET group compared with the TP group (+194; 95% CI, 10-378; $P = .039$). Results for ROM measurements favored the PRET group with active external rotation ROM (+13; 95% CI, 6.5-20; $P < .001$) and passive abduction ROM (+8; 95% CI, 1-15; $P = .029$) reaching statistical significance after adjusting for relevant baseline variables.

Associations Among Objective Measures and Patient-rated Outcomes

Improvement in muscular strength was associated significantly with reduction in the SPADI total score (correlation coefficient [r] = −.35; $P = .011$) and in the Pain subscale score ($r = -.42$; $P = .002$), but not in the Disability subscale score ($r = -.14$; $P = .319$). Improvement in muscular endurance also was

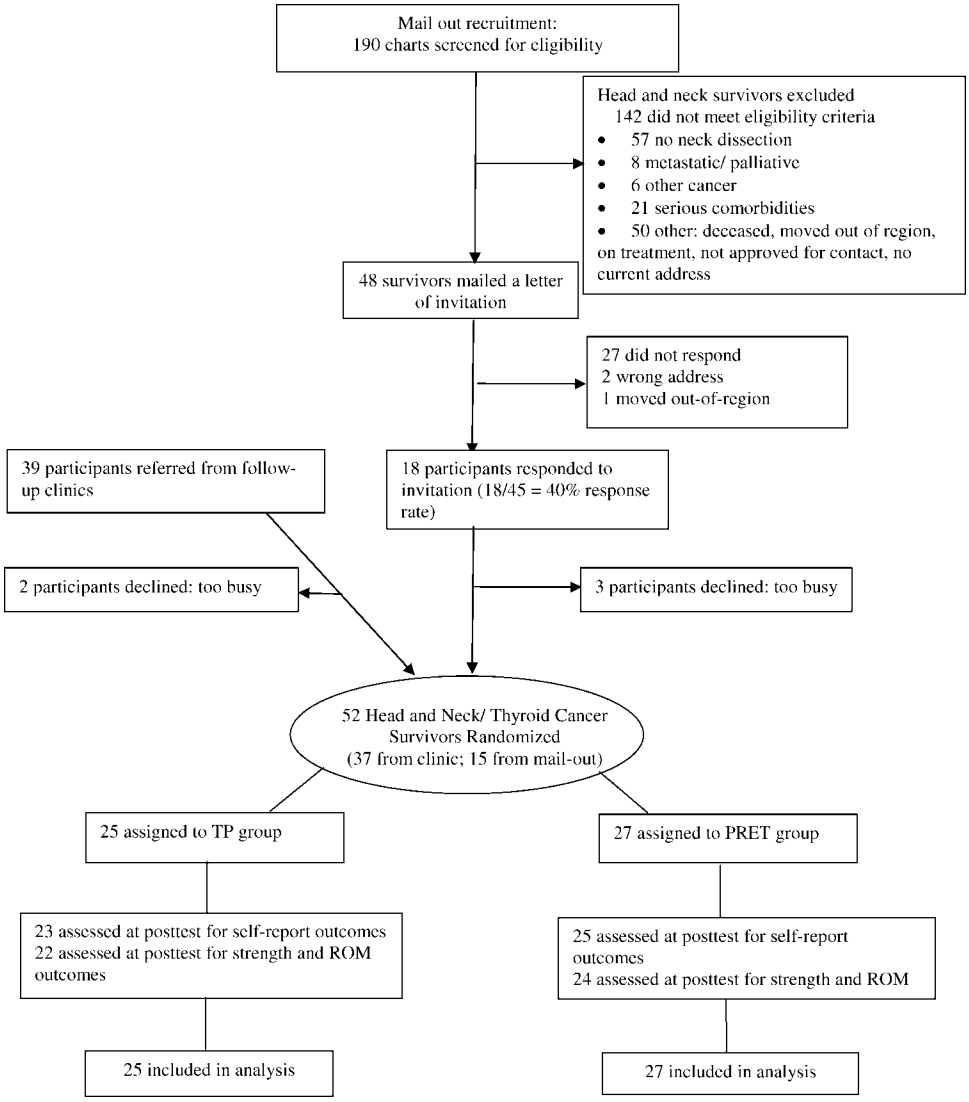

FIGURE 1. Flow of participants through the trial. TP indicates standardized therapeutic exercise protocol; PRET, progressive resistance exercise training; ROM, range of motion.

associated significantly with reduction in the SPADI score ($r = -.29$; $P = .037$) and the in Pain subscale score ($r = -.35$; $P = .010$). Improvement in abduction ROM was associated with reduction in the Disability subscale score ($r = -.28$; $P = .046$).

Adverse Events

One participant in the PRET program experienced increased pain as a result of soft-tissue injury to the scapular region. Despite changes to the exercise program, the participant continued to experience increased pain after sessions and elected to withdraw from the study.

DISCUSSION

The major novel finding of the trial was that the PRET program had a beneficial effect on shoulder pain. The standardized effect size of d = .84 represents a large effect on pain[16] and the percentage reduction in pain of 52% in the PRET group exceeds the 30% to 50% reduction in pain for patient-perceived improvement.[17,18] The improvement in pain was associated with increases in upper extremity strength and endurance. The findings are consistent with the hypothesis that reductions in pain may be mediated by improvements in muscular strength and endurance. It is believed that pain is secondary to trapezius muscle atrophy, which leads to the

TABLE 1
Baseline Demographic, Medical, and Behavioral Profile of Participants

Variable	No. of participants (%)			*P*
	Overall (n=52)	TP (n=25)	PRET (n=27)	
Demographic profile				
Mean age [range], y	52 [32–76]	57 [43–76]	53 [32–76]	.092
Women	15 (29)	8 (32)	7 (26)	.762
Married	35 (67)	18 (72)	17 (63)	.625
Completed university	26 (50)	14 (56)	12 (44)	.701
Income >$80,000/y	21 (40)	12 (48)	9 (33)	.401
On disability	20 (38)	9 (36)	11 (41)	.574
Median time from surgery [range], mo	15 [2–180]	17 [2–180]	12 [2–120]	.384
<9 mo	22 (42)	10 (40)	11 (41)	
9–17 mo	8 (15)	4 (16)	4 (15)	
≥18 mo	23 (44)	11 (44)	12 (23)	.993
Medical profile				
Diagnosis				.537
Oral/oropharynx	32 (62)	16 (64)	16 (59)	
Larynx/hypopharynx	12 (23)	6 (24)	6 (22)	
Thyroid	2 (4)	1 (4)	1 (4)	
Other*	6 (12)	2 (8)	4 (15)	
Disease stage				.254
I	3 (6)	1 (4)	2 (7)	
II	6 (12)	3 (12)	3 (11)	
II	12 (23)	3 (12)	9 (33)	
IV	30 (58)	18 (72)	12 (44)	
Bilateral neck dissection	40 (77)	18 (72)	22 (81)	.517
Neck dissection type				.520
RND	9 (17)	5 (20)	4 (15)	
MND: SCM sacrificed	5 (10)	1 (4)	4 (15)	
MND to Level 5	20 (38)	11 (44)	9 (33)	
SND (Level 5 spared)	18 (35)	8 (32)	10 (37)	
Radiation therapy				.445
Bilateral neck	37 (71)	15 (60)	22 (81)	
IMRT protocol	5 (10)	4 (16)	1 (4)	
Unilateral neck	2 (4)	1 (4)	1 (4)	
Chemotherapy protocol				.668
Cisplatin	9 (17)	4 (16)	5 (19)	
Carboplatin	3 (6)	1 (4)	2 (7)	
Carboplatin/cisplatin plus 5FU	2 (4)	1 (4)	1 (4)	
Pain medication				
Daily narcotic medication	12 (23)	7 (28)	5 (19)	.315
Behavioral profile				
Current exerciser†	8 (15)	4 (16)	4 (15)	.603
Current smoker	6 (12)	1 (4)	5 (19)	.618
Current regular drinker	3 (6)	1 (4)	2 (7)	.494

TP indicates standardized therapeutic exercise protocol; PRET, progressive resistance exercise training; RND, radical neck dissection; MND, modified radical neck dissection; SCM, sternocleidomastiod muscle; SND, selective neck dissection; IMRT, intensity-modulated radiotherapy; 5FU, 5-fluouracil.

* Parotid (n = 2), sarcoma mandible (n = 2), and unknown primary (n = 2).

† Current exerciser, ≥150 minutes of moderate-strenuous exercise per week.

downward and lateral displacement of the scapula and droop of the shoulder.[19] Increased strength of the scapular muscles may alleviate pain by improving the positioning of the scapula and, thus, the mechanics of the shoulder complex.

There was a significant difference in favor of PRET for overall SPADI score. The decrease in overall pain and disability of −9.6% in favor of the PRET group met the minimal clinically important difference (MCID), or the smallest difference of importance to clinicians and patients, for the SPADI scale.[20] A significant difference in the Disability subscale score in favor of the PRET group also was observed after adjusting for baseline differences, suggesting greater

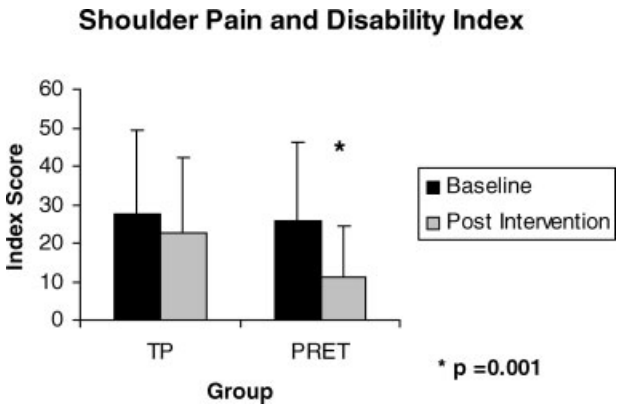

FIGURE 2. Shoulder pain and disability index: baseline and postintervention scores. TP indicates standardized therapeutic exercise protocol; PRET, progressive resistance exercise training.

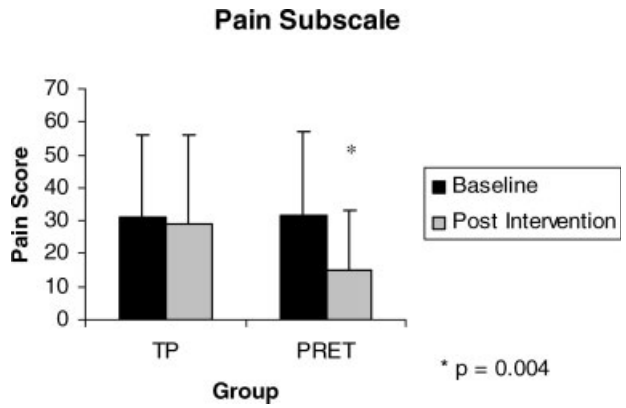

FIGURE 3. Pain subscale: baseline and postintervention scores. TP indicates standardized therapeutic exercise protocol; PRET, progressive resistance exercise training.

TABLE 2
Effects of Progressive Resistance Exercise Training on Patient-rated Disability and Quality of Life Measures

	Mean (SD)			Group differences in mean change: mean [95% CI]			
Variable	Baseline	Postintervention	Mean Change	Unadjusted	*P*	Adjusted*	*P*
SPADI Disability subscale							
TP (n=25)	23.6 (22.6)	16.1 (14.6)	−7.4 (16.9)				
PRET (n=27)	19.6 (18.8)	7.6 (10.1)	−11.8 (15.3)	−4.2 [−13.3 to 4.7]	.337	−9.6 [−13 to −2.5]	.005
NDII							
TP (n=25)	52.2 (21.8)	60.2 (21.9)	+8 (13.4)				
PRET (n=27)	55.8 (20.9)	68.6 (22)	+12.8 (17.5)	+4.8 [−3.9 to 13.5]	.278	+4.8 [−4 to 13.6]	.278
FACT-An (score, 0–188)							
TP (n=25)	130.6 (30.9)	134.4 (34)	+3.9 (10)				
PRET (n=27)	133.9 (23.8)	142.4 (27)	+8.5 (19.3)	+4.6 [−4.0 to 13.3]	.287	+6.5 [−2.9 to 15.9]	.147
FACT-G (score, 0–108)							
TP (n=25)	76.4 (18.4)	78.1 (19.3)	+1.7 (6.9)				
PRET (n=27)	79.4 (13.7)	83.9 (15.6)	+4.4 (10.6)	+2.7 [−2.3 to 7.7]	.287	+4.5 [−0.7 to 9.7]	.091
Fatigue subscale (score, 0–52)							
TP (n=25)	32.7 (11)	34.3 (11.1)	+1.6 (5.6)				
PRET (n=27)	33.5 (9.7)	36.7 (9)	+3.1 (9)	+1.5 [−2.7 to 5.7]	.478	+1.4 [−3.1 to 5.8]	.540

SD indicates standard deviation; 95% CI, 95% confidence interval; SPADI, Shoulder Pain and Disability Index; TP, standardized therapeutic exercise protocol; PRET, progressive resistance exercise training; NDII, Neck Dissection Impairment Index; FACT-An, Functional Assessment of Cancer Therapy-Anemia. FACT-G, Functional Assessment of Cancer Therapy-General.
* Adjusted for baseline value, age, sex, cancer stage, time since surgery (category), neck dissection type, and pain medication use.

benefit from PRET in shoulder disability as well as pain. Positive effects of PRET were observed in both active and passive ROM. Larger effects were observed consistently in the PRET group, and the data suggest that even ROM may be improved to a greater degree in PRET compared with TP.

Although the current study did not detect a difference in quality of life, there was a trend in favor of the PRET group that approached the MCID of 7 points on the FACT-An and exceeded the 4-point MCID on the FACT General (FACT-G) instrument after adjusting for relevant baseline variables. A recent meta-analysis examining exercise interventions for breast cancer survivors reported a significant improvement on the FACT-G scale of 4.6 points.[21] This finding in the HNC population suggests a potential efficacy benefit in quality of life from PRET that warrants further research with a larger sample of HNC survivors.

NDII standardized score improved in both groups and favored the PRET group but did not reach statistical significance. The NDII examines the impact of

TABLE 3
Effects of Progressive Resistance Exercise Training on Muscular Strength and Endurance

	Mean (SD)			Group differences in mean change: mean [95% CI]			
Variable	**Baseline**	**Postintervention**	**Mean change**	**Unadjusted**	***P***	**Adjusted***	***P***
1 RM 2-arm							
Seated row, kg							
TP (n=25)	35.2 (20.6)	41.3 (23.1)	+5.5 (7.9)				
PRET (n=27)	43.9 (17.9)	60.2 (21.1)	+16.3 (11.1)	+10.9 [5.5–16.3]	<.001	+10.8 [5.4–16.2]	<.001
Chest press, kg							
TP (n=25)	30.0 (16.8)	37.0 (21.1)	+7.1 (10)				
PRET (n=27)	35.4 (14.7)	51.4 (20.6)	+16.0 (12.5)	+8.9 [2.6–15.2]	.007	+7.3 [0.8–13.8]	.029
1 RM affected shoulder							
Seated row, kg							
TP (n=25)	17.1 (10.4)	20.6 (11.1)	+3.6 (4.7)				
PRET (n=27)	19.7 (8.8)	27.6 (10.3)	+7.9 (5.2)	+4.3 [1.5–7.1]	.003	+4.2 [1.4–7.1]	.004
Chest press, kg							
TP (n=25)	15.1 (8.9)	17.5 (9.8)	+2.3 (4.6)				
PRET (n=27)	16.2 (7.9)	24.0 (10.7)	+7.8 (6.2)	+5.5 [2.4–8.5]	.001	+4.8 [1.7–7.9]	.003
Standard load, reps × kg							
Endurance test							
TP (n=25)	469 (313)	712 (415)	+243 (325)				
PRET (n=27)	567 (267)	1032 (432)	+466 (324)	+223 [42–403]	.017	+194 [10–378]	.039

SD indicates standard deviation; 95% CI, 95% confidence interval; 1 RM, 1 repetition maximum strength; TP, standardized therapeutic exercise protocol; PRET, progressive resistance exercise training; reps, repetitions.

* Adjusted for baseline value, age, sex, cancer stage, time since surgery (category); neck dissection type, and pain medication use.

neck dissection on activities beyond those of just daily living and includes items related to work and recreational activities; however, the instrument does not separate shoulder symptoms from neck symptoms. The shoulder-specific PRET program may have some potential benefit beyond TP for work and recreational activities that requires further investigation.

The PRET prescription for this study focused on strengthening the scapular muscles to optimize shoulder alignment and posture. The resistance training protocol was prescribed with the resistance weight starting at 25% to 30% of 1-RM, whereas other studies in cancer patients have prescribed resistance exercise training starting at 60% to 85% of 1-RM.[22,23] Despite the more conservative approach, the strength gains of 37% to 48% from the PRET program compare favorably with the reported gains of 30% to 45% in upper extremity strength from a previous 12-week study in breast cancer survivors.[23]

The fact that both groups received an intervention with an exercise component allowed us to control for potential nonspecific intervention factors, such as social interaction with the therapist, expectation of benefit, and a sense of accomplishment, which may confound patient-rated outcomes in less optimally controlled trials. Other study strengths included blinded evaluation of outcomes, intention-to-treat analysis, limited loss-to-follow-up, and excellent adherence comparable to other cancer trials.

A potential limitation of the study was that the treatments for both groups were administered by the first author (M.L.M.). However, we believed that it was important to have the same physical therapist provide treatments to both groups to ensure continuity and consistency in the delivery of the treatment protocol.

A limitation in our study was the wide range in time from surgery among participants. The results of the study may have been limited by long-term survivors with deficits refractory to TP that focused primarily on active and passive ROM and basic strengthening exercises. Further research is needed examining PRET in specific stages in the recovery process after surgery.

We also did not differentiate between location and type of pain in the study participants. Therefore, we do not know whether our intervention resulted in positive effects for the differing presentations of pain that occur in HNC survivors, such as neuropathic pain in the neck region. Moreover, we did not attempt to characterize differential involvement of the upper, middle, and lower trapezius, which may affect the HNC survivor's clinical presentation and response to treatment. The rate of bilateral neck

dissection was high in our cohort; however, a limited neck dissection was performed on the contralateral side almost exclusively, with minimal morbidity. The therapeutic effect of PRET, however, may be more modest in cohorts that undergo fewer bilateral procedures.

In summary, the current trial demonstrated important improvements in shoulder pain and disability, upper extremity strength, and movement in HNC survivors after neck dissection. The addition of PRET should be considered in the rehabilitation of HNC survivors.

REFERENCES

1. Cappiello J, Piazza C, Giudice M, De Maria G, Nicolai P. Shoulder disability after different selective neck dissections (levels II-IV versus levels II-V): a comparative study. *Laryngoscope*. 2005;115:259–263.
2. Koybasioglu A, Tokcaer AB, Uslu S, Ileri F, Beder L, Ozbilen S. Accessory nerve function after modified radical and lateral neck dissections. *Laryngoscope*. 2000;110:73–77.
3. van Wilgen CP. Morbidity after neck dissection in cancer. *Dutch J Phys Ther*. 2007;117:116–117.
4. van Wilgen CP, Dijkstra PU, van der Laan BF, Plukker JT, Roodenburg JL. Shoulder and neck morbidity in quality of life after surgery for head and neck cancer. *Head Neck*. 2004;26:839–844.
5. Taylor JC, Terrell JE, Ronis DL, et al. Disability in patients with head and neck cancer. *Arch Otolaryngol Head Neck Surg*. 2004;130:764–769.
6. McNeely ML, Parliament M, Courneya KS, et al. A pilot study of a randomized controlled trial to evaluate the effects of progressive resistance exercise training on shoulder dysfunction caused by spinal accessory neurapraxia/neurectomy in head and neck cancer survivors. *Head Neck*. 2004;26:518–530.
7. Mor V, Laliberte L, Morris JN, Wiemann M. The Karnofsky performance status scale. An examination of its reliability and validity in a research setting. *Cancer*. 1984;53:2002–2007.
8. Schag CC, Heinrich RL, Ganz PA. Karnofsky performance status revisited: reliability, validity, and guidelines. *J Clin Oncol*. 1984;2:187–193.
9. Borg GAV. Borg's Perceived Exertion and Pain Scales. London, UK: Human Kinetics; 1998.
10. Roach KE, Budiman-Mak E, Songsiridej N, Lertratanakul Y. Development of a shoulder pain and disability index. *Arthritis Care Res*. 1991;4:143–149.
11. Heald SL, Riddle DL, Lamb RL. The shoulder pain and disability index: the construct validity and responsiveness of a region-specific disability measure. *Phys Ther*. 1997;77:1079–1089.
12. Norkin CN, White DJ. Measurement of Joint Motion: A Guide to Goniometry. Philadelphia: FA Davis Company; 1995.
13. Cella D. The Functional Assessment of Cancer Therapy-Anemia (FACT-An) scale: a new tool for the assessment of outcomes in cancer anemia and fatigue. *Semin Hematol*. 1997;34(3 suppl 2):13–19.
14. Cella DF, Tulsky DS, Gray G, et al. The Functional Assessment of Cancer Therapy scale: development and validation of the general measure. *J Clin Oncol*. 1993;11:570–579.
15. Taylor RJ, Chepeha JC, Teknos TN, et al. Development and validation of the neck dissection impairment index: a quality of life measure. *Arch Otolaryngol Head Neck Surg*. 2002;128:44–49.
16. Cohen J. Statistical Power Analysis for the Behavioural Sciences. London, UK: Academic Press; 1969.
17. Dworkin RH, Turk DC, Farrar JT, et al. Core outcome measures for chronic pain clinical trials: IMMPACT recommendations. *Pain*. 2005;113:9–19.
18. ten Klooster PM, Drossaers-Bakker KW, Taal E, van de Laar MA. Patient-perceived satisfactory improvement (PPSI): interpreting meaningful change in pain from the patient's perspective. *Pain*. 2006;121:151–157.
19. Remmler D, Byers R, Scheetz J, et al. A prospective study of shoulder disability resulting from radical and modified neck dissections. *Head Neck Surg*. 1986;8:280–286.
20. Williams JW Jr, Holleman DR Jr, Simel DL. Measuring shoulder function with the Shoulder Pain and Disability Index. *J Rheumatol*. 1995;22:727–732.
21. McNeely ML, Campbell KL, Rowe BH, Klassen TP, Mackey JR, Courneya KS. Effects of exercise on breast cancer patients and survivors: a systematic review and meta-analysis. *CMAJ*. 2006;175:34–41.
22. Segal RJ, Reid RD, Courneya KS, et al. Resistance exercise in men receiving androgen deprivation therapy for prostate cancer. *J Clin Oncol*. 2003;21:1653–1659.
23. Courneya KS, Segal RJ, Mackey JR, et al. Effects of aerobic and resistance exercise in breast cancer patients receiving adjuvant chemotherapy: a multicenter randomized controlled trial. *J Clin Oncol*. 2007;25:4396–4404.