INTRALARYNGEAL RELEASE FOR TRACHEAL ANASTOMOSIS

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An operation for obtaining additional length in order to achieve end-to-end anastomosis of the trachea without significant suture-line tension is described. The intralaryngeal procedure lengthens the larynx approximately 1 to 2 cm without restricting its function. It is an expedient, effective technique when used primarily, or adjunctively, with a suprahyoid or mediastinal release.

The increasing incidence of tracheal stenosis is well documented and results from two primary sources. The first is external trauma secondary to our high-velocity mobile society. The second is from our increased use of sophisticated resuscitation and assisted-ventilation equipment.

The most appropriate treatment for circumferential tracheal stenosis is sleeve resection and end-to-end anastomosis.[1] The successful completion of this procedure, however, is in large part related to suture-line tension. The recurrence of stenosis in the subglottic and tracheal areas is assured if excessive tension on the suture line is operative.

Early experiments by Cantrell and Folse[3] elegantly demonstrate that in dog anastomoses, a tension of less than 1,700 g was necessary for consistent primary healing. Above this level there were unpredictable results, and when the tensions were greater than 2,200 g, the suture line invariably separated and restenosed. Histologic correlation of these findings revealed that a primary healing wound with minimal scarring was evident when the mucosa grew over the sutures, creating an intact ciliated epithelium across the anastomotic line. Montgomery is even more demanding and states that the tension on the suture line should not exceed 1,000 g to assure a successful reconstruction .[4]

Although the concept of minimal tension is generally agreed upon, the amount of tracheal resection which can be accomplished without release techniques is in some dispute. The controversy probably arises from the fact that as a patient ages, the relative elasticity of the annular ligaments of the trachea decreases. Thus, the younger patient has an improved chance of accommodating extended tracheal resections without release. Montgomery states that a tracheal gap of 3 cm can be closed without release techniques in a substantial percentage of patients.[4] Some authors, however, have reported achieving successful primary anastomoses of up to 4 and 5 cm.[5,6] The key component, however, is tension, and this must be scrupulously tailored to a minimum in each individual case.

Previously there have been four methods of releasing tension at a tracheal anastomosis, aside from the technique of keeping the patient's head in extreme flexion for approximately ten days postoperatively. The first method is well accepted and is achieved by mobilizing the distal trachea from the thorax.[7,8] This lengthening procedure, however, is intrathoracic and the inherent dangers of mediastinal dissection exist. The maximum amount of mobilization accomplished with this technique is 6 cm.

The second technique is the lengthening of the annular ligaments of the trachea which can add up to 1.5 cm. Complete circumferential sectioning of the ligaments will disrupt the tracheal blood supply which runs in a vertical direction based on the superior and inferior thyroid arteries. A staggered effect must therefore be used, contralaterally sectioning the ligaments on either side of the anastomosis.

The third method for extending length is the suprahyoid release technique of Montgomery.[4] This is well tolerated by the patient, is easy to accomplish, and involves releasing the larynx or hyoid bone from its upper muscular attachments.

The fourth method is an infrahyoid release technique reported by Dedo,[9] which separates the thyroid cartilage from its attachments superiorly to the hyoid bone.

This paper now reports a fifth operative technique which can be used either primarily for minimal tracheal resection or as an adjunctive technique to any or all of the above-mentioned release techniques. This procedure does not interfere with the other release techniques, is well tolerated by the patient, and does not limit the physiologic functioning of the larynx, trachea, or upper aerodigestive tract.

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Presented at the meeting of the American Laryngological Association, New Orleans, April 10-11, 1983.
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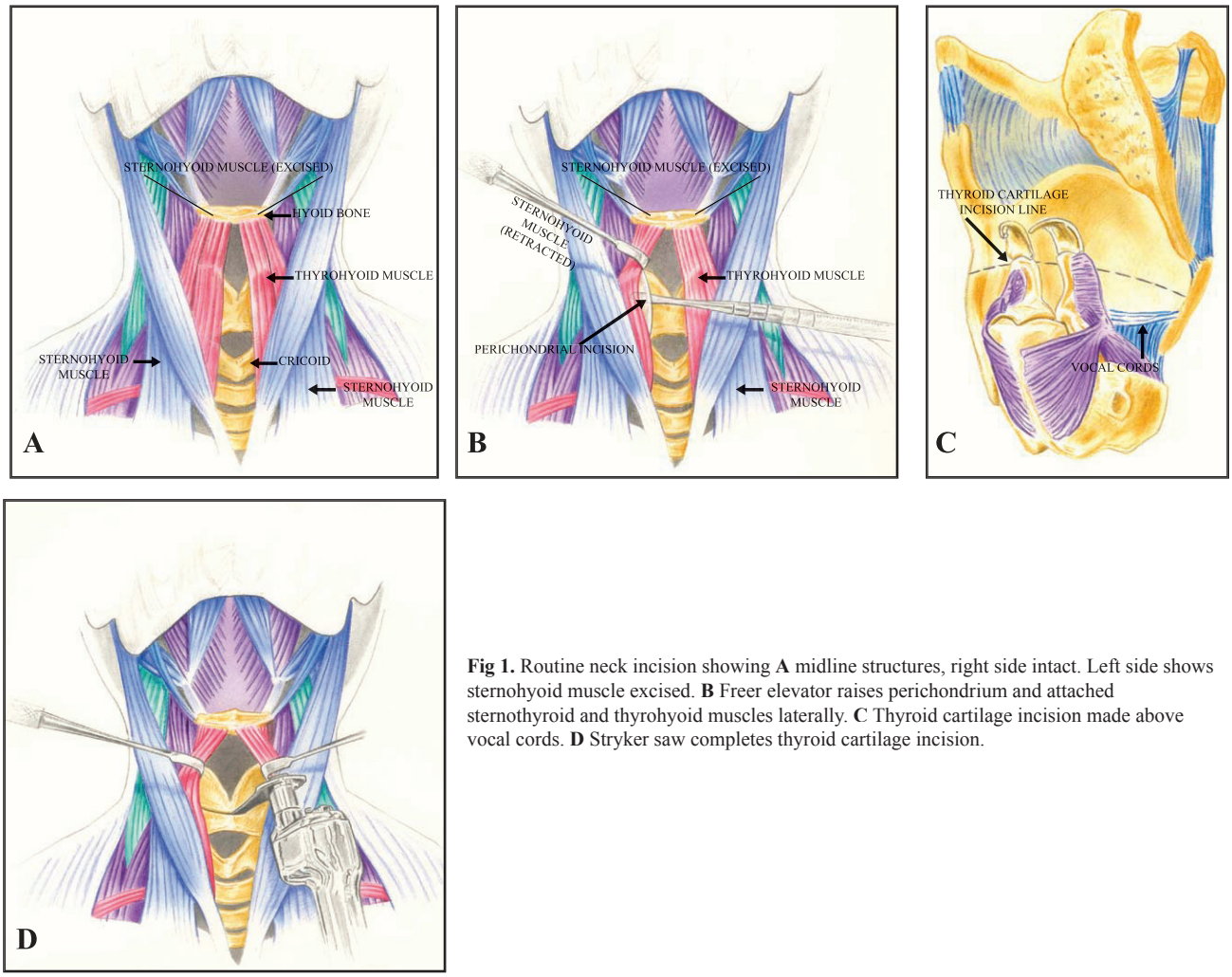

Fig 1. Routine neck incision showing **A** midline structures, right side intact. Left side shows sternohyoid muscle excised. **B** Freer elevator raises perichondrium and attached sternothyroid and thyrohyoid muscles laterally. **C** Thyroid cartilage incision made above vocal cords. **D** Stryker saw completes thyroid cartilage incision.

The experimental data substantiating the intralaryngeal release technique is derived from three sources. The technique was performed in canine experiments and consistently revealed at least 1 cm but no more than 2 cm of extension with a tension of less than 1,000 g. Fresh cadaver dissections allowed for a second source of experimental data and correlated well with the canine experiments, displaying a range of 1 to 2 cm with a control of 1,000 g tension. An additional experimental technique involving living patients undergoing total laryngectomy was performed intraoperatively ‘before the larynx was removed, and in these cases a range of 1 to 2 cm was consistently accomplished with less than 1,000 g tension. This last piece of data, however, is somewhat skewed based on the fact that all these cases had an intrinsic laryngeal carcinoma which in some instances hindered the release of the laryngeal structures.

Routine neck incisions and flaps are outlined and raised exposing the midline neck structures. Dissection is carried out between the strap muscles down to the anterior tracheal and laryngeal surfaces. The thyroid cartilage is exposed between retractors (Fig 1A) and the subglottic stenosis is appropriately handled as dictated by the individual clinical situation. The intralaryngeal release procedure is then performed. The sternohyoid muscles are retracted laterally, exposing the sternohyoid and thyrohyoid muscles. These are then elevated with the perichondrium of the thyroid cartilage until the edge of the posterior margin of the thyroid ala is reached (Fig 1B). A transverse cut in the thyroid perichondrium just above the vocal cords is outlined (Fig 1C), and a Stryker saw completes the incision (Fig 1D). The inner perichondrium of the thyroid cartilage is incised, exposing a thick inner thyroid membrane composed of a confluence of the inner laryngeal mucosa and the inferior extent of the thyroepiglottic ligament (Fig 2). This highly elastic membrane stretches, completing the procedure.

It should be noted that the intrinsic laryngeal structures are not exposed, and the superior laryngeal nerves, both internal and external, as well as the recurrent laryngeal nerves are preserved. The technique can be used adjunctively or as a primary technique for minimal tracheal resection. A postoperative course of neck flexion for ten days is considered helpful in all cases. We caution the use of this technique in children where interruption of the

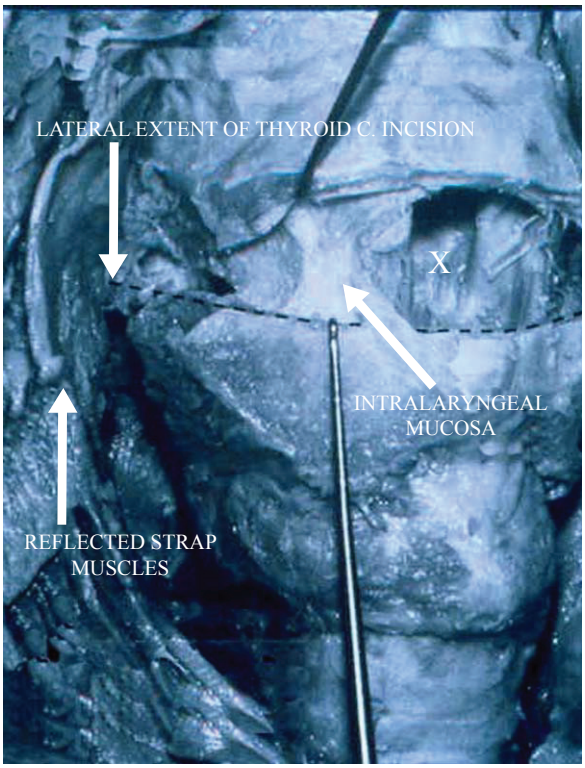

Fig 2. Separation of superior and inferior halves of thyroid laminae exposing intact internal perichondrium and laryngeal mucosa.

laterally situated thyroid cartilage growth center is possible.

This technique has been used successfully as a primary release in two cases. The first patient was a 54-year-old woman who underwent primary tracheal resection encompassing three tracheal rings (T2T5) for a primary hemangioma. The intralaryngeal release technique was performed to enhance sutureline approximation by decreasing tension.

The second patient was a 48-year-old woman with a long-standing history of stridor and increasing dyspnea secondary to traumatic intubation. Examination revealed a subglottic stenosis necessitating tracheal resection of three rings with end-to-end anastomosis. The intralaryngeal release procedure was performed primarily to decrease suture-line tension. Both cases healed primarily without experiencing any problems of deglutition, voice production, or breathing.

In summary, a new procedure utilized to lengthen the larynx when accomplishing tracheal anastomosis has been described, illustrated, and compared to currently acceptable techniques for minimizing tracheal suture-line tensions. It is hoped that the intralaryngeal technique will increase the percentage of successful tracheal reconstructions when utilized along with the standard operations or as a primary procedure.

ACKNOWLEDGMENT- Ms. Robin E. Lubins conceived and produced all the photographic and illustrative components of this paper.

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