

HEAD AND NECK

# Shoulder function after selective and superselective neck dissections: clinical and functional outcomes

## *Disfunzione della spalla in seguito a svuotamento linfonodale laterocervicale selettivo e superselettivo: risultati clinici e funzionali*

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### SUMMARY

The aim of this work is to assess the clinical and functional outcome of patients who underwent different types of neck dissection, with special regards to the spinal accessory nerve, trapezius muscle and shoulder function. From February 2008 to July 2010, we evaluated 17 cases of neck dissection in patients affected by laryngeal carcinoma clinically staged N0. We performed selective neck dissection (IIA-IIB-III-IV) in 11 cases (group A) and superselective neck dissection in 6 cases (group B). All patients underwent clinical examination before surgery to evaluate shoulder function. They also underwent functional evaluation of the spinal accessory nerve through electromyography (study of muscular activity) and electroneurography (study of motor action potential). Patients were evaluated before surgery (T0), 8 days after surgery (T1) and 21 days after surgery (T2). In all cases, at the end of surgery it was possible to assess the integrity of the spinal accessory nerve. The average value of the MAP was 13.06 in group A and 10.98 in group B at T0. Eight days after surgery (T1) the value of MAP was reduced to 1.35 in group A and 6.15 in group B. Electromyography evaluation showed signs of denervation in 6 cases in group A and in 2 cases in group B. Voluntary activity was not detectable in 6 cases in group A, while it was present, even if reduced, in all cases in group B. At 21 days after surgery (T2), we found a value of MAP of 1.03 in group A and 6.43 in group B. Electromyography showed signs of denervation in 10 patients in group A and in 3 cases in group B. Voluntary activity was not detectable in 10 cases in group A, while it was present in all cases in group B. The arm abduction test was 2.5 in group A and 4.0 in group B. Neck dissection quality of life questionnaire showed a value of 24.17 in group A and a value of 25.5 in group B. Our data thus confirm that surgical manipulation of the nerve may be associated with severe impairment of nerve conduction when sublevel IIB is involved in the dissection.

KEY WORDS: Neck dissection • Spinal accessory nerve dysfunction • Shoulder disability

### RIASSUNTO

Scopo di questo lavoro è stato valutare l'outcome clinico e funzionale di pazienti sottoposti a svuotamento linfonodale laterocervicale per tumori laringei in stadio clinico N0. In particolare l'attenzione è stata focalizzata sul nervo accessorio spinale e sulla funzionalità della spalla. Da Febbraio 2008 a Luglio 2010 sono stati studiati 17 casi di svuotamento linfonodale laterocervicale; in 11 casi è stato eseguito uno svuotamento selettivo (livelli IIA-IIB-III-IV)(gruppo A) e in 6 casi uno svuotamento superselettivo (livelli IIA-III-IV) (gruppo B). I pazienti sono stati valutati prima dell'intervento (T0) con un test clinico e con uno studio electroneurografico (valutazione dell'attività muscolare) ed elettromiografico (studio del potenziale d'azione motorio). Quest'ultimo è stato ripetuto a 8 giorni (T1) e a 21 giorni (T2) dall'intervento. Una valutazione clinica è stata effettuata a distanza di un mese mediante il "neck dissection quality of life questionnaire" e l'"Arm abduction test". Nello studio electroneurografico a T0 il valore medio del potenziale d'azione motorio (MAP) è risultato 13,06 nel gruppo A e 10,98 nel gruppo B. A T1 il MAP risultava 1,35 nel gruppo A e 6,15 nel gruppo B. Lo studio elettromiografico ha mostrato segni di denervazione in 6 casi del gruppo A e in 2 casi del gruppo B. L'attività volontaria non era registrabile in 6 casi del gruppo A mentre era presente, seppur ridotta, in tutti i casi del gruppo B. A T2 il valore del MAP è risultato di 1,03 nel gruppo A e di 6,43 nel gruppo B. L'elettromiografia ha confermato i segni di denervazione in 10 casi del gruppo A e in 3 casi del gruppo B. L'attività volontaria non era registrabile in 10 casi del gruppo A ed era invece presente in tutti i casi del gruppo B. L'"arm abduction" test è risultato di 2,5 nel gruppo A e 4 nel gruppo B. Il "Neck dissection quality of life questionnaire" ha mostrato un valore di 24,17 nel gruppo A e di 25,5 nel gruppo B. I nostri dati confermano che la manipolazione chirurgica del nervo accessorio può determinare una severa disfunzione quando il sottolivello IIB è compreso nella dissezione.

PAROLE CHIAVE: Svuotamento linfonodale laterocervicale • Nervo accessorio spinale • Disfunzione della spalla

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## Introduction

A safe oncological result is, obviously, the goal of cancer therapy, but an improvement in the patient's quality of life after extensive surgery must be considered. Neck dissection is an important step during laryngeal cancer treatment in terms of cosmetic disfigurement, but also in terms of short- and long-term morbidity. For many years, the gold standard to treat neck metastases was radical neck dissection, but the modern trend of cancer surgery is to eradicate tumours trying to prevent short- and long-term consequences as much as possible; from this point of view, whenever possible, modified radical neck dissections, selective neck dissections and superselective neck dissections can be performed. Sacrifice or injury of the spinal accessory nerve leads to denervation and atrophy of the trapezius muscle with the onset of shoulder disability; patients show shoulder droop, pain, weakness and limited range of motion. In modified radical neck dissection and selective and superselective neck dissections, the manipulation of the spinal accessory nerve is lower <sup>1</sup>. This fact might help patients to have better subjective outcomes, but also to lessen morbidity after a such an invasive surgery. The authors studied the 11<sup>th</sup> nerve syndrome in terms of electroneurographical and electromyographical data and subjective outcomes in patients treated for laryngeal cancer with neck dissections with no spinal accessory nerve section. The aim of the study is to describe objective and subjective trauma to the nerve after different modalities of neck dissection.

## Materials and methods

Fromince February 2008 to July 2010 we assessed 17 cases of neck dissection in patients affected by laryngeal carcinoma clinically staged N0. This was a preliminary study, and thus we describe our initial results, even if the number of patients is limited.

We performed selective neck dissection (IIA-IIB-III-IV) in 11 cases (group A) and a superselective neck dissection (IIA-III-IV) in 6 cases (group B).

All patients underwent clinical examination before surgery to evaluate shoulder function, and in particular abduction of the arm. All patients underwent functional evaluation of the spinal accessory nerve using electromyography and electroneurography.

All patients were evaluated before surgery (T0), 8 days after surgery (T1) and 21 days after surgery (T2). We studied the variation of amplitude of the motor action potential (MAP) about 1 week after surgery to evaluate the degree of reduction in the immediate postoperative period. The reduction of amplitude of MAP in this period can be explained by neuroapraxia or axonotmesis. In neuroapraxia, conduction recovers in few days, while in axonotmesis the impairment is detectable for a longer time (even many months). The decision to study patients at 21 days after surgery was also

because spontaneous activity after denervation is detectable by electromyographical study after 3 weeks.

By electroneurography, we studied the amplitude of the motor action potential obtained stimulating the spinal accessory nerve at the superior part of the sternocleidomastoid muscle and deriving the response 10 cm caudally. Electromyography is the study of the electrical activity produced by a skeletal muscle through a needle-electrode introduced in the superior part of the trapezius. We evaluated the spontaneous activity (sign of denervation), the voluntary activity induced by a mild activation of the muscle, and the maximal activity, induced by elevation of the shoulder against resistance. We assigned different values to the different degrees of denervation: 0 for no spontaneous activity; 1 to fibrillation and Jasper +; 2 to fibrillation and Jasper ++; 3 to fibrillation and Jasper +++.

We also assigned different values to voluntary activity: 0 no activity; 1 poor transition or single oscillation; 2 mild transition; 3 interference.

We used electromyography to assess only the superior part of the trapezius muscle, because this part is not directly damaged during neck dissection, while the sternocleidomastoid muscle is subjected to traction and devascularization during the procedure.

Shoulder function was evaluated from a clinical point of view using the Neck Dissection Quality of Life questionnaire and the arm abduction test in all patients one month after surgery. The arm abduction test studied the degree of abduction of the arm, resulting in a value between 1 and 5. One was abduction less then 90°; 5 was abduction more than 180° (Table I).

**Table I.** Arm abduction test.

### ARM ABDUCTION TEST (score)

You can raise your arm:

- Up to 180° without pain or effort (5)
- Up to 180° but with pain or effort (4)
- Up to more than 150° but less than 180° (3)
- Up to more than 90° but not less than 150° (2)
- Up to less than 90° (1)

Neck Dissection Quality of Life questionnaire investigated seven items each with a value between 1 and 5 (1 severe impairment; 5 normal activity). The level of impairment was obtained by adding the values (Table II).

## Results

Electroneurography studied the amplitude of the motor action potential (MAP). In all preoperative evaluation, we found similar values in both groups. The average value of MAP was 13.06 in group A and 10.98 in group B. Electromyography showed a normal pattern of activation of the superior part of the trapezius muscle without signs of denervation in both groups. Eight days after surgery (T1), the value of MAP was reduced to 1.35 in group A and

**Table II.** Neck Dissection Quality of Life questionnaire.

Question	Score
Are you bothered by neck or shoulder stiffness?	1-5
Are you bothered by constriction of your neck?	1-5
Are you bothered by neck or shoulder pain?	1-5
Are you bothered by numbness of your neck?	1-5
Do you think your shoulder is dropped?	1-5
Have you been limited in your ability to reach above for objects because of your shoulder or neck?	1-5
Are you bothered by the appearance of your neck?	1-5
<b>Total</b>	<b>7-35</b>

6.15 in group B, with strong reduction of the value in the selective neck dissection group and mild reduction in the superselective neck dissection group.

Electromyography showed signs of denervation in 6 cases in group A and in 2 cases in group B. Voluntary activity was not detectable in 6 cases in group A, while it was present, even if reduced, in all cases in group B.

The evaluation at 21 days after surgery (T2) showed a value of the MAP of 1.03 in group A and 6.43 in group B. This means that in group B there was a recovery of the values of the potential compared to the results at T1.

The reduction of amplitude of the MAP confirmed 21 days after surgery allowed us to define the damage of the conduction as axonotmesis, and not only as neuroapraxia.

Electromyography showed signs of denervation in 10 patients in group A and in 3 cases in group B. Voluntary activity was not detectable in 10 cases in group A, while it was present in all cases in group B.

The arm abduction test was 2.5 in group A and 4.0 in group B. The Neck Dissection Quality of Life questionnaire showed a value of 24.17 in group A and 25.5 in group B.

## Discussion

Shoulder dysfunction after neck dissection was firstly described by Ewing and Martin in 1952<sup>2</sup>. From an anatomic point of view, shoulder dysfunction means trapezius deficit due to various degrees of injury to the spinal accessory nerve (SAN); signs and symptoms referred to SAN trauma include shoulder droop, scapular dyskinesia, trapezius atrophy, loss of shoulder abduction and shoulder and neck pain<sup>1-3</sup>. Many studies demonstrate that there is a close link between the technique used for neck dissection and postoperative morbidity. In the past, the standard treatment to remove neck metastases was radical neck dissection (RND)<sup>4</sup>; in this procedure the SAN, internal jugular vein and sternocleidomastoid muscle are sacrificed together to the five levels of cervical nodes. Whenever possible, considering the morbidity of what can be called the “shoulder syndrome”, many surgeons started to perform modified radical neck dissections (MRND), preserving the nerve, and selective

neck dissections (SND), removing only nodes at higher risk of metastases. In this study, superselective neck dissections were also considered, removing only levels IIa, III and IV. Less extensive surgery means less morbidity and better quality of life. The decision to study differences between resection or not of level IIB is because during removal of this sublevel the accessory nerve is stretched, so that we wanted to describe the damage from an objective point of view, with the help of neurophysiological procedures. The key-concept is that non-radical dissections can be performed in a clinically-negative neck (N0) because metastatic spread follows a specific pattern. Considering that in laryngeal cancer sublevel IIB is involved by metastatic spreading in only 3% of cases (and only when sublevel IIA is positive for metastases), we aimed to preserve this by dissection in a clinically N0 neck in order to reduce nerve damage.

Kuntz AL et al. studied shoulder function in different types of neck dissections, MRND-RND-SND, from a subjective point of view. The results collected from questionnaires confirmed that the three forms of neck dissection affect quality of life differently; in particular, they recorded a trend toward decreased pain after treatment in SND and MRND cases. Analysis can also be performed according to shoulder function; in the same publication by Kuntz et al., the MRND group reported greater shoulder disability at 6 months compared to the SND group, but by 12 months there was no difference between the two groups<sup>4</sup>. In our analysis, subjective tests show no significant differences between the two groups even if, when sublevel IIB is spared, a better trend is seen.

Cheng PT et al. analyzed shoulder function in the same techniques, but from a functional standpoint using electromyographical data. An objective evaluation of shoulder muscles strength by isokinetic testing and electromyographical and electroneurographic studies on the spinal accessory nerve were performed. In patients who underwent selective nerve dissection, normal and shoulder strength returned to preoperative levels within 6 months<sup>5</sup>. It is necessary to underline that objective data collected from electromyographical tests are rarely comparable to subjective findings: patients may refer, answering questionnaires, a modest perception of shoulder disability, even though electromyographical findings are often abnormal. This is also clear from our results: even in the presence of objective damage to the spinal accessory nerve, functional impairment does not affect the patient's quality of life. In a study by Cappiello et al., two groups of 20 were compared patients after neck dissection: group A was received a SND involving clearance of levels II-IV, while group B received a SND involving clearance of levels II-V. One year after surgery all patients underwent evaluation of shoulder function with a questionnaire, clinical inspection, strength and motion tests, electromyography of the upper trapezius and sternocleidomastoid muscles and electroneurography of the spinal accessory nerve. Group

B had higher percentage of muscular sequelae; electromyographic abnormalities were less frequently found in group A than in group B, but even though a higher number of abnormalities was found by electrophysiological testing, only a limited number of patients, mostly in group B, referred shoulder function disability affecting daily activities<sup>6</sup>. In our study, the answers collected from the Neck Dissection Quality of Life questionnaire showed a high percentage of negative feelings expressed by patients even though the score recorded in all tests did not demonstrate a worsening in quality of life. It is important to underline that no significant differences are present between the two groups. The fact that all patients in our study adjuvant therapies were not necessary should be stressed, even though some authors such as Watkins et al. demonstrated that radiotherapy and chemotherapy do not contribute additional detriment to shoulder function<sup>7</sup>. We aimed to preserve sublevel IIB in clinically N0 neck, meaning patients in which adjuvant therapy is not indicated.

Shoulder dysfunction can be explained by causes other than trauma to the spinal accessory nerve. One open question is how shoulder function can be so impaired even when the integrity of the nerve is preserved. For example, adhesive capsulitis is described as a cause of shoulder dysfunction in patients who underwent neck dissection. In article report by Patten et al., the causes of 11<sup>th</sup> nerve syndrome were analyzed, and numerous findings of shoulder disability could be attributed to adhesive capsulitis. In that study, the authors proposed that adhesive capsulitis is a principal component of 11<sup>th</sup> nerve syndrome that can significantly compound the morbidity of a neck dissection even when the accessory nerve recovers. They recorded numerous findings attributable, in their opinion, to adhesive capsulitis of the glenohumeral joint, and not to injury of the spinal accessory nerve, thus providing an explanation for the persistence of many shoulder symptoms that are unrelated to trapezius muscle dysfunction<sup>8</sup>. The same idea is supported by Eisele et al. who claim that many patients complain of symptoms that exceed those purely due to denervation of the trapezius muscle. They describe these symptoms as restrictions of external and internal rotation of the shoulder, pain while lying on the involved side and mechanical limits to both lateral shoulder abduction and forward shoulder flexion. All these symptoms are described in the syndrome of adhesive capsulitis<sup>9</sup>.

In addition to these aspects, many authors underline the importance of considering the patient's mental health in the postoperative period, as the presence of depression may have a significant impact on shoulder pain and dysfunction<sup>10-11</sup>.

## Conclusions

Shoulder function after neck dissection gives rise to a wide range of opinions about the causes, exams to perform and treatment of shoulder dysfunction, also considering the problem of informed consent. The most important consideration to be made is the absolute respect of the oncological safety and, in our opinion, appropriate preoperative counseling, underlining that surgery will cause some degree of morbidity that will affect negatively quality of life. Considering that sublevel IIB is rarely involved in metastatic spread and that resection of this sublevel causes reduction of conduction of the spinal accessory nerve and denervation of the trapezius muscle, we suggest to preserve this sublevel in a clinically N0 patient in the contralateral side of the tumor. We also suggest to preserve sublevel IIB, especially in patients for whom it is important to preserve shoulder function for reasons linked to employment or in those with neuromuscular disease.

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