Transoral Laser Microsurgery for Squamous Cell Carcinoma of the Base of the Tongue

Wolfgang Steiner, MD; Oliver Fierek, MD; Petra Ambrosch, MD; Christian P. Hommerich, MD; Martina Kron, PhD

Objective: To determine the role of transoral laser microsurgery for base of tongue squamous cell carcinoma.


Settings: University hospital department.

Patients: We reviewed 48 previously untreated patients with base of tongue squamous cell carcinoma, who were treated with transoral laser microsurgery. Distribution of the T categories were T1, 2%; T2, 25%; T3, 15%; and T4, 58%; 94% belonged to the stages III and IVa. Selective neck dissection was performed in 43 patients; 23 patients underwent postoperative radiotherapy with or without simultaneous chemotherapy.

Main Outcome Measures: Local control rate, recurrence-free and overall survival rates, mean performance status scale scores for normalcy of diet and understandability of speech.

Results: The Kaplan-Meier 5-year local control rate was 85%. There was no local recurrence in T1 and T2 lesions, but there was a 20% local recurrence rate in T3 and T4 tumors. Kaplan-Meier 5-year recurrence-free and overall survival rates were 73% and 52%, respectively. Mean performance status scale scores were 92% for normalcy of diet and 88% for understandability of speech. Twenty-one patients survived at least 5 years after treatment. They have a preserved larynx and live without tracheostoma or gastrostomy tube.

Conclusions: Our concept of organ and function preserving laser microsurgery for selected patients with base of tongue cancer seems to be justified considering the achieved oncological and functional results. Final proof of the effectiveness of the new therapeutic concept presented herein requires well-designed prospective studies.

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TREATMENT OPTIONS for base of tongue carcinoma are controversial. Standard treatment approaches include surgery, external beam radiation, chemotherapy, brachytherapy, or multimodality treatment. Combined therapy concepts generally obtain a higher locoregional control but often result in poor quality of life owing to severe impairment of swallowing and speech. The poor disease control has been attributed to advanced stage of disease due to a lack of early symptoms, deep tumor invasion, and cervical lymph node metastases in two thirds of the patients at diagnosis. The establishment of the transoral carbon dioxide laser microsurgery for the treatment of cancer of the upper aerodigestive tract1,2 has also provided a new alternative for the treatment of the tumors of the tongue base. The present study is a retrospective review of base of tongue squamous cell carcinoma (SCC), treated by transoral laser microsurgery mainly in combination with a unilateral or bilateral selective neck dissection with or without postoperative radiotherapy or chemoradiation with curative intent and the aim to preserve organ and function.

METHODS

We reviewed the medical records of 136 patients who were initially treated at the Department of Otorhinolaryngology–Head and Neck Surgery of the University of Goettingen, Germany, between 1986 and 1997, with the diagnosis of SCC of the tongue base. Treatment with primary radiotherapy and/or chemotherapy alone led to the exclusion of 30 patients from the study. From the 86 patients who underwent primary laser surgery, we excluded 27 patients with previous treatment for cancer or simultaneous second primary tumor, 6 patients with advanced unresectable N3 neck disease (stage IVb), and 5 patients with simultaneous distant metastases (stage IVc). Finally, 48 patients with SCC of the
base of the tongue underwent transoral carbon dioxide laser microsurgery with curative intent. The mean age of the 39 men and 9 women was 57 years (range, 38-85 years). Follow-up ranged from 5 to 153 months (median, 47 months). Tumors were staged according to the current TNM classification of malignant tumors as formulated by the International Union Against Cancer (UICC)1 and the American Joint Committee on Cancer (AJCC) in 1997.2 Postoperative T and N categories including 5 not surgically treated N0 necks are given in Table 1. Thirty-five tumors (73%) were classified as pT3 and pT4 lesions. Forty-five patients (94%) belonged to the advanced stages III or IVa. Thirty-eight tumors (79%) were moderately and 10 (21%) poorly differentiated.

According to the current classification of malignant tumors edited by the UICC and AJCC, T1 to T3 tumor categories are assigned corresponding to the greatest superficial dimension. The T4 category includes extension to adjacent structures (eg, soft tissues of the neck and deep extrinsic muscle of tongue) and to adjacent sites (eg, the larynx).3,4 We assigned 7 patients to the pT4 category because of extension to the deep extrinsic muscle of tongue with or without involvement of the epiglottis and 21 patients because of extension to the epiglottis, including 8 patients with involvement of the preepiglottic space and 2 patients with involvement of the arytenoid cartilage. Tumors infiltrating the soft tissues of the neck were not treated transorally with curative intent.

The distending bivalved oropharyngoscope developed by Steiner1 has proved to be useful for exposing the tongue base. Apart from the postcrioid region, the base of the tongue is the most unfavorable area for endoscopic surgery. The surgeon can usually only see a certain segment, and the area may lack surrounding landmarks, such as piriform sinus or larynx, for orientation. Multiple changes of the position of the oropharyngoscope were necessary to achieve good exposure of the tumor and the surrounding healthy tissue during the entire operation. The duration of the surgical procedure was generally between 1 and 5 hours.

In all but 1 case, several cuts had to be made through the tumor depending on its size and localization. The minimum had been 1 incision perpendicular to one another that cross in the middle of the tumor. This was sufficient for small lesions. In the case of more extended tumors with invasion of adjacent sites and structures, more cuts into manageable pieces were necessary. If histopathological analysis showed a positive resection margin, a second resection was generally carried out to obtain clear margins. The basal resection margin, which was stained with a blue marking pen, was of main interest regarding the verification of complete resection.

Another difficulty consists in the differentiation between tumor and lingual tonsil because of the increased carbonization by the higher tissue density of the base of the tongue due to increased vascularization, the large proportion of lymphatic and glandular tissue, and fibrosis from previous inflammatory processes in the base of the tongue.1 Frozen-section examinations improved safety of tumor-free margins.

Because of the tumor extension in 14 patients, parts of both sides of the tongue base were resected. The adjacent sites and structures that also had to be resected because of tumor invasion are listed in Table 2. Nine patients (19%) showed positive resection margins in the histopathological analysis. One patient refused a second resection, and another was postoperatively treated with chemotherapy. The other 7 patients received another resection; in 4 cases residual cancer was found. In 1 of 4 cases, a positive resection margin was observed again; after a third resection there was no more evidence for tumor.

Based on our large experience for the elective and therapeutic application of selective neck dissection,3 we generally performed level II and III dissections for N0 and N1 necks and additionally level IV dissections for N2 necks. If there were more than 2 suspicious lymph nodes or if there was a positive result from a frozen-section examination of 2 lymph nodes during the level II and/or III operation, level IV was included in the surgical procedure. If any suspicious lymph node was detected before operation by B-mode ultrasound, computed tomography (CT), or magnetic resonance imaging (MRI) in level I and/or IV, the corresponding level of the neck was also included for surgery.

Neck dissection was performed in 43 patients (90%); in 21 (44%) it was performed only ipsilaterally to the lesion and in 22 (46%), bilaterally, mainly as a delayed procedure 6 to 32 days after laser surgery (median, 10 days). In all but 1 patient, level II and III selective neck dissection was performed, and level I and/or IV was completed in 26 (41%) of 64 neck sides. Only 1 neck side was treated with a modified radical neck dissection. Histopathologically proven lymph node found in 33 patients (69%), 5 of whom had bilateral or contralateral neck disease. Ten patients had extranodal tumor spread.

Twenty-three patients (48%) underwent postoperative radiotherapy of the primary site and bilateral neck. The main indication for this procedure was a deep infiltration of the extrinsic muscle of the tongue with or without clear margins and advanced neck disease, including multiple lymph node metastases and extranodal tumor spread because of rupture of the capsule. Median dose delivered was 5670 (range, 5400-7000) rad (56.7 [range, 54-70] Gy). Adjuvant chemotherapy in combination with postoperative radiotherapy was administered to 12 patients (25% of all patients; 52% of radiated ones). Nine patients received carboplatin, 2 received cisplatin alone, and 1 received cisplatin in combination with fluorouracil.

Survival analyses were done by the Kaplan-Meier method.8 The overall survival time was defined as the interval between

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**Table 1. Distribution of the pN and pT Categories of 48 Patients**

<table>
<thead>
<tr>
<th>pT1</th>
<th>pT2</th>
<th>pT3</th>
<th>pT4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>N0/pN0 1 (2) 2 (4) 1 (2) 11 (23) 15 (31)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pN1 0 2 (4) 1 (2) 6 (12) 9 (19)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pN2 0 8 (17) 5 (10) 11 (23) 24 (50)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total 1 (2) 12 (25) 7 (15) 28 (58) 48 (100)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Data are number (percentage) of patients.

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**Table 2. Resected Adjacent Sites, Subsites, and Structures**

<table>
<thead>
<tr>
<th>Locality</th>
<th>Partial Resection</th>
<th>Total Resection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventricular bands 1 (2) 2 (4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arytenoid cartilage 2 (4) 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vallecule glossopipiglottica 15 (31) 21 (44)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lateral oropharyngeal wall/tonsil 26 (54) 3 (6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posterior pharyngeal wall 2 (4) 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piroform sinus 8 (17) 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aryepiglottic fold 3 (6) 7 (15)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posterior floor of the mouth 8 (17) 0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Data are number (percentage) of patients.
Horwitz et al. For normalcy of diet and understandability of
tion. He was successfully treated conservatively with heparin.
femoral vein thrombosis 1 day after the selective neck dissec-
cer. Another patient experienced bilateral lung embolism due to
electrocoagulation. One patient had a postoperative gastric ul-
could be managed by further microlaryngopharyngoscopy with
from the wound cavity was observed. In all cases the bleeding
aryepiglottic fold in 1 patient. In 2 patients diffuse hemorrhage
bleeding vessel was localized at the base of the tongue in 1 pa-
tient, at the lateral oropharyngeal wall in 1 patient, and at the
base carcinoma.
mean, 51 months) after laser microsurgery of the tongue
had lung metastases 7 months after primary treatment. In 1 case the
second primary cancer was found at the contralateral an-
terior floor of the mouth, and in another case at the pos-
terior pharyngeal wall after 124 months. The second pri-
mary tumors were diagnosed between 13 and 124 months
after treatment.

Two (6%) of the 3 patients with distant metastasis did not have local or neck recurrence; 1 had bone me-
tastases 8 months after primary treatment and the other
had lung metastases 7 months after primary treatment.
Second primary malignancies occurred in 8 pa-
tients (17%). In 6 patients the second primary tumor was not localized in the head and neck region and occurred
in the esophagus, lung, liver, or prostate. In 1 case the second primary cancer was found at the contralateral an-
terior floor of the mouth, and in another case at the pos-
terior pharyngeal wall after 124 months. The second pri-
mary tumors were diagnosed between 13 and 124 months
(mean, 51 months) after laser microsurgery of the tongue
base carcinoma.

An overview of TNM-related treatment failures in
13 patients (27%) is given in Table 3. Local recurrence
alone was seen in 6 patients, with simultaneous neck re-
currence in 1 patient. Three patients had late or recur-
rent neck metastases alone, and a further patient had re-
gegional recurrence in combination with a distant metastasis.

Table 3. Overall Patterns of TNM-Related Treatment Failure
Among 48 Patients

<table>
<thead>
<tr>
<th>Site</th>
<th>No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local recurrence alone</td>
<td>6 (13)</td>
</tr>
<tr>
<td>Locoregional recurrence</td>
<td>1 (2)</td>
</tr>
<tr>
<td>Late/recurrent neck metastases</td>
<td>3 (6)</td>
</tr>
<tr>
<td>Distant and recurrent neck metastases</td>
<td>1 (2)</td>
</tr>
<tr>
<td>Distant metastases with locoregional control</td>
<td>2 (4)</td>
</tr>
<tr>
<td>Total</td>
<td>13 (27)</td>
</tr>
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</table>

Seven patients (15%) developed local recurrence. The histologically analyzed margins of the primary malignan-
cies were free of tumor at definitive pathological ex-
namination in all cases. The Kaplan-Meier 5-year local control rate was 85%; the estimate of local control is shown in
Figure 1. There was no local recurrence in 13 cases with
T1 or T2 lesions. All 7 observed local recurrences oc-
curred in the 35 patients (20%) with T3 or T4 tumors,
including 2 local recurrences in 7 patients (29%) with
T3 lesions and 5 local recurrences in 28 cases (18%) of
T4 tumors. Five of the patients with local recurrence died
of disease and 1 additional patient died of intercurrent
disease. One patient is alive 8 years after salvage therapy
without evidence of disease. Regional recurrence with
local control occurred in 4 patients (8%), together with lung
metastasis in 1. One patient had a locoregional recur-
rence.

Five patients with clinically N0 necks did not un-
dergo neck dissection or postoperative radiotherapy. One
of them refused all further therapy after laser surgery, and
in the other cases, we avoided further procedures be-
cause of advanced age (between 74 and 85 years) and poor
general conditions. One patient had a late neck metas-
tasis after 10 months and died of neck disease, 2 pa-
tients died because of intercurrent disease, and 2 pa-
tients are alive without evidence of tumor 5 and 13 years
after treatment.

Five patients with postoperative hemorrhage within the first 7 days after laser surgery. Two bleeding
events occurred within the first 24 hours after operation. The bleeding vessel was localized at the base of the tongue in 1
patient, at the lateral oropharyngeal wall in 1 patient, and at the
aryepiglottic fold in 1 patient. In 2 patients diffuse hemorrhage from the wound cavity was observed. In all cases the bleeding
could be managed by further microlaryngopharyngoscopy with
electrocoagulation. One patient had a postoperative gastric ul-
cer. Another patient experienced bilateral lung embolism due to
femoral vein thrombosis 1 day after the selective neck dissec-
tion. He was successfully treated conservatively with heparin.

RESULTS

the date of surgery and the date of the last consultation or date
of death. For the determination of recurrence-free survival, in-
tercurrent deaths and deaths due to second primary tumors,
as well as patients alive without recurrence, were regarded as
censored observations. Uncensored observations included loc-
ral and regional recurrences, distant metastases, and deaths of
disease. For the calculation of the local control rate, local and
locoregional recurrences were considered as events.

Within the first year after surgery, we asked all patients
about their diet tolerance. In 20 living patients we collected cur-
rent data using the performance status scale for patients with
head and neck cancer developed by List et al7 and modified by
Horwitz et al.8 For normalcy of diet and understandability of
speech, the scales were rated from 0% to 100%, with 100% rep-
resenting normal function. Time between operation and eval-
uation ranged from 35 to 153 months (median, 71 months). We
excluded 2 patients because of second primary malignancy of
the oral cavity or posterior pharyngeal wall; 1 patient has been
lost to follow-up.

Five patients (10%) experienced postoperative hemorrhage within the first 7 days after laser surgery. Two bleeding
events occurred within the first 24 hours after operation. The bleeding vessel was localized at the base of the tongue in 1
patient, at the lateral oropharyngeal wall in 1 patient, and at the
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Figure 1. Kaplan-Meier estimate of local control.

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<tr>
<td>Total</td>
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Figure 2. Kaplan-Meier estimates of recurrence-free and overall survival.

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Distant metastases with locoregional control were observed in 2 patients. The 5-year recurrence-free and overall survival rates were 73% and 52%, respectively. The Kaplan-Meier estimates of recurrence-free and overall survival are shown in Figure 2.

The oncological results of laser microsurgery alone vs combined therapy for T4 tumors, stage IVa lesions, and all patients are given in Table 4. In all 3 groups, fewer local and locoregional recurrences could be achieved with combined treatment, although postoperative radiotherapy generally was performed in the less favorable cases. However, distant metastases did not occur in patients who underwent surgery alone, but in those who underwent combined therapy in 3 cases. This signifies a percentage of 23% for patients with pT4 tumors and 13% for all patients treated with laser surgery and radiation.

Forty patients (83%) needed nasogastric feeding. The median duration was 15 days (range, 2-64 days). No patient was tracheotomized perioperatively or postoperatively. There was no need for a secondary laryngectomy for functional reasons. Within the first year after surgery, 35 patients (73%) had an undisturbed oral intake of all food consistencies. Seven patients (15%) only fed on semisolid food. Two patients (4%) noted occasional aspiration without pneumonia independent of the food consistence. Three patients (6%) had severe dysphagia and recurrent aspiration after surgery without tendency of improvement. They required a gastrostomy tube until death. Two of them died due to intercurrent disease 16 and 30 months after surgery. One patient had recurrent tumor and died of disease 36 months after primary treatment. Figure 3 demonstrates a patient with undisturbed postoperative swallowing function before and 24 months after extensive tumor resection: parts of both sides of the tongue base and vallecula, the right lateral oropharyngeal wall, the epiglottis completely, the preepiglottic space partially, and selective neck dissection on each side. The closure between the tongue and the posterior pharyngeal wall (Figure 3D) prevents aspiration before swallowing; closure of the top of the airway by the tongue and laryngeal elevation prevent aspiration during and after swallowing.

At the time of analysis, 21 patients had survived at least 5 years after laser surgery. All had preserved larynx, and none depended on tracheostoma or gastrostomy tube. At the time of assessment, the mean performance status scale scores of the 20 living patients were 92% (range, 40%-100%) for normalcy of diet, and 88% (range, 50%-100%) for understandability of speech. Patients with T2 tumors had a score of 92% for both functions; patients treated for T3 or T4 lesions presented scores of 92% and 86%, respectively (Table 5).

For the present study, only patients were included whose tumors were evaluated before operation as being resectable with curative intent using laser microsurgery with conservation of organ and function. Compared with the 1992 UICC and AJCC classifications, the UICC and AJCC 1997 classifications specify that tumor extension to the larynx must be evaluated as a T4 lesion. For this reason there was a stage migration of 5 tumors from T2 to T4 and 15 tumors from T3 to T4, and the incidence of T3 and T4 lesions rose from 62.5% to 73%.

All 5 patients with postoperative hemorrhage underwent extensive primary tumor resections, including vallecula (all cases), lateral oropharyngeal wall with tonsil (4 cases), epiglottis and aryepiglottic fold (3 cases each), and extrinsic muscle of the tongue and piriform sinus (2 cases each). The resulting extensive wound cavities that remain open for spontaneous healing lead to a granulation process with the advantage of a smaller defect and a better function of the tongue on one hand but a higher risk of postoperative bleeding on the other. In more than 700 patients operated on curatively between 1986 and 1994 in our hospital with transoral laser microsurgery for SCC of the upper aerodigestive tract, the rate of postoperative bleeding was 3.1% without subsequent death. The highest rates were found for the oropharynx (6.4%) and supraglottis (7.0%). Both regions are also important in the present study. After conventional surgery of tongue base carcinoma including diverse flap reconstruction methods, the most frequent complication is postoperative fistula, which has been reported in 4.6% to 16% of cases. Hemorrhage does not seem to be a major problem and has been reported in only up to 3.6%. We have never observed fistulas after transoral laser resections in the upper aerodigestive tract.

Treatment of malignant tumors of the base of the tongue is still characterized by poor outcome. In the 1950s

### Table 4. Some Selected Oncological Results of Laser Surgery Alone vs Laser Surgery Combined With Postoperative Radiotherapy (With/Without Chemotherapy)*

<table>
<thead>
<tr>
<th>Category</th>
<th>Local Recurrences</th>
<th>Locoregional Recurrences</th>
<th>Distant Metastases</th>
<th>TNM-Related Recurrent Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>T4</td>
<td>Surgery alone (n = 15)</td>
<td>27</td>
<td>33</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Combined therapy (n = 13)</td>
<td>8</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>Stage IVa</td>
<td>Surgery alone (n = 20)</td>
<td>20</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Combined therapy (n = 21)</td>
<td>10</td>
<td>19</td>
<td>14</td>
</tr>
<tr>
<td>All patients</td>
<td>Surgery alone (n = 25)</td>
<td>20</td>
<td>28</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Combined therapy (n = 23)</td>
<td>9</td>
<td>17</td>
<td>13</td>
</tr>
</tbody>
</table>

*Data are percentage of patients (n = 48).
and 1960s, 5-year survival rates were achieved in up to 20%, increasing a decade later to sometimes more than 30%. Advances in therapeutic strategies in the last decades led to improvements in locoregional disease control. But overall survival rates have not significantly improved because of a shift from locoregional recurrences to distant metastases.

Figure 3. Preoperative sagittal (A) and axial (B) magnetic resonance images (MRIs) with gadolinium of a pT4 pN2a squamous cell carcinoma of the base of the tongue. Both sides of the base of the tongue are involved by tumor, and the epiglottis is invaded (arrows). Sagittal MRIs 24 months after surgery demonstrate the tissue defects of the base of the tongue and the epiglottis during respiration (C) and the closure between the tongue and posterior pharyngeal wall during swallowing (D).

Foote et al\textsuperscript{12} obtained a 5-year local control rate of 74% and a 5-year overall survival rate of 55% (including 24% of patients with T3 or T4 lesions). For surgical treatment alone, which was mainly performed as partial glossectomy with mandibular osteotomy or partial mandibulectomy. Surgical treatment combined with postoperative radiotherapy (including between 30% and 61% of pa-
patients with T3 or T4 tumors) resulted in better local control rates of 77% to 94%, but the overall survival rates were only 41% to 55%.9,10,13-15

There is insufficient literature comparing oncological results of surgery alone with surgery combined with postoperative radiotherapy carried out in the same institution. Nisi et al13 reported local control rates of 78% and 92% for patients treated with surgery alone or combined therapy, respectively. As the only treatment failure, distant metastases occurred in 2% and 13%, respectively.

In the present study, the frequencies of recurrent disease, including local and regional recurrences and distant metastases, for T4 tumors, stage IVa disease, and for all patients did not differ considerably between both therapy groups, although there are better local and locoregional control rates found in the combined treated group of patients. However, there were also more distant metastases detected.

For primary radiation therapy with or without brachytherapy, 5-year local control rates are reported between 44% and 78%; more than half of the treated patients had T3 or T4 lesions.16-18 Five-year overall survival rates in these studies range from 27% to 50%. In studies with 29% to 45% of patients presenting T3 or T4 tumors, the 5-year local control and overall survival rates were 88% to 89% and 72% to 86%, respectively.8,19 Tumors, the 5-year local control and overall survival rates of patients presenting with distant metastases without extranodal disease are 32%.9,10,14,15,17,19,22-24 Development of distant metastases was reported in 10% to 17% of patients, and after combined modality therapy. This is owing to a greater proportion of patients presenting with distant metastases. After single-modality therapy distant metastases are reported in 10% to 17% of patients, and after combined modality therapy the incidence is between 17% and 32%.9,10,14,15,17,19,22-24 Development of distant metastases was significantly influenced by overall tumor stage, nodal stage, extracapsular tumor spread, and positive resection margins in the histopathological analysis. In an autopsy study, Kotwall et al25 observed the highest incidence (53%) of occult distant metastases of all SCC of the upper digestive tract for base of tongue carcinoma.

Only 3 patients (6%) in the present study had distant metastases. All had IVa tumor stage and had been treated with surgery and adjuvant radiotherapy. One of them showed pN2c neck disease with extracapsular tumor spread; the other 2 had pN2c or pN1 neck disease without extranodal disease. Only 1 of 10 patients with extracapsular nodal disease spread developed distant metastases; 2 (9%) of 23 patients with pN1/2 neck metastases without extranodal spread had distant metastases. The 3 patients with distant failure had negative resection margins in the histopathological analysis. However, in contrast to all other studies mentioned above, it is difficult to explain why we only obtained an incidence of 6% of distant metastases (9% for surgery alone and 13% for combined therapy), especially since we had similar rates of advanced stage disease, neck metastases, and extracapsular tumor spread. Besides other reasons, the exclusion of patients with very advanced tumor disease, such as unresectable primary tumors and N3 neck metastases, may explain this fact.

Due to the difficulty to improve the recurrence-free and overall survival, functional outcome and thus quality of life assume increasing importance in evaluating the superiority of one modality of treatment over another with similar locoregional disease control. Total glossectomy is a frequently performed surgical therapy for advanced carcinoma involving the base of the tongue in some institutions.26-28 Ruhl et al27 reported on 54 T3 and T4 lesions treated with total glossectomy, 21 of which were treated in combination with a total laryngectomy. Reconstruction consisted of using a pectoralis major myocutaneous flap, a forehead flap, or a deltopectoral flap. Total laryngectomy was performed in 16% to 35% of cases as part of a combined tumor resection because of tumor invasion or to prevent severe complications due to aspiration.11,13-15 Weber et al23 reported on 17 total laryngectomies in 33 patients (51.5%) with T3 or T4 base of tongue tumors, declaring that tumor extension into the epiglottis, aryepiglottic fold, or piriform sinus were indications for total laryngectomy. In contrast, Machtay et al28 did not perform any total glossectomy or total laryngectomy. Patients in whom this surgery would have been deemed necessary to resect their tumor were all treated with postoperative radiotherapy with or without chemotherapy. The surgical approach used in some institutions included total or partial mandibulectomy in 13% to 35%.9,11-14

The consequence of sacrificing organs is a rather poor functional outcome and thus incurs a limited quality of life. In 10 patients who underwent primary surgery and postoperative radiation therapy, Harrison et al29 found some mean performance status scores of 50% (for those with T1 or T2 tumors) and 32% (for those with T3 or T4 tumors) for normalcy of diet and 65% (for those with T1 or T2 tumors) and 35% (for those with T3 or T4 tumors) for understandability of speech. For the same treatment modality, Nisi et al30 obtained scores of 56% for normalcy of diet and 84% for understandability of speech; however, for a group of patients who underwent surgery alone, mainly partial glossectomy, they found scores of 91% and 96%, respectively.15,30 For patients who underwent total glossectomy, Ruhl et al27 reported mean performance status scores of 28.6% for normalcy of diet and

| Table 5. Mean Performance Status Scale Scores (Percentage) by T Stage of 20 Patients |
|---------------------------------|-----------------|-----------------|
|                                | All Patients    | T2 (n = 6)      | T3 and T4 (n = 14) |
| Normalcy of diet               | 92              | 92              | 92               |
| Understandability of speech    | 88              | 92              | 86               |
46.4% for understandability of speech. Two of the 7 patients had also undergone a total laryngectomy (all had T3 or T4 tumors).

For primary external beam radiation with or without brachytherapy, the functional results generally were superior. Mean performance status scores for normalcy of diet for patients with T1 and T2 tumors were between 74% and 94%. In contrast, Harrison et al reported a score of only 63% for 8 T1 cases, and Horwitz et al obtained a score of 100% for those with T1 or T2 lesions. The mean scores for diet tolerance range from 76% to 100% for patients with T3 tumors and 50% to 84% for those with T4 tumors. For the understandability of speech, mean scores ranged from 83% to 100%, with higher scores for smaller tumor stages. The mean performance status scores for functional outcome of the present study are comparable with the good results after radiation therapy with or without brachytherapy and are better than most data for surgery described in the literature.

Within 1 year after concomitant chemoradiation for stage III and IV disease of the head and neck including the tongue base, Vokes et al observed only 29% with undisturbed oral intake of all food consistencies. In the present study, 73% of all patients had undisturbed oral intake within the first year after operation. Another indicator for the postoperative functional status of swallowing is the dependence on a permanent gastrostomy tube. Rates ranged from 5% to 18% after primary surgical treatment with or without postoperative radiation therapy. Ruhl et al reported that 4 (57%) of 7 long-term survivors after total glossectomy receive nutrition only by gastrostomy tube. The mean performance status scores for functional outcome of the present study are comparable with the good results after radiation therapy with or without brachytherapy and are better than most data for surgery described in the literature.

Because the current classification of malignant tumors edited by the UICC and AJCC does not consider the depth of infiltration to classify tongue base tumors, it is impossible to define the contraindications for laser microsurgery only related to the T categories. On one hand, there is a contraindication for T2 and T3 lesions with a very deep infiltration of the intrinsic muscles of the tongue; on the other hand, T4 tumors with infiltration of the extrinsic muscles of the tongue or the larynx could be intervened using transoral laser microsurgery. The main limits of this operation method are the infiltration of the neck and the sequelae of postoperative functional disturbance, such as impossibility of swallowing and recurrent aspiration. If there is a tongue base carcinoma with more than 2-cm infiltration into the intrinsic muscles of the tongue and/or 4-cm infiltration into the extrinsic muscles of the tongue, laser microsurgical excision of the lesion can lead to severe persistent functional disturbance. Furthermore, at least 1 hypoglossal nerve must be preserved.

Although most of our patients had good postoperative functional results, even with advanced tumor disease, after surgery 3 patients (6%) in the present study had severe dysphagia and recurrent aspiration without tendency of improvement and required a gastrostomy tube. This seems to be due to extended tumor resections including adjacent sites and structures that play an important role in swallowing. In all 3 patients, the posterior floor of the mouth or the preepiglottic space was resected. This can lead to aspiration after swallowing. Furthermore, all 3 patients had a unilateral or bilateral resection of the lateral oropharyngeal wall, resulting possibly in some disturbance of the swallowing reflex and consequently in aspiration before swallowing. Four of 6 further patients with resections of the lateral oropharyngeal wall combined with resections of the posterior floor of the mouth or the preepiglottic space, who took part in the collection of present data using the performance status scale, had a mean score of 72% for normalcy of diet (all patients, 92%). This includes 2 patients unable to eat solid food. These data suggest a higher risk for persisting severe aspiration when laser microsurgery of the base of the tongue is combined with resections of various adjacent sites and/or structures.

There are no other publications available about long-term results after transoral laser microsurgery of base of tongue cancer. Therefore, it is impossible to compare the presented oncological and functional results with the treatment outcome achieved elsewhere using the same operation method, but also with the results presented by other authors after diverse single or combined treatment modalities. There are several reasons for this; for example, the UICC and AJCC staging systems from different editions (ie, 1992 and 1997) are used, consideration of the depth of infiltration into the intrinsic muscles of the tongue for the evaluation of the T categories is absent, or there is different selection criteria for exclusion from a study and indication of postoperative chemoradiation.

Our experience suggests a higher risk for persisting severe aspiration when laser microsurgery of the base of the tongue is combined with enlarged resections of the lateral oropharyngeal wall and of the posterior floor of the mouth or supraglottic larynx including the preepiglottic space. To prevent subsequent poor functional outcome, we do not perform laser microsurgery on tumors infiltrating the soft tissue of the neck and on tumors with very extensive spread to adjacent sites and structures. Our concept of organ- and function-preserving laser microsurgery for selected patients with SCC of the tongue base seems to be justified considering the achieved oncological and functional results, but final proof of the effectiveness of the new therapeutic concept presented here requires well-designed prospective studies, with standardized surgical procedures carried out by head and neck surgeons skilled in laser surgery.

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CONCLUSIONS
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