Type I Thyroplasty: Pitfalls of Modifying the Isshiki Approach. How I Do It

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Summary: The Isshiki type I thyroplasty medializes the membranous portion of the vocal fold. Since its introduction into this country more than 10 years ago, several authors have reported modifications of the Isshiki approach primarily for the purpose of speeding the operation and ‘‘simplifying’’ the procedure. The major modifications have included: (a) incision, versus retraction, of the strap muscles; (b) removing the window external perichondrium; (c) varying the placement and size of the window and prosthesis; (d) removal of the window cartilage; (e) fiberoptic versus nonvisualization of the larynx intraoperatively; (f) incision of the inner perichondrium; and (d) use of silastic block substitutes. The principles of Isshiki’s original technique will be reiterated in the ongoing discussion, and the reasons for not modifying certain aspects of the technique will be examined from the standpoint of complications and negative impact that manifest when modification is done. Key words: Thyroplasty—Type I—Isshiki—Modification.

Since embracing the Isshiki type I thyroplasty (1) more than 10 years ago, American surgeons have modified these techniques primarily for the purpose of speeding the operation and ‘‘simplifying’’ the procedure (2–5). This anterior vocal fold medialization has all but replaced teflon injection for unilateral vocal fold paralysis because of thyroplasty’s apparent lack of serious complications. Lack of complications, however, were based on Isshiki’s original descriptions, not on any modifications of that technique. Changes in this accepted and well-studied technique should be made carefully and with a solid theoretical basis for improvement of the original.

The major modifications of the Isshiki type I thyroplasty have included changes in handling of the strap muscles (incision versus retraction), varying the placement of the thyroplasty window, removal of the window cartilage, nonvisualization of the larynx intraoperatively, vertical placement of the silastic block (rather than horizontal), use of silastic block substitutes, and incision of the inner perichondrium. Each of these modifications will be examined in light of Isshiki’s original descriptions and the author’s experience with more than two hundred type I thyroplasties over the past 10 years.

MODIFICATIONS OF THE TYPE I THYROPLASTY

Incision

The anterior horizontal neck incision was first placed at the midpoint height of the thyroid cartilage by Isshiki. This position allows direct access to the middle of the thyroid cartilage but variable access to the midposterior thyroid ala for arytenoid adduction procedures, or to the lower thyroid cartilage for possible combination with a cricopharyngeal myotomy. Although adequate, the author prefers an incision slightly lower in the neck at the level of the cricothyroid membrane to reach all of the above mentioned areas easily.

Strap muscles

The strap muscles in the type I thyroplasty are usually easily retracted and the surgery may be done without complete incision of either the sternothyroid or thyrohyoid muscles, except for the anterior part of the latter. However, visualization of the posterior ipsilateral larynx
is necessary for precise placement of the vocal fold line, using the Isshiki procedure. The vocal fold line is marked first at the halfway height of the thyroid cartilage in the midline. That height is then also used to mark a second point superior to the lower border of the thyroid ala, just in front of the cricothyroid joint. With experience it is easier to find the posterior lower border, but it is very easy in the beginning to not find it. An easy way to be certain is to uncover the lateral thyroid ala by incising the sternohyoid muscle high in the neck (2 cm below its hyoid insertion) and removing the thyrohyoid muscle completely from its origin at the oblique line. Theoretically, this could worsen the effect of the strap muscles on the larynx; but if the straps are reapproriated at the end of the procedure, then postoperative function will be quickly restored.

The argument for full exposure of the lateral thyroid ala is straight-forward. The correct placement of the vocal fold line is the ultimate key to success of any thyroplasty operation. A misplaced line will cause total failure of especially the type I thyroplasty and the arytenoid adduction. The most common mistake made in type I thyroplasty is placing the posterior portion of the window too high and lateral to the ventricle, and the author believes the primary reason for this is nonvisualization of the entire posterolateral larynx. Since careful separation and incision of the strap muscles may be repaired at the close of the operation it is, in the author’s view, well worth the effort to make certain the procedure has its best chance of success with proper placement of the vocal fold line.

External perichondrium

Keeping or removing the external perichondrium should not affect greatly the outcome of the type I thyroplasty. However, theoretically the window cartilage may have a better chance of viability postoperatively with its perichondrium attached; and it is possible that, if resorption of any window cartilage is in fact a real problem, leaving the perichondrium intact should lead to less chance of cartilage resorption. Intraoperatively, the external perichondrium has been useful in preserving the correct orientation of the window cartilage if destabilization of the window ensues from violation of the inner perichondrium. The external perichondrium may then be grasped and the cartilage righted once again.

Window size and placement

For reasons unknown to the author several surgeons have modified not only the size of the type I window, but also its placement on the thyroid ala. A slight digression to the anatomy, physiology, and voice generation of the vocal folds is needed to study the possible effects of these two important modifications.

According to the myoelastic theory of voice production, the vocal folds are brought into approximation in the midline by the intrinsic laryngeal muscles, and air from the lungs is pushed past the folds, causing periodic, symmetric movement of the mucosa. The Bernoulli effect is cited as the initiator of mucosal movement by drawing the mucosa of the vocal folds together with the increased speed of the airstream past the folds. When the glottis is closed the subglottic pressure then increases and finally “blows” the folds apart, and the cycle begins again. Until recently this theory was thought to explain mucosal wave production completely, but data from recent studies by Titze (6,7) have argued rather convincingly that some other force must be present to keep the folds in motion throughout the vibratory period without the built-in dampening effect of the Bernoulli principle itself. Thus Titze has proposed that the vocal folds act more like an oscillating body than a vibrating one and has theorized that the supraglottis, and specifically the introitus of the vocal tract (ventricles and false cords) play a key role as a coupling device with the glottis, allowing these two areas to work in harmony as a complete oscillating unit.

Titze’s theory predicts that deformation or medialization of the ipsilateral ventricle and/or false cord will affect the vocal tract adversely, and this is confirmed in practice. For example, experience shows us that misplaced or migrated teflon does not help a patient’s ease of phonation, although the vocal sound may be stronger. In addition, raspiness, the sound equivalent of airflow turbulence, is usually present. Using Bernoulli’s law the total energy of a fluid in motion is the sum of the fluid’s inertial energy plus its kinetic energy. Since the inertial energy of a fluid (air in our circumstance) is proportional to its pressure and the kinetic energy (flow) is proportional to the radius of the tube through which the fluid is flowing and the square of its velocity, one sees that decreasing the tube radius above the glottis will increase the supraglottic fluid pressure and raise the resistance to flow, decreasing the vocal efficiency. That is the reason why patients with laryngeal medialization above the true cords do not notice much improvement in the effort of phonation which, in properly performed medializations of just the true fold, is a universal postoperative outcome. One therefore needs to be diligent and precise with medialization to avoid adverse surgical outcomes.

The size of the window has also been modified by several surgeons, including the author. Since other surgeons who report modifying the window size have given little reason for doing so, one can only speculate that it is
possibly for reasons of “efficiency” or to speed the operation along. Ishihaki (1) has written that the window height (rectangle width) may be approximately 6 mm in the male and 5 mm in the female. However, this rectangular width will leave the inferior portion of the thyroid cartilage in danger of fracturing because the thin strip of remaining cartilage (3–4 mm in males and 2 mm in females) may be too fragile for the surgical stress, particularly if the upper border of the rectangle is exactly in its correct place at the superior border of the vocal fold. This may, in fact, have been a secondary reason for some surgeons to move the entire window cartilage superiorly to preserve more cartilage stability inferiorly, yet unknowingly negatively affecting the supraglottic vocal tract.

When first faced with this dilemma the author unwittingly decided to decrease the width of the cartilage window to preserve both the stability of the inferior thyroid ala and the position of the upper edge of the cartilage window at the vocal fold margin. To my surprise the patient’s postoperative voice was better than expected, and in fact better than most medializations performed by the author prior to that time. We now know, again from Titze’s work (7), that the best shape of the upper vocal fold is vertical in the sagittal plane, but vertical for only a short distance before tapering laterally toward the subglottis. Making the window of narrower width allowed for a flatter medialization of the superior vocal fold and hence a more efficient vocal mechanism. At present the author prefers to make the window cartilage width half the distance between the closest margin of the lower border of the thyroid cartilage and the vocal fold line. Since the lower border of the thyroid cartilage is fairly straight, the width of the window is very close to one half the vocal fold height.

**Window removal**

Probably the most universal modification of the type I thyroplasty has been in removing the window cartilage. The reasons for this are many, but essentially this maneuver is seen as time-saving for the surgeon and easier for medializing with a prosthesis that is fashioned to fit inside the thyroid ala. Supposing the window cartilage to be similar to a three-dimensional rectangular “block,” several surgeons have removed this window and replaced it with another block of their own fashion. As this author’s previous work has pointed out (8) the window cartilage is not a uniform structure with uniform thickness but varies from thinner anterosuperiorly to thicker posteroinferiorly. To adequately replace this cartilage with a surrogate, then, would require shaping the medial portion of the prosthesis to mimic the normal cartilage. In the author’s experience it is much easier to leave the window cartilage in place to preserve the real cartilage:soft tissue relationship than to try to copy normality over again. It means, however, modifying how the window cartilage is medialized and stabilized to conform more closely with the original Ishihaki technique or his present silastic “plug” technique to fill the window completely.

**Fiberoptic visualization for medialization**

Medialization thyroplasty was begun with both auditory and visual confirmation of a good result. In most cases the author has found, and Ishihaki has described, that visual confirmation is more important than the auditory. Several reasons exist for this fact. First, visualization of the larynx allows precise confirmation that the horizontal window has been placed correctly. Probing with a 27-gauge needle or a blunt instrument at the superior window margin is easily seen on the TV monitor, and medialization of the window cartilage will be visually precise. If it appears that edema of the vocal fold has already occurred because of surgical trauma then correctly compensating for that edema is possible only visually, since the voice would sound good at a final distance short of the proper medialization. Lastly, auditory perceptions of the patient are invariably faulty past the very first phonatory try with medialization. The ear compensates rather quickly and outside forces come to act on the larynx to negatively affect surgical decisions almost immediately. In addition, the remaining laryngeal muscles will have to readjust and reset themselves postoperatively for the new vocal fold position; this continues for approximately 2 months after surgery. Consequently, auditory perceptions alone are unreliable in gauging proper vocal fold medialization.

Occasionally a patient under local anesthesia is unable to cooperate with the surgeon and neither visual nor auditory confirmation of correct medialization may be obtained. In those instances the surgeon must recheck all the measurements leading up to the window placement (midline thyroid height, vocal fold line, width and length of the window). If all are correct, then the average depth of medialization for each sex is best used in conjunction with the surgeon’s perception of the preoperative videostroboscopic assessment. These average depths have been found to be approximately 3 mm anteriorly and 4 mm posteriorly in the male, and 3 mm anteriorly and 3.5 mm posteriorly in the female. Those measurements, although not perfect, will be close enough to improve the patient’s voice in most cases.

**Inner perichondrium**

Preservation of the inner perichondrium is an important part of thyroplasty surgery. Keeping this membrane
intact will positively affect the stability of the window cartilage in the immediate postoperative period. Whether the final vocal outcome is affected negatively by the surgeon’s cutting through the inner perichondrium in some instances is not definitely known but is feared. In practice, however, there are one or two small areas where the inner perichondrium is violated in virtually all cases. It is almost impossible not to do this unless the Isshiki method for cutting almost through the cartilage and finishing with a chisel cut through the medial cartilage is performed. No figures are available comparing one procedure with the other.

Besides making the window cartilage unstable by interrupting the inner perichondrium, bleeding will occur with that maneuver; and if muscle has been violated as well, immediate swelling in the vocal fold will ensue. The latter is most important because it will make it very difficult to perform a precise medialization in the face of edema or hematoma. At that point one can only guess at correct depth of medialization with no certainty at all. Consequently, prevention of trauma is best.

**Medialization substances**

Several other substances have been used for static repositioning of the anterior vocal fold, most notably hydroxylapatite. Flint and Cummings have shown nicely that the hydroxylapatite material, in the face of a preserved inner perichondrium, will spur regeneration of bone growth at the edges of the thyroplasty window. This further helps to stabilize the prosthesis but makes revision thyroplasty harder to perform. No prosthesis material other than the former and the standard silastic is used in any great amount.

**CONCLUSIONS**

The Isshiki type I thyroplasty is a well-thought-out operation that, although it may be enhanced with certain modifications, may also have negative results from other modifications. Attention to the anatomy, physiology, and vocal production of the larynx will aid the surgeon in choosing which modifications to make and which to discard. Attention to detail is important, since minor variations in the position of the altered vocal fold and its spatial relationship to surrounding soft tissue make large differences in the final vocal outcome. The larynx will be able to adjust to some modifications but not to all.

Future or present modification of the type I thyroplasty should be done only after careful consideration of the physiologic consequences of that change, and postoperative results should be published and scrutinized with the same standards that were applied to the original. Only with very close observation will we be able to determine the positive or negative effects of each modification, and be able to choose with confidence which ones will help the surgical outcomes of our patients.

**REFERENCES**