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Surgical Treatment of Glottic Web Using Butterfly Mucosal Flap Technique: Experience on 12 Patients

Taner Yilmaz, MD

**Objectives:** Many surgical methods have been described for the treatment of glottic web, with very little experience of each. Butterfly mucosal flap technique utilizes superior and inferior mucosal flaps on corresponding surfaces of the web; superior flap is elevated with its base on one vocal fold and inferior flap is elevated with its base on the other vocal fold. These flaps are sutured to the vocal fold where flap’s base is located. This requires four to six microsutures. The disadvantage of this technique is its difficulty. The advantages are single-stage endoscopic outpatient surgery and high success rate.

**Methods:** This is an individual prospective cohort study. All consecutive 12 cases of glottic web were treated with butterfly mucosal flap technique and followed for at least 1 year postoperatively. Voice Handicap Index (VHI)-30 including physical, functional, emotional, and total scores; acoustic analysis with /a/; aerodynamic measures; and respiratory function tests with a spirometer were determined pre- and postoperatively.

**Results:** Six patients were male; five were female; and one was male-to-female transsexual. Their ages ranged between 9 and 60 years with a mean of 36. All webs were caused by surgical trauma. All webs were cured with one surgery. The postoperative VHI scores, acoustic analysis results, aerodynamic measures, and respiratory function test results of patients improved significantly postoperatively (P < 0.05).

**Conclusion:** Although technically difficult, butterfly mucosal flap technique is a very successful single-stage endoscopic surgical option for the treatment of glottic webs.

**Key Words:** Glottic web, congenital anterior, glottis, vocal cords, laryngoscopy, laryngostenosis, laryngeal diseases.

**Level of Evidence:** 2

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**INTRODUCTION**

Glottic web is a bridge of scar tissue covered superiorly and inferiorly by epithelium between the free edges of true vocal folds at the anterior commissure. It can be congenital or acquired. Acquired webs are more commonly observed today than congenital ones. Causes of acquired webs may be surgical iatrogenic trauma, external trauma or intubation, infection (M. Tuberculosis, C. Diphtheriae, B. Cereus), reflux, and radiation therapy. If the web is congenital, it is advised to examine the patient for submucosal palatal cleft, aberrant pulses of medialized internal carotid artery in nasopharynx that are observed in chromosome 22q11 deletion (velocardiofacial syndrome and DiGeorge syndrome). After diagnosis of glottic web, it is a sound clinical practice to rule out the possibility of subglottic stenosis by endoscopy of the airway or computed tomography scan of the larynx.

Anterior glottic web is a difficult-to-treat clinical entity in laryngology. The main challenge in the treatment of anterior glottic webs has been the reformation of web after surgery. Many treatment modalities have been introduced into the literature to overcome this problem. Recurrent web formation has prompted the laryngologists to recommend staged procedures or the use of endoscopic keel. Surgical treatments of web can be briefly categorized as endoscopic versus open via laryngofissure, single versus two stages, use of laser versus cold instruments, and use of keel versus no keel. Obviously, single-stage and endoscopic ones have advantages over the multiple-stage and open techniques.

Indications for surgery of glottic web are airway obstruction and dysphonia. If none is present, the web does not require any treatment other than observation. If a patient with web has hoarseness, one has to be sure that the web is truly causing dysphonia.

Butterfly mucosal flap technique was first described by Schweinfurth as a case report in 2002, but acoustic, aerodynamic, and airway parameters of the case were not published. Later, Xiao et al. published their results with the same technique on 32 patients; however, they included only grade, breathiness, roughness (GBR), Voice Handicap Index (VHI)-10, and maximum phonation time as voice parameters in their article; they did not find a significant improvement in grade and roughness postoperatively.

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Additional supporting information may be found in the online version of this article.

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Furthermore, they did not measure acoustic, aerodynamic, and airway parameters. This article will be the first to include all acoustic, aerodynamic, and airway parameters after butterfly mucosal flap technique on anterior glottis webs.

This study was conducted to present a single surgeon’s experience on butterfly mucosal flap technique used for the treatment of glottic webs.

**MATERIALS AND METHODS**

This is an individual prospective cohort study. Twelve otherwise healthy, consecutive patients with anterior glottic web who were operated on using butterfly mucosal flap technique between 2010 and 2016 and followed up for at least 1 year postoperatively were included in the study.

This study was approved by the ethics committee of our university (number GO 18/203). The study conforms to recognized standards laid down by Declaration of Helsinki.

Six patients were male, five were female, and one was male-to-female transsexual. Their ages ranged between 9 and 60 years with a mean of 36. Etiology of glottic web was postsurgical trauma during microlaryngoscopy in all cases. None of the patients had preoperative tracheotomy, and none required postoperative tracheotomy.

According to Cohen classification system, type 1 describes an anterior web covering less than 35% of the glottis; type 2 describes one covering 35% to 50% of the glottis; type 3 describes one covering 50% to 75% of the glottis; and type 4 describes one covering 75% to 100% of the glottis.

Prospectively performed preoperative evaluations included:

1. GRB of grade, roughness, breathiness, asthenia, strain (GRBAS) scale: GRBAS grading was done by a speech language pathologist who did not know the condition of patients.
2. VHI-30 including physical, functional, emotional, and total scores
3. Aerodynamic analysis using Aerophone II Model 6800 (Kay Elemetrics, Lincoln Park, NJ) including maximum phonation time (sec), mean flow rate (l/sec), mean resistance (cmH2O/l/s), mean power (W), mean efficiency (ppm), and mean pressure (cmH2O)
4. Acoustic analysis with /a/ at comfortable pitch and loudness using CSL Model 4300B (Kay Elemetrics, Lincoln Park, NJ) including fundamental frequency (Fo) (Hz), jitter percent (%), shimmer percent (%), and noise-to-harmonic ratio
5. Respiratory function tests with a spirometer (Vmax Vntus SPIRO spirometry device; CareFusion, Yorba Linda, CA) including forced vital capacity (l), forced expiratory volume in 1 second (l), peak expiratory flow (l/s), forced inspiratory capacity (l), forced inspiratory volume in 1 second (l), and forced inspiratory flow 50 (l/s) (maximum inspiratory flow at inhalation of 50% of volume).

Every patient was followed up every 2 months up to 1 year, then yearly. Preoperative examinations were redone 1 year after surgery. Minimum follow-up was 1 year, and mean follow-up was 2 years.

**Surgical Technique**

After placing the laryngoscope tip (Kleinsasser) just above vocal folds, the superior epithelium is incised along the free border of vocal ligament of the left vocal fold using microscissors. Then the superior epithelial flap is elevated within the fibrous tissue plane of web toward the free border of vocal ligament of the right vocal fold, thus creating a right-based superior epithelial flap. The inferior epithelial flap is created by cutting the inferior mucosa of web along the free edge of the right vocal ligament using upturned microscissors; this flap will be left-based. Both sutured flaps will cover all bare areas with mucosa, thus diminishing the risk of reformation of web postoperatively (Figs. 1–6) (Supporting Video S1: Intraoperative video). The author ties the knot outside the laryngoscope and pushes the knot with a knot pusher. The reason for using 6/0 suture is its thread length, which is 45 cm, the minimum thread length with which one can tie the knot outside of the laryngoscope.

The significance was taken as P < 0.05. For comparisons of preoperative and postoperative results of scale variables, the Wilcoxon signed rank test for paired samples was used.
RESULTS

Two webs were classified as type 1, five as type 2, and five as type 3 according to Cohen classification system.\(^4\)

All cases were thin webs. All patients had residual web of 1 mm or less in anteroposterior length.

The comparison of preoperative and postoperative subjective voice evaluation; VHI-30; and acoustic, aerodynamic, and spirometry analysis results were demonstrated in Table I (Supporting Appendix 1 and 2, available online). All parameters were statistically significantly different postoperatively compared to preoperative results (\(P < 0.05\)).

DISCUSSION

Because web already is a scar tissue, the vocal folds remain scarred after treatment of web. Thus, normal voice cannot be attained and should not be promised to a patient. However, voice improves postoperatively. Because web decreases vibrating portion of membranous vocal folds, fundamental frequency of voice with web is higher than expected. After treatment of web, the fundamental frequency drops because there is more membranous vocal fold to vibrate despite postoperative scar tissue on vocal folds. According to results of this study, there is a statistically significant improvement in both subjective and objective voice parameters. However, despite significant improvements in the respiratory and phonatory parameters, the data does show significant variation both in the subjective as well as the objective data. For example, two patients in this series did not report improvement of their postoperative voices in VHI-30; this may be due to already-scarred vocal folds remaining scarred again. Furthermore, failure to obtain significant objective and subjective voice improvement may be the result of traumatic surgery, such as keel placement for several weeks and two-stage surgery.

The simplest and oldest treatment of web was to excise the web or scar using a cold instrument or \(\text{CO}_2\) laser. Nevertheless, it could make the injuries worse or enlarge the raw surfaces, resulting in rewebbing and worse rescarring. Thus, it should be abandoned.\(^5\)

Surgery of the web is contraindicated in case of an active HPV infection.\(^1\) The reason behind this contraindication may be possible virus seeding into soft tissues of the neck during placement and removal of stent. However, with the butterfly mucosal flap technique, this contraindication is not valid because there is no stent and
### TABLE I.
Comparison of Preoperative and Postoperative Acoustic, Aerodynamic, and Spirometric Results of All Web Patients and When Controlled for Web Type (Wilcoxon signed rank test).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Preoperative Mean</th>
<th>Postoperative Mean</th>
<th>Statistics</th>
<th>Web Type</th>
<th>Pre-/Postoperative Mean</th>
<th>Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade</td>
<td>2.17</td>
<td>0.92</td>
<td>Z = -2.88, P = 0.004</td>
<td>Type 1–2</td>
<td>1.86/1</td>
<td>Z = -2.12, P = 0.034</td>
</tr>
<tr>
<td>Roughness</td>
<td>2.17</td>
<td>0.92</td>
<td>Z = -2.88, P = 0.004</td>
<td>Type 1–2</td>
<td>1.86/1</td>
<td>Z = -2.12, P = 0.034</td>
</tr>
<tr>
<td>Breathiness</td>
<td>1.25</td>
<td>0.17</td>
<td>Z = -2.92, P = 0.004</td>
<td>Type 1–2</td>
<td>1/0.14</td>
<td>Z = -2.45, P = 0.014</td>
</tr>
<tr>
<td>F0</td>
<td>209</td>
<td>171</td>
<td>Z = -2.99, P = 0.003</td>
<td>Type 1–2</td>
<td>161/130</td>
<td>Z = -2.37, P = 0.018</td>
</tr>
<tr>
<td>Jitter %</td>
<td>4.64</td>
<td>2.77</td>
<td>Z = -2.83, P = 0.005</td>
<td>Type 1–2</td>
<td>3.61/2.64</td>
<td>Z = -2.20, P = 0.028</td>
</tr>
<tr>
<td>Shimmer %</td>
<td>7.38</td>
<td>3.95</td>
<td>Z = -2.83, P = 0.005</td>
<td>Type 1–2</td>
<td>5.11/3.60</td>
<td>Z = -2.20, P = 0.028</td>
</tr>
<tr>
<td>NHR</td>
<td>0.48</td>
<td>0.19</td>
<td>Z = -2.75, P = 0.006</td>
<td>Type 1–2</td>
<td>0.35/0.18</td>
<td>Z = 2.03, P = 0.043</td>
</tr>
<tr>
<td>MPT</td>
<td>10.4</td>
<td>16.3</td>
<td>Z = -2.85, P = 0.004</td>
<td>Type 1–2</td>
<td>11.7/17.6</td>
<td>Z = -2.21, P = 0.027</td>
</tr>
<tr>
<td>Mean airflow</td>
<td>0.20</td>
<td>0.13</td>
<td>Z = -2.83, P = 0.005</td>
<td>Type 1–2</td>
<td>0.19/0.13</td>
<td>Z = -1.87, P = 0.062</td>
</tr>
<tr>
<td>Mean resistance</td>
<td>51.0</td>
<td>21.9</td>
<td>Z = -2.85, P = 0.004</td>
<td>Type 1–2</td>
<td>35.7/25.6</td>
<td>Z = -2.00, P = 0.046</td>
</tr>
<tr>
<td>Mean power</td>
<td>0.06</td>
<td>0.09</td>
<td>Z = -2.85, P = 0.004</td>
<td>Type 1–2</td>
<td>0.07/0.09</td>
<td>Z = -2.01, P = 0.044</td>
</tr>
<tr>
<td>Mean efficiency</td>
<td>49.9</td>
<td>82.5</td>
<td>Z = -2.83, P = 0.005</td>
<td>Type 1–2</td>
<td>61.9/79.6</td>
<td>Z = -1.86, P = 0.063</td>
</tr>
<tr>
<td>Mean pressure</td>
<td>6.82</td>
<td>4.86</td>
<td>Z = -2.82, P = 0.005</td>
<td>Type 1–2</td>
<td>6.69/5.70</td>
<td>Z = -1.86, P = 0.063</td>
</tr>
<tr>
<td>FVC</td>
<td>3.87</td>
<td>4.67</td>
<td>Z = -2.85, P = 0.004</td>
<td>Type 1–2</td>
<td>4.26/4.79</td>
<td>Z = -1.99, P = 0.046</td>
</tr>
<tr>
<td>FEV1</td>
<td>2.29</td>
<td>2.78</td>
<td>Z = -2.85, P = 0.004</td>
<td>Type 1–2</td>
<td>2.50/2.76</td>
<td>Z = -1.99, P = 0.046</td>
</tr>
<tr>
<td>PEF</td>
<td>4.81</td>
<td>5.99</td>
<td>Z = -2.83, P = 0.005</td>
<td>Type 1–2</td>
<td>5.23/6.05</td>
<td>Z = -1.86, P = 0.063</td>
</tr>
<tr>
<td>FIC</td>
<td>3.17</td>
<td>3.93</td>
<td>Z = -3.06, P = 0.002</td>
<td>Type 1–2</td>
<td>3.61/4.23</td>
<td>Z = -2.37, P = 0.018</td>
</tr>
<tr>
<td>FIF50</td>
<td>1.19</td>
<td>1.86</td>
<td>Z = -2.85, P = 0.004</td>
<td>Type 1–2</td>
<td>1.43/1.91</td>
<td>Z = -1.99, P = 0.046</td>
</tr>
<tr>
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<td>1.55</td>
<td>2.22</td>
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</tbody>
</table>

F0 = Fundamental frequency; FEV1 = forced expiratory volume in 1 second; FIC = forced inspiratory capacity; FIF = forced inspiratory flow; FIV1 = forced inspiratory volume in 1 second; FVC = forced vital capacity; NHR = noise-to-harmonic ratio; PEF = peak expiratory flow; VHI = Voice Handicap Index; MPT = Maximum phonation time.
everything happens within glottis. Thus, there is no risk of virus seeding elsewhere. The surgeon should also take into account that, even in the absence of papillomas within larynx, the virus might be present in the normal-appearing squamous epithelium, and virus seeding to other tissues could take place during keel placement or removal. However, in the medical literature there is no report of virus seeding during endoscopic keel placement and removal after glottic web treatment.

Many different surgical approaches were published for glottic web in an attempt to prevent reformation of web and obtain better voice. These techniques included mucosa graft from lower lip,6 buccal mucosa,7 silastic sheet to lateralize one vocal fold,8 silastic keel placement with Lichtenberger technique,9,10 endoscopic laser anterior commissurotomy,11 an external procedure using a thyroid cartilage piece with its overlying perichondrium to act as a keel,12 and 2/0 silk suture knot tied in an O-shaped loop over the web at the anterior commissure to act as a keel.13,14

McGuirt et al.15 were the first to use an endolaryngeal mucosal flap for treatment of glottic web. They elevated a mucosal flap on the superior surface of the web and sutured it to the undersurface of the vocal fold on which it was based. The other vocal fold was left uncovered to heal by secondary intention. Because one vocal fold was completely covered with mucosa, web did not reform. It is the author’s opinion that this flap is best for type 1 webs and webs for which one mucosal flap was unintentionally ruptured intraoperatively.

The main principle in web treatment using the buttery mucosal flap technique is not creating uncovered mucosal surfaces to prevent reformation of web. Using butterly mucosal flap technique, Xiao et al.3 were the first to publish their experience on 32 patients. Their GRB, VHI, and maximum phonation time scores significantly improved in all patients after surgery. They pointed out that this technique achieved maximal preservation of vocal fold morphology and reduced the chance of secondary injury and readhesion to vocal folds. Because the web was a scar tissue itself and surgery could only separate the adhesion but could not improve scar formation, they believed that little improvement was expected postoperatively in the grade of hoarseness and roughness of voice. However, postoperative improvement on closure of vocal folds led to increased sound breath and longest phonation time, which improved the subjective feelings that patients had about their voices.3

Schweinfurth2 advises removing the redundancy of mucosal flaps in this technique. However, it is the author’s experience that every small piece of mucosa must be preserved and used to cover all deepithelialized vocal fold area during web surgery. Even in the largest web, there is no redundancy of mucosa because mucosa shrinks during flap development, and mucosal flaps are barely sufficient to cover all deepithelialized vocal fold area. This is why the author uses microscissors instead of the CO2 laser, which further induces mucosal shrinkage.

The butterfly mucosal flap technique is useful for the treatment of thin webs. Thick webs that involve subglottis and/or supraglottis are better treated with another method because mucosa at the anterior commissure will not be sufficient to cover the anterior commissure in case of a thick web. Anterior glottic webs with thickness of up to 1 cm can be managed with this technique, while keeping in mind the insufficiency of mucosa anteriorly mentioned in the preceding sentence. Anterior glottic webs with thickness above 1 cm should not be treated with this technique. The second disadvantage of this technique would be its technical difficulty.

CONCLUSION

Although technically difficult, butterfly mucosal flap technique is a very successful single-stage endoscopic surgical option for the treatment of glottic webs. Although normal voice cannot be attained, there is significant postoperative subjective and objective voice and airway improvement after butterfly mucosal flap technique. This appears to be a promising technique for the treatment of glottic web.

BIBLIOGRAPHY