Vocal cord paralysis associated with anterior cervical fusion: considerations for prevention and treatment

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In a series of 375 patients with anterior cervical fusions, long-term follow-up results complete with laryngeal examination were obtained in 102 patients. One patient was found to have an inferior laryngeal nerve palsy, and one had a superior laryngeal nerve palsy. Both deficits were thought to be the result of surgical trauma. Measures to minimize the incidence of vocal cord paralysis include careful surgical technique and knowledge of the surgical anatomy of the laryngeal nerves. Suggestions are given for the assessment of postoperative hoarseness, and for the management of vocal cord paralysis.

KEY WORDS: vocal cord paralysis • laryngeal nerve injury • anterior cervical fusion • surgical complications

Following the introduction by Robinson and Smith of the anterior approach to the cervical spine for disc removal and fusion and its popularization by Cloward, the operation has gained widespread acceptance as a relatively safe and effective method of intervertebral disc surgery in the cervical spine. Like other operations in the low anterior aspect of the neck, this technique requires dissection in the vicinity of the laryngeal nerves, thus involving the risk of vocal cord paralysis.

Cloward and others have mentioned occurrences of vocal cord paralysis, but no systematic examination of a series of patients has been carried out to identify the actual incidence of permanent vocal cord paralysis complicating anterior cervical fusion. The report by Flynn of documented vocal cord paralysis in only 52 of 45,457 cases (one per 876 cases) reported by questionnaire seemed much lower than the 5.9% reported by Astor, et al., in patients undergoing carotid endarterectomy, or the 6.8% reported by Hockauf and Sailer in patients subjected to thyroidectomy for benign disease, both procedures involving dissection in the anterior aspect of the neck. In addition, Cloward mentioned a 2% incidence of permanent hoarseness, presumably from vocal cord paralysis, following anterior fusion. Heeneman reviewed the charts of 85 patients who had undergone anterior cervical fusion, and found that nine (11%) were noted to have postoperative voice changes. On indirect laryngoscopy all were found to have unilaterally impaired or absent vocal cord mobility. Six recovered function over 3 months, but three did not. The vocal cords in all nine patients appeared to show normal tension, but a failure of abduction and a paramedian position were noted, indicating loss of inferior nerve function as opposed to superior laryngeal nerve function.

Several difficulties arise in estimating the incidence of vocal cord paralysis after neck surgery. First, some patients have impaired vocal cord mobility with minimal or no change in their voice. If one uses voice impairment as the criterion for selecting patients for laryngeal examination, these patients will not be identified. Second, postoperative vocal cord paralysis may occur as a result of endotracheal intubation. The mechanism of injury is thought to be compression of the anterior branch of the recurrent nerve between the thyroid lamina and the tube or cuff as the branch passes under the mucosa of the larynx to the lateral cricoarytenoid and thyroarytenoid muscles. Such injury may not be common, but could erroneously be attributed to surgical trauma. Third, hoarseness following surgery can be the result of injury to the recurrent or superior laryngeal nerve and be unrelated to surgery, as from direct trauma or from a motor-vehicle accident. Fourth, as a result of swelling in the soft tissues of the pharynx and larynx associated with cervical fusion, patients may have dysphagia and hoarseness with normal vocal cord mobility.
In this report we describe our experience with laryngeal nerve injury in anterior cervical fusions based on systematic examination of the patients available for long-term follow-up review. We also describe our methods of avoiding injury to the inferior and superior laryngeal nerves, and of rehabilitating the larynx should injury occur.

**Clinical Material and Methods**

Between January, 1970, and August, 1983, 375 patients underwent anterior cervical fusions at our institutions. Of these, 105 were lost to follow-up review, and 270 patients were contacted by letter and asked to make themselves available for examination. The 102 patients who responded form the basis of this study. They were examined in an office setting, and laryngeal examination was performed with an indirect (mirror) laryngoscope. If the larynx was difficult to examine because of an anterior location, overhanging epiglottis, or hyperactive gag reflex, a Machida fiberoptic laryngoscope was passed transnasally and used to assess vocal cord function directly. Specific notation was made of vocal cord abduction, adduction, and bowing. The ability of the epiglottis to tip anteriorly on phonation was also recorded. The patients were asked to count out loud to as high a number as possible on a single inspiration, as a rough test of their ability to minimize air loss during phonation. Historical information relative to laryngeal function following the surgery was also obtained. The patients were asked if they noted a change in their voice after surgery, and how long it lasted. The patients were asked if any difficulty in swallowing after surgery, and how long it lasted. They were asked if they had undergone any other surgery on their neck or chest before or after the cervical fusion. A note was made of any incidental abnormality found in the larynx during laryngoscopy.

**Results**

The results of this study are summarized in Table 1. The follow-up period in these 102 patients ranged from 6 months to 14 years (mean 5.2 years).

One patient was found to have a right recurrent nerve paralysis, with the cord fixed in the paramedian position; this almost certainly resulted from surgical trauma during anterior fusion, since the patient noted hoarseness and aspiration of liquids immediately after surgery. The aspiration stopped and the voice returned to normal without specific treatment, so at the time of examination 6 months following surgery the patient was free of symptoms. One patient had a superior laryngeal nerve paralysis, with hoarseness and shortening and bowing of the vocal cord, but intact abduction and adduction. The epiglottis tipped poorly. The paralysis was thought to be due to surgical trauma since the symptoms first occurred at the time of surgery. The fact that the right side of the larynx was affected was indicative of an iatrogenic cause, since the operation had been done from the right side as were all those in this series.

Eight patients were found to have incidental abnormalities in the larynx. One had bilateral leukoplakia. One had a superior laryngeal nerve palsy on the side opposite the surgery, with symptoms not arising at the time of surgery. Three patients had laryngeal polyps or polypoid laryngitis. Three patients had laryngeal myasthenia with mild symmetrical bowing of the vocal cords on phonation. It is interesting to note that 22 patients recalled being hoarse after the anterior fusion procedure, and 17 had difficulty in swallowing. It would seem that these symptoms should not be taken as particularly worrisome unless they last more than 6 weeks.

**Discussion**

**Prevention of Laryngeal Nerve Injury**

Understanding the variable anatomy of the laryngeal nerves, and the function of the larynx can help the surgeon to minimize the chance of vocal cord injury during cervical fusion. The recurrent laryngeal nerves follow different courses on the right and left sides. On the right, the nerve leaves the main trunk of the vagus nerve and passes anterior to and under the subclavian artery. It then ascends in the neck, having a variable relation to the inferior thyroid artery, and a more constant relation to the inferior cornu of the thyroid cartilage. It then frequently bifurcates or trifurcates before entering the larynx. A recurrent inferior laryngeal nerve always lies under the lateral lobe of the thyroid gland and its sheath, the so-called “ligament of Berry.” In about 1% of cases, however, the right inferior laryngeal nerve is nonrecurrent, arising from the main trunk of the vagus and passing directly into the larynx. The nonrecurrent nerve is associated with an aberrant subclavian artery which is retroesophageal and arises from the descending aorta (Fig. 1).

On the left side, the recurrent laryngeal nerve passes under and posterior to the aorta at the site of origin of the ligamentum arteriosum. Nonrecurrence of the left inferior laryngeal nerve is rare, and is associated with a right-sided aortic arch and a retroesophageal left subclavian artery. The nerve rises in the neck somewhat more medially on the left side than on the right.

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**TABLE 1**

<table>
<thead>
<tr>
<th>Postoperative Complications</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>hoarseness (patient recollection)*</td>
<td>22</td>
</tr>
<tr>
<td>dysphagia (patient recollection)</td>
<td>17</td>
</tr>
<tr>
<td>recurrent nerve palsy</td>
<td>1</td>
</tr>
<tr>
<td>superior nerve palsy</td>
<td>1</td>
</tr>
<tr>
<td>incidental laryngeal abnormality</td>
<td>8</td>
</tr>
</tbody>
</table>

* Duration of hoarseness: 2 days to 3 months.
Vocal cord paralysis and anterior cervical fusion

Injury to the inferior laryngeal nerves results in impairment of abduction and adduction of the vocal cord, with the cord motionless in the midline or in a lateral position. The voice is hoarse, and air loss causes a weak, breathy quality. Over a period of several weeks, the opposite vocal cord frequently begins to cross the midline, resulting in return of voice strength and minimizing air loss. If the cords do not approximate well, aspiration especially of liquids may occur due to spillage through the glottis.

The superior laryngeal nerves arise from the vagus and divide into two branches: an internal sensory branch which penetrates the thyrohyoid membrane, and an external branch which accompanies the superior thyroid artery and supplies motor fibers to the cricothyroid muscle. Injury to the nerve may cause hoarseness due to inability of the cricothyroid muscle to tense the vocal cord during phonation. Such an injury may also promote aspiration of food and liquids due to loss of sensation in the larynx.

Our approach in anterior cervical fusion procedures utilizes a right-sided incision, usually made horizontally in a skin crease, and carried through the platysma. A cleavage plane is bluntly dissected between the carotid sheath and the thyroid gland. During the early part of the dissection up to the time when the surgeon (R.A.B.) is ready to drill out the interspace, retraction is done with Army-Navy retractors. During this dissection, care should be taken to inspect the field carefully. If the recurrent nerve is in its most common location, it will lie posterior and medial to the right thyroid lobe and will be retracted from the field. But in approximately 1% of cases, the nerve will arise directly from the vagus and pass to the posterior aspect of the cricothyroid joint without descending into the mediastinum; such a “non-recurrent” nerve is in special danger during dissection in the area lateral to the right thyroid lobe. Any structure traversing this area, other than the middle thyroid vein, should be suspected of being a nonrecurrent laryngeal nerve. If gentle retraction of such a structure is not possible, an attempt should be made to identify with certainty a normal-sized recurrent nerve (1 to 3 mm in diameter) in the usual location. For this the following technique may be used: the thyroid lobe is retracted medially after ligation of the middle thyroid vein. Palpation of the tissues lateral to the larynx and trachea may then reveal a recurrent nerve tensed by this maneuver. The nerve is often easily identified about 0.5 cm inferior to the tip of the inferior cornu of the thyroid cartilage, and can be palpated by running the finger along the posterior border of the thyroid cartilage to its end. If the patient is not paralyzed by muscle relaxants given by the anesthesiologist, a nerve stimulator can be used to stimulate a suspected inferior laryngeal nerve while an observer watches the larynx through a laryngoscope. Definite motion confirms the identity of the recurrent nerve. Identification may be aided by inserting a No. 27 needle through the cricothyroid membrane, and advancing it superiorly and laterally into the ipsilateral true cord. Stimulation of the suspected nerve with an electric nerve stimulator on a high setting is then carried out, and identification is confirmed by motion of the needle.

If a nonrecurrent inferior laryngeal nerve is identified, and cannot be retracted, the surgeon is faced with a difficult decision. Possible solutions include dividing the nerve or closing the incision and making a left-sided approach. If there is a possibility that the nerve has already been traumatized, it may be better to sacrifice the nerve, since a unilateral vocal cord paralysis is a much less serious disability than a bilateral paralysis. In the vast majority of cases, however, gentle blunt dissection proceeds through this area without any suspected nonrecurrent laryngeal nerve being encountered. Care must still be taken, however, to handle tissue gently and to avoid unduly vigorous retraction of the carotid sheath, larynx, and trachea. The longus colli muscles are then dissected bilaterally using a cutting cautery to create an edge under which sharp-toothed Cloward retractors are placed. We have modified the left-sided retractor teeth by bending them into an obtuse angle, which assures their placement into the muscle and not into the esophagus. Similarly, the right-sided retractor is carefully placed into the longus colli muscle. Particular care is taken during the operation to release tension on the retractors when they are not actually required, such as when x-ray films are being taken, or when the bone plug is being taken from the hip.
**Evaluation and Rehabilitation of Vocal Cord Injury**

Even in the absence of injury to the laryngeal nerves, the patient may be hoarse following surgery. If the cough is adequate, and aspiration is not a problem, expectant management is appropriate. Should symptoms persist for more than 6 weeks, or if airway obstruction or aspiration is present, laryngoscopy should be performed. The examination can usually be done easily with a laryngeal mirror or flexible fiberoptic laryngoscope, without anesthesia.

Close approximation of the vocal cords is required for phonation. Paralysis of the adductor muscles of the larynx results in a breathy voice and possibly in aspiration. The position of the paralyzed vocal cord varies with the nature of the injury, whether superior, inferior, or combined; however, considerable variation may be noted in function of the larynx in patients with similar injuries. Isolated inferior nerve injury often (but not always) produces a paramedian position of the vocal cord. Combined superior and inferior nerve injury may produce an intermediate, more lateral, position since the adducting effect of the cricothyroid muscle, the only muscle innervated by the superior laryngeal nerve, is lost. Isolated superior nerve paralysis is often asymptomatic aside from minor throat irritation or cough, and treatment is neither available nor necessary.

In contrast, inferior nerve injury often produces serious sequelae. Initial treatment is dependent not only on the symptoms present but also on the probable mode of injury. When a surgical injury involves a nerve that is thought to be anatomically intact, expectant management is indicated in the absence of severe aspiration. Recovery is expected within 6 to 12 weeks. If the inferior nerve is not intact, more definitive treatment is necessary. Although surgical restoration of function to a paralyzed cord through the use of a nerve-muscle pedicle has been described, the procedure has not achieved wide acceptance. Injection of the paralyzed cord with Teflon paste or Gelfoam or (for temporary effect) Gelfoam is the most widely used rehabilitative techniques, and are usually satisfactory in restoring the voice and cough and preventing aspiration. The Teflon paste or Gelfoam is injected transorally under topical anesthesia between the vocalis muscle and the thyroid cartilage. The probability of spontaneous return of normal function determines the choice of agents. Gelfoam paste is an inert substance, both insoluble and nonantigenic, with minimal foreign-body reactivity. It remains in the tissues without change for many years. Injection of Teflon or Gelfoam can be completed within a few minutes. The injected mass adducts the cord, producing improved glottic closure with a more effective cough. Fine control of the voice is not frequently attained due to loss of ability to tense the cord. An overall improvement in approximately 80% of patients can be expected. Transient postoperative edema can be controlled with corticosteroid administration. The most common reason for failure of this method is improper surgical technique with inexact positioning of the paste within the tissues.

Even if permanent inferior nerve paralysis is present, spontaneous compensation, perhaps aided by speech therapy, may very well be sufficient to restore normal laryngeal function. In the absence of significant aspiration, 6 months should elapse before Teflon paste injection is considered.

Based on our study, it appears that, despite the use of careful technique, a small number of patients undergoing anterior cervical fusion suffer postoperative recurrent nerve palsy. It may be helpful to advise the patient preoperatively of the possibility of a weakening of the voice, particularly if the patient depends on the voice for a livelihood. If the voice is noted to be hoarse or weak preoperatively, the larynx should be examined when possible to document any impairment of laryngeal function.

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**References**

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