Background: The swallowing deficits that result from oral or oropharyngeal resections vary considerably depending on the site, extension of the resection, and type of reconstruction. Most patients will experience some degree of dysphagia despite the reconstructive effort. Furthermore, a glossectomy is frequently associated with voice and speech difficulties.

Objectives: To characterize swallowing in patients who underwent a glossectomy and to define the limits and the compensatory movements using video fluoroscopic analysis.

Design and Setting: Video fluoroscopic evaluation of 15 patients who underwent glossectomies at the Centro de Tratamento e Pesquisa Hospital do Câncer A. C. Camargo, São Paulo, Brazil.

Patients: We examined 15 patients: 5 who underwent a partial glossectomy, 2 who underwent a subtotal glossectomy, and 8 who underwent a total glossectomy with laryngeal preservation and reconstruction with myocutaneous flaps (9 pectoralis major flaps and 1 latissimus dorsi flap). The 15 patients were enrolled in a program that included voice, speech, and swallowing rehabilitation.

Results: All patients who underwent a partial glossectomy had difficulties with formation and anteroposterior propulsion of the bolus in the oral cavity and an increase in oral transit time, which was more evident with materials of thicker consistencies. All patients who underwent a total or subtotal glossectomy with laryngeal preservation had an increase in oral transit time and stasis of food in the oral cavity, the pharynx, and the superior esophageal sphincter. Of the 15 patients, 2 had moderate and asymptomatic aspiration. These 2 patients had swallowing compensations, such as increased buccal, mandibular, pharyngeal, and laryngeal activity and voluntary protection of the larynx during swallowing.

Conclusions: This study demonstrates the effectiveness of swallowing in patients who were enrolled in voice, speech, and swallowing rehabilitation after undergoing a partial or total glossectomy. An increase in oral transit time was detected in all patients. Only 2 of the 10 patients who underwent a total glossectomy had persistent asymptomatic aspiration.


NORMAL SWALLOWING is a dynamic and short process. The preparation phase begins when the food is placed in the oral cavity and undergoes mastication and extends until the tongue moves to centralize the bolus. In the oral phase, the tongue initiates an anteroposterior movement, directing the food backward and generating negative pressure in the oral cavity, and propels the bolus toward the pharynx. The normal transit time of the oral phase takes less than 1 second.1 By the undulatory movement of the tongue, the bolus reaches the anterior palatine arch from which the pharyngeal phase of swallowing begins. The swallowing reflex is responsible for elevating and closing the larynx and for velopharyngeal closure, which prevents nasal reflux. Finally, the esophageal phase of swallowing begins when the bolus reaches the superior esophageal sphincter (SES), and the region opens as a consequence of a complex set of events.

Glossectomies may result in dysphagia, and the severity depends on the extension of resection, the mobility of the residual portion, the type of reconstruction, the involvement of other structures...
PATIENTS AND METHODS

From April 1, 1993, to March 31, 1997, 45 patients underwent a subtotal or total glossectomy and 210 patients underwent a partial glossectomy at the Department of Head and Neck Surgery and Otolaryngology, Centro de Tratamento e Pesquisa Hospital do Câncer A. C. Camargo, São Paulo, Brazil. Between August 15, 1997, and October 30, 1997, 15 patients who underwent treatment at the Department of Voice, Speech, and Swallowing Rehabilitation at the same hospital participated as volunteers in the present study. The patients underwent glossectomies (8 total, 2 subtotal [the presence of 10% of the base of the tongue], and 5 partial) 3 to 50 months prior to the video fluoroscopic evaluation. Of the 15 patients, only 3 did not have complaints about swallowing. Two patients received food orally and by a nasogastric tube. The remaining 13 patients received oral feeding (patients who underwent total and subtotal glossectomies received liquid, thick liquid, and paste food and patients who underwent partial glossectomies received food of all consistencies). All patients received speech and voice therapy for a mean of 3 months. Of the 15 patients, 11 used alcohol and tobacco.

Table 1 shows the data regarding age, sex, TNM staging, tumor site, histological type, extent of resection, surgical procedure, reconstruction of the esophageal region, and adjuvant treatment.

Video fluoroscopic evaluation of swallowing was carried out at the Department of Imaging using radiographic equipment (model system 1600E; GE Medical Systems, Milwaukee, Wis) and was performed jointly by a radiologist (B.C.) and a speech pathologist (C.L.B.F., E.C.-A., N.M.S.M., or A.P.B.B.). Patients stood during the examination, and the focus of the fluoroscopic image was defined anteriorly by the bifurcation of the airway and esophagus (the seventh cervical vertebra). Different types and quantities of material were given during the anteroposterior (profile) and lateral views. The material used was liquid barium and paste barium. For patients who underwent a partial glossectomy, a solid material (cracker) also was given. The patients were instructed to swallow 2 or 3 types of material 3 times each (liquid, paste, and solid) in variable amounts. The patients were directed to swallow both the liquid and the paste in quantities of 3, 5, and 10 mL (3 mL given with a spoon and 5 and 10 mL given with a syringe placed on the anterior portion of the oral cavity) and to continuously swallow liquid from a cup (15-20 mL). For the solid material, the patients were instructed to masticate the material well before swallowing. The videotapes were analyzed jointly by 5 speech pathologists (C.L.B.F., E.C.-A., N.M.S.M., or A.P.B.B.) experienced in video fluoroscopic evaluation. The oral transit time for swallowing was evaluated following these criteria: for liquid, normal (≤1 second) or increased (>1 second) and for paste and solid, normal (≤3 seconds) or increased (>3 seconds).

RESULTS

All patients swallowed the standardized quantities of liquid, paste, and solid materials, although aspirations were observed.

Table 2 describes the events observed in the oral and pharyngeal phases and the presence of aspiration, penetration (the entry of food to the level of the vocal folds), and conclusion of swallowing (functional swallowing or mild or moderate aspiration) of each patient.

Regarding the swallowing mechanism of patients who underwent a total or subtotal glossectomy, we observed stasis in all areas of the oropharyngeal tract, especially in the valleculae, the flap, the tongue stump (in patients who underwent subtotal glossectomies), and the SES (Figure 1). In addition, we observed a reduction of laryngeal elevation and, consequently, a reduction of the SES opening. The oral transit time was longer for all food consistencies, especially for paste (>3 seconds). We less frequently observed the characteristic stasis of the anterior and lateral sulcus and the hard and soft palate (Table 2).

Two patients had asymptomatic aspiration after swallowing (Figure 2). Laryngeal penetration of food was observed before swallowing in 2 patients, during swallowing in 4 patients, and after swallowing in 8 patients, but these patients were able to cough or clear their throats during this mechanism, eliminating the risk of aspiration. All patients moved the food and their heads backward. The patients used the following maneuvers: the supraglottic maneuver (the patients were taught how to close the airway before, during, and after deglutition) (8 patients), the Mendelsohn maneuver (the patients were taught to hold the larynx elevated for a longer period during deglutition) (2 patients), and multiple deglutitions (2 patients). Compensatory movements of lip protrusion, suction, and intraoral space reduction through mandible movements also were fairly frequent (Figure 3).

We detected functional swallowing in 8 patients and moderate aspiration after deglutition in 2 patients. One
Table 1. Characteristics of 15 Patients Who Underwent Glossectomies*

<table>
<thead>
<tr>
<th>Patient No./Age, y/Sex</th>
<th>TNM Staging†</th>
<th>Tumor Site</th>
<th>Histological Type</th>
<th>Extension of Tongue After Resection, %</th>
<th>Surgical Procedure</th>
<th>Flap Location</th>
<th>Adjuvant Treatment</th>
<th>Chemotherapy</th>
<th>Radiotherapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/10/F</td>
<td>T3 N0 M0</td>
<td>Oral cavity and base of tongue</td>
<td>Sarcoma</td>
<td>100</td>
<td>Total glossectomy and SOHND</td>
<td>Latissimus dorsi</td>
<td>Before</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>2/52/F</td>
<td>T4 N0 M0</td>
<td>Oral cavity and base of tongue</td>
<td>SCC</td>
<td>100</td>
<td>Total pelveglossectomy, amplified SOHND, and MRND</td>
<td>Pectoralis major</td>
<td>None</td>
<td>After</td>
<td></td>
</tr>
<tr>
<td>3/71/M</td>
<td>TX NX M0</td>
<td>Floor of mouth</td>
<td>SCC</td>
<td>100</td>
<td>Total glossectomy and left SOHND</td>
<td>Pectoralis major</td>
<td>After</td>
<td>After</td>
<td></td>
</tr>
<tr>
<td>4/51/M</td>
<td>TX NX M0</td>
<td>Floor of mouth</td>
<td>SCC</td>
<td>100</td>
<td>Total pelveglossectomy, sectional mandibulectomy, right RND, and left ESOSHN</td>
<td>Pectoralis major</td>
<td>Before</td>
<td>Before</td>
<td></td>
</tr>
<tr>
<td>5/75/M</td>
<td>TX N0 M0</td>
<td>Base of tongue</td>
<td>SCC</td>
<td>100</td>
<td>Total glossectomy, RND, and SOHND</td>
<td>Pectoralis major</td>
<td>None</td>
<td>Before</td>
<td></td>
</tr>
<tr>
<td>6/56/M</td>
<td>T4 N2 M0</td>
<td>Floor of mouth</td>
<td>SCC</td>
<td>100</td>
<td>Total pelveglossectomy, marginal mandibulectomy, and bilateral MRND</td>
<td>Pectoralis major</td>
<td>After</td>
<td>After</td>
<td></td>
</tr>
<tr>
<td>7/61/M</td>
<td>T3 N2c M0</td>
<td>Tongue</td>
<td>SCC</td>
<td>100</td>
<td>Total pelveglossectomy, right RND, and left ESOSHN</td>
<td>Pectoralis major</td>
<td>None</td>
<td>After</td>
<td></td>
</tr>
<tr>
<td>8/54/M</td>
<td>T3 N2b M0</td>
<td>Tongue</td>
<td>SCC</td>
<td>100</td>
<td>Total glossectomy, right ESOSHN, and left RND</td>
<td>Pectoralis major</td>
<td>None</td>
<td>Before</td>
<td></td>
</tr>
<tr>
<td>9/52/M</td>
<td>T3 N2b M0</td>
<td>Floor of mouth and tongue</td>
<td>SCC</td>
<td>90</td>
<td>Subtotal pelveglossectomy and bilateral RND</td>
<td>Pectoralis major</td>
<td>None</td>
<td>After</td>
<td></td>
</tr>
<tr>
<td>10/68/M</td>
<td>T2 N0 M0</td>
<td>Tongue</td>
<td>SCC</td>
<td>90</td>
<td>Subtotal pelveglossectomy, right ESOSHN, and left MRND</td>
<td>Pectoralis major</td>
<td>None</td>
<td>After</td>
<td></td>
</tr>
<tr>
<td>11/31/F</td>
<td>TX NX M0</td>
<td>Floor of mouth</td>
<td>Hemangioma</td>
<td>5-25</td>
<td>Partial glossectomy</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>12/56/M</td>
<td>T2 N0 M0</td>
<td>Floor of mouth and tongue</td>
<td>SCC</td>
<td>25-50</td>
<td>Partial pelveglossectomy and SOHND</td>
<td>Tongue</td>
<td>None</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>13/80/M</td>
<td>TX NX M0</td>
<td>Tongue border</td>
<td>SCC</td>
<td>5-25</td>
<td>Partial pelveglossectomy and left MRND</td>
<td>None</td>
<td>Before</td>
<td>After</td>
<td></td>
</tr>
<tr>
<td>14/44/F</td>
<td>T2 N0 M0</td>
<td>Tongue border</td>
<td>SCC</td>
<td>5-25</td>
<td>Partial pelveglossectomy and left ESOSHN</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>15/53/M</td>
<td>T4 N1 M0</td>
<td>Lower gum</td>
<td>SCC</td>
<td>5-25</td>
<td>Pelveglossectomy, marginal mandibulectomy, and MRND</td>
<td>None</td>
<td>None</td>
<td>After</td>
<td></td>
</tr>
</tbody>
</table>

*SOHND indicates supraomohyoid neck dissection (ND); SCC, squamous cell carcinoma; pelveglossectomy, partial glossectomy with pelvectomy (floor of the mouth resection); MRND, modified radical ND; RND, radical ND; and ESOSHN, extended SOHND.

†According to the Union Internationale Contre le Cancer.4

Table 2. Descriptions of Swallowing in 15 Patients Who Underwent Glossectomies*

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Oral Phase</th>
<th>Pharyngeal Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>RVLV</td>
<td>RBFP</td>
<td>IOTT</td>
</tr>
<tr>
<td>1</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>2</td>
<td>No</td>
<td>No</td>
</tr>
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<td>3</td>
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<td>No</td>
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<td>14</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>15</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

* RVLV indicates reduced vertical lingual movement; RBFP, reduced bolus formation and propulsion; IOTT, increased oral transit time; DSR, delayed swallowing reflex; SOC, stasis in oral cavity (lateral and anterior sulcus and hard and soft palate); STS, stasis in tongue stump; SF, stasis in the flap; RLMT, reduced lateral movement of the tongue; IVC, inefficient velopharyngeal closure; RVC, reduced vestibule closure; SV, stasis in valleculae; SP, stasis in pharynx; SSES, stasis in superior esophageal sphincter; RSESO, reduced superior esophageal sphincter; RLE, reduced laryngeal elevation; RGC, reduced glottic closure; SPS, stasis in pyriform sinus; and ellipses, not applicable.
patient (patient 5) underwent a gastrostomy, and another patient (patient 8) underwent a total laryngectomy. In patient 8, the swallowing mechanism after the laryngectomy was functional with liquid, thick liquid, and paste. We observed compensatory maneuvers that increased the oral phase, but the patient showed stasis in the flap and the oropharynx, and the presence of a cricopharyngeal bar, which increased the oropharyngeal transit time. The patient maintained the nutritional status.

During follow-up, 1 patient died of cancer recurrence, 2 were alive with recurrence (1 underwent a gastrostomy because of a second primary tumor in the esophagus and 1 had a second primary tumor in the soft palate), and 7 were alive with no evidence of disease.

Patients who underwent partial glossectomies showed an increase in oral transit time for paste foods, stasis in the oral cavity (anterior and lateral sulcus and hard and soft palate), a reduction of anteroposterior propulsion of the tongue, and an increase in the number of deglutitions to clear the valleculae (Table 2). Aspiration before deglutition and after penetration was observed in 1 patient who used the supraglottic maneuver of airway protection, the maximization of tongue stump mobility, and the control of the bolus in the oral cavity, which was eventually cleared. The types of maneuvers used were lip protrusion (3 patients) and suction and lowering of the mandible (1 patient). Suction and lowering of the mandible allowed for more participation of the buccinator muscles, which helped to diminish the intraoral space, to increase the intraoral pressure, and, consequently, to eject the food.

**COMMENT**

The issue of the functionality of swallowing after a total glossectomy dates from the proposition of the technique in 1953; because of the risk of postsurgical aspiration, a total laryngectomy was carried out at the same time as the glossectomy. Total glossectomy with laryngeal preservation was proposed by Kothary and DeSouza in 1973, and since then the functional results of the technique have been discussed, but few objective studies have been developed.

The tongue is a fundamental organ for normal dynamic swallowing, and it is involved not only in the preparation of the food and the formation of the bolus but also in the dynamic pharyngeal phase of swallowing. The understanding of the physiology of swallowing, the sequelae resulting from tongue resections, and the pos-
Montesi et al described similar results in 23 patients. A glottic maneuver was proved effective in 8 patients. All patients in the present study underwent radiotherapy: one was 75 years of age and the other was 80 years of age. The 2 patients with aspiration received preoperative radiotherapy and chemotherapy. Approximately 1 month after surgery, the patients still require a longer period of rehabilitation. The main findings regarding swallowing after a glossectomy were the presence of stasis (especially in the flap) of the valleculae, the pharynx, and the SES. Penetration before swallowing is due to alterations in oral-motor control; penetration during swallowing indicates inadequate airway closure; and penetration after swallowing occurs when the tongue is stasis. Eight patients were able to clear the occasional penetration of food and eliminate the risk of aspiration through compensatory and airway protection maneuvers. Although large residues of material accumulated in the oral cavity, the pharynx, and the airway protection may result in persistent aspirations, aspiration was detected in only 2 patients. Materials that accumulated in the oral cavity, owing to the lack of food propulsion, were compensated for by moving the head backward, which helped with oral clearing because of gravity. In 2 patients, static materials in the oropharyngeal region were moved by multiple deglutitions. The Mendelsohn maneuver was used to address specifically the presence of stasis in the SES region because it enabled an increase in laryngeal elevation and, consequently, a longer period of SES opening.

The 2 patients with aspiration received preoperative radiotherapy: one was 75 years of age and the other excessively used alcohol and did not benefit from the rehabilitation program. Pauloski et al described a significant reduction in the oral and pharyngeal phases of swallowing in patients who underwent radiotherapy. They reported an increase in the oral transit time in materials of paste consistency, a reduction in the efficiency of oropharyngeal swallowing, an increase in pharyngeal residue, and a reduction of the opening period of the SES. All patients in the present study underwent radiotherapy except 1 patient who required a shorter rehabilitation time, had a better compensation of all oropharyngeal characteristics, and an increase in laryngeal elevation.

Another frequent compensation found in patients who underwent a total or partial glossectomy was the increase in activity of the lips and the mandible, as Massengill et al and Kothary and DeSouza previously described. Aguilar et al and Logemann et al described the importance of rehabilitation programs involving oral feeding, exercises for oral structure mobility, control of consistency and texture of food, and facilitation of postures adopted during meals.

Partial tongue resections with primary closure (the suture of the tongue to the floor of the mouth) cause a temporary dysphagia due to edema and or difficulties in triggering the swallowing reflex. In addition to these symptoms, we also observed the reduction of tongue elevation, the anterior and lateral movement of the tongue, and the impairment of speech, mastication, and swallowing. Esophageal reconstruction with primary closure will generate swallowing difficulties during oral transit, such as the accumulation of food in the oral cavity, especially in the lateral sulcus, or even the inability to contain food in the oral cavity using the lips. We observed the following results: difficulty in forming and retaining the food; increase in oral transit time, especially for paste materials; stasis in the anterior and lateral sulcus, hard palate, and valleculae; reduction of lingual propulsion; and increase in the number of swallows used in an attempt to clear the valleculae. The compensations developed by patients who underwent partial glossectomies were similar to the compensations described for patients who underwent total glossectomies, that is, using mainly lip protrusion and suction.

Cancer and its treatment (surgery, radiotherapy, and/or chemotherapy), especially when involving the stomatognathic and respiratory systems, can alter the voice, the speech, and the swallowing mechanism. Although glossectomies impose limits to the process of deglutition, they still allow, most of the time, for functional deglutition. The study of swallowing using video fluoroscopic evaluation is considered the criterion standard for the diagnosis and planning of treatment of these patients. Since swallowing is a dynamic and quick process, the possibility of recording the examination on videotape guarantees a continuous analysis of limits and compensations of patients who underwent glossectomies.

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2. Montesi A, Pesaresi A, Serri L, Salmistraro D, Cavalli ML, Segoni A. Dynamic...