

1 **Epiglot Rekonstrüksiyonlu Frontal Anterior Larenjektomi**

2 **(Tucker Operasyonu): Onkolojik ve Fonksiyonel Sonuçlar**

3 **Özet**

4 **Amaç:** Epiglot rekonstrüksiyonlu frontal anterior larenjektomi (Tucker operasyonu) ile tedavi
5 edilen hastaların fonksiyonel ve onkolojik sonuçlarını değerlendirmek.

6 **Hastalar ve Yöntemler:** Eylül 1985-Kasım 2009 yılları arasında, erken glottik tümörü olan
7 58 hastaya Tucker operasyonu uygulandı. Dekanülasyon zamanı, nazogastrik sondanın
8 çıkarılması, hastanede yatış ve onkolojik sonuçlar analiz edildi. Akustik analiz ve Ses
9 Handikap Endeksi (SHE) vokal fonksiyon değerlendirmesi için kullanıldı.

10 **Bulgular:** Ortalama dekanülasyon ve nazogastrik sonda çıkarılma süreleri sırasıyla $11,8 \pm 7,6$
11 ve $15,4 \pm 4,4$ gündü. Ortalama hastanede yatış süresi $19,3 \pm 6,1$ gündü. Erken dekanülasyon
12 uygulamasının hastaların dekanülasyon ve hastanede yatış sürelerini belirgin şekilde azalttığı
13 bulundu. Beş yıllık genel sağ kalım oranı %81,5, primer hastalığa spesifik sağ kalım oranı
14 %96,9 bulundu. On yıllık genel ve primer hastalığa spesifik sağ kalım oranları sırasıyla %67
15 ve %95,2 bulundu. Beş yıllık lokal kontrol oranı %95,4, nodal kontrol oranı %95,2 bulundu.
16 Ortalama jitter, shimmer ve gürültü-harmonik oranı değerleri sırasıyla $8,10 \pm 5,59$,
17 $16,60 \pm 5,81$ ve $0,51 \pm 0,23$ bulundu. Bu değerler belirgin bir artışı gösteriyordu. Total SHE
18 skoru ve alt grup SHE skorları (SHE-emosyonel hariç) hastaların hafif düzeyde ses sorunu
19 yaşadığını gösterdi.

20 **Sonuç:** Tucker operasyonu yüksek onkolojik başarı oranları ve tatminkar fonksiyonel
21 sonuçlarıyla erken glottik karsinomların tedavisinde tercih edilebilecek tekniklerden biridir.

22 **Anahtar Sözcükler:** Larengeal neoplaziler; Karsinom, Skuamöz Hücre; Larenjektomi

26 **Frontal Anterior Laryngectomy with Epiglottic Reconstruction**

27 **(Tucker's Operation): Oncologic and Functional Results**

28 **Abstract**

29 **Objective:** To evaluate functional and oncological results of patients who were treated with
30 frontal anterior laryngectomy with epiglottic reconstruction (Tucker's operation).
31

32 **Patients and Methods:** From September 1985 to November 2009, 58 patients whose early
33 glottic carcinomas were operated with Tucker's operation. The time of decannulation,
34 nasogastric tube removal, hospitalization and oncological results were analyzed. Acoustic
35 analysis and Voice Handicap Index (VHI) were used to evaluate vocal function.

36 **Results:** The mean time for decannulation and nasogastric tube removal were 11.8 ± 7.6 and
37 15.4 ± 4.4 days, respectively. The mean duration of hospital stay was 19.3 ± 6.1 days. It was
38 found that early decannulation significantly reduced patients' decannulation and
39 hospitalization time. The 5-year overall and cause-specific actuarial survival rates were 81.5%
40 and 96.9%, respectively. The 10-year overall and cause-specific survival rates were 67% and
41 92.3%, respectively. The 5-year local and nodal control rates were 95.4% and 95.2%,
42 respectively. The mean values for jitter, shimmer and noise-to-harmonic ratio were
43 $8.10 \pm 5.59\%$, $16.60 \pm 5.81\%$ and 0.51 ± 0.23 , respectively, and these scores showed a significant
44 increase. Total VHI score and subscale scores except VHI-emotional noted that patients had
45 mild level vocal disability.

46 **Conclusion:** Tucker's operation is one of the preferable techniques in the treatment of early
47 glottic carcinoma with its high oncologic success rate and satisfactory functional results.

48 **Key words:** Laryngeal Neoplasms; Carcinoma, Squamous Cell; Laryngectomy

51 **Introduction**

52 There are various treatment modalities for early glottic cancer. It has been treated by
53 radiotherapy, transoral excision with or without laser or open partial laryngectomy.¹ The basic
54 goals of partial laryngectomy techniques that are used in the surgical treatment of laryngeal
55 cancer are to provide complete surgical resection in compliance with the oncologic principles
56 and in addition to maintain deglutition, phonation and respiration, which are the physiologic
57 functions of larynx.² To achieve these goals in the surgical management of glottic cancer,
58 many laryngeal reconstructive techniques have been described. One of these techniques is the
59 frontal anterior laryngectomy with epiglottic reconstruction described by Tucker et al.³ in
60 1979 for treatment of laryngeal carcinoma involved glottic region. This technique allows
61 removal of the two vocal cords, of one arytenoid cartilage (when required), anterior
62 commissure with thyroid cartilage, anterior part of both false vocal cords, and of 1 cm of
63 subglottis.^{4,5} Oncological and functional results of this technique are limited to few reports in
64 the English literature.⁵⁻⁷ The purpose of the present study was to evaluate functional and
65 oncological results of 58 patients who were treated with frontal anterior laryngectomy with
66 epiglottic reconstruction (Tucker's operation).

67 **Materials and Methods**

68 In this retrospective study, we analyzed 58 patients with early-stage glottic carcinoma and
69 underwent Tucker procedure between September 1985 and November 2009. There were 56
70 male and 2 female patients with a median age of 56.5 years (range, 40-78 years). All patients
71 were preoperatively examined by suspension microlaryngoscopy and most of them (51
72 patients who were operated after 1992) endoscopically examined using 30° and 70° telescopes
73 to assess possible involvement of the ventricles, the anterior commissure, and the subglottic
74 region. None of the patients received previous radiation therapy. Two patients had been
75 treated surgical procedure (cordectomy=one patient and horizontal glottectomy=one patient).

76 The arytenoid cartilage on the tumor-bearing side was resected in 13 patients, and both
77 arytenoid cartilages were preserved in the remaining 45 patients. Functional ipsilateral neck
78 dissection was performed in 6 patients. All of the patients had squamous cell carcinoma with
79 glottic localization. Patients, who did not have squamous cell carcinoma, were excluded.
80 Patients, who had adjuvant chemoradiotherapy after surgery, salvage treatment (total
81 laryngectomy or radiotherapy) due to locoregional recurrences and functional failures (who
82 could not be decannulated) were not included in the analysis of vocal and late swallowing
83 function. While 39 of 58 patients had T1 glottic tumors, the remaining 19 patients were
84 suffered from T2 glottic tumors. Eleven (T1a) out of 39 cases with T1 glottic tumors had
85 tumors with one cord-involvement and reached the anterior commissure and did not impair
86 the movement of the cord, while the remaining 28 cases (T1b) had tumors involving the
87 anterior commissure partially reaching the opposite cord or covering both cords extending
88 from the anterior commissure without impairing the movement of the cords.

89 Voice exercises were started on the fifth day post-operatively and swallowing and movement
90 of the base of tongue exercises were started on the seventh day. In our study, 29 patients were
91 operated until 2003, nasogastric feeding tube was removed after patients started to swallow
92 liquid nutrition without having any problems, and in the following days, decannulation was
93 performed. However, early decannulation (during the first postoperative week if possible) was
94 preferred in 29 patients operated after 2003, and the nasogastric tube was removed in the
95 following days of no difficulty in swallowing.

96 Vocal and late swallowing functions could be evaluated in 26 patients who have follow-up
97 more than one year after surgery. Vocal functions were evaluated by acoustic analysis and
98 voice handicap index (VHI). Computerized Speech Lab Model 4500 from Kay Elemetrics
99 Corp. and Multi Dimensional Voice Program Model 5105 (NJ, USA) was used to perform

100 objective acoustic analyses. Fundamental frequency (Fo), jitter %, shimmer %, noise-to-
101 harmonic ratio (NHR) and maximum phonation time (MPT) parameters were assessed.

102 The VHI is a questionnaire devised by Jacobson et al.⁸ whereby the patient evaluates his own
103 voice. Turkish version of the VHI was validated previously.⁹ The VHI is a 30-item
104 questionnaire with three subgroups -functional, physical and emotional- each containing 10
105 items. In each subgroup, a point of 8 or over showed deteriorated voice quality. And a total
106 score, ranging between a minimum of 0 and a maximum of 120, is obtained. Vocal disabilities
107 were classified as mild (less than 30), moderate (31-60), severe (61-90), and too severe (91-
108 120).¹⁰

109 Acoustic analysis data of 10 individuals (9 males and 1 female) aged between 54 and 75
110 (median age, 60 years) with no voice-related complaints, who have been previously reported
111 by our department with the same equipment, were used as the control group data.¹¹

112 The scale formed by Leipzig¹² and Pearson¹³ (0: none; 1: occasional cough, no clinical
113 problem; 2: constant cough, worsening with meals or swallow; 3: pulmonary complications)
114 was used to evaluate the late postoperative aspiration.

115 *Statistical Analysis*

116 Analysis of functional results such as decannulation time, nasogastric tube removal, and
117 hospital stay was performed by Independent-samples *t*-test. The Kaplan-Meier analysis was
118 used to evaluate overall survival, cause specific survival, local control, and nodal control. The
119 parametric χ^2 test and the nonparametric Mann-Whitney U test were used for the analysis of
120 qualitative and quantitative variables, respectively. Mann-Whitney U test was used to
121 compare vocal function results of the study groups. Spearman correlation test was used for
122 correlation analysis. A *p* value below 0.05 was considered statistically significant. All of
123 functional results were expressed as mean±standard deviation.

124

125 **Results**

126 A great majority of patients were smoking (93.1%) and drinking alcohol (65.5%). Only 3
127 patients (5.2%) were non-smokers and non-drinkers. The dysphonia symptom was the basic
128 complaint during initial referral of patients. The median symptom duration was 5 months
129 (range, 1 month-6 year). Three of the patients had repeat biopsies (2 times in 1 case, 3 times
130 in 1 case, and 4 times in 1 case) for diagnostic purposes. No patient died in the immediate
131 postoperative period. Postoperative complications/problems are shown in Table 1. One patient
132 with aspiration pneumonia was managed successfully with antibiotic therapy. Postoperative
133 histopathologic examination showed tumor free of resection margin in 50 patients (86.2%),
134 positive surgical margin in four patients (6.9%) and close-contiguity margin in four patients
135 (6.9%). In only one patient with positive surgical margin (in addition with cartilage invasion)
136 underwent adjuvant chemoradiotherapy. Other patients with positive or close-contiguity
137 margins were followed closely. There were no metastatic lymph nodes in all neck specimens.
138 In the follow-up period, complications were seen between three and 15 months. Granulation
139 or polypoid tissue formations in the endolaryngeal region were among the most common
140 problems encountered during postoperative follow-up. To eliminate local recurrence at early
141 period, these lesions were excised by microlaryngoscopy in 7 out of 9 patients during follow-
142 up period. Laryngeal synechia or stenosis was seen in two patients. In one patient, it was only
143 confined to the epiglottis, and was easily treated by microlaryngoscopy. In the other patient,
144 an endolaryngeal stent was placed due to stenosis associated with endolaryngeal synechia, and
145 decannulation could not be performed as the patient was overstressed and in panic, although
146 the patient's airway was sufficient after removal of the stent. The patient preferred to stay
147 with the tracheotomy.

148 *Functional Results*

149 Decannulation and deglutition were within 15 days in two-thirds of patients. Eighty percent of
150 patients could be discharged from hospital within 21 days (Table 2).

151 *Decannulation:* All patients were successfully decannulated. The mean decannulation time
152 was 11.8 ± 7.6 days (range: 2 to 29 days). While the average decannulation time was 5.1 ± 2.0
153 days in 29 patients who were decannulated early, the average decannulation time was
154 18.4 ± 4.7 days in 29 patients who were decannulated late. In the follow-up period, the patient
155 who could not be decannulated after treatment of laryngeal stenosis was considered as
156 functional failure.

157 *Deglutition:* All patients were able to swallow. Nasogastric tube was removed after a mean
158 duration of 15.4 ± 4.4 days (range: 8 to 33 days). While the average nasogastric tube removal
159 time was 14.4 ± 3.1 days in patients who were decannulated early, the average nasogastric tube
160 removal time was 16.3 ± 5.2 days in patients who were decannulated late.

161 *Hospital stay:* The mean duration of hospital stay was 19.3 ± 6.1 days (range: 10 to 40 days).
162 While the hospitalization period was 16.7 ± 3.3 days in patients who were decannulated early,
163 the hospitalization period was 21.8 ± 7.1 days in patients who were decannulated late.

164 When the functional results were analyzed, mean time for decannulation and hospital stay was
165 significantly decreased in 29 patients who were decannulated early ($p < 0.05$). Preservation of
166 both arytenoids did not significantly reduce these functional parameters ($p > 0.05$) (Table 3).

167 *Acoustic analysis:* The mean F_0 was 179.27 ± 71.32 Hz and the MPT was 9.1 ± 4.2 seconds.
168 Jitter and shimmer averages were 8.10 ± 5.59 percent and 16.60 ± 5.81 percent, respectively.
169 The mean NHR value was 0.51 ± 0.23 (Table 4). The mean F_0 in the patients was higher than
170 that in the control group (140.6 Hz). However, the increase in the average F_0 was not
171 statistically significant ($p > 0.05$). Mean jitter, shimmer and NHR values in patients with
172 Tucker's operation significantly increased compared to the ones in the control group

173 (p=0.004, p=0.004 and p=0.0001 respectively). In addition, the MPT value in patients
174 significantly shortened (p<0.05) compared to the one in the control group (16.4 sec).

175 *Voice Handicap Index:* The mean of total VHI scores was 25.7±2.3 points. The mean of VHI
176 scores for physical, functional and emotional subscales were 9.3±7.4, 9.5±8.3 and 6.9±9.2,
177 respectively. The mean VHI-emotional score was lower than the VHI-physical and the VHI-
178 functional values (Table 4).

179 There was no significant correlation between the acoustic parameters and VHI scores except
180 for a positive correlation between shimmer and VHI-functional subscale (Table 5). The
181 number of preserved arytenoid cartilages (two arytenoids=21 cases; single arytenoid=5 cases)
182 was found to have no impact on both the acoustic analysis and on total VHI and subscale
183 scores (p>0.05).

184 *Late swallowing and aspiration:* The Grade 1 aspiration problem described in seven of the 26
185 patients was infrequently experienced only during drinking water.

186 *Oncologic Results*

187 Mean follow-up time was 68.2 months (range, 10-216 months). Two patients were not shown
188 up at the follow-up period. Thus, oncologic results could be evaluated in remaining 56
189 patients.

190 *Survival:* The 5-year and 10-year overall survival rates were 81.5 % and 67.0 %, respectively
191 (Fig. 1). The 5-year and 10-year cause-specific survival rates were 96.9 % and 92.3 %, respectively
192 (Fig. 2). Eleven patients died during postoperative follow-up period. The causes
193 of death were intercurrent disease (six patients), metachronous second primary cancers (three
194 patients), metastatic disease (one patient), and local recurrence (one patient). Local
195 recurrence, nodal recurrence and positive or close-contiguity surgical margin were significant
196 factors over cause-specific survival (Table 6).

197 *Local and nodal recurrences:* Locoregional recurrences occurred in three patients. One
198 patient had local recurrence, one patient had local and nodal recurrence, and one patient had
199 nodal recurrence. The 5-year actuarial local control rate was 95.4%. The locoregional
200 recurrences were noted after a period ranging from 22 to 41 months after the surgery. Two
201 patients, in whom locoregional recurrence developed, had positive or close-contiguity surgical
202 margin. There was no locoregional recurrence in 6 of 8 patients with positive or close-
203 contiguity surgical margin at follow-up. Salvage therapy for a patient with local recurrence
204 was performed via total laryngectomy with postoperative radiotherapy. However, this patient
205 died due to uncontrollable disease. The local recurrence developed in postoperative 28th
206 month in the patient with locoregional recurrence was controlled via supracricoid partial
207 laryngectomy with cricohyoidopexy. The nodal recurrence, which developed in the
208 postoperative 41th month in this patient, was treated via radiotherapy. This patient died in
209 postoperative 64th month due to metastatic pulmonary disease. A patient with nodal
210 recurrence was treated via radiotherapy. The 5-year actuarial nodal control rate was 95.2%.
211 The most important factor affecting local recurrence was close-contiguity or positive surgical
212 margin. And the most important factor influencing nodal recurrence was local recurrence or
213 positive surgical margin (Table 6).

214 **Discussion**

215 The surgical approach to be adopted in the treatment of early glottic cancers may vary
216 depending on the tumor localization, its spread and the surgeon's personal experience.
217 Optimal surgical approach for early-stage glottic carcinoma should maintain a safe oncologic
218 progress while offering a good functional result that will meet the patient's expectations. In
219 order that Tucker's operation can be implemented, the lesion should be primary glottic tumor
220 allowing for resection leaving at least one of the arytenoid cartilages intact, the epiglottis
221 should not have an involvement, ventricular involvement should be minimal, subglottic

222 extension should be less than 1 cm, vocal cords should not be fixed and no thyroid cartilage
223 infiltration should be present.⁴ The patient being over the age of 75, poor patient cooperation,
224 cardiac or pulmonary disease, presence of arytenoid fixation, subglottic extension being over
225 1 cm anteriorly and 0.5 cm laterally and over involvement of ventricular folds or anterior
226 commissure are the contraindications for this technique.¹⁴ The 5-year local control rates
227 reported in the literature for this technique ranges between 87% and 94%.^{5,14,15} The 5-year
228 actuarial local control rate found in our study was 95.4% and the 5-year nodal control rate was
229 95.2%. Obviously, locoregional control rates found in our study were high, with the oncologic
230 inadequacy seen only in 3 patients. Findings of our study also support the data that local
231 control is the most important factor affecting nodal control in glottic tumors.¹⁶ The rate of
232 success to be achieved in locally controlling the tumor in glottic cancers is dependent upon
233 the tumor's anterior commissure and/or its relationship with the paraglottic space and how
234 much the surgical technique to be applied controls such spaces. Anterior commissure and
235 paraglottic space are weak barrier points with regards the invasion of glottic tumors to thyroid
236 cartilage, due to its anatomical properties.^{5,15} While Tucker's operation bears the risk of
237 oncologic inadequacy in glottic tumors where there is massive anterior commissure
238 involvement, significant ventricle involvement causing thickening in ventricular bands or with
239 posterior ventricular involvement because it does not permit full paraglottic space resection
240 despite permitting "en bloc" anterior commissure resection, and because it is a
241 transcartilaginous technique.^{5,14,15} In such glottic tumors, our choice is supracricoid partial
242 laryngectomy with cricohyoidoepiglottopexy which is almost similar in indications but allows
243 full resection of the thyroid cartilage and paraglottic space.² The 5-year survival rates reported
244 in the literature for this technique ranges between 82% and 95%.^{5-7,14,15} The 5-year overall
245 survival and cause-specific survival rates obtained in our series were 81.5% and 96.9%,
246 respectively. In the literature, it is emphasized that lymph node recurrence or presence of

247 unclear surgical margin deteriorates survival.^{15,17} Two out of 3 patients in our study, who
248 developed oncologic inadequacy (cases who developed local or locoregional recurrence), had
249 positive or close-contiguity surgical margin. The findings of our study show that positive or
250 close-contiguity surgical margin is the most important factor affecting both local recurrence
251 and nodal recurrence. Moreover, local recurrence, nodal recurrence and positive or close-
252 contiguity surgical margin were found as factors affecting cause-specific survival. Thus,
253 patients with no clear surgical margins need a closer follow-up.

254 Successful treatment outcomes by use of transoral laser surgery or radiotherapy for early glottic
255 cancer have been reported. In a series of 163 patients with T1 glottic squamous cell carcinoma
256 who were treated with radiotherapy alone, Nomiya et al.¹⁸ have reported a 95.9% 5-year
257 cause-specific survival rate and a 90.1% 5-year local control rate. In this series, the 5-year
258 cause specific survival and local control rates for patients with T1b tumors were 93% and
259 85%, respectively.¹⁸ In a current review, it has been highlighted that transoral laser surgery
260 has similar success rates with those obtained by conventional conservation surgery. In
261 addition, transoral laser surgery has better postoperative function and less morbidity.¹⁹
262 Nowadays, although there is a growing tendency to use of transoral laser surgery and
263 radiotherapy as an initial treatment for early laryngeal cancer, anterior commissure
264 involvement should be considered because of the risk of local recurrence of such
265 involvement. In 2009, Rödel et al.²⁰ who had great experience on transoral laser surgery,
266 reported that anterior commissure involvement caused a decrease at 5-year local control rates
267 (for T1a tumors 73% vs 89% and T1b tumors 68% vs 86%). In our practice, the basic
268 selection criterion of patients with T1 glottic tumors for Tucker operation is the involvement
269 of the anterior commissure. In our series, 11 of 39 patients with T1 glottic tumors had tumors
270 reaching the anterior commissure, while the remaining 28 patients had tumors involving the
271 anterior commissure. The functional target of partial laryngectomy techniques is to make sure

272 that swallowing, speech and respiration are comfortably maintained requiring no permanent
273 tracheotomy. The mean time of the nasogastric tube removal has been ranging between 12-17
274 days,^{5,7} decannulation time between 6.1-20 days,^{7,15} and hospitalization time between 16-22
275 days.^{5,21} Our mean functional results were inside the average time notified in the
276 literature.^{5,7,15,21} At our clinic, we used to prefer decannulation following no-aspiration
277 swallowing during swallowing/speech rehabilitation process of open partial laryngectomies in
278 order to minimize the risk of serious pulmonary complications associated with early
279 postoperative aspiration.² However, after 2003, we revised our approach to the subject, and
280 started to apply the decannulation before the removal of the nasogastric tube. With this
281 approach, there has been a significant improvement in functional results in cases decannulated
282 early without aspiration-induced pulmonary complications. The argument of Laccourreye et
283 al.²², who suggest that early decannulation is one of the keys to successful swallowing
284 rehabilitation, is clearly supported from a comparative point of view with the findings of our
285 study. It was reported that the preservation of both arytenoid cartilages facilitated neoglottic
286 closure, improving the patients' swallowing and vocal functions.^{6,23} Contrary to these reports,
287 we found that the preservation of both arytenoid cartilages had no positive effect on their
288 swallowing, decannulation and hospitalization durations. In our study, the patient who
289 developed endolaryngeal stenosis had been discharged without problem after Tucker's
290 operation. This patient was intubated because of respiratory arrest due to a heart attack during
291 follow-up period and had stayed in intensive care unit for a month and he was
292 retracheotomized. We think that the stenosis in this case was secondary to the long-term
293 entubation and retracheostomy rather than the surgical technique. However, outcome of this
294 patient was considered as a functional failure. Occasional cough (grade 1 aspiration problem)
295 was described by seven of 26 patients (26.9%) were questioned for late postoperative
296 aspiration. This problem is common after conservation surgery; it may be often encountered

297 with this innocent problem. In one series, grade-I aspiration problem after conservation
298 surgery was reported in approximately half of the cases.⁷

299 In our work, the mean Fo value was 179.27 ± 71.32 Hz. Though not statistically significant,
300 this value demonstrated an increase. The length, mass, and tension of vocal folds are the main
301 factors determining fundamental frequency.²⁴ It was reported that Fo value increased with the
302 increase in the resection dimension of anatomic structures at the glottic level.^{24,25} In our study,
303 mean jitter, shimmer and NHR values were 8.10 ± 5.59 , 16.60 ± 5.81 and 0.51 ± 0.23 ,
304 respectively. Our acoustic evaluation noted a significantly increase in the value of the jitter
305 ($p=0.004$), shimmer ($p=0.004$) and NHR ($p=0.0001$). The mean MPT value of patients was
306 9.1 ± 4.2 sec, showing a significant reduction ($p=0.001$). The increase of jitter and shimmer
307 shows aperiodicity in the glottal cycle and an increase in the variation of voice wave
308 amplitude, and NHR analyses the aperiodic components of voice.²⁴

309 In our study, self-perceptual voice evaluation showed that the vocal disability scores of
310 patients were at a mild level. Moreover, while the average functional and physical subscale
311 scores similarly showed that the patients had a mild level of vocal disability, average
312 emotional subscale score was lower. This may be interpreted to mean that the patients were
313 less affected emotionally when using their voices, although they were physically and
314 functionally strained. In the study of Olthoff et al.²⁶ between total laryngectomy patients with
315 voice prosthesis and patients who underwent partial laryngectomy with transoral laser
316 surgery, both patient groups graded their voices as “well” in the questionnaire performed for
317 evaluation purposes. Therefore, it can be sufficient to have a post-treatment communication
318 language for most patients with larynx cancer. Although acoustic and perceptual
319 measurements are important parameters for the evaluation of vocal function, they provide no
320 information about the patients’ perception of their own voice qualities.¹⁰ In our study, lack of
321 any significant correlations between the acoustic parameters and VHI scores, except for a

322 positive correlation between shimmer and VHI-functional subscale, is a finding supporting
323 this datum. Findings of this study also showed that the number of preserved arytenoid
324 cartilages had no effect on both acoustic analysis and on total VHI and subscale scores.
325 Although not considered within the scope of this study, it is quite important to have a
326 communication language with “intelligible speech”. As an organ-preserving surgery, the
327 Tucker’s procedure also offers a communication language with intelligible speech. Although
328 the oncologic results and early postoperative functional results have been evaluated in almost
329 all patients, the late functional results could be evaluated in 44.8% of the patients in the
330 present study. Thus, late functional results should be interpreted in that aspect.
331 In conclusion, Tucker’s operation is an effective procedure in the treatment of glottic
332 laryngeal carcinomas when anterior commissure resection is needed. As a single-stage
333 technique, it has satisfactory functional results and high oncologic success rates.

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417 **Table 1.** Postoperative complications and problems.

| Complications / Problems | No. of patients |
|------------------------------------|------------------------|
| Early post-operative period (n=58) | |
| Aspiration pneumonia | 1 |
| Subcutaneous emphysema | 2 |
| Follow-up period (n=56) | |
| Granulation tissue/polyps | 9 |
| Laryngeal synechia or stenosis | 2 |

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434 **Table 2.** Postoperative functional data (n=58 patients).

| Number of days | No. of patients (%) | | |
|----------------|---------------------|---------------|---------------|
| | NT* Removal | Decannulation | Hospital stay |
| < 10 | 3 (5.2) | 29 (50.0) | - |
| 10-15 | 35 (60.3) | 10 (17.2) | 19 (32.8) |
| 16-21 | 16 (27.6) | 13 (22.4) | 27 (46.5) |
| > 21 | 4 (6.9) | 6 (10.3) | 12 (20.7) |

435 * NT: nasogastric tube

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453 **Table 3.** Analysis of functional parameters (n=58 patients).

| | NT* Removal | | Decannulation | | Hospital stay | |
|--------------------------------------|-------------|----------------|---------------|----------------|---------------|----------------|
| | Days±SD* | <i>p</i> value | Days±SD* | <i>p</i> value | Days±SD* | <i>p</i> value |
| Arytenoid cartilage resection | | | | | | |
| One resected (n=13) | 14.2±2.9 | 0.293 | 12.2±7.4 | 0.801 | 18.0±4.2 | 0.396 |
| None resection (n=45) | 15.7±4.7 | | 11.6±7.7 | | 19.7±6.5 | |
| Decannulation procedure | | | | | | |
| Late (n=29) | 16.3±5.2 | 0.112 | 18.4±4.7 | <u>0.0001</u> | 21.8±7.1 | <u>0.001</u> |
| Early (n=29) | 14.4±3.1 | | 5.1±2.0 | | 16.7±3.3 | |
| All patients (n=58) | 15.4±4.4 | - | 11.8±7.6 | - | 19.3±6.1 | - |

454 * NT: nasogastric tube, SD: standard deviation.

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467 **Table 4.** Results of the acoustic voice analysis and voice handicap index scores (n=26
 468 patients).

| Parameters | Mean±SD | Median | Range |
|------------------------------|--------------|--------|--------------|
| Maximum phonation time (sec) | 9.1± 4.2 | 8.5 | 4-18 |
| Fundamental frequency (Hz) | 179.27±71.32 | 188.67 | 69.15-356.79 |
| Jitter (%) | 8.10±5.59 | 5.71 | 1.90-20.49 |
| Shimmer (%) | 16.60±5.81 | 15.27 | 6.35-31.45 |
| Noise-to-harmonic ratio | 0.51±0.23 | 0.52 | 0.16-1.05 |
| Voice handicap index (VHI) | 25.7±2.3 | 22.5 | 0-100 |
| VHI-functional | 9.5±8.3 | 9 | 0-36 |
| VHI-physical | 9.3±7.4 | 8.5 | 0-24 |
| VHI-emotional | 6.9±9.2 | 4 | 0-40 |

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481 **Table 5.** Spearman’s rho correlation coefficients between acoustic voice analysis parameters

482 and voice handicap index scores.

| | Voice Handicap Index | | | |
|-------------------------|----------------------|------------|----------|-----------|
| | Total | Functional | Physical | Emotional |
| Maximum phonation time | -0.031 | -0.084 | -0.178 | 0.054 |
| Fundamental frequency | 0.333 | 0.338 | 0.342 | 0.270 |
| Jitter | 0.079 | 0.165 | 0.016 | 0.043 |
| Shimmer | 0.283 | 0.417* | 0.086 | 0.220 |
| Noise-to-harmonic ratio | 0.160 | 0.247 | 0.073 | 0.062 |

483 *p=0.048

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496 **Table 6.** *P* values of the univariate analysis of local recurrence, nodal recurrence, overall and
 497 cause-specific survival.

| Independent factors | Local recurrence | Nodal recurrence | Overall Survival | Cause-specific Survival |
|-------------------------------|---------------------|---------------------|---------------------|----------------------------|
| Age | 0.796 | 0.283 | <u>0.023</u> | 0.796 |
| Arytenoid cartilage resection | 0.275 | 0.480 | 0.481 | 0.275 |
| Positive margins | <u>0.001</u> | <u>0.023</u> | 0.075 | <u>0.001</u> |
| Close-contiguity margins | <u>0.001</u> | 0.773 | 0.075 | <u>0.001</u> |
| Local recurrence | – | <u>0.0001</u> | <u>0.004</u> | <u>0.0001</u> |
| Nodal recurrence | – | – | 0.275 | <u>0.0001</u> |

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512 **Legends for Figures:**

513 **Figure 1.** The 5-year and 10-year overall survival rates (n=56 patients).

514 **Figure 2.** The 5-year and 10-year cause-specific survival rates (n=56 patients)

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