ACRM
AMERICAN CONGRESS OF REHABILITATION MEDICINE

Archives of Physical Medicine and Rehabilitation

journal homepage: www.archives-pmr.org

Archives of Physical Medicine and Rehabilitation 2013;94:113-9

ORIGINAL ARTICLE

Impact of Neck Dissection on Scapular Muscle Function: A Case-Controlled Electromyographic Study

Aoife C. McGarvey, BAppSc,[a,b] Peter G. Osmotherly, MMedSc,[b] Gary R. Hoffman, MBBS, FACS, FRCS,[c,d] Pauline E. Chiarelli, PhD[b]

From the [a]Calvary Mater Newcastle Hospital, Newcastle; the [b]School of Health Sciences and the [c]School of Medicine and Public Health, Faculty of Health, University of Newcastle, Callaghan; and the [d]John Hunter Hospital, New Lambton, NSW, Australia.

Abstract

Objective: To assess the dynamic activity of scapular muscles in patients with accessory nerve dysfunction after neck dissection surgery, compared with both their unaffected side and with age- and sex-matched controls.

Design: A case-control investigation.

Setting: Physiotherapy department of a hospital.

Participants: Two groups of 10 participants were recruited. One group consisted of neck dissection patients with demonstrated clinical signs of accessory nerve injury. The second group was composed of matched healthy individuals.

Interventions: Surface electromyographic activity of the upper trapezius, middle trapezius, rhomboid major, and serratus anterior muscles was compared dynamically during scapular strengthening exercises.

Main Outcome Measures: Electromyographic activity comparisons were made between the neck dissection affected side, the neck dissection unaffected side, and the matched healthy control side. Raw data and data expressed as a percentage of maximal voluntary isometric contraction were compared.

Results: The neck dissection affected side demonstrated significantly less upper trapezius and middle trapezius muscle activity compared with the neck dissection unaffected side and matched control group. The neck dissection unaffected side had significantly less upper trapezius muscle activity than the matched control group.

Conclusions: Trapezius muscle activity is significantly reduced in accessory nerve shoulder dysfunction as a result of neck dissection, both in the affected and unaffected sides. This needs to be considered in the rehabilitation of this patient group.

Archives of Physical Medicine and Rehabilitation 2013;94:113-9

Accessory nerve shoulder dysfunction (ANSD) is a debilitating and painful condition that can result from neck dissection surgery that is undertaken in the management of cancer. Accessory nerve injury can occur during cervical lymphadenectomy, even when the nerve is preserved.[1] Since the accessory nerve is the main motor supply to the trapezius muscle,[2,3] its neural impairment leads to reduced trapezius muscle strength, causing the scapula to be depressed, abducted, and medially rotated at rest. Dynamically, trapezius muscle weakness leads to reduced active shoulder abduction and flexion as a result of reduced scapular lateral rotation and elevation during these movements.[4,5] The resultant abnormal scapular biomechanics cause mechanical overload of the scapular complex, leading to shoulder pain and reduced regional function.[6]

Patients who undergo neck dissection may require adjuvant radiation therapy over the lateral aspect of the neck.[7] The radiation field includes both the accessory nerve and the trapezius muscle. Radiation therapy causes fibrosis of muscle fibers and the neural sheath, as well as nerve demyelination.[8,9] This ultimately results in muscle atrophy,[10] compounding trapezius muscle weakness. Additionally, treatment for head and neck cancer often causes significant weight loss[11] and, therefore, likely global loss of muscle mass. Reduced physical activity levels in head and neck cancer patients are yet another factor compounding muscle

Supported by the Hunter Medical Research Institute Barker Scholarship and the Hunter New England Allied Health Research Committee Grant.

No commercial party having a direct financial interest in the results of the research supporting this article has or will confer a benefit on the authors or on any organization with which the authors are associated.

0003-9993/13/$36 - see front matter © 2013 by the American Congress of Rehabilitation Medicine
http://dx.doi.org/10.1016/j.apmr.2012.07.017

weakness. More than half of patients are classified as sedentary after treatment,[12] which may be further exacerbated by cancer-related fatigue.

Accessory nerve conduction has been investigated after neck dissection by using needle intramuscular electromyographic activity of the trapezius muscle on the operated side.[13-15] Such studies indicate reduced trapezius electromyographic activity. However, they fail to inform about trapezius electromyographic activity under dynamic conditions, or about the electromyographic activity of other accessory scapular muscles. These studies also fail to compare scapular muscle electromyographic activity in the affected side with either the unaffected side or with healthy individuals.

The primary aim of this study was to measure the surface electromyographic (SEMG) dynamic activity of scapular muscles resulting from strengthening exercises that may be prescribed for patients with ANSD after neck dissection, compared with the SEMG activity of scapular muscles on their unaffected side and with the SEMG activity of scapular muscles in healthy age- and sex-matched controls. Improved appreciation of the levels of scapular muscle activity in patients with ANSD compared with the patients' unaffected arm and compared with healthy individuals would provide valuable insight into the nature of the muscle activity differences between these groups, thereby enlightening exercise prescription in rehabilitation for patients with ANSD.

Methods

The investigation was designed as a case-control study. The first muscle group to be electromyographically studied was that in participants who demonstrated the clinical signs of ANSD after neck dissection (ie, scapula depression, reduced active shoulder abduction, and scapula winging at rest and/or on active shoulder abduction), labeled "neck dissection affected" (NDA). The second group of electromyographic-studied muscles was that of the unaffected side of the same neck dissection participants, labeled "neck dissection unaffected" (NDU). A control group of muscles was studied in healthy individuals, age and sex matched to the neck dissection participants. The level of SEMG activity was recorded from bilateral scapular muscles (upper trapezius, middle trapezius, rhomboid major, serratus anterior) of all participants. All data were maintained in a deidentified form using assigned participant numbers.

Neck dissection participants were recruited from the Calvary Mater Newcastle Hospital via a letter of invitation. Inclusion criteria for neck dissection participants were (1) neck dissection surgery for cancer that occurred within the last 2 years; (2) shoulder pain on the operated side, with onset after neck dissection; (3) clinical signs of ANSD demonstrated on the operated side; and (4) age greater than 18 years. Criteria for exclusion from the study included patients who had (1) accessory nerve sacrifice; (2) a history of shoulder or neck pain, or both, in the past 6 months before neck dissection surgery; (3) signs of adhesive capsulitis (reduced shoulder external rotation, abduction, and internal rotation); (4) the presence of residual locoregional cancer or distant metastases to other regions; or (5) a preexisting medical condition with an inability to repeatedly lift a 2.0-kg weight or perform exercise against resistance.

List of abbreviations:

ANSD	**accessory nerve shoulder dysfunction**
MVIC	**maximum voluntary isometric contraction**
%MVIC	**raw RMS dynamic exercise/MVIC**
NDA	**neck dissection affected**
NDU	**neck dissection unaffected**
RMS	**root mean square**
SEMG	**surface electromyographic**

Healthy volunteers were sex and age matched to within 1 year of the neck dissection participants. The healthy control participants were recruited from the Hunter Medical Research Institute Volunteer Register. Volunteers were excluded if they had (1) a history of shoulder or neck pain, or both, within the past 6 months; (2) previous neck dissection surgery; (3) existing cancer in any area of the body; or (4) a preexisting medical condition with an inability to repeatedly lift a 2.0-kg weight or perform exercise against resistance. Baseline participant characteristics were recorded as described in table 1.

The study conformed to the Declaration of Helsinki, and was approved by Hunter New England Health Human Research Ethics Committee and the University of Newcastle Human Research Ethics Committee. Written informed consent was obtained from all participants.

Ten electrodes were placed over 4 muscles (active electrodes) as summarized in appendix 1, with 2 bony prominences being earth electrodes (the spinous process of C7 and the ipsilateral clavicle). Electrode location was standardized according to anatomic and SEMG human studies,[16-18] and accepted procedures for SEMG sensor placement were followed.[19] Collection of SEMG recording occurred with the use of the ADI PowerLab 8SP (ML 785)[a] and 2 dual bioamplifiers (ML135).[a]

SEMG signals were amplified and filtered with a low-pass filter of 50Hz, with data acquired at a sampling rate of 2kHz and a recording range of 0 to 2mV. Raw electromyographic signals were then transmitted from the electrodes to a computer for processing (Lab Chart v7 for Windows XP operating system)[a] and storage for future analysis.

Neck dissection participants were asked to perform a series of 10 maneuvers, first on the affected arm and then on the unaffected arm. The healthy participants performed the maneuvers on the left arm first, and then the right arm. Each maneuver performed was sequentially ordered (appendix 2). Practice of each maneuver occurred before testing to maximize correct performance. Three repetitions were performed for each maneuver, with at least a 30-second rest between each repetition. A minimum of 60 seconds of rest occurred between different maneuvers. The maneuvers involved 7 dynamic scapular strengthening exercises with a 2.0-kg weight, and 4 maximum voluntary isometric contractions (MVICs) for each muscle being tested.

The MVICs for each muscle were based on normalization studies for the muscles under investigation, which would also be feasible for participants to perform[16,20,21] (see appendix 2). For the MVIC, the same researcher applied maximal manual pressure, and participants held the contraction in the isometric position for a period of 3 seconds.

For the dynamic strengthening exercises, 3 seconds was counted to reach the endpoint of the exercise, and then 3 seconds to return to the starting position. If the maneuver was incorrectly performed, the maneuver was repeated with feedback provided to correct the participant's performance. If a participant experienced pain or was physically unable to correctly perform the maneuver, then the maneuver was ceased and the trial was then excluded from subsequent data analysis.