In designing this study, we were motivated by the diversity of opinions among neurosurgeons, otolaryngologists, and speech pathologists at our institution regarding the effect of approach side on the incidence of RLN injury after ACS surgery. As indicated later in this section, a thorough review of the available literature did not resolve the issue. In 2003 Ghanayem summarized the situation this way: “The question as to whether the right recurrent laryngeal nerve is at greater injury (risk) than the left remains unanswered.” At our institution, a relatively large number of ACDF procedures are performed from both the right and the left sides, affording us an opportunity to perform a retrospective study of this issue. We report the results of this study.

Numerous authors have documented the incidence of RLN injury after ACS surgery. A few studies have compared the incidence of RLN injury after right- or left-sided approaches; however, these reports had either relatively small sample sizes, especially involving the left side, or a nonhomogeneous patient data set. Studies favoring either a right- or a left-sided approach are found in the literature. Arguments supporting a left-sided approach have been based on anatomical factors and the possible occurrence of a nonrecurring inferior laryngeal nerve on the right, while proponents of a right-sided approach have argued that it is more comfortable for right-handed surgeons, that a left-sided approach puts the thoracic duct at risk, and that the esophagus lies anatomically slightly to the left, which renders a right-sided approach safer. In only two of these studies a cohort of patients in which the surgical approach was from the left was compared with a cohort in which it was from the right. These two retrospective studies found that side of approach had no influence on the incidence of RLN injury. However, we believe that the results of these studies were confounded by a relatively small sample size and nonhomogeneity of the...
Clinical Material and Methods

After approval for this retrospective study was obtained from the Institutional Review Board at Gundersen Lutheran Medical Center, the paper and electronic charts of 418 patients who underwent one- or two-level, instrumented primary ACDF between January 1995 and February 2004 were reviewed. The study was restricted to patients who underwent one- or two-level instrumented primary ACDFs, to provide a more homogeneous data set than prior reports. From these charts and the electronic medical records, the following data were collected: surgeon, patient demographics, preoperative diagnosis, side of exposure, number of levels fused, and whether there was an RLN injury. If there was an RLN injury, the time from operation to referral for OVC was noted. Times from operation to referral for OVC were compared between patients with right-sided RLN injury and those with left-sided RLN injury. Comparisons of study variables in patients with right- versus left-sided approaches were analyzed for statistical significance using chi-square, Fisher exact, and Student t-tests. Our sample size was chosen to be large enough for detection of a 5% difference with a 90% power.

Seven surgeons were included in the study: two who operated using primarily a left-sided exposure and five who operated using predominantly a right-sided exposure. Preoperative diagnoses were classified as radiculopathy, myelopathy, or other. The category of other diagnoses included fractures, subluxations, other injuries resulting from trauma, preventative surgeries, and diffuse idiopathic sclerotic hypertrophy.

All patients who demonstrated persistent dysphonia, as judged by the surgeon, in their postoperative follow-up examination were referred for evaluation by an otolaryngologist and/or a speech pathologist. The diagnosis of RLN injury was made by OVC using laryngeal endoscopy, baseline laryngeal videoendoscopy, or indirect examination of the vocal cords. Recurrent laryngeal nerve injury was defined as documented postoperative ipsilateral vocal cord paresis or paralysis with the vocal cord located in the paramedian position.

Results

Patient demographic data are presented in Table 1. Age and sex were not significantly different between patients in the right- and left-sided approach groups. Of the seven surgeons included in the study, one who operated using a left-sided approach performed the majority (90.7%) of the left-sided procedures. Three hundred thirty-three patients underwent surgery for radiculopathy, 48 for myelopathy, and 59 for other reasons. The diagnoses of both myelopathy and radiculopathy were made in 12 patients, radiculopathy and other in seven patients, and myelopathy and other in three patients. The time from surgery to referral for OVC ranged from 2 weeks to 6 months, with a mean of 2.2 months. There was no statistical difference between the time to referral for OVC between patients with right-sided RLN injury and those with left-sided RLN injury (p = 0.581, Student t-test).

Surgical data are presented in Table 2. The proportion of one-level procedures performed from the right side was not statistically different from the percentage performed from the left side; thus, the fraction of two-level procedures performed from the right side also was not statistically different from the proportion performed from the left side (p = 0.215, chi-square test). There was also no significant difference between the right and left side for one-level procedures and the surgical levels exposed (p = 0.745, Fisher exact test) or between the right and left side for two-level procedures and the surgical levels involved (p = 0.752, Fisher exact test).

Data concerning the occurrence of RLN injury are reported in Table 3. Eight RLN injuries (1.9%) were noted overall. Of these, five (1.5%) occurred after a one-level ACDF and three (3.5%) resulted from a two-level procedure. The difference between the number of RLN injuries that occurred after a right- or left-sided approach was not statistically significant (p = 0.808, chi-square test). The difference in the incidence of RLN injury between the right and left side was not statistically significant for one-level ACDFs (p = 0.657, Fisher exact test) or for two-level ACDFs (p = 1.00, Fisher exact test). The difference in the incidence of RLN injury among individual surgeons was not statistically significant (p = 0.506, chi-square test).

Table 3 shows that the incidence of RLN injury for right- and left-sided procedures for each vertebral level involved were similar (p = 1.00 for all levels, Fisher exact test). There was also no significant effect of diagnosis on the incidence of RLN injury (p = 0.209 for all, Fisher exact test).

Discussion

After reviewing the literature on the incidence of RLN injury after ACS surgery, we determined that the rate of this complication in our study (1.9%) compares very well with the documented values, except for the survey results, which have a known problem with un-
derreporting, and except for the prospective study by Jung et al.,14 in which the protocol included preoperative, immediate postoperative, and 3-month OVC, thereby identifying a large number of asymptomatic RLN injuries. Dysphagia is a common problem after ACS surgery and sometimes accompanies RLN injury. Hartman and colleagues10 reported the incidences of dysphagia, RLN injury, and the combination of RLN injury and dysphagia in 200 consecutive patients with ACDFs at our institution. The incidence of dysphagia was 3.5%, RLN injury 2.5%, and combined RLN injury and dysphagia 1.5%. The current study focused on whether the incidence of RLN injury varies relative to exposure side.

During ACS surgery, the side of approach is likely influenced by the surgeon’s opinion of which side is associated with a lower likelihood of RLN injury. As noted earlier, there are several literature citations concerning the incidence of RLN injury1,4,6,8,10,11,13,14,16,18–20 and support of one side of approach over the other.7,13–15,17–19,23 The two previous studies comparing the incidence of RLN injury between a patient cohort in which the approach was from the right with a cohort in which it was from the left side are retrospective.2,3 The only other study in which both cohorts included more than 100 patients defined RLN injury as we did, based on referral for OVC because of persistent dysphonia.7 In the current study, we have tried to obviate some of the difficulties of previous reports relating to sample size2,11,18–20 and nonhomogeneous procedure sets.2 Because not all postoperative cases of dysphonia or hoarseness are due to RLN injury, the diagnosis of this injury in a retrospective study must depend ultimately on referral for OVC. This limitation necessarily introduces each surgeon’s bias regarding the timing of referrals, such that symptomatic RLN injuries that resolve before the threshold for referral are not counted. In addition, this approach fails to diagnose both asymptomatic injury and preexisting RLN injuries. The incidence of postoperative asymptomatic RLN injury may be as high as 15.9%, and the incidence of preexisting asymptomatic RLN injury may be as high as 1.6%.14 Because a preexisting asymptomatic RLN injury would not be expected to become symptomatic postoperatively in the absence of a second injury during surgery, it would likely not confound the results of a retrospective study based on postoperative referral of patients with persistent symptoms for diagnosis by OVC.

If surgeons operating from one side tended to refer patients for OVC earlier than surgeons operating from the other side, the rate of RLN injury reported for that side could increase. In our study, there was no statistically significant difference in time of referral for OVC between patients in whom the approach was from the left and those in whom it was from the right side. Because the referral patterns were not different between the right- and left-sided cases, we would not expect this bias to alter the outcome of our study.

If there is a greater propensity for RLN injury with exposure on one side over the other, this difference should still be reflected in our study in the cases ultimately referred for OVC. In fact, the effect of exposure side on the rate of clinically apparent RLN injury might be magnified in these circumstances; in other words, less severe injuries (those being subjected to less stretch) would occur on the side associated with the lower rate of clinically apparent RLN injury, and they would become asymptomatic or resolve before the patient is referred for OVC. Therefore, despite the shortcomings of this retrospective study, we expect that it would detect any difference in the incidence of RLN injury relative to exposure side. Of course, only clinically apparent injuries are significant in practice. No surgeon performs OVC immediately postoperatively and periodically thereafter in patients with no symptoms of RLN injury.

Multiple causes of RLN injury have been reported in the literature.1,7,8,11,13,16,19,23 One possible cause is endotra-
Recurrent laryngeal nerve injury may also arise from compression of the RLN between the wall of the larynx and the endotracheal tube when the larynx is retracted. However, this cause of RLN injury should not have a significant effect on the study data because the larynx is retracted during ACDF, whether the surgery is performed using a left- or a right-sided approach. Furthermore, it has been shown that reducing the cuff pressure of the endotracheal tube during retraction in ACS surgery decreases the incidence of RLN injury.

Anatomical arguments have also been given to support one side of approach over the other. One argument supporting a right-sided approach is that the esophagus is retracted less severely during a right-sided approach because the esophagus lies anatomically slightly to the left. Therefore, according to this argument, the risk of stretching or compressing the RLN would be less after a right-sided approach. A few studies have also argued that a left-sided approach places the thoracic duct at risk. However, because dissection is usually performed medial to the carotid sheath, there should be minimal risk to the thoracic duct. Still others have favored a right-sided approach because it may be more convenient and comfortable for right-handed surgeons, making them less likely to injure the RLN.

Anatomical arguments have also supported a left-sided approach. Because the left RLN is longer and enters the tracheoesophageal groove from a much more gradual angle than the right RLN, which is shorter and enters the groove at a much steeper angle, it has been argued that the left RLN would not be stretched as much as the right RLN during retraction, thus minimizing injury. In addition, because the left RLN ascends at a more gradual angle, it is more protected within the tracheoesophageal groove and would be less likely to be sectioned.

The possibility of a nonrecurrent inferior laryngeal nerve has also been given as a reason in favor of a left-sided approach. However, the reported incidence of such a nerve in the literature is less than 1%, and can be identified through careful dissection, it should not have a large effect on the incidence of RLN injury.

Conclusions

Within the limits of this retrospective study design, it was shown that the side of approach during instrumented ACDF has no significant effect on the incidence of RLN injury. We agree with Beutler, et al., in stating that the choice of approach side may be made based on the individual surgeon’s preference.

Acknowledgments

We thank Cathy Mikkelson Inderberg, M.A., for editorial assistance; Jennifer Lee, B.S., for assistance with data collection; and David E. Hartman, Ph.D., BC-NCD, for sharing his expertise about the anatomy and etiology of RLN injury.
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Manuscript received July 28, 2005. Accepted in final form January 11, 2006. This work was supported by the Gundersen Lutheran Medical Foundation, which funded the summer research fellowship of Mr. Kilburg.

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\[J. Neurosurg: Spine / Volume 4 / April, 2006\]