Cable Grafting of the Spinal Accessory Nerve After Radical Neck Dissection

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Background: From January 1981 through March 1996, 20 patients with head and neck cancer underwent radical neck dissection with sacrifice of the spinal accessory nerve and immediate reconstruction of the nerve using a microsurgical technique and a cable graft of the great auricular nerve.

Methods: Postoperative shoulder function was assessed via a subjective questionnaire, objective strength testing, and/or postoperative electromyography. The latter was used to evaluate for the presence and amplitude of voluntary motor potentials, the presence of fibrillation potentials, and nerve conduction latency. The group of patients who underwent cable grafting of the spinal accessory nerve was compared with a group of patients who underwent modified radical neck dissection with preservation of the spinal accessory nerve and with another group of patients who underwent a classic neck dissection with sacrifice of the spinal accessory nerve and no reconstruction.

Results: In terms of shoulder function, the group of patients in whom the spinal accessory nerve was reconstructed occupied an intermediate position; ie, their postoperative shoulder function was better than that of the patients who underwent radical neck dissection without reconstruction but not as good as that of the patients who underwent modified neck dissection with preservation of the spinal accessory nerve.

Conclusion: Cable grafting of the spinal accessory nerve that has been sacrificed during radical neck dissection results in improved shoulder function in the postoperative period.

PATIENTS AND METHODS

From January 1981 through March 1996, 20 patients underwent classic RND with division of the spinal accessory nerve for the eradication of metastases to the cervical lymphatics from head and neck cancer. These patients underwent immediate reconstruction of the spinal accessory nerve with a CG using the great auricular nerve. The results of the initial experience with the use of this technique were published earlier.3

Usually, the ipsilateral great auricular nerve was used. Frozen sections obtained from the great auricular nerve at the point where it enters the lateral triangle of the neck along the posterior aspect of the sternocleidomastoid muscle were always negative for neoplasm, as were frozen sections of the proximal and distal ends of the transected spinal accessory nerve.

An adequate length of great auricular nerve was obtained to prevent tension on the nerve. The anastomoses were performed under magnification using 3 or 4 nylon sutures (8-0) at both the proximal and distal sites of reapproximation. The CG was completed in 20 to 30 minutes.

Evaluation of the functional success of RND with CG was performed using a subjective questionnaire to evaluate shoulder function, strength testing of the trapezius muscle, and electromyography (EMG) of the trapezius muscle. The patients who underwent an RND with CG were compared with those who underwent a modified neck dissection (MND) with preservation of the spinal accessory nerve and with those who underwent an RND without CG. Subjective and objective testing was performed 9 to 43 months (median, 15 months) after RND with CG; 10 to 23 months (median, 14 months) after MND, and 12 months to 28 years (median, 20 months) after RND without CG.

The subjective questionnaire evaluated the patient’s perceived ability to reach overhead, to lift an object overhead, and to carry a heavy object. The presence and degree of pain in the shoulder were also noted. Responses were assigned values of 0 (poorest functional category) to 4 (normal functional category). Objective strength testing was performed according to the methods of Daniels and Worthington4 and included evaluation of elevation, abduction, and depression of the scapula, along with adduction of the scapula, so that the upper, middle, and lower portions of the trapezius muscle were evaluated. Again, values of 0 to 4 were assigned.

The resting position of the point of the shoulder was noted and assigned a value of 0 if it was significantly lowered, 1 if it was slightly lowered, and 2 if it was normal. These values were added to the totals for the objective strength testing. The testing was performed by a single member of the Physical Therapy Department.

Electromyography was performed postoperatively in the upper portion of the trapezius muscle. The presence of voluntary motor potentials, the absence of fibrillation potentials, and the nerve conduction latency were recorded.

Scores for postoperative EMG testing were obtained by assigning a value of 1 if voluntary motor potentials were present and 0 if they were absent. Similarly, a value of 1 was assigned if fibrillation potentials were absent and 0 if they were present. A value of 2 was assigned if nerve conduction latency was normal, 1 if it was increased, and 0 if there was no nerve excitability.

mean of 12.9 of 16 on the subjective questionnaire and a mean of 9.9 of 18 on objective strength testing. Ten of 12 patients in the RND group exhibited voluntary motor potentials, and 5 of 12 displayed an absence of fibrillation potentials. Eight patients were tested for nerve conduction latency, and 6 of 8 demonstrated increased conduction latency. The other 2 had no evidence of spinal accessory nerve conduction. The patients who underwent classic RND without reconstruction of the spinal accessory nerve scored a mean of 9.2 of 16 on the subjective questionnaire and a mean of 6.2 of 18 on objective strength testing. One of 6 exhibited voluntary motor potentials and 0 of 6 displayed an absence of fibrillation potentials. None had any evidence of conduction of electrical activity

The analysis of variance7 method was used to evaluate overall differences among the 3 groups. The Fisher least-significant-difference test and the Duncan multiple range test7 were used to determine if a specific group differed significantly from another group. The χ2 test was used to evaluate differences in the presence of voluntary motor potentials and the absence of fibrillation potentials. The Cochran-ManTEL-HAENSZEL test8 was used to evaluate differences in nerve conduction latencies.

When considered overall, and subjected to an analysis of variance test, the 3 groups were shown to differ significantly on all 5 tests (P<.01). When one group was compared with another, the score on the subjective questionnaire for the MND group and for the RND with CG group was significantly higher than for the RND without CG group (P<.04). However, the RND with CG group did not differ significantly from the MND group (P=.08). On the objective strength testing, all 3 groups differed significantly from one another (P<.01).

The proportion of patients with voluntary motor potentials was significantly different for the RND with CG group vs the RND without CG group and for the MND group vs the RND without CG group (P<.01). Only the MND group and the RND without CG group differed significantly regarding the absence of fibrillation potentials (P=.01). The RND with CG group did not differ significantly from the MND group regarding the presence of voluntary motor potentials (P=.07) or the absence of fibrillation potentials (P=.06). For nerve conduction latency scores, all groups differed significantly from one another (P<.01).

COMMENT

The primary goal of neck dissection for metastatic head and neck cancer is eradication of malignant disease and not maximization of postoperative shoulder function.
However, in selected cases with limited nodal disease, a modified procedure can be performed, sparing the spinal accessory nerve and often the sternocleidomastoid muscle and internal jugular vein, without compromising the control of the cancer. For more extensive nodal disease, RND with sacrifice of the spinal accessory nerve is still required. In these latter cases, when the nodal disease is of moderate size and located in the jugulodigastric area, the proximal and distal portions of the severed spinal accessory nerve can readily be identified, and a CG using the great auricular nerve can be interposed to provide reinnervation of the trapezius muscle. Previously, frozen sections of the proximal and distal ends of the ipsilateral great auricular nerve were always negative for tumor invasion. When nodal disease in the upper neck area is extensive, then a proximal portion of the accessory nerve cannot be preserved after adequate resection, thus eliminating the opportunity for CG.

Although the spinal accessory nerve does have some sensory function, its primary role is the provision of motor input to the trapezius muscle. There is some evidence that there is alternative motor input to the trapezius muscle via the cervical plexus. This seems to be highly variable and not dependable. The trapezius muscle is considered to have 3 portions: upper, middle, and lower. The upper and lower thirds rotate the scapula on the chest wall and allow abduction of the upper extremity from 90° to 120°. The upper portion of the trapezius muscle also elevates the scapula along with the levator scapula muscle, thus setting the level of the point of the shoulder. The middle portion of the trapezius muscle addsucts the scapula and stabilizes it in conjunction with the serratus anterior muscle. The serratus anterior muscle also serves to aid in abduction of the upper extremity.

Comparisons of techniques of neck dissection that preserve or reconstruct the anatomical integrity of the spinal accessory nerve with those that sacrifice this nerve are complicated by the fact that there are other determinants of postoperative shoulder function. As mentioned, there may be alternative motor input through the cervical plexus, leading Brown et al to describe the motor innervation of the trapezius muscle as the "spinal accessory nerve plexus." Preoperative shoulder dysfunction and adhesive capsulitis, age of the patient, and motivation to pursue postoperative range-of-motion exercises and rehabilitation are interrelated factors that determine shoulder function after neck dissection. As noted, the levator scapula and serratus anterior muscles can, to some degree, compensate for loss of trapezius function. The degree to which this compensation occurs is determined by whether the motor supply to these muscles is interrupted during neck dissection (ie, by dissection deep to the prevertebral fascia) and by the extent to which the muscles are strengthened through postoperative rehabilitation. Flaps for reconstruction of the head and neck, such as the pectoralis major or the latissimus dorsi myocutaneous flaps, when harvested from the side ipsilateral to the side of the neck dissection can compromise postoperative shoulder function.

Even when the spinal accessory nerve is thought to have been left anatomically intact, as in MND, postoperative shoulder disability can exist. There is often a temporary neuropraxia related to intraoperative dissection of the nerve that can improve over the 12 months after surgery. More permanent shoulder disability can result from a greater degree of injury to the spinal accessory nerve.

The spinal accessory nerve can be unknowingly transected during MND. Retraction of the sternocleidomastoid muscle causes an artifactual alteration in the course of this nerve at a point after it has exited the posterior border of the sternocleidomastoid muscle, allowing the spinal accessory nerve to be confused with cervical sensory roots. Despite these limitations, the findings of several studies support the theory that postoperative shoulder function is improved when the spinal accessory nerve is preserved or reconstructed.

There have been previous studies on CG of the spinal accessory nerve, but in only 1 (to our knowledge) was there an attempt to evaluate postoperative trapezius function. Anderson and Flowers performed postoperative EMG in 4 cases. In recent years, more sophisticated methods for evaluating postoperative trapezius and shoulder function have been described. The "gold standard" may be that used by Hillel et al, which is based on sophisticated strength-testing technology. Other methods for rehabilitation of postoperative shoulder function after neck dissection include physical therapy and range-of-motion exercises, orthopedic reconstruction of the shoulder girdle, and preservation of the cervical plexus, which attempts to maintain alternative motor input to the trapezius. Certainly, physical therapy and range-of-motion exercises are important after CG, as reinnervation does not occur for about 5 months, allowing plenty of time for adhesive capsulitis to occur. When the latter occurs in older patients, it is very difficult to reverse.

**CONCLUSIONS**

Cable grafting of a spinal accessory nerve that has been sacrificed during RND results in improved postoperative shoulder function compared with RND without reconstruction of the spinal accessory nerve. However, postoperative shoulder function is best when the anatomical integrity of the spinal accessory nerve is not interrupted, as in the performance of MND.

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