Airway Management in Patients Who Develop Neck Hematomas After Carotid Endarterectomy

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BACKGROUND: Progressive airway compromise from neck hematoma and edema is a feared complication of carotid endarterectomy (CEA). Despite this, the relationship of airway management technique to patient outcome has not been systematically studied in this population. We report the rate of successful airway management using various techniques in post-CEA patients.

METHODS: A 10-year retrospective analysis was conducted to identify patients requiring airway management for neck exploration within 72 hours after CEA at Mayo Clinic, Rochester, MN.

RESULTS: Three thousand two hundred twenty-five patients underwent CEA over a 10-year period at our institution. Forty-four (1.4%) required neck exploration for hematoma, and 42 of these required airway management immediately before neck exploration surgery. (The tracheal tube had not been removed after CEA in the remaining 2 patients.) The average interval between the completion of CEA and return to the operating room for hematoma evacuation was 6.0 ± 6.0 hours (mean ± SD; range, <1–32 hours). Fiberoptic airway management, performed before the induction of anesthesia, was successful in 15 of 20 patients (75%) and, in patients in whom fiberoptic tracheal intubation failed, direct laryngoscopy (DL) was successful in all 5 (3 before and 2 after the induction of general anesthesia). In the remaining 22 patients, DL was used as the initial management technique without a trial of fiberoptic intubation. DL was successful in 5 of 7 patients (71%) when performed before induction of general anesthesia and was successful in 13 of 15 patients (87%) when performed after induction of general anesthesia. Hematoma decompression facilitated DL in 3 of 4 failures of DL; tracheostomy was performed in the remaining patient. An arterial site of bleeding was subsequently identified in 36% of patients in whom no difficulty was encountered during laryngoscopy for hematoma evacuation versus 6% in whom difficulty was noted ($P = 0.03$). In 36 of 44 patients (82%), the tracheal tube was removed within 24 hours of surgery for neck exploration. No adverse events related to airway management were noted. There were no deaths at 2 weeks after hematoma evacuation.

CONCLUSIONS: Multiple techniques resulted in successful airway control both before and after the induction of general anesthesia. Tracheal intubation was accomplished with both fiberoptic visualization and DL. In instances of poor direct visualization of the glottis, decompression of the airway by opening of the surgical incision may facilitate intubation of the trachea.

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In large randomized controlled trials of patients with severe internal carotid artery atherosclerosis, carotid endarterectomy (CEA) has been reported to reduce the risk of subsequent stroke.[1,2] One rare, but potentially fatal, complication of CEA is postoperative upper airway obstruction. In the North American Symptomatic Carotid Endarterectomy Trial, postoperative wound hematoma occurred in 5.5% of CEA patients, making it a more frequent complication than myocardial infarction (0.9%) or major stroke and death (2.1%).[3] Although the North American Symptomatic Carotid Endarterectomy Trial does not detail the outcomes of those patients with neck hematoma after CEA, other series have reported that up to 50% of neck hematomas after CEA require surgical evacuation.[4]

Reintubation of the trachea for airway protection and to facilitate general anesthesia for hematoma evacuation may be complicated by distortion of airway structures by edema and hematoma concurrent with patients' diminished physiologic reserve.[5] Because CEA has become an increasingly routine procedure, many centers have moved toward reducing

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hospital length of stay for these patients (e.g., in an attempt to lessen costs and reduce infection risk).[4,6,7] An expanded understanding is required to anticipate risk factors for hematoma formation, timing for the development of symptoms, and evidence for success in maintenance of airway patency in those patients with ventilatory compromise after CEA.

Individual case reports in the medical literature have described various methods for securing the airway in this situation.[5,8–12] Successful airway management has been reported with methods including direct laryngoscopy (DL), fiberoptic tracheal intubation, and the laryngeal mask airway. The indexed literature contains no systematic evaluation of airway management in a large series of patients. As such, the incidence of airway compromise, the time course of its evolution and resolution, and the relationship of management techniques to outcomes have not yet been elucidated. Given the diversity of CEA practices worldwide and the fact that airway difficulties after CEA have not systematically been subjected to scientific oversight, it is possible that short-stay CEA practices are inadequate to address the feared complication of symptomatic postoperative neck hematoma. Our study was designed to address these limitations in the indexed literature and explore the incidence, timing, and outcomes of neck hematoma after CEA in a decade-long series of patients at a major medical center.

METHODS

After approval by the Institutional Review Board, patients who underwent CEA at Mayo Clinic, Rochester, MN, between January 1, 1998 and December 31, 2007, were identified using the International Classification of Diseases (ICD)-9 procedure codes in Mayo Clinic's surgical database. The Mayo Clinic anesthesia database was then searched for patients who required a second anesthetic within 72 hours of their initial CEA. Each medical record that matched these criteria was then reviewed by hand to identify those patients who required operative neck exploration or hematoma evacuation.

Using a systematic survey form, the medical record was reviewed for demographic data and information pertaining to airway management for both the initial CEA and the subsequent airway management and neck exploration. Details pertaining to the CEA procedure (i.e., side of surgery, need for patch graft, and development of ischemia upon carotid occlusion), type of anesthesia, and volume of IV fluids administered intraoperatively were recorded. Maximum arterial blood pressure in the interval between restoration of carotid flow and leaving the operating room (OR) after CEA, and during the period between leaving the OR after CEA and returning for hematoma evacuation, was noted. The time interval between leaving and returning to the OR was also recorded. The operative report describing hematoma evacuation was reviewed to determine whether a specific site of bleeding was noted. Postoperative outcome (i.e., time to tracheal extubation and 2-week mortality) was tabulated.

Patients who required airway management for hematoma evacuation were stratified into 2 groups based on the difficulty encountered with airway management. On anesthetic records at our institution, airway difficulty is typically graded on a scale of 0 to 2. A grade of 0 refers to situations in which no meaningful difficulty was encountered during tracheal tube placement, with perhaps the exception of repositioning the head or changing the laryngoscope blade to achieve success. A score of 1 refers to cases that required a moderate change in technique (e.g., use of intubating stylet and use of alternate technique such as fiberoptic bronchoscopy or intubating laryngeal mask airway) before success. Finally, a score of 2 is reserved for patients in whom tracheal intubation proved difficult and, if successful at all, was accomplished only after introducing multiple airway management techniques. Study subjects were considered to have "easy" airway management if a grade of 0 for airway management was recorded or if notes specifically stated that airway management was without difficulty. Subjects were considered to have "difficult" airway management if (1) a score of 1 or 2 was noted for the degree of airway management difficulty, (2) a note was made in the record describing difficulty, or (3) the first technique used to manage the airway ultimately failed.

Demographic, surgical, and anesthetic factors were compared between groups. Significant differences in categorical variables was assessed using the Fisher exact test or Pearson χ^2 test, as appropriate; differences in continuous variables were assessed using 2-tailed Student *t* test. A P value <0.05 was considered significant.

RESULTS

Three thousand two hundred twenty-five patients underwent CEA during the interval studied and 44 (1.4%) required subsequent neck exploration and hematoma evacuation. No patient required a second hematoma evacuation after the same CEA or after a subsequent contralateral endarterectomy.

Demographic information is presented in Table 1. All patients received general anesthesia for their CEA, and there was no evidence of airway management difficulty during the initial CEA surgery in any of the 44 patients. The interval between the completion of CEA and return to the OR for hematoma evacuation was 6.0 ± 6.0 hours (mean ± SD; range, <1–32 hours). Intraprocedural anticoagulation with unfractionated heparin (typically administered as an IV bolus of 5000 U followed by additional doses, as needed, to maintain the desired activated clotting time) was not reversed in any of the 44 patients after completing CEA surgery.

Among the 44 patients, the tracheal tube was not removed after initial CEA in 2 patients (5%). Upon

Table 1. Demographics and Perioperative Data

	Value	Median (range)
N	44	
Age (yr)	75 ± 6	75 (59–85)
Sex (male)	59%	
Right-sided CEA	52%	
Fabric patch graft	82%	
Ischemia upon carotid occlusion	23%	
Maximum blood pressure after flow restoration in OR		
Systolic (mm Hg)	176 ± 24	175 (122–220)
Diastolic (mm Hg)	78 ± 12	78 (50–103)
Maximum blood pressure after leaving OR to return to OR		
Systolic (mm Hg)	171 ± 29	170 (105–230)
Diastolic (mm Hg)	75 ± 17	71 (47–132)
Duration between leaving OR to return to OR (h)	6.4 ± 6.5	4.9 (1.0–31.6)
Site of bleeding		
Arterial	25%	
Discrete venous	11%	
Diffuse oozing	30%	
Bleeding site not documented	34%	

CEA = carotid endarterectomy; OR = operating room.

emergence from anesthesia, these 2 patients had neurologic compromise manifested by weakness contralateral to the CEA surgical site. Their tracheas remained intubated for postoperative imaging and, after a brief stay in the intensive care unit (ICU), both patients returned to the OR with the endotracheal tube in place for hematoma evacuation. Tracheas of the remaining 42 patients were extubated at the end of their CEA surgery. In 7 patients, the hematoma was identified in the postanesthesia care unit (PACU), and the patients were returned to the OR. The remaining 35 patients recovered from the procedure in the PACU and then were transferred to the ICU or monitored ward. Thirty-four of these patients returned to the OR from the ICU or monitored ward, whereas one patient was subsequently transferred from the monitored setting to the general care floor where his hematoma was identified 31.6 hours after leaving the OR after initial CEA.

One of the 42 patients (2%) had his endotracheal tube removed postoperatively but later developed rapid progression of airway compromise. After a failed attempt at DL, an emergency tracheotomy was performed in the ICU. The patient was then transferred to the OR for hematoma evacuation. No other patient required tracheostomy in this series. Another patient developed rapid respiratory compromise in the ICU, was tracheally intubated in the unit, and was then transported to the OR for hematoma evacuation. Thus, the airway was secured via the oral route in the OR in 40 of the 42 patients. Of the 41 patients undergoing oral-tracheal intubation, 24 (59%) were performed immediately before induction of general anesthesia and the remaining 17 (41%) after induction of general anesthesia. No patient in this series, once anesthetized, required awakening for further airway management.

Excluding the 2 patients in whom the tracheal tube was not removed after initial CEA, the details pertaining to airway management in the remaining 42 patients can be found in Figure 1. Tracheal intubation before the induction of general anesthesia via application of a local anesthetic to the airway and visualization with the use of a fiberoptic bronchoscope was conducted in 20 patients (48%). This technique was successful in 15 of 20 patients (75%). In the remaining 5 patients, the airway was secured successfully with DL either before or after the induction of general anesthesia in 3 and 2 patients, respectively. In each of these 5 patients managed with DL after failed fiberoptic visualization, the DL was described as being difficult with limited view of the glottis, although intubation was nevertheless successful in all 5 instances.

DL, using topical local anesthetics with or without mild sedation, was performed as a primary management technique in 7 patients (17%) before induction of general anesthesia. This technique was successful in 5 of 7 patients (71%). Successful airway management was accomplished in the remaining patients via tracheostomy in one patient (described above) and after a second attempt at DL but after surgical release of the hematoma in the other patient.

DL after the induction of general anesthesia was initially attempted in 15 of 42 patients (36%). This technique was successful in 13 patients (87%). In the remaining 2 patients, a second attempt at DL was successful only after surgical release of the neck hematoma. In the 3 patients (from all treatment groups) requiring decompression to facilitate DL, the time interval between completion of the initial CEA and return to the OR for hematoma evacuation was 5.4, 1.7, and 1.7 hours. The source of bleeding in these 3 patients was not clearly identified based on the operative report. The difference in time between CEA and hematoma evacuation was not statistically different between those in whom the neck incision was opened to facilitate tracheal tube placement (2.9 ± 2.1 hours) versus those in whom the incision was reopened after tracheal tube placement (6.6 ± 6.6 hours; $P = 0.35$).

Data from the 42 patients who required airway management for hematoma evacuation were stratified based on airway difficulty, and results can be found in Table 2. Twenty-five patients had easy airway management and 17 were difficult. There were no differences between groups with respect to the demographic, surgical, or physiological variables evaluated. A larger fraction of patients in whom a specific arterial bleeding site was identified had easy airway management (36% vs 6% for easy versus difficult airway management; $P = 0.03$). There was no difference in the time interval between exiting the OR after CEA and returning for hematoma evacuation in those with arterial versus nonarterial bleeding site (6.4 ± 6.8 hours vs 6.4 ± 5.9 hours for arterial versus nonarterial sites, respectively; $P = 0.98$).

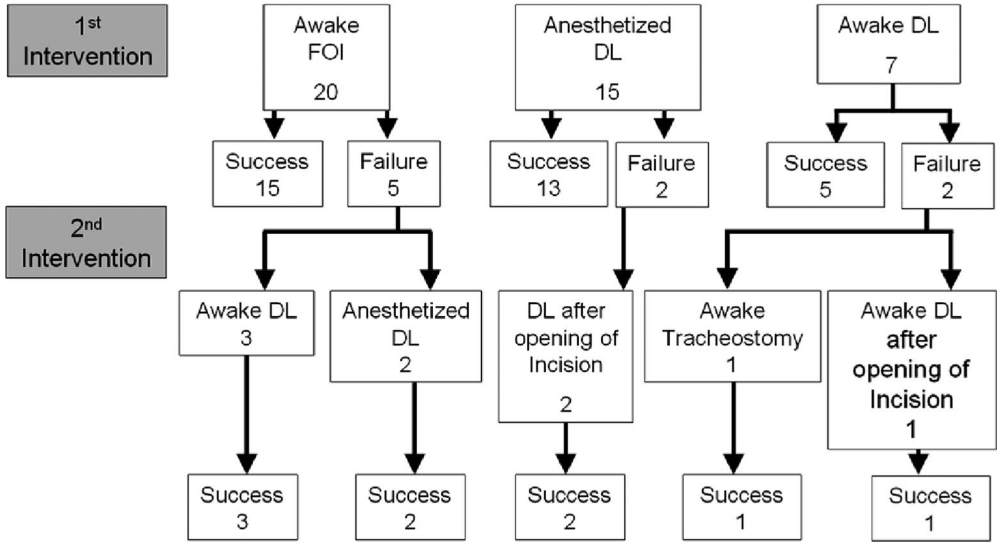

Figure 1. Patients requiring airway management for hematoma evacuation after carotid endarterectomy (CEA) (n = 42). No patient, after anesthetized, required awakening for further airway management. DL = direct laryngoscopy; FOI = fiberoptic intubation.

Table 2. Patient Data Stratified Based on Ease of Airway Management for Hematoma Evacuation

	Easy intubation	Difficult intubation	*P*
N	25	17	
Weight (kg)	76 ± 15	71 ± 21	0.46
Age (yr)	74 ± 7	77 ± 5	0.17
Sex (male)	14 (56%)	11 (65%)	0.57
Right side CEA	16 (64%)	6 (35%)	0.07
Patch graft used (yes)	19 (76%)	15 (88%)	0.44
Ischemia with occlusion (yes)	5 (20%)	5 (29%)	0.71
Shunt used (yes)	5 (20%)	6 (35%)	0.3
Crystalloid infused intraoperatively (mL)	2640 ± 1215	2638 ± 1201	0.99
Maximum SBP post-unclamping in OR (mm Hg)	180 ± 20	168 ± 22	0.11
Maximum DBP post-unclamping in OR (mm Hg)	80 ± 12	75 ± 13	0.26
Time to return to OR after OR exit (h)	7.9 ± 8.2	4.2 ± 1.6	0.07
Maximum SBP between OR exit and OR reentry (mm Hg)	165 ± 26	176 ± 30	0.24
Maximum SBP between OR exit and OR reentry (mm Hg)	71 ± 13	79 ± 22	0.17
Arterial bleeding site identified	9 (36%)	1 (6%)	0.03

CEA = carotid endarterectomy; SBP = systolic blood pressure; DBP = diastolic blood pressure; OR = operating room.

Of the 44 patients who required reexploration, the tracheal tube was removed uneventfully in the OR after hematoma evacuation in 7 patients (16%). The remaining 37 patients (84%) were transferred to the ICU, and the tracheal tube was uneventfully removed within the ensuing 24 hours in 29 patients. No mortality or adverse event related to airway management was noted within 14 postoperative days in any patient.

DISCUSSION

Our research determined that difficulty with tracheal tube placement is common in patients returning to the OR for hematoma evacuation after CEA. It occurred in 40% of cases despite a history of no difficulty in earlier airway management for CEA in the same patients. Upon airway management before hematoma evacuation, an initial attempt at fiberoptic laryngoscopy and tracheal tube placement, performed before the induction of general anesthesia, was associated with a 75% success rate. Additionally, a first attempt at DL had a success rate of 71% and 87% when performed either before or after the induction of general anesthesia, respectively. DL was associated with a high success rate after failed awake fiberoptic techniques, and, in the few patients in whom DL proved challenging, opening the prior neck incision to release the hematoma facilitated a subsequent attempt at DL. The identification of a specific arterial bleeding site was associated with ease of laryngoscopy and tracheal tube placement. No patients who required hematoma evacuation experienced major adverse events or died as a result of airway management.

Hematoma formation after CEA is a rare event that has been reported at rates ranging from 1.9% to 5.5%,[3,13] and our database yielded a similar rate of 1.4%. Risk factors associated with hematoma formation have also been described and include nonreversal of heparin, intraoperative hypotension, general anesthesia, perioperative aspirin use, and the use of a shunt.[14] All 44 patients in our study underwent general anesthesia and nonreversal of heparin (which is standard practice at our institution), but information regarding perioperative aspirin use was not consistently documented in the medical record. Therefore, the confounding effects of these factors could not be reliably assessed in our retrospective investigation.

This study also correlates with past work done on the etiology of neck hematoma formation. Computed tomographic studies have shown that even in the absence of hematoma formation, post-CEA patients have increased airway edema that may decrease the transverse airway diameter by up to 75% (62% ± 13%; mean ± SD) compared with perioperative diameter.[15] This edema has been attributed to disruption of lymphatic drainage during the operative period[16] and results in swelling of the tracheal mucosa, supraglottic airway, glottic aperture, and the cricothyroid membrane.[15] The edema may thus complicate many airway management techniques including fiberoptic visualization, DL, and even surgical cricothyroidotomy. Hematoma formation further distorts the anatomy of the airway and makes standard airway techniques still more challenging.

Forty-two of the 44 patients in our study returned for hematoma evacuation within 24 hours after initial CEA. The remaining 2 patients raise questions regarding the disposition of patients after CEA (i.e., whether it is safe to discharge CEA patients from the hospital within 24 hours after surgery). All but one patient in our series were found to have expanding hematoma formation while in a monitored setting (PACU or ICU). In addition, the quoted 5.5% incidence of hematoma in the CEA population[3] raises concerns about the wisdom and safety of pressing for shorter post-CEA hospital stays (e.g., 12 hours) in CEA patients who could go on to develop dire respiratory compromise after discharge.

In our series of patients, 25% of neck hematomas were associated with arterial bleeding identified at the time of evacuation, concurring with a previously reported rate of 20%.[17] Of note, the presence of an arterial bleeding site was associated with easy laryngoscopy and tracheal tube placement. One would expect that an arterial bleeding site would cause more rapid expansion of the hematoma resulting in a shorter time interval between CEA and subsequent hematoma evacuation. However, the interval between CEA and hematoma evacuation was similar between those with and without an arterial bleeding site identified at hematoma evacuation (6.4 ± 6.8 hours vs 6.4 ± 5.9 hours for arterial versus nonarterial sites, respectively; $P = 0.98$). Even though the total time between CEA and return to the OR did not differ between the arterial and nonarterial bleeding sites, it is possible that those in the arterial group had a shorter bleeding time. Specifically, a previously hemostatic wound could have developed arterial bleeding in response to a mechanical or hemodynamic stress and opened a site of arterial bleeding that expanded dramatically and was detected before venous congestion could cause airway distortion. Although our data yielded no objective insights into why arterial and venous bleeding might confer different challenges in managing the airway, venous congestion leading to airway distortion could provide one possible explanation.

The retrospective format of this study makes it difficult to assess the decision making that led to the choice of airway management technique in each patient with neck hematoma. The anesthesiologist may have selected an awake fiberoptic technique initially because a difficult airway was anticipated, spontaneous ventilation was being maintained, and the patient was stable enough to tolerate the time necessary for topical airway anesthesia and a conservative approach to airway management. Likewise, DL could have been selected either because the anesthesiologist anticipated little difficulty with reintubation of the trachea or because a patient was in extremis and the clinical situation was too urgent to allow time for topical airway anesthesia. Given the lack of standardization of the clinical decision making, it is difficult to compare the success rate of DL with fiberoptic techniques. It is probable that some fiberoptic patients could have been managed by DL with equal success and *vice versa*. If any comparison of these 2 techniques can be extracted from these clinically disparate circumstances, it is the suggestion of the viability of DL as both a primary airway management technique and a rescue technique after failed fiberoptic intubation. Although this is conjecture, the interpretation is supported by the 5 patients who had failed attempts at fiberoptic management and their tracheas were then successfully intubated by DL versus only 1 patient who required emergency tracheotomy because of failed DL.

In 3 patients (1 awake and 2 after induction of general anesthesia), initial attempts at DL were unsuccessful, and only after the surgeon released the prior CEA surgical incision was DL successful in facilitating tracheal intubation. In these patients with an acute bleeding episode, we suspected that hematoma expansion developed rapidly and surgical decompression led almost instantly to improved conditions for tracheal intubation. However, it is impossible to prove this point because our methodologies could not determine when postoperative bleeding began. The time interval between initial CEA and return to the OR in these 3 patients was 1.7 to 5.4 hours: numerically less but not statistically different from those in whom the neck incision was not opened to facilitate tracheal tube placement.

The limitations of this study are implicit in its retrospective format. The data were collected from a training institution and document the success of airway management techniques, but the skill level of the providers was not standardized. Thus, standard techniques such as DL may have been more successful than advanced techniques such as fiberoptic intubation when performed by resident physicians. The 0 to 2 airway difficulty scale used at Mayo Clinic was implicit in the study design. This scale offers helpful clinical information for patients undergoing surgery. A patient who has been challenging to tracheally intubate in the past will have a flag on the chart that indicates previous 2-difficulty intubation, and an advanced airway technique is used for perioperative management. However, this system is subject to reporting bias, influenced by the comfort and skill level of the provider, and is ultimately scored by each anesthesia provider to indicate difficulty for that isolated clinical encounter. A host of clinical alterations could contribute to converting a previously 0-difficulty (easy) airway into a 2-difficulty (challenging) airway.

Only the success of those techniques used can be evaluated, whereas other potential techniques such as laryngeal mask airway and videolaryngoscopes cannot be compared because of a lack of data. Thus, although the laryngeal mask airway offers theoretic promise and has been reported in the setting of post-CEA respiratory compromise, none of the cases among our 44 patients were managed with this technique, and its success in comparison with DL or fiberoptic techniques cannot be evaluated.[8] Even among the techniques used, each airway management scenario offered unique clinical and anatomic challenges, making standardization difficult. In only 15 of 20 patients (75%), awake fiberoptic techniques resulted in successful tracheal intubation, whereas in 17 of 17 patients (100%), anesthetized DL techniques were successful. Although this implies that general anesthesia and DL improved conditions, induction of anesthesia with an inability to intubate the trachea has potentially dire consequences that make a fiberoptic technique in a spontaneously breathing patient favorable. In the 15 patients who had successful primary fiberoptic management, there is no retrospective way to assure that DL after induction of general anesthesia would have been equally successful as fiberoptic laryngoscopy and tracheal intubation before the induction of general anesthesia. It is also true, however, that retrospective data may be the only available information for studying this low-frequency, high-acuity population. As such, continuing study and updated reports of the success or failure of additional airway techniques may enlarge the understanding of this pathophysiology and assist with the safe management of patients requiring airway management for neck hematoma after CEA. Finally, the authors are aware of at least 2 patients during the study period who required tracheal intubation for respiratory distress after CEA but who did not require operative intervention. There may have been others as well. Our methods would not retrospectively detect such patients (whether they had airway compromise from postoperative neck hematoma, other sources such as edema, or multiple origins) who required airway management but did not return to the OR for hematoma decompression.

In summary, based on an analysis of this 42 patient series, it seems that although post-CEA neck hematoma may introduce potentially life-threatening airway compromise in patients with previously simple airway management, multiple techniques resulted in successful airway control. This 10-year experience and established clinical guidelines[18] support a stepwise approach to the studied population. A stable patient may prudently be managed by maintenance of spontaneous ventilation while awake fiberoptic intubation of the trachea is performed. However, if fiberoptic intubation is unsuccessful or if the patient is physiologically unstable, our results suggest that DL (with the patient either awake or after induction of general anesthesia), and possible decompression of the trachea by opening of the surgical incision, will likely be successful. In closely monitored patients receiving timely airway assessment and management, emergency tracheotomy is rarely required.

REFERENCES

1. Randomised trial of endarterectomy for recently symptomatic carotid stenosis: final results of the MRC European Carotid Surgery Trial (ECST). Lancet 1998;351:1379–87
2. Barnett HJ, Taylor DW, Eliasziw M, Fox AJ, Ferguson GG, Haynes RB, Rankin RN, Clagett GP, Hachinski VC, Sackett DL, Thorpe KE, Meldrum HE, Spence JD. Benefit of carotid endarterectomy in patients with symptomatic moderate or severe stenosis. North American Symptomatic Carotid Endarterectomy Trial Collaborators. N Engl J Med 1998;339:1415–25
3. Beneficial effect of carotid endarterectomy in symptomatic patients with high-grade carotid stenosis. North American Symptomatic Carotid Endarterectomy Trial Collaborators. N Engl J Med 1991;325:445–53
4. Cikrit DF, Larson DM, Sawchuk AP, Lalka SG, Shafique S, Dalsing MC. Short-stay carotid endarterectomy in a tertiary-care Veterans Administration hospital. Am J Surg 2004;188: 544–8
5. Kwok OK, Sun KO, Ahchong AK, Chan CK. Airway obstruction following carotid endarterectomy. Anaesth Intensive Care 2004;32:818–20
6. Harbaugh KS, Harbaugh RE. Early discharge after carotid endarterectomy. Neurosurgery 1995;37:219–24
7. Kaufman JL, Frank D, Rhee SW, Berman JA, Friedmann P. Feasibility and safety of 1-day postoperative hospitalization for carotid endarterectomy. Arch Surg 1996;131:751–5
8. Augoustides JG, Groff BE, Mann DG, Johansson JS. Difficult airway management after carotid endarterectomy: utility and limitations of the Laryngeal Mask Airway. J Clin Anesth 2007;19:218–21
9. Martin R, Girouard Y, Cote DJ. Use of a laryngeal mask in acute airway obstruction after carotid endarterectomy. Can J Anaesth 2002;49:890
10. Munro FJ, Makin AP, Reid J. Airway problems after carotid endarterectomy. Br J Anaesth 1996;76:156–9
11. Bohrer H, Kick O. Management of difficult intubation in the case of upper airway obstruction due to carotid endarterectomy rebleeding. J Cardiothorac Vasc Anesth 1992;6:776
12. O'Sullivan JC, Wells DG, Wells GR. Difficult airway management with neck swelling after carotid endarterectomy. Anaesth Intensive Care 1986;14:460–4
13. Welling RE, Ramadas HS, Gansmuller KJ. Cervical wound hematoma after carotid endarterectomy. Ann Vasc Surg 1989;3:229–31
14. Self DD, Bryson GL, Sullivan PJ. Risk factors for post-carotid endarterectomy hematoma formation. Can J Anaesth 1999;46:635–40
15. Carmichael FJ, McGuire GP, Wong DT, Crofts S, Sharma S, Montanera W. Computed tomographic analysis of airway dimensions after carotid endarterectomy. Anesth Analg 1996;83:12–7
16. Wells DG, Zelcer J, Wells GR, Sherman GP. A theoretical mechanism for massive supraglottic swelling following carotid endarterectomy. Aust N Z J Surg 1988;58:979–81
17. Kunkel JM, Gomez ER, Spebar MJ, Delgado RJ, Jarstfer BS, Collins GJ. Wound hematomas after carotid endarterectomy. Am J Surg 1984;148:844–7
18. American Society of Anesthesiologists Task Force on Difficult Airway Management: practice guidelines for management of the difficult airway. Anesthesiology 2003;98:1269–77