# Functional Evaluation of the Spinal Accessory Nerve After Neck Dissection

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Modifications of the classic radical neck dissection as described by Crile [1] have become increasingly popular and, in many medical centers, are considered to be part of the standard surgical armamentarium for the head and neck surgeon. The impetus for many of these modifications has been the amelioration of functional disabilities attendant upon classic radical neck dissection. Prominent among these disabilities is the shoulder dysfunction that results from sacrifice of the spinal accessory nerve. Excision of this nerve results in anatomic and functional disabilities of the shoulder on the operated side.

Bateman [2] has stated that the trapezius muscle is an important part of the suspensory mechanism of the shoulder. Trapezius paralysis allows the shoulder to droop, causes abnormal rotation of the scapula in abduction, and causes considerable aching and pain in the shoulder. When the trapezius is weak or paralyzed, the scapula is unstable and flares out or wings, as is commonly observed after radical neck dissection. Nahum et al [3] attribute the shoulder syndrome resulting from radical neck dissection entirely to trapezius palsy after accessory nerve destruction. They attribute the pain to strain placed on other supporting shoulder muscles, such as the rhomboids and levator scapulae, because of the drooping of that shoulder.

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Despite this knowledge, there has been no prospective study to evaluate the disability associated with a treatment program involving radical neck dissection and modifications of it which, to varying degrees, spare the spinal accessory nerve. It is assumed that these modifications of neck dissection cause less disability than the traditional procedure. Nevertheless the point is contentious and still unresolved. The purpose of this study is to quantitate the degree of permanent disability associated with the radical neck dissection and modifications of it.

## Material and Methods

All patients who underwent neck dissections on the head and neck oncology service at the University of Arkansas for Medical Sciences from January 1980 to June 1982 were evaluated before surgery by an occupational therapist. Objective measurements of range of motion and muscle strength were taken at the neck, shoulder, and scapula bilaterally. Additionally, the patients answered subjective questions regarding their activities of daily living to correlate this information with further measurements of shoulder function. Independently and without the knowledge of the participating therapists the operating surgeons (ourselves) assigned a risk factor to each patient after performing what was considered to be the appropriate cancericidal neck dissection (Table I). In the immediate postoperative period and again 6 months later, all measurements and questionnaires were repeated by the occupational therapist.

One hundred nine patients were evaluated for this study. The control group (risk factor 0,1) consisted of 13 patients who all had major head and neck surgery, usually wide-field laryngectomy, without further dissection into neck. The other patients were evenly divided among those who underwent one of two types of modified neck dissections and those who had a classic radical neck dissection. In one type

of modified procedure, the submaxillary, jugular, digastric, and upper and midjugular groups of nodes were removed (risk factor 2) (Figure 1). For patients with cancer of the hypopharynx or larynx, this modified procedure also included the lower jugular group of nodes and the posterior cervical nodal groups (risk factor 3). In none of these modified procedures was the spinal accessory nerve, jugular vein, or sternocleidomastoid muscle removed. Exact technical details of this procedure have been described elsewhere by Suen [4]. The second type of modified procedure was performed on patients whom we believed required a radical neck dissection for clinically positive nodes, but the spinal accessory nerve did not appear to be in close proximity to the nodes. This procedure removes every nodal group, as in a classic radical neck dissection, but spares the spinal accessory nerve, which is dissected out throughout its course (risk factor 4). Any patient whose neck was staged preoperatively or at the time of surgery as $N_2$ or $N_3$ had a classic radical neck dissection with sacrifice of the spinal accessory nerve.

**TABLE I Risk Factors For Spinal Accessory Nerve During Neck Surgery**

| Risk Factor | Explanation |
|---|---|
| 0 | Surgery did not approach nerve. |
| 1 | Dissection to nerve with little or no manipulation of nerve. |
| 2 | Nerve dissected out in upper third and slight or moderate traction of nerve during dissection. |
| 3 | Nerve dissected out in upper third and in posterior cervical triangle. Traction of nerve but no obvious injury. |
| 4 | Radical neck dissection with nerve dissected out throughout entire course and preserved. |
| 5 | Nerve divided and sutured primarily. |
| 6 | Part of nerve resected and grafting performed. |
| 7 | Nerve resected with no reconstruction. |

## Results

The results of this analysis are presented in Tables II through IV. An evaluation of 13 control patients validated the objective means of the overall evaluation. In none of the 13 patients was there any change in the range of motion or muscle strength at the neck, shoulder, or scapula between those measurements taken before major head and neck surgery and those repeated 6 months later. In addition, none of the patients in this group complained of pain on reaching above the level of the shoulder, or on lifting objects. One patient with shoulder drop was documented to have had it since previous injury.

Among patients who had modified neck dissection with preservation of the spinal accessory nerve, jugular vein, and sternocleidomastoid muscle (risk factors 2 and 3), the distribution of subjective disability (that is, pain) correlated exceedingly well with decreased objective movement and strength at the neck and shoulder (Table II). In almost every case among 36 patients so treated, the degree of objective loss of range of motion and strength was increased as the subjective experience of pain increased. In other words, patients who complained of increasing pain on reaching above the level of their shoulder had an average decrease in range of motion and muscle strength of 23 percent at the neck and 26 percent at the shoulder when those measurements were compared with others taken 6 months after modified neck dissection (preoperative versus postoperative values). Those with less pain, had an average de-

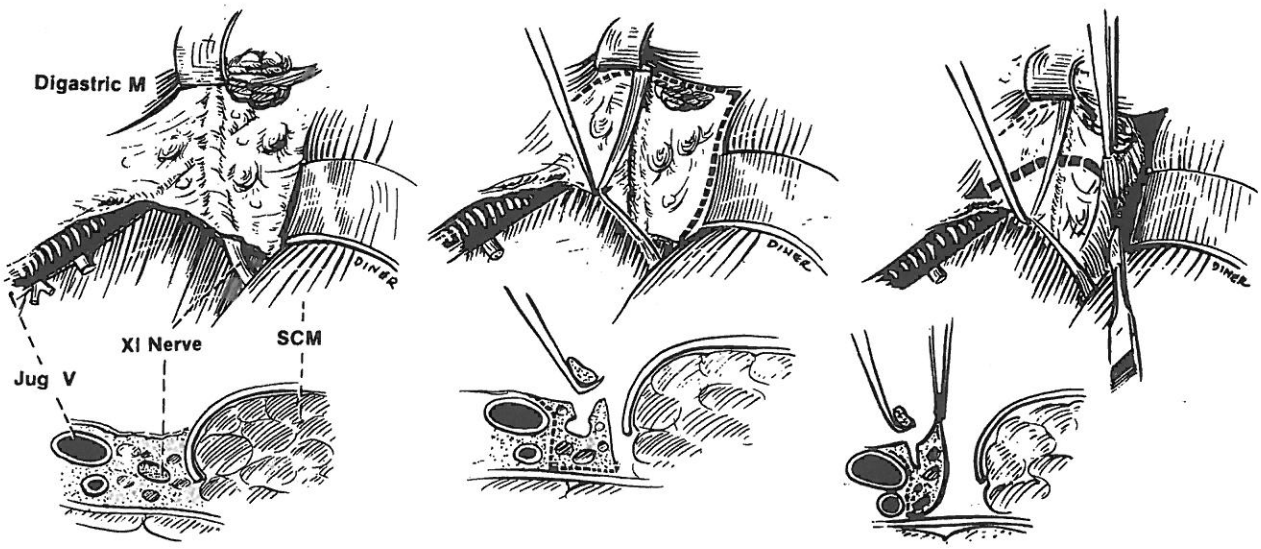


*Figure 1. Cross-section view of a modified neck dissection. The spinal accessory nerve is identified posterior to the jugular vein in the upper neck (left). The upper jugular and jugulodigastric nodes are fully dissected (middle) and delivered under the nerve (right). M = muscle; Jug V = jugular vein; SCM = sternocleidomastoid muscle.*

**TABLE II Risk Factors 2 and 3 in 36 Patients**

| Pain Level* | Patients (n) | SD (n) | Neck (%) | Shoulder (%) | Scapula (%) |
|---|---|---|---|---|---|
| 0–1 | 25 | 3 | −11 | − 7 | + 5 |
| 2 | 9 | 5 | −23 | −26 | +11 |
| 3 | 2 | 1 | −40 | −28 | +15 |
| | | | | 0 | −21 |

* 0–1 = little or no pain; 2 = increased pain when reaching above the level of the shoulder; 3 = increased pain when lifting.
SD = shoulder drop; + = increase in range of motion; − = loss of range of motion.

**TABLE III Risk Factor 4 in 28 Patients**

| Pain Level* | Patients (n) | SD (n) | Neck (%) | Shoulder (%) | Scapula (%) |
|---|---|---|---|---|---|
| 0–1 | 18 | 5 | −12 | −11 | +13 |
| 2 | 7 | 6 | −19 | −23 | +17 |
| 3 | 3 | 3 | −32 | −34 | +14 |

* 0–1 = little or no pain; 2 = increased pain when reaching above the level of the shoulder; 3 = increased pain when lifting.
SD = shoulder drop; + = increase in range of motion; − = loss of range of motion.

crease of only 11 percent at the neck and 7 percent at the shoulder.

In all patients, when dysfunction of the shoulder was evident there was winging of the scapula of 13 to 15 percent. This measurement was constant throughout all groups and undoubtedly represented the degree of abduction and outward rotation of the scapula when there is a loss of stabilization by the trapezius muscle. In itself, this measurement did not correlate with the subjective degree of pain or disability but rather confirmed the loss of innervation by the spinal accessory nerve only.

In the group of patients with risk factors 2 and 3, a large percentage of patients had good functional movement and minimal pain. Seventy percent of patients (25 of 36) experienced minimal or no pain and minimal or no objective dysfunction at the neck and shoulder. Only 3 of these 25 patients experienced shoulder drop and functional objective loss of movement and strength.

Among patients with the modification of neck dissection in which the spinal accessory nerve was spared but all nodal groups were removed in an otherwise classic radical neck dissection (risk factor 4), a different distribution of patients was discovered (Table III). Eighteen of 28 patients so treated had minimal dysfunction (65 percent); however, 5 of those 18 patients (29 percent) had shoulder drop and scapular winging which indicated a loss of spinal accessory nerve function. Overall, 14 of 28 patients (50 percent) had loss of spinal accessory nerve innervation to the trapezius muscle, as documented by objective measurement. This apparent discrepancy between functional usefulness of the shoulder (65 percent) and objective innervation to the shoulder muscles (50 percent) was significant.

Among 35 patients treated with a classic radical neck dissection (Table IV), 14 had subjective evidence of minimal pain and dysfunction (40 percent). A much larger percentage of these patients had pain on attempted use of that shoulder (that is, reaching or lifting) and nearly all had evidence of objective shoulder dysfunction. Nevertheless, the fact that 40 percent of the patients had minimal pain and dysfunction despite loss of innervation at the shoulder seems important.

## Comments

The type of neck dissection to be chosen for therapy of metastatic carcinoma from the head and neck remains a therapeutic dilemma. Lindberg [5] has outlined the probability of metastases to the neck from various sites in the upper aerodigestive tract, and these data form the basis of much of the literature on the technique and indications for functional modifications of the radical neck dissection [6,7]. Skolnik et al [8] detected no metastases in the posterior triangle among 51 neck dissections for carcinomas in various sites of the head and neck in which there were no positive jugular nodes. He concluded that the posterior triangle could be preserved in radical neck surgery in a clinically negative neck, making preservation of the spinal accessory nerve very simple. This concept has been challenged by Conley [9] and questioned by Schuller et al [10], who confirmed a low frequency of metastatic nodes involving the posterior triangle but found a large percentage of metastases (42 percent) in close proximity to the spinal accessory nerve where it comes to lie near the internal jugular vein. These and other investigations have led to the introduction of modified neck dissections as described herein.

Our study indicates that there may be a functional disability associated with any neck dissection in which the spinal accessory nerve is dissected out and placed in some degree of traction. If the risk of functional disability is great enough in the modified neck dissections then the question of whether the modified neck dissection is as effective as the radical neck dissection for controlling neck disease becomes meaningless, and the classic radical neck dissection advocated by Hayes Martin would be the only logical approach to surgical treatment of cervical neck disease. If there is no functional advantage, all other arguments for modified neck dissections carry little weight. Our analysis, however, is not that clear. Although there may be functional disability associated with any type of neck dissection, those neck dissections in which the nerve is minimally dissected

(risk factors 2 and 3) are associated with the least amount of dysfunction. Seventy percent of those patients and 60 percent of patients in whom the spinal accessory nerve was spared but otherwise was a classic radical neck dissection (risk factor 4) had minimal dysfunction by both subjective and objective criteria of evaluation, compared with 40 percent of patients who experienced the same dysfunction after undergoing classic radical neck dissection. Furthermore, even when the functional disability was the same, there was less pain associated with modified as compared with radical neck dissection. Twenty percent of patients who underwent modified radical neck dissection (risk factor 4) who had no associated pain or subjective dysfunction nevertheless had shoulder dysfunction by objective measurement. The message here seems to be that dissection of the spinal accessory nerve may not predictably alter the objective shoulder disability of a particular patient, and he is less likely to have the pain associated with the shoulder syndrome of a classic radical neck dissection.

We have given considerable thought to why 30 percent of these patients with minimal dissection of the spinal accessory nerve (risk factors 2 and 3) had shoulder dysfunction and pain to some degree. The most likely possibility is that near the entrance of the nerve into the sternocleidomastoid muscle, the nerve commonly divides and the branch to the trapezius may continue medially to the muscle which makes it vulnerable to injury during the dissection of the nodes underneath the lower sternocleidomastoid muscle and in the posterior cervical triangle. This injury could be from transection of the nerve or from strong traction.

It is important to note that there was a large group of patients (40 percent) who underwent classic radical neck dissection (risk factor 7) with minimal disability. These patients did well despite the loss of trapezius innervation and despite the presence of shoulder drop and objective loss of motion and strength at the neck and shoulder. They have given impetus to retention of the classic radical neck dissection as the standard from a functional point of view by which all modifications must be measured and evaluated. Why some of these patients did well and others did not is unclear, although it is probably related to preoperative strength, activity, and motivation of the patient. Those patients who are well developed, utilized their neck and shoulder in daily work and other activities, and are therefore able to use other compensatory muscles and movements may do better regardless of the type of neck dissection performed.

There were several other factors not considered in our evaluation that may have influenced the results. One is that the majority of these patients were given instructions for shoulder exercises and therapy by the occupational therapist preoperatively and postoperatively. Also, shoulder braces were given to most patients with a shoulder drop after surgery. We did not assess whether patients followed the therapy program and to what extent the therapy influenced the pain and dysfunction. The other factor not evaluated was whether or not the patients received radiotherapy as part of their overall treatment and whether our results may have been influenced by the irradiation. Schuller et al [*11*] indicated that the total treatment appeared to influence the degree of shoulder dysfunction.

**TABLE IV Risk Factor 7 in 35 Patients**

| Pain Level* | Patients (n) | SD (n) | Neck (%) | Shoulder (%) | Scapula (%) |
|---|---|---|---|---|---|
| 0–1 | 14 | 12 | − 7 | −13 | +14 |
| 2 | 13 | 10 | −24 | −27 | +14 |
| 3 | 8 | 8 | −38 | −36 | +15 |

*0–1 = little or no pain; 2 = increased pain when reaching above the level of the shoulder; 3 = increased pain when lifting.
SD = shoulder drop; + = increase in range of motion; − = loss of range of motion.

## Summary

The pain and dysfunction associated with a loss of innervation by the spinal accessory nerve has motivated surgeons to modify the classic radical neck dissection. A prospective study of 109 patients who underwent either a radical neck dissection or a modification of it with preservation of the spinal accessory nerve revealed that those patients in whom the nerve, muscle, and vein were preserved had less dysfunction (30 percent) than those with nerve preservation only (50 percent) or classic radical neck dissection (60 percent). In addition, even when the functional disability was the same, there was less associated pain with nerve-sparing procedures. Furthermore, a large group of patients (40 percent) who underwent classic radical neck dissection had minimal disability. Given these results, a prospective study of recurrence data in these patients is indicated.

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