International Journal of Advanced Community Medicine

E-ISSN: 2616-3594
P-ISSN: 2616-3586
IJACM 2019; 2(3): 37-40
Received: 15-07-2019
Accepted: 17-08-2019

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Shoulder syndrome after neck dissection in patients with malignancies in the maxillofacial area

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DOI: https://doi.org/10.33545/comed.2019.v2.i3a.82

Abstract
Objective: Neck dissections are surgical interventions where lymph nodes from specific areas of the neck, together with non-lymphatic structures – sternocleidomastoid muscle, internal jugular vein and accessory nerve are removed. Important anatomical structures could be damaged during the surgery, causing postoperative complications associated with impaired function of the musculoskeletal system of the shoulder.
The aim of the present study is to determine the degree of impairment in shoulder movements (motor function), depending on the volume of surgery in neck dissection.
Methods: Constant Shoulder Score (CSS) was used to evaluate the motor function of the operated patients. The results obtained were analyzed by SPSS Vers23.0.
Results: A statistically significant difference was found F (2,65) = 167,733, $p< 0.001$, for the motor function of the shoulder in the three groups of neck dissection. A Tukey post hoc test was conducted to show that the arithmetic mean of the CS scale for radical neck dissection (RND) (X = 42.90) was statistically significantly different from the arithmetic mean of the supraomohyoid neck dissection (SOHND) groups (X = 66.50) and selective neck dissection (SND) (X = 67.14). The SOHND group was not statistically significantly different from the SND group.
Conclusion: Analysis of the motor function of the shoulder shows its involvement in all neck dissections. At the 6th month postoperatively, a pronounced morbidity in all patients was determined following neck dissection.

Keywords: Active range of motion (AROM), neck dissection, shoulder syndrome, postoperative consequences

Introduction
In the second half of the nineteenth century, neck dissections are proposed as surgical procedures aiming the removal of regional lymph nodes in the cervical region due to malignancies of the head and neck. In 1888 Franciszek Jawdynski described in detail the en-bloc resection of the cervical metastatic mass [1, 2]. In 1905 George Crile reported the management of 105 patients diagnosed with head and neck cancer and 121 radical neck dissections [3]. In 1952, Osvaldo Suarez proposed some modified techniques for the preservation of nymph structures. He calls this surgical procedure "functional" or "conservative" neck dissection [4, 5].
Neck dissections are surgical interventions where lymph nodes from specific areas of the neck, together with non-lymphatic structures – sternocleidomastoid muscle, internal jugular vein and accessory nerve are removed. Important anatomical structures could be damaged during the surgery, causing postoperative complications associated with various impaired function [6, 7, 8, 9]. The assessment and analysis of the postoperative outcomes are primarily defined as complications in specific target structures – nerves [10, 11], blood vessels [12, 13, 14], as well as overall assessment of chronic morbidity [15].
Shoulder/Humeral disorders. Chronic humeral morbidity is considered to be an inevitable consequence in the surgical treatment of cervical metastases [16]. Ewing and Martin in 1952 [17] described for first time the postoperative morbidity after neck dissection. Nahum *et al*. [18] introduce the term “shoulder syndrome” to describe its clinical presentation characterized by pain, limited abduction in the shoulder joint, anatomical deformities of the scapula. If the accessory nerve (motor nerve) is resected denervation of the supplied muscles is observed (sternocleidomastoid muscle and trapezius). The paralysis of trapezoid muscle results in lateral displacement and lateral rotation of the scapula (Figure 1) [19].

Restrictions in the degree of mobility is mainly related to impaired abduction and anteroflexia in the shoulder joint [20, 21].

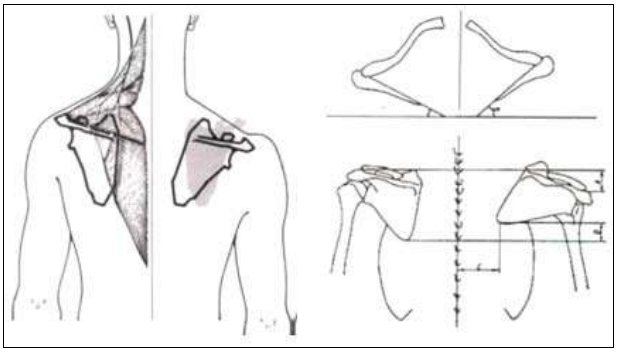

Fig 1: Lateral displacement and lateral rotation of the scapula (по H. R. Krause, 1992)

Partial preservation of the function of m. trapecius after resection of the spinal accessory nerve, is due to its double innervation from the cervical plexus, found in 18% of the cases (18).

Despite preservation of the accessory nerve in neck dissections, patients complain of "shoulder syndrome". Sist *et al*. [22] suggest that this is due to neuropraxia of the nerve.

The purpose of the present study is to determine the degree of postoperative shoulder morbidity, depending on the volume (type) of the neck dissection in patients with malignancies in the maxillofacial and cervical areas.

Materials and methods

Patients. Patients diagnosed of cervical metastases die to malignant tumors in the maxillofacial and cervical areas were examined. The study was conducted in the period 2016 - 2019 in Maxillofacial surgery clinic, Alexandrovska Hospital. The following were selected as exclusion criteria in the selection of patients: previous radiotherapy, additional diseases of the musculoskeletal system. All patients completed informed consent prior participation in this study.

Methods. Impaired shoulder function after neck surgery was evaluated by Constant Shoulder Score (CSS), as it is considered gold standard in Europe [23]. It is composed of 4 parts: first part - PAIN - reported (evaluated) by the patient and scored with a maximum value of 15 points; second part - Daily Activity - reported by the patient and scored with a maximum value of 20 points; the third part - MOBILITY RATES - evaluated by the clinician and scored with a maximum of 40 points (Figure. 2); the fourth part - POWER - evaluated by the clinician and scored with a maximum of 25 points (Figure. 3). A fully functioning arm has a higher value on the scale, with a maximum score of 100. The values obtained are grouped into four stages.: poor functioning – less than 30 points, limited functioning – 30 to 39 points, good functioning – 40–59 points, very good functioning – 60–69 points, excellent functioning over 70 points.

Fig 2: Degree of mobility in articulatio humeri: 1 – anterior flexion, 2 – lateral elevation, 3 – external rotation, 4 – internal rotation

Fig 3: Measurement of abduction force by an isometric tensiometer

Statistical analysis

The statistical analysis is conducted via SPSS Vers23.0. A significance level that rejects the null hypothesis is assumed to be $\alpha = 0.05$.

Descriptive statistics represent the measures of the central distribution trend and the scattering of variables.
Comparative deductive statistics
Parametric statistical tests
One-way ANOVA - ANOVA.
Levene dispersion homogeneity test.
Tests for stability of equality of arithmetic means - Brown-Forsyte, Welch.

Results

Sixty eight patients with neck dissections were examined. The cohort is represented by 25 women and 43 men, with a mean age of 61.18 years (SD 13.66). Radical neck dissection (RND) was performed in 31 patients, suprachomichioid neck dissection (SOHND) was performed in 30 patients and selective neck dissection (SND) in 7 patients.

Evaluation of the shoulder function. Preoperatively, high levels of functional activity of the shoulder girdle were recorded in all patients.

Significant deviations in the function of the shoulder were observed six months postoperatively: SOHND – X=66.50, SD=6.323, CI95%=[64.14, 68.86]; RND – X=42.90, SD=4.49, CI95%=[41.26, 44.55]; SND – X=67.14, SD=3.53, CI95=63.88, 70.41. Statistically significant impairment of the shoulder mobility was found in all three types of neck dissection $F(2,65)=167.733$, $p< 0.001$. A Tukey post hoc test was conducted to show that the arithmetic mean of the CS scale for RND (X = 42.90) was statistically significantly different from the arithmetic mean of the SOHND groups (X = 66.50) and SND (X = 67.14). The SOHND group was not statistically significantly different from the SND group (Figure.4).

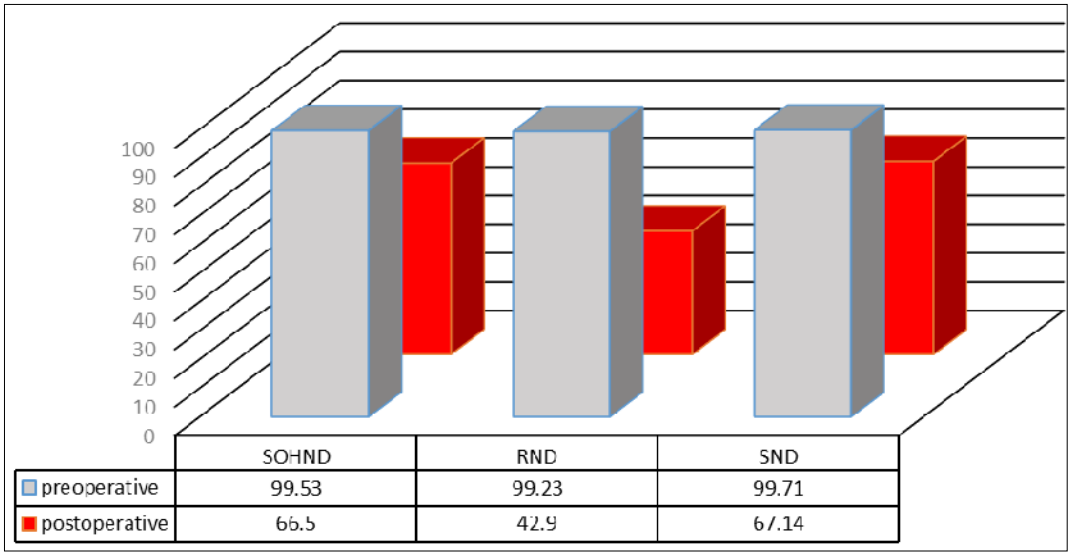

Fig 4: Assessment of the function of the shoulder via the CS scale, preoperatively and postoperatively, in cervical dissections

Discussion

Humeral involvement in neck surgery - neck dissection is accompanied by the development of shoulder syndrome. If the spinal accessory nerve is damaged, trapezoid muscle impairment and Active Range of Motion (AROM) restriction of the shoulder always occur. Denervation of m.trapezius causes falling of the shoulder. Due to the preserved function of m. levator scapulae, lateral rotation and lateral displacement of the scapula is observed. Physical examination of the shoulder is always performed bilaterally, evaluating the active abduction of the arm, the development of trapezoid muscle atrophy, as well as the changed position of the scapula inferiorly. The postoperative evaluation should be complex, evaluating several clinical features of postoperative shoulder morbidity. This is necessary due to the fact that pain causes immobilization in the humeral joint without muscle denervation.

Ewing and Martin discuss the role of cicatricial change as a main factor limiting the shoulder mobility (17). Transection of the spinal accessory nerve and myotomy of the sternocleidomastoid muscle cause marked musculoskeletal dysfunction [24]. Shoulder pain is a consequence of impaired accessory nerve function. In addition to neural dysfunction, additional causes of shoulder pain are hypertrophy of the sternoclavicular joint and hypertension of the m. rhomboideus and m. levator scapulae.

Neurapraxia after neck dissection with preservation of the spinal accessory nerve is followed by trapezoid muscle disfunction.

We find a significant difference between the RND group and the other two groups (SOHND and SND), which is explained by the volume of the surgery. In RND, the spinal accessory nerve is affected, which causes impaired active shoulder function. In SOHND and SND, the nerve is preserved, and therefore no difference is found between the SOHND and the SND groups, as no damage the spinal accessory nerve and the sternocleidomastoid muscle is seen.

Conclusion

Assessment of shoulder morbidity in neck dissections shows a higher degree of musculoskeletal function involvement in RND, compared to SOHND and SND. The reason is related to the neurotomy of the spinal accessory nerve. The effects of radical neck dissection on the musculoskeletal disorders persist for years, with incomplete recovery reported.

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