Recurrent laryngeal nerve palsy during anterior cervical spine surgery: a prospective study

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Object. Recurrent laryngeal nerve (RLN) palsy is a well-known complication of cervical spine surgery. Nearly all previous studies were performed without laryngoscopy in asymptomatic patients. This prospective study was undertaken to discern the true incidence of RLN palsy. Because not every RLN palsy is associated with hoarseness, the authors conducted a prospective study involving the use of pre- and postoperative laryngoscopy.

Methods. Prior to anterior cervical spine surgery preoperative indirect laryngoscopy was performed in 123 patients to evaluate the status of the vocal cords as a sign of function of the RLN. To assess postoperative status in 120 patients laryngoscopy was repeated, and in cases of vocal cord malfunction follow-up examination was conducted 3 months later. In the group of 120 patients who attended follow-up examination, two (1.6%) had experienced a preoperative RLN palsy without hoarseness. Postoperatively the rate of clinically symptomatic RLN palsy was 8.3%, and the incidence of RLN palsy not associated with hoarseness (that is, clinically unapparent without laryngoscopy) was 15.9% (overall incidence 24.2%). At 3-month follow-up evaluation the rate had decreased to 2.5% in cases with hoarseness and 10.8% without hoarseness. Thus, the overall rate of early persisting RLN palsy was 11.3%.

Conclusions. Laryngoscopy revealed that the true incidence of initial and persisting RLN palsy after anterior cervical spine surgery was much higher than anticipated. Especially in cases without hoarseness this could be proven, but the initial incidence of hoarseness was higher than expected. Only one third of new RLN palsy cases could be detected without laryngoscopy. Resolution of hoarseness was approximately 70% in those with preoperative hoarseness. The true rate of RLN palsy underscores the necessity to reevaluate the surgery- and intubation-related techniques for anterior cervical spine surgery and to reassess the degree of presurgical patient counseling.

KEY WORDS • recurrent laryngeal nerve • cervical spine • hoarseness • laryngoscopy • complication

HOARSENESS as a complication of anterior cervical spine surgery is well known,1,5,10,14,16,18,24,25 It is caused by palsy of one or both of the RLNs. The unilateral RLN palsy with a paramedian position of the vocal cord is most expressed clinically by dysphonia. Other reported symptoms are aspiration and dysphagia;24 however, the paralysis may be clinically silent. The clinical picture of bilateral RLN palsy with the typical position of the vocal cords corresponds most frequently with a high-level dyspnea with inspiratory stridor. In earlier studies unilateral RLN palsy was reported to be the most frequent nerve-related complication during an anterior approach to the cervical spine.9,20,42 The incidence of a permanent hoarseness due to RLN palsy has been reported to range from 2 to 4%.5,14,16,24 In the neurosurgical literature, several authors have reported lower rates.1,13,38 Many authors published rates for combined transient and permanent RLN palsy, which can be as high as 7%,8 and 11%.16 It has been contended that RLN palsy is underreported.27,42 The wide range of reported RLN palsy rates makes this statement appear likely to be true. As noted, RLN palsy may be clinically unapparent—that is, without manifestation of hoarseness.4 It is therefore misleading to assume that the incidence of RLN palsy is only in the 2 to 4% range unless indirect laryngoscopy has been used to assess the true incidence. To date, we are aware of only two studies involving indirect laryngoscopic examination in all patients. In most instances only symptomatic patients were examined laryngoscopically, even in recent prospective studies.18

Typically the RLN will not be surgically exposed during anterior cervical spine surgery.15 The nerve’s course varies and it is a thin structure (1–3 mm) so the surgeon may have difficulties identifying and exposing it.25 In contrast to neurosurgical techniques it is general standard in thyroid surgery to expose the RLN to avoid causing iatrogenic injury of the nerve.19,26 Recently there have been reports of a sensitive and a trauma-related monitoring procedure for the RLN during spine surgery, such as vocal cord EMG,18 although precise criteria for intervention remain unclear. Localization and monitoring of the RLN is

Abbreviations used in this paper: EMG = electromyography; RLN = recurrent laryngeal nerve.
more commonly used in thyroid surgery, although RLN palsies are not more frequent in this surgery.11,19,21,36,39

To establish the true incidence of RLN palsy, we undertook a prospective study to examine all patients who underwent anterior cervical spine surgery and pre- and postoperative laryngoscopy to document the status of the vocal cords. We discuss the possible impact on surgical standards and whether discussion of a change is necessary.

Clinical Material and Methods
After obtaining informed written consent from 123 patients who underwent anterior cervical spine surgery (anterior cervical discectomy, corpectomy, and osteosynthetic fusion procedures), indirect laryngoscopy was performed to evaluate the preoperative status of the vocal cords. A preoperative examination was necessary to exclude spontaneous, asymptomatic vocal cord palsy. A second laryngoscopy was conducted in the early postoperative period (3rd–7th postoperative day). At the same time vocal cord function was clinically examined. In case of laryngoscopically proven dys- or malfunction of the vocal cords, both examinations were repeated during a follow-up examination 3 months later.

One hundred twenty patients, 80 males and 40 females, were finally included in the study. We had to exclude four patients (one prior to the study and three because of missing follow up) for the following reasons. One patient with an esophageal carcinoma and extensive mediastinal and spinal metastases was excluded primarily because the emergency character of the operation prevented a preoperative laryngoscopy; another patient was not willing to endure the inconvenience of another follow-up laryngoscopy; one patient died of presumed massive gastrointestinal hemorrhage immediately after the operation; the other patient died several months later of pneumonia after a prolonged postoperative stay in the intensive care unit. A general discussion of other complications is not intended by the study. The third secondarily excluded patient was not willing to endure the inconveniences of a follow-up laryngoscopic examination.

The examination period comprised 2 years and the distribution of neurosurgical procedures included 78 anterior cervical discectomies without fusion (methacrylate spacer) and 42 osteosynthetic fusions (29 with corpectomy). Overall 51.6% of the procedures were multilevel involving larger exposure of the cervical spine (Table 1). The approach to the cervical spine was right sided in all cases. In 96.6% of the cases follow-up data were available after 3 months.

Results
Laryngoscopy detected preoperative, asymptomatic unilateral RLN palsy in two cases (1.6%). In one of the patients a specific history was absent. The other patient had a history of brainstem infarction with hemiparesis and multiple cranial nerve palsies including unilateral laryngeal nerve palsy without hoarseness. Postoperative laryngoscopy demonstrated no deterioration in either case.

All patients underwent a laryngoscopy in the early postoperative period (Day 3–7) and there were 29 (24.2%) new unilateral palsies. In all of these cases a 3-month follow-up examination had been performed. We discovered 28 new right-sided vocal cord palsies (including four cases with a decrease of motion of the vocal cord) and, surprisingly, one left-sided vocal cord palsy. Examination of neither the operative report nor the anesthesia protocol record yielded an answer for that phenomenon. It could, however, be related to mechanical maltreatment caused by intubation, yet this was not demonstrated on follow-up examination. Of those 29 new laryngoscopically pathological findings, in only 10 cases (34.5%) were they clinically symptomatic in the early postoperative period, manifesting with moderate hoarseness. This represents an incidence of 8.3% in the entire operated group.

Among the 19 cases of RLN palsy not associated with hoarseness 3-month follow-up status was normal in 11, decreased motion (paresis) was noted in six, and vocal cord palsy remained in two. In cases of early postoperative decreased motion of the vocal cord, follow-up laryngoscopy was always normal.

At 3-month follow-up examinations of the 10 clinically symptomatic patients (RLN palsy with hoarseness), inconspicuous laryngoscopic and clinical manifestations were observed in two cases. Three patients (2.5%) continued to experience moderate hoarseness and five patients suffered persisting RLN palsy (two with decreased motion [paresis] and three with so-called standstill palsy [plegia]) without hoarseness. At follow-up examinations 10.8% of the patients continued to experience asymptomatic RLN plegia or paresis. Within 3 months 13 (44.8%) of the 29 patients with new RLN palsy recovered completely, eight (27.6%) recovered incompletely, and pathological lesions remained in eight (27.6%) (Table 2). No correlation between level or extent of operation and RLN palsy was demonstrated (Table 1).

Discussion
Damage to the RLN is a well-known problem in anterior cervical spine and thyroid surgery. In contrast to the thyroid surgery, in which it is standard to expose the RLN and monitoring becomes more frequent,11,19,21,36,39 in spine surgery these procedures are not used—at least they are not mentioned in the standard textbooks.15,17,30 Various mechanisms of trauma are known to cause palsy. Palsy may be related to indirect intraoperative injury to the nerve, entrapment of the nerve between instrumentation and endotracheal tube, or traction injury of the nerve.16,27,41

The endotracheal tube alone can be a cause for RLN
Intraoperative RLN palsy during anterior cervical surgery

<table>
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<th>Variable</th>
<th>Preop</th>
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<th>Paresis (%)</th>
<th>Paralysis (%)</th>
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* Decreased motion of the vocal cord.
† Standstill of the vocal cord.

palsy and is reported to account for 7.5 to 11.2% of all vocal cord paralyses.2,3,4,11 In addition spontaneous preoperative RLN palsy (possibly asymptomatic) may exist, as in this series (1.6%), or in the only other two series that prospectively examined all patients (1.5%10 and 1.6%6). Not all forms of postoperative RLN palsy are therefore caused by intraoperative manipulation. Because of the anatomy of the RLN, the traumatic injury to the nerve must likely occur during a right-sided approach (in cervical spine surgery), although not all authors have confirmed this hypothesis.8 The right-sided nerve is shorter and has a more oblique course than the left RLN.22 Traction interrupts perineural blood flow and traumatizes the nerve.41,5 Other authors have demonstrated the possible influence of endotracheal tube cuff pressure on RLN injury.1,18,32 The increase of the retractor-induced cuff pressure reduces mucosal blood flow unilaterally and may trap the nerve itself contralaterally. As a result of these studies deflation and reinflation of the endotracheal tube cuff is known to reduce the iatrogenic trauma to the RLN, as was demonstrated byapelbaum and colleagues.1 In thyroid surgery the RLN was mostly found to be damaged by the ligature of the inferior thyroid artery or by unspecific traction of the surrounding tissue.34 Other important influences of the incidence of RLN palsy include extension and type of operation and, especially in patients with carcinoma, the experience of the surgeon.13,34 The authors of earlier studies showed that the routinely practiced identification or exposure of the RLN significantly reduces the risk for RLN palsy.39 Precise data regarding the significance of exposing the RLN do not exist because other cofactors reduced the incidence of a RLN palsy in the period from 1950 to 1960 (from ~20% to 2–4% in thyroid surgery).12,33,34 In our study we found that postoperatively the initial incidence of hoarseness was higher (8.3%) than expected compared with most review-based rates,14,42 but it was similar to rates reported in other prospective studies,18 in which symptoms lasted for more than 24 hours in 15%, and hoarseness in 10.4% combined with dyspnea in 1.6% was reported.6,31 The rate of permanent hoarseness (2.5%) was equivalent to rates reported earlier.5,10,16 In the monoperated population, some degree of RLN impairment exists before surgery and is clinically unapparent, which corresponds to the 1.6% rate in this study and to 1.5%,6,22 in the only other prospective studies in which all patients underwent preoperative laryngoscopy. One group documented an incidence of four vocal cord lesions in 4% including RLN palsy revealed on preoperative laryngoscopy.35 In addition patients can suffer palsy after undergoing an anterior cervical spine approach without hoarseness, which is similar to experiences in thyroid surgery. This phenomenon is obviously not well known outside otorhinolaryngology circles and is explained by the variable ability of the unaffected vocal cord to position itself close to the affected vocal cord, which is fixed in an intermedian or paramedian position.28 The recovery rate of the RLN is usually relatively good (~80%), but most authors performed laryngoscopy only in patients with hoarseness, presumably missing RLN palsy in cases without hoarseness. We documented an overall recovery rate of approximately 55% (70% for evident cases and 42% for clinically unapparent cases). We found an incidence of 10.8% of persistent asymptomatic vocal cord palsies in the 3-month follow-up examination, corresponding to 24.2% of all early postoperative vocal cord palsies. We confirmed that decreased vocal cord motion (that is, paresis but not palsy) never led to permanent hoarseness.

Based on these results it is necessary to discuss whether spine surgeons should learn to perform routine exposure of the RLN, as it is the gold standard in thyroid surgery. The surgeon starts with demonstrating the course of the nerve in situ.

Is it justified and cost effective to conduct laryngoscopic screening of all patients preoperatively who undergo cervical spine surgery and to perform a phoniatric examination in the future as requested by Francois and colleagues?39 The answer, on one hand, is no because the spontaneous incidence of RLN palsy is 1.6%; however, in patients with a higher risk of RLN damage, such as those undergoing cervical repeated operation, those with an enlarged thyroid, or those who have undergone thyroid surgery, surgeons should consider undertaking preoperative laryngoscopy to avoid exposing the healthy side contralateral to an already damaged RLN. The same caution should be applied in cases involving preexisting hoarseness. Laryngoscopic screening also appears useful because of the danger of permanent hoarseness or dyspnea in cases of an undetected contralateral RLN palsy in a patient in whom earlier neck surgery has been performed. Clearly an additional trauma to the ipsilateral RLN may lead to bilateral vocal cord palsy and associated problems such as severe inspiratory stridor, dysphasia with aspiration, aphonia, or respiratory disorder requiring the urgent need of a respirator,22 intubation, or tracheotomy.

Other precautions such as observation and deflation/re-
The general trend for microsurgery, at least in disc surgery, involves small incisions and possibly more blind retraction of the tissue. This especially affects the rightsided RNL, as has been demonstrated in cadaveric specimens. Retraction causes a decrease in blood flow and may damage nerve fibers. Thus it may be prudent not to stress the minimalistic approach but to obtain an adequate exposure in the soft-tissue layers between the neurovascular bundle and the thyroid–esophagus soft-tissue mass.

To avoid the well-known rate of permanent hoarseness (2%) associated with anterior cervical spine surgery, it might be necessary to expose the RNL routinely, although this would not actually guarantee an avoidance of RNL palsies because the dissection of the nerve itself could also cause a palsy if done incorrectly.

The addition of cuff pressure reduction after retractor insertion might also be helpful. Preoperative laryngoscopy for at-risk cases is also advisable. Intraoperatively EMG monitoring of the laryngeal muscles connected to special endotracheal tubes does not seem to be a reliable method to reduce the risk of RNL palsy.

In the future we plan to conduct another prospective study to assess a left-sided approach, as we know the RNL is better protected anatomically when this approach is used. In addition cuff pressure will be reduced when the retractor is inserted.

Conclusions

Recurrent laryngeal nerve palsy and associated hoarseness is a well-known complication of anterior cervical spine surgery. An unexpectedly high incidence of asymptomatic RNL palsies and a high rate of persisting RNL palsy during a 3-month follow-up period were found in this study. The level or extent of the operation was not predictive of the nerve injury. The recovery rate was also lower than has been reported. Several possible solutions, such as preferential left-sided approach, preoperative laryngoscopy in certain at-risk patients, and reduction in cuff pressure, are discussed. Further studies appear to be needed.

References


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