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Original Article

Adherence to a shoulder dysfunction physical therapy protocol after neck dissection with accessory nerve preservation in head-and-neck cancer patients: An uncontrolled clinical trial

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ABSTRACT

Objective: Accessory nerve (AN) manipulation or resection during neck dissection (ND) generates accessory nerve shoulder dysfunction (ANSD). The aim of the present study was to assess adherence to a supervised physiotherapy protocol and subsequent changes in the functionality scores of patients with ASND with accessory nerve (AN) preservation.

Methods: This study consisted of an uncontrolled clinical trial was carried out at the Department of Head and Neck Surgery and Otorhinolaryngology at the A.C. Camargo Cancer Center, comprising progressive isotonic and isometric strengthening of scapular stabilizer muscles. In patients with head-and-neck cancer underwent ND with AN preservation and patients with ANSD. Shoulder range of motion (ROM), middle trapezius, lower trapezius, rhomboid and anterior serratus muscle strength, pain, and quality of life (QoL) were measured in the pre-operative and 1st and 3rd post-operative months. There were included patients over 18 years old, with head-and-neck cancer who underwent ND with AN preservation and patients with ANSD.

Results: A total of 55 patients were evaluated, with a mean age of 53 (±13.23). Significant improvement in the functionality scores of almost all variables between pre- and post- physiotherapy was observed. Most patients (70.9%) adhered and completed the protocol, obtaining significantly greater ROM abduction ($P = 0.009$) and lower trapezius strength ($P = 0.011$) than partially performing patients.

Conclusion: When performed completely, the proposed physiotherapy protocol can minimize loss in muscle movements and strength, especially limited after ND. The results indicate that the proposed protocol is safe and has the potential to reduce ANSD.

Keywords: Accessory nerve, shoulder dysfunction, neck dissection, physical therapy, cancer

Introduction

Accessory nerve shoulder dysfunction (ANSD) is a common complication after neck dissection (ND) in head-and-neck cancer treatment. It is caused by trapezius muscle weakness, due to accessory nerve (AN) denervation caused for temporary injury (traction, dissection, and devascularization during surgery)[1] or permanent injury, due to resection. ANSD is characterized by pain, heaviness, shoulder depression and protrusion, limited range of movement (ROM), especially abduction, and winged scapula.[2-4] Even with AN preservation, damage still occurs,[1,4,5,6] ranging from 5–20% (5) to 36.9%[1] according to the type of ND. This can generate physical and aesthetic changes, with loss of shoulder curvature contour, acromion and scapula prominence,[2] and quality of life (QoL) losses.[7]

The trapezius muscle stabilizes and rotates the scapula according to the degree of shoulder movement,[8] and due to weakness or paralysis, other muscles attached to the scapula, such as the anterior serratus, rhomboids, rotator cuff and deltoid, and attempt to compensate for movement and become inefficient, causing additional soft-tissue lesions, such as subdeltoid bursitis and supraspinatus tendinopathy.[9] If these subsequent changes do not occur, passive ROM is preserved, although the trapezius exhibits electromyographic[10] and ultrasound[9] alterations. Shoulder pain, then occurs, is not well located, nor associated with movement,[11] ranging from mild-to-moderate.[12]

Physiotherapy should begin early in the post-operative period, normalizing shoulder ROM, trapezius force,[3,9,13] physical function, QoL,[14] and preventing injuries.[9] Failure to screen for disability after ND leads to delays in rehabilitation referral,[15] which only occurs at the patient's request[16] or when ASND is evident and symptomatic.[17] In a pathophysiological and biomechanical point of view, shoulder strengthening should be directed toward the trapezius and scapular muscles.[18] The strongest evidence is based on physiotherapy comprising progressive and supervised resistance.[19]

The exercises performed, such as isotonic and isometric strengthening, in addition to mobility and stretching exercises, point to better effects on the physical function of the neck and shoulder, quality of life, and reduced pain.[19] The aim of this study was to assess adherence to a supervised physiotherapy protocol after ND with AN preservation and subsequent changes in patient functionality scores. Since there is a gap in the literature on such procedures and follow-ups, proving how new this study is.

Materials and Methods

An uncontrolled clinical trial was carried out at the Department of Head and Neck Surgery and Otorhinolaryngology at the A.C.Camargo Cancer Center, São Paulo, Brazil, approved by the institution's Research Ethics Committee (no. 851/06). The eligibility criteria were patients over 18 years old, with head-and-neck cancer who underwent ND with AN preservation and patients with ANSD and patients who signed a free and informed consent form were included in the study. Patients who underwent previous surgery or radiation treatment in the cervical region and patients exhibiting previous pathologies in the shoulder homolateral to the procedure unrelated to cancer or psychiatric illness that interfere with physical therapy follow-up were excluded from the study. Patients were evaluated preoperatively, on the 30th day and on the 3rd month after surgery. The physiotherapy protocol was started immediately after the 30th day evaluation, consisting of 20 face-to-face sessions, divided into three phases, two weekly sessions, individualized and supervised by the same physiotherapist, and an oncological physiotherapy specialist. Missed sessions were rescheduled. The load for the beginning of the isotonic strengthening comprised 50% of one maximum repetition (MR) and isometric strengthening was started by supporting limb weight [Figure 1]. At home, patients underwent stretching and active mobility. During the exercises, the physical therapist verbally stimulated posture maintenance and a slow breathing rhythm with no inspiratory blocks.

The following outcomes were evaluated: Pain (visual analog scale), constant score, quality of life (University of Washington – UWQoL, concerning pain, activity, leisure, shoulder, and composite score domains), flexion, extension, abduction, external and internal shoulder rotation ROM (goniometry – universal goniometer) and muscle forces of the middle trapezius, lower trapezius, anterior serratus, and rhomboids [manual test, Figure 2]. The gradations of this test were as follows: (1) Palpable contraction without movement; (2) minimal movement maintenance against gravity; (3) integral maintenance against gravity; (4) integral maintenance against gravity and moderate resistance; and (5) integral maintenance against gravity and vigorous resistance. All evaluations were performed by the same examiner. The assessments of this study were not performed blindly.

A descriptive analysis of the population was performed using means and standard deviation for continuous variables and absolute and relative frequency for categorical variables. Alterations in functionality scores between the analyzed periods were calculated by the paired samples t-test Crude and adjusted linear regression was performed to assess changes in shoulder functionality scores, according to partial or complete protocol completion. Variables exhibiting $P < 0.20$ in the crude analysis were selected to comprise the adjusted model, which was obtained using the step-wise forward method. Variables exhibiting $P < 0.05$ were maintained in the model. All analyses were performed using the SPSS v23.0 software. In this study, the intention was not to buy externally, but the patient with himself, and the groups were treated with logistic regression. For this purpose, all possible bias factors were excluded from the study.

Results

This study included 55 patients, 70.9% of them males, with an average age of 53 (±13.23). Most presented a primary site in the oral cavity (52.7%) and clinical Stage III/IV (67.3%). Concerning ND, 78.2% underwent selective ND without the need for rotation of the pectoralis major myocutaneous flap (PMMF) or microsurgery (90.9%) [Table 1].

Of the total number of patients, 39 underwent the complete protocol (70.9%) and 16 (29.1%), a partial protocol. Of the latter, only five subjects abandoned physical therapy before beginning of strengthening. The others interrupted physical therapy during the second (seven patients) and thirdrd (four patients) phases (when strengthening exercises were already applied), as they were not able to support rehabilitation due to their physical status or because they were undergoing radiotherapy with conflicting schedules concerning physical therapy treatment. This study was carried out from January 2007 to June 2008.

Table 2 presents the observed pre-operative score changes 30 days and 3 months after surgery regarding functionality, considering the total population. Significant improvements in the scores of almost all analyzed variables were observed when comparing the assessments performed between 30 days and 3 months after surgery, with the exception of the shoulder domain ($P = 0.075$), composite score ($P = 0.054$), anterior

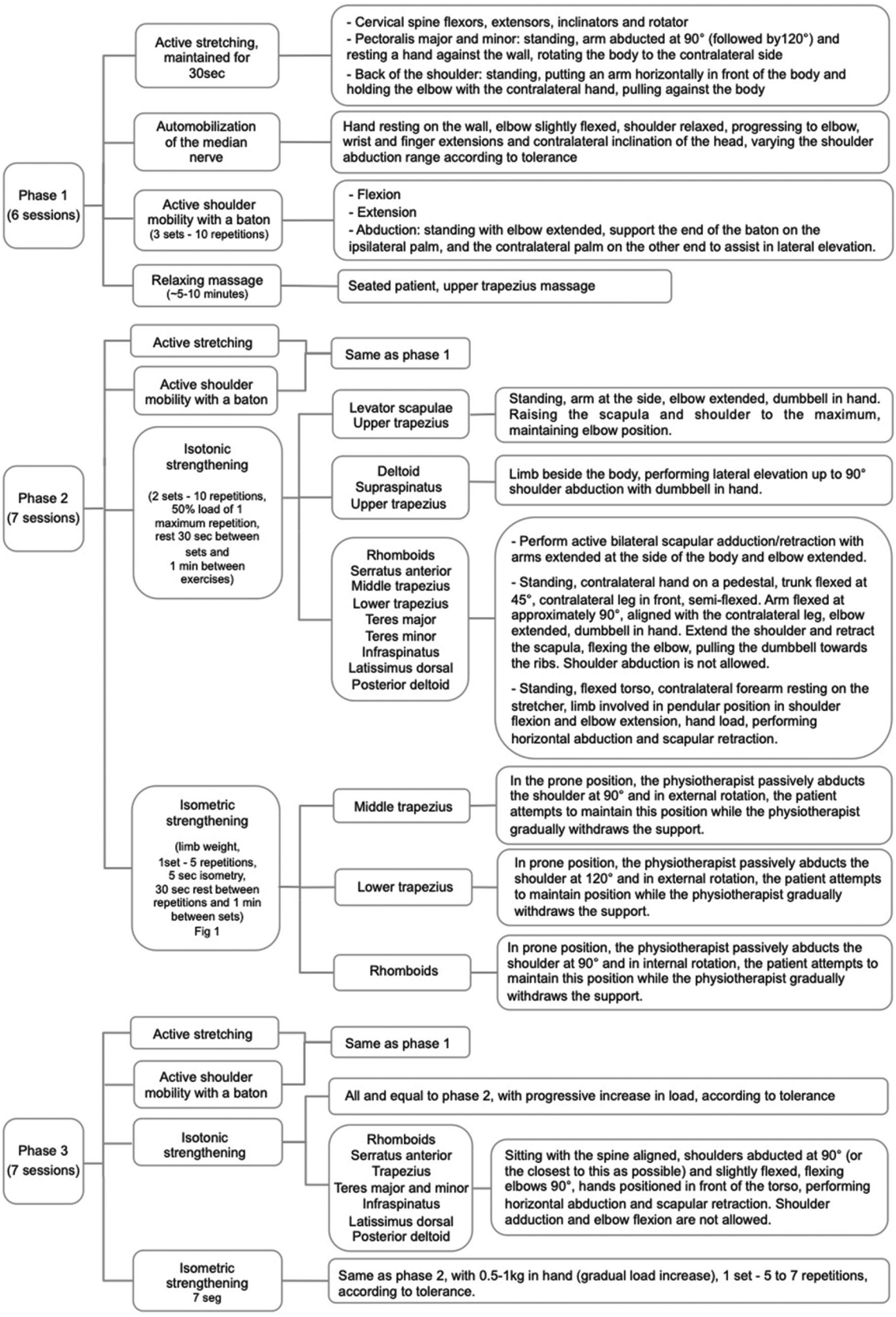

Figure 1: Physical therapy protocol. Description of the physiotherapy protocol performed, according to the phase and exercises performed in each of the respective phases

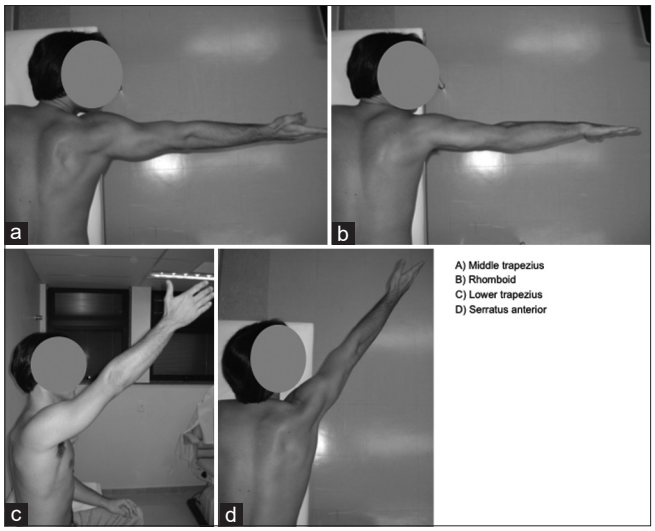

Figure 2: Positioning for manual muscle strength test and for the isometric strengthening of the physiotherapy protocol. (a-d) Positions for muscle strength tests, (a, b, and d) physiotherapist offers resistance at the distal end and supports the patient on the contralateral scapula, picture c resistance is offered at the distal end and on the lateral edge of the scapula. (a-d) Positions for isometric strengthening as described in Phases 2 and 3 of Figure 1

serratus muscle strength (P = 0.709), and internal rotation ROM (P = 0.948).

Score changes between the 30 days and 3 months, according to adherence to the rehabilitation protocol (partial or complete), are exhibited in Table 3. No statistically significant differences between groups for patient-reported variables (pain, quality of life, and constant score) were detected. For muscle strength, however, a greater gain was observed for the group that completed the protocol concerning the lower trapezius muscle (P = 0.011). Concerning ROM, the group that performed the complete protocol showed greater gain in abduction (P = 0.009).

A simple linear regression was performed (complementary table) to exclude the effect of possible confounding variables on the observed associations. Variables with $P < 0.20$ were selected for adjustment. After adjustment, the mean difference in muscle strength change was observed, where patients who underwent the complete protocol exhibited a 0.815 difference in lower trapezius strength gain (P = 0.044) compared to those who underwent a partial protocol. Regarding shoulder abduction ROM changes, the group that completed the protocol displayed a 35.9° increase compared to the partial underwent group (P = 0.009) [Table 3].

Discussion

The physiotherapy protocol for recovering ANSD with AN preservation proved to be safe and capable of improving functionality scores, stabilizing the scapula and improving glenohumeral ROM. Most of the patients adhered to the treatment, obtaining significantly greater ROM and strength gains, reducing the level of pain and improving QoL.

More extensive ND and T3 and T4 tumors influence ANSD.[20] Both are due to the advanced clinical stage, which is consistent with the present study, where most subjects presented III/IV clinical staging. The present research shows that this was also recently evidenced in the Brazilian population.[21]

In ANSD, difficulties in performing basic tasks cause more damage, predisposing patients to fibrosis, intracapsular adhesion, and soft tissue and brachial plexus damage.[13]

Table 1: Demographic and clinical profile details of the study participants (n=55)

Variables	n (%)
Age	
Mean (SD)	53.13 (±13.23)
Age group	
≤60 years	39 (70.9)
>60 years	16 (29.1)
Sex	
Male	39 (70.9)
Female	16 (29.1)
Tumor location	
Oral cavity	29 (52.7)
Thyroid	10 (18.2)
Larynx	7 (12.7)
Other	9 (16.4)
Clinical stage	
I and II	18 (32.7)
III and IV	37 (67.3)
ND type	
Selective	43 (78.2)
Modified radical	12 (21.8%)
PMMF	
Yes	05 (9.1)
No	50 (90.9)
Radiotherapy	
No	21 (38.2)
Yes	34 (61.8)
Reconstruction	
No	38 (69.1)
PMMF	05 (9.1)
Microsurgery	12 (21.8)
Laterality of ND	
Unilateral	31 (56.4)
Bilateral	17 (30.9)
Affected side	
Right	38 (69.1)
Left	17 (30.9)

Table 2: Pre-operative functionality score alterations 30 days and 3 months after surgery, considering the total population included in this study

Variable	Pre-operative (*n*=55)	30 days (*n*=55)	3 months (*n*=50)	Changes from 30 days to 3 months (beginning and end of the intervention) (*n*=50)*	
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (95% CI)	*P* value
Variables reported by the patient					
Shoulder pain (EVA)	0.58 (1.45)	3.53 (2.85)	2.50 (1.96)	–0.94 (–1.58—0.30)	**0.005**
Constant Score	72.74 (5.09)	50.64 (11.16)	60.03 (9.73)	8.48 (6.31–10.65)	**<0.001**
UW pain (score)	75.91 (28.85)	75.00 (20.41)	81 (17.51)	6.63 (0.45–12.81)	**0.036**
UW activity (score)	90.45 (16.31)	68.18 (22.28)	79.59 (17.43)	11.73 (5.67–17.80)	**<0.001**
UW recreation (score)	86.36 (23.97)	64.81 (22.53)	76.04 (20.60)	13.30 (6.65–19.94)	**<0.001**
UW shoulder (score)	96.82 (12.78)	62.73 (23.51)	70.41 (21.45)	7.14 (–0.75–15.04)	0.075
Composite score	83.74 (14.18)	68.43 (15.90)	71.52 (16.18)	3.30 (–0.06–6.66)	0.054
Muscle strength					
Middle trapezius	4.22 (0.63)	2.69 (0.80)	3.42 (0.83)	0.75 (0.51–1.00)	**<0.001**
Lower trapezius	4.02 (0.76)	1.90 (0.80)	2.79 (1.13)	0.85 (0.55–1.15)	**<0.001**
Serratus anterior	4.36 (0.48)	4.00 (0.33)	4.04 (0.33)	0.02 (–0.87–0.13)	0.709
Rhomboid	4.25 (0.55)	3.02 (0.81)	3.46 (0.84)	0.45 (0.21 a 0.69)	0.001
Shoulder ROM					
Flexion	164.27 (17.23)	125.27 (22.69)	138.52 (17.69)	12.18 (8.23–16.13)	**<0.001**
Extension	59.27 (12.87)	49.35 (10.05)	55.54 (10.23)	5.88 (3.53–8.23)	**<0.001**
Abduction	170.40 (12.73)	76.04 (34.96)	115.42 (43.97)	37.64 (26.02–49.26)	**<0.001**
External rotation	83.22 (15.85)	70.13 (18.37)	76.10 (16.22)	5.64 (3.16–8.12)	**<0.001**
Internal rotation	67.38 (13.40)	62.44 (16.00)	63.30 (13.36)	0.14 (–4.18–4.46)	0.948

*Calculated only for patients with assessment in both periods

Table 3: Pre-operative functionality score alterations, simple, and adjusted linear regressions between 30 days and 3 months after surgery and according to protocol: partial or complete (*n*=50)

Variable	Changes from 30 days to 3 months* (beginning and end of the intervention)			Simple linear regression		Adjusted linear regression	
	Complete	Partial	*P* value	Beta (95% CI)	*P* value	Beta	*P* value
	Means (SD)	Mean (SD)					
Variables reported by the patient							
Shoulder pain (EVA)	–1.00 (2.20)	–0.72 (2.49)	0.726	----	----	----	----
Constant Score	9.24 (8.22)	5.77 (4.34)	0.186	----	----	----	----
UW pain (score)	5.92 (22.83)	9.09 (16.85)	0.672	----	----	----	----
UW activity (score)	13.81 (22.28)	4.54 (15.07)	0.203	----	----	----	----
UW recreation (score)	12.50 (21.13)	15.91 (28.00)	0.667	----	----	----	----
UW shoulder (score)	7.24 (28.42)	6.82 (25.23)	0.965	----	----	----	----
Composite score	4.48 (11.79)	–0.77 (10.93)	0.193	----	----	----	----
Muscle strength							
Middle trapezius	0.84 (0.82)	0.45 (0.93)	0.188				
Lower trapezius	1.06 (0.98)	0.18 (0.87)	**0.011**	–0.874 (–1.54 a –0.207)	0.011	–0.815 (–1.607 a –0.024)	0.044[a]
Serratus anterior	0.02 (0.43)	0.00 (0.00)	0.845	----	----	----	----
Rhomboid	0.55 (0.79)	0.09 (0.94)	0.110	----	----	----	----
Shoulder range of motion							
Flexion	13.67 (14.78)	6.91 (8.74)	0.156	----	----	----	----
Extension	5.05 (8.60)	8.81 (6.43)	0.185	----	----	----	----
Abduction	45.53 (42.38)	9.63 (15.89)	**0.009**	–35.902 (–62.263 a –9.541)	0.009	----	----
External rotation	6.23 (8.95)	3.54 (7.92)	0.373	----	----	----	----
Internal rotation	0.02 (16.32)	0.54 (10.86)	0.921	----	----	----	----

*Calculated only for patients with assessment in both periods, [a]Adjusted by ND group and type, **No adjustment variables were found for developing the model

Complementary Table : Simple linear regression between possible adjustment variables for the statistically significant associations between the functionality score alterations at 30 days and after 3 months according to the completion of the partial or complete protocol (*n*=50)

Variable	Lower trapezius		Abduction	
	Beta	*P* value	Beta	*P* value
Age	–0.003	0.791	–0.031	0.943
Sex	0.009	0.979	8.337	0.523
Clinical stage	–0.415	**0.189**	–12.310	0.318
ND type	–0.503	**0.187**	–14.300	0.327
PMMF	–0.080	0.797	–0.603	0.956
Radiotherapy	–0.085	0.781	0.567	0.962
Reconstruction	–0.106	0.579	–9.186	0.203
ND laterality	0.073	0.812	6.731	0.569
Affected side	0.049	0.876	5.715	0.644

Values in bold were selected for the multiple linear regression model (*P*<0.20)

However, increased scapular muscle strength relieves pain and improves scapular positioning.[22] Therefore, progressive strength training in peripheral nerve injuries prevents disuse and reinforces neural adaptation and should be encouraged as soon as possible in the post-operative period. Thus, the suggested physiotherapy protocol aimed at strengthening the scapular-stabilizing musculature from the 4th week onward and stretching the anterior musculature of the shoulder, as pectoralis strengthening may contribute to shoulder imbalance. This conduct has been previously described.[1]

Strength load is divergent. In this study, we began isotonic strengthening with 50% of the 1 RM load and achieved significant improvements. Other studies began with 25–30% of the 1 RM load[22,23] or with 0.5 kg at the distal end[1] and also reported improvements. However, even today, there is no clear literature on a specific resistance load to be applied.

An electromyographic analysis demonstrated that strengthening above the head is more effective in recruiting the upper and middle trapezius fibers.[24] However, the authors admit that shoulder ROM above 90° is not always possible due to subacromial impact and glenohumeral restriction. Thus, they suggest shoulder lifting exercises with a limb extended at the side of the body and a unilateral curved stroke, which also results in high activity levels of these muscles and avoids impact. The curved stroke was also effective for rhomboid activity. In the present study, both exercises were performed. Only the anterior serratus did not show any significant improvement. However, we did not address the tested exercises that would activate this muscle.[24]

McGarvey *et al*.[1] performed a similar intervention than the one herein, of progressive scapular strengthening exercises for 12 weeks, obtaining significant abduction improvements at 3 months. However, only one supervised session was performed a week, and the control group was heterogeneous, with some individuals undergoing additional physical therapy and others, not. On the other hand, Wu *et al*.[17] noted no physiotherapy benefits after ND. This may be due to certain issues, such as patients with AN resection, comparison of two different physiotherapy treatments performed at two different hospitals, difficulties in adhering to face-to-face care, and strengthening initiated late with generalized shoulder ROM exercises. Lauchlan *et al*.[25] concluded that physical therapy does not influence functional status in the 1st year after surgery. However, intervention took place for only 24 patients, through an individual holistic program using an instruction leaflet to prevent adhesive capsulitis.

The post-operative physiotherapy initiation period is controversial. Baggi *et al*.[26] intervened on the 5th day, through an exercise booklet and excluded patients with PMMF. These patients were present in our sample and we began on the 30th day. McGarvey *et al*.[1] began within 8 weeks and McNeely *et al*.[22,23] after 8 weeks. The early start of physical therapy prevents secondary complications, such as joint fibrosis and adhesive capsulitis,[13,22,27] which were not observed herein.

Due to the morbidity of cancer treatment, the challenge with these patients is to obtain adherence to physical therapy.[28] A total of 71% adherence was observed at the end of the study, but most patients presented clinical Stage III/IV and required radiotherapy. This was a reason for the withdrawal of 9% of the patients among those who underwent the partial protocol and occurred in the first phase. The rest of the patients abandoned the protocol when noting strengthening. Some strengthening sessions may have a positive impact on shoulder function, since significant improvement in most of the outcomes was observed in the present study when evaluating all patients.

Other studies have reported higher rates. McNeely *et al*.,[23] for example, obtained 93% adherence and later, 91%.[28] McGarvey *et al*.[1] reached 82.2%, but with only one face-to-face session per week (out of a total of three). Wu *et al*.[17] reached 80.6%, but most of the intervention was home-based, while Lauchlan *et al*.[25] obtained 75%. More extensive neck procedures and daily alcohol consumption are related to lower adherence.[28]

Dijkstra[11] reported that 70% of assessed patients report shoulder pain during the post-operative period, consistent with the present study, where we obtained 72.7% on the 30th day, decreasing to 56% at the end of the protocol. Pain improvement is associated with increased upper limb strength.[22] Pain intensity variations, from moderate (30th day) to mild (3rd month), agree with Bodack *et al*.[12]

Significant UWQoL pain, activity, and leisure improvements at the end of therapy were noted, consistent with other studies, with progressive strengthening[22] or not.[25] Adequate

physiotherapist orientation increased patient participation in daily activities, even with functional decreases.[25]

The shoulder domain of the UW-QoL is sensitive for ASND screening, but among all domains, is one of the last to be mentioned by patients presenting oral cavity and oropharynx cancer in terms of importance.[29] This may be the reason for the lack of significance observed for this item, as in our sample, 52.7% of patients exhibited the primary site in these anatomic locations.

This study presents certain limitations. As this is a clinical trial without a comparison group, it is not possible to state that the gains obtained in muscle strength and ROM are due to the physiotherapy protocol. In addition, a bias related to loss of patient follow-up is also noted. However, this study demonstrated that the proposed physiotherapy protocol was safe and has good adherence. Its results can be generalized for populations with the same sociodemographic profile, although it is necessary to evaluate the effectiveness of the proposed intervention in randomized clinical trials.

Conclusion

Most patients adhered to the proposed physical therapy, based on strengthening the scapular stabilizing muscles and stretching the pectorals. Patients who completed treatment showed a significant increase in the lower trapezius strength and shoulder abduction ROM between 30 days and 3 months compared to those who underwent the partial protocol. The results indicate that the proposed protocol is safe and has the potential to reduce ANSD.

Authors' Declaration Statements

Ethics approval and consent to participate

All procedures carried out in studies involving human participants were in accordance with the ethical standards of the Institutional and National Research Committee and with the 1964 Declaration of Helsinki and its subsequent amendments or comparable ethical standards. This study was approved by the A. C. Camargo Research Ethics Committee under protocol number 851/06 on November 21, 2006.

Competing interests

Nil.

Conflict of interest

The authors have no conflicts of interest to declare.

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Authors' Contributions

All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by all authors. And, this was written of the manuscript, by all authors together. All authors read and approved the final manuscript.

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