Objective: To define the site-specific swallowing dysfunctions of patients with head and neck cancer with respect to tumor site and stage by videofluoroscopic oropharyngeal motility (OPM) study prior to initiation of treatment.

Design: Retrospective survey.

Setting: Academic university institution.

Patients: A consecutive sample of 79 patients with stage III or IV head and neck cancer without prior treatment or tracheotomy. Patients were divided into groups according to tumor site: oral cavity (n = 7), oropharynx (n = 27), larynx (n = 24), and hypopharynx (n = 10). Patients with sinonasal, nasopharyngeal, and unknown primary carcinomas served as the comparison group (n = 11).

Intervention: All patients underwent OPM study prior to treatment.

Main Outcome Measures: Parameters of swallowing function, including oral impairment, pharyngeal impairment, cervical esophageal impairment, aspiration, and Swallowing Performance Status Scale (SPSS) score (a global measure of swallowing function) were extracted from the pretreatment OPM study and analyzed with reference to tumor site, T stage, and overall stage. The relations between tumor site and area or degree of dysfunction, and between stage of disease and area or degree of dysfunction were analyzed using χ² and Fisher exact tests.

Results: Aspiration status, cervical esophageal impairment, and pharyngeal impairment examined as a function of disease site showed statistically significant differences between groups, with laryngeal and hypopharyngeal sites revealing the most severe dysfunctions. The SPSS score did not correlate with tumor site, T stage, or overall stage. Other OPM parameters analyzed as a function of T stage and overall stage revealed no consistent patterns.

Conclusions: Hypopharyngeal and laryngeal disease sites have a high degree of pretreatment functional impairment. The SPSS score is a good global measure of swallowing dysfunction. In addition, significant site-specific dysfunctions are found when the OPM study is analyzed via its separate parameters. It is therefore critical that posttreatment function is compared with baseline pretreatment dysfunction.

PATIENTS AND METHODS

PATIENTS

Eligible were all patients newly diagnosed with stage III or IV head and neck cancer treated at the University of Chicago (Ill) from 1987 to 1996. Eligible patients underwent pretreatment OPM studies that were summarized on standard OPM record forms. Patients were excluded if they had (1) any treatment (surgery, radiation, or chemotherapy) prior to OPM study or (2) indwelling tracheotomy at the time of OPM study. Based on a review of medical records, a total of 79 patients met the above criteria and are included in the present sample. Patients were divided into groups according to tumor site, ie, oral cavity (n = 7), oropharynx (n = 27), larynx (n = 24), and hypopharynx (n = 10). Patients with sinonasal, nasopharyngeal, and unknown primary carcinomas served as a comparison group (n = 11), as these tumor sites historically are not known to affect swallowing function.

INSTRUMENT

The OPM study consists of a videofluorographic recording of a patient’s swallow in lateral and anterior-posterior views and is based on the videofluorographic evaluation of swallowing described previously by Logemann. The University of Chicago Speech and Swallowing Center has conducted more than 5000 OPM evaluations since 1991 with the use of the standardized OPM record. This computerized database storage and reporting system has standardized OPM study procedures and interpretation. Because the reporting format is standardized, interrater and intrarater variability is low. In addition, the swallowing evaluation for each head and neck cancer patient was conducted and reported by the senior speech pathologist (E.M.) to ascertain reliability and consistency of reporting. The recording is made by the speech pathologist while the patient swallows small amounts of liquid barium, paste barium, and a barium-coated cookie. Slow-motion, frame-by-frame analysis was utilized to evaluate oral, pharyngeal, laryngeal, and cricopharyngeal function. Special attention was also given to presence and etiology of aspiration, which was closely monitored during the study. Other parameters of aspiration (laryngeal sensitivity, response to therapeutic techniques, percentage aspirated) were documented on the OPM record. The results of the OPM study were recorded and summarized on the OPM record (Figure). Selected summary parameters of dysfunction, as defined by the OPM study, were extracted from the OPM record. The following were chosen as representative parameters of swallowing dysfunction: current diet, oral impairment, pharyngeal impairment, cervical esophageal impairment, presence of aspiration, and Swallowing Performance Status Scale (SPSS) score. (The precise etiology of aspiration was not included in the summary parameters analyzed.) Each of these parameters was analyzed with reference to tumor site, T stage, and overall stage. The SPSS scores are based on the parameters of dysfunction detailed by the OPM study and are designated by the speech therapist at the conclusion of the study (Table 1). The mean SPSS score for each tumor site was calculated. The SPSS scores were then compared between tumor site groups.

STATISTICAL ANALYSIS

Descriptive statistics (eg, frequency, mean scores, and SDs) were used to present the prevalence of specific pretreatment swallowing dysfunction. Overall SPSS scores are presented for the total sample and then by group based on tumor site (oral cavity, oropharynx, larynx, or hypopharynx). Analysis using χ² and Fisher exact statistics were used to examine the relationship between tumor site and area or degree of dysfunction, and between stage of disease and area or degree of dysfunction. These analyses were performed separately for each outcome variable, ie, area or degree of dysfunction (eg, esophageal impairment). Given the small sample size and therefore the limited numbers of patients per tumor site group, further statistical tests were not done, and overall P values are presented.
detailed objective analysis of the swallowing function of the larger group of patients was completed. In addition, there are no conclusive published reports in the literature of detailed pretreatment swallowing dysfunction of head and neck cancer patients with respect to tumor stage and site. Clearly, objective baseline studies of site-specific swallowing dysfunction are needed that target patients who have the greatest dysfunction at the

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**Oropharyngeal Motility (OPM) Study Data Entry Form**

**Observations**

1. Reflex Time
   - 0 = No Reflex
   - 1 = Normal
   - 2 = Delayed

2. Reflex Strength
   - 0 = No Reflex
   - 1 = Weak
   - 2 = Adequate
   - 3 = Normal

3. Pharyngeal Impairment
   - 0 = Normal
   - 1 = Mild
   - 2 = Moderate
   - 3 = Severe

4. Pharyngeal Symmetry
   - 0 = Normal
   - 1 = Bulge to right
   - 2 = Bulge to left

5. Pharyngeal Transit Time (seconds)

6. Cerv. Esoph. Impairment
   - 0 = Normal
   - 1 = Mild
   - 2 = Moderate
   - 3 = Severe

7. Cerv. Esoph. Sequelae
   - 0 = None
   - 1 = Zeekes
   - 2 = Reflex
   - 3 = Other

8. % Aspiration
   - 0 = None
   - 1 = 1-19%
   - 2 = 20-39%
   - 3 = 40-59%
   - 4 = 60-79%
   - 5 = 80-99%
   - 6 = 100%

9. Swallowing Performance Scale
   - 1. Normal
   - 2. WFL: abnormal oral or pharyngeal stage but able to eat regular diet without modifications or swallowing precautions.
   - 3. Mild impairment: mild dysfunction in oral or pharyngeal stage, requires modified diet or therapeutic swallowing precautions. Requires modified diet and therapeutic precautions to minimize aspiration risk.
   - 4. Moderate impairment: moderate dysfunction in oral or pharyngeal stage, requires modified diet and swallowing precautions to minimize risk of aspiration.
   - 5. Moderate-Severe dysfunction and requires supplemental enteral feeding support; moderate dysfunction in oral or pharyngeal stage, aspiration noted on exam, requires modified diet and swallowing precautions to minimize risk of aspiration, needs supplemental enteral feeding support.
   - 6. Severe impairment: severe dysfunction with significant aspiration or inadequate oropharyngeal transit to esophagus; NPO requires primary enteral feeding support.

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start of treatment so that intensive rehabilitation may be initiated. Also, this information is important in an analysis of treatment outcome. Posttreatment speech and swallowing dysfunction may be related to the pretreatment cancer bulk or pain. As functional parameters and quality-of-life measures assume greater importance with newer multimodality therapies, it is critical that posttreatment function is compared with the baseline pretreatment dysfunction.

We hypothesized that there are consistent site-specific swallowing abnormalities that are associated with carcinoma of the upper aerodigestive tract. The specific aim of this study was to define the site-specific swallowing dysfunctions of head and neck cancer patients with respect to tumor site and stage by OPM study prior to initiation of treatment.

**RESULTS**

There were 61 men and 18 women in the entire study group, including the comparison group. Fourteen patients had stage III carcinomas and 54 patients had stage IV tumors. All comparison group patients (n = 11) had stage IV disease. One patient had a T1 tumor, 9 had T2 tumors, 25 had T3 tumors, and 33 patients had T4 tumors. The mean age was 57.6 years, with a range of 16 to 81 years. Fifty-nine patients (75%) were eating a normal diet, whereas only 3 (4%) were taking a nonoral diet at the time of OPM study. Seventeen patients (22%) were tolerating a liquid, pureed, or soft diet.

Patients with oral cavity carcinoma had a mean SPSS of 2.4 (within functional limits to mild impairment), whereas oropharyngeal cancer patients displayed a mean score of 3.0 (mild to moderate impairment). Laryngeal cancer patients had an SPSS score of 3.7, and those with hypopharyngeal cancer had a mean score of 4.1 on the SPSS. Control subjects scored 2.2 on the SPSS. The difference between the mean scores was statistically significant (P < .001, 1-way analysis of variance).

There were several site-specific significant findings when tumor site was compared with the OPM parameters (Table 2 and Table 3). Aspiration status was significantly different by disease site, and the overall differences between sites were statistically significant (P < .001). Only 14% of patients with cancer of the oral cavity and 30% with cancer of the oropharynx aspirated, whereas 67% of patients with laryngeal and 80% with hypopharyngeal cancer aspirated. Similarly, cervical esophageal impairment was significantly different as a function of tumor site (P = .02). Thirty percent of patients with hypopharyngeal cancer showed moderate to severe esophageal impairment, whereas 0%, 4%, and 0% of patients with oral cavity, oropharyngeal, and laryngeal cancer, respectively, showed this degree of impairment. Disease site was also compared with pharyngeal impairment, and a significant difference was found between the groups (P = .003).

Sixty percent of patients with hypopharyngeal and 42% with laryngeal cancer revealed moderate to severe pharyngeal impairment, but only 14% of those with oral cavity and 7% with oropharyngeal cancer showed this degree of impairment. Analysis of disease site as a function of oral impairment revealed that 57% of patients with oral cavity and 59% with oropharyngeal cancer had a mild to moderate degree of oral impairment, whereas only 30% of patients with hypopharyngeal and 17% with laryngeal cancer showed this degree of oral impairment (P = .02). There was no sta-

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**Table 1. The Swallowing Performance Status Scale**

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Normal</td>
</tr>
<tr>
<td>2</td>
<td>Within functional limits: abnormal oral or pharyngeal stage; able to eat regular diet without modifications or swallowing precautions</td>
</tr>
<tr>
<td>3</td>
<td>Mild impairment: mild dysfunction in oral or pharyngeal stage; requires modified diet and swallowing precautions to minimize aspiration risk</td>
</tr>
<tr>
<td>4</td>
<td>Mild-moderate impairment with need for therapeutic precautions: mild dysfunction in oral and pharyngeal stage; requires modified diet and therapeutic precautions to minimize aspiration risk</td>
</tr>
<tr>
<td>5</td>
<td>Moderate impairment: moderate dysfunction in oral or pharyngeal stage; aspiration noted on examination; requires modified diet and swallowing precautions to minimize risk of aspiration</td>
</tr>
<tr>
<td>6</td>
<td>Moderate-severe dysfunction and requires supplemental enteral feeding support: moderate dysfunction in oral or pharyngeal stage; aspiration noted on examination; requires modified diet and swallowing precautions to minimize risk of aspiration; needs supplemental feeding support</td>
</tr>
<tr>
<td>7</td>
<td>Severe impairment: severe dysfunction with significant aspiration or inadequate oropharyngeal transit to esophagus; NPO; requires primary enteral feeding support</td>
</tr>
</tbody>
</table>

*From Karnell and MacCracken. NPO indicates nothing by mouth.

**Table 2. Aspiration Status by Site**

<table>
<thead>
<tr>
<th>Site</th>
<th>Aspirated, No. (%) of Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral cavity</td>
<td>6 (86) 1 (14)</td>
</tr>
<tr>
<td>Oropharynx</td>
<td>19 (70) 8 (30)</td>
</tr>
<tr>
<td>Hypopharynx</td>
<td>2 (20) 8 (80)</td>
</tr>
<tr>
<td>Larynx</td>
<td>8 (33) 16 (67)</td>
</tr>
<tr>
<td>Comparison†</td>
<td>9 (91) 1 (9)</td>
</tr>
</tbody>
</table>

*P < .001.
†Data for 1 patient missing.

Patients (34%); and moderate-severe to severe impairment, 3 patients (4%). One patient had missing data. The mean (SD) SPSS score for each anatomical site is summarized in the following tabulation.

<table>
<thead>
<tr>
<th>Site</th>
<th>Mean (SD) SPSS Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral cavity</td>
<td>2.4 (1.3)</td>
</tr>
<tr>
<td>Oropharynx</td>
<td>3.0 (1.1)</td>
</tr>
<tr>
<td>Hypopharynx</td>
<td>4.1 (1.2)</td>
</tr>
<tr>
<td>Larynx</td>
<td>3.7 (1.3)</td>
</tr>
<tr>
<td>Comparison†</td>
<td>2.2 (1.2)</td>
</tr>
</tbody>
</table>
tistically significant association when site was com-
pared with SPSS score.

An examination of OPM parameters as a function of T stage revealed no consistent patterns. When T stage was compared with aspiration status, cervical esophageal impairment, pharyngeal impairment, oral impairment, and SPSS score, no statistically significant associations were found (Table 4).

Overall stage (III vs IV) was compared with the OPM parameters of aspiration, cervical esophageal impairment, pharyngeal impairment, and SPSS score. Thirty-six percent of patients with stage III disease and 11% of those with stage IV disease showed moderate to severe impairment on their SPSS score, whereas 64% of stage III and 89% of stage IV patients showed no or mild impairment (P = .03). No statistically significant associations were found for the other variables (Table 4).

**COMMENT**

Videofluoroscopic evaluation of patients via OPM study has become a standard tool for studying swallowing dysfunction caused by head and neck cancer, both prior to and after treatment. Parameters such as oral preparatory, oral, pharyngeal, and esophageal phases of swallowing and presence of symptomatic or asymptomatic aspiration are documented.

A review of our pretreatment data yielded the following findings that suggest that the overall differences between the described groups with reference to the specific dysfunctions are statistically significant. More patients with hypopharyngeal and laryngeal cancers aspirated than did patients with oral cavity or oropharyngeal cancer. Patients with hypopharyngeal cancer had more severe esophageal impairment than did patients with oral cavity, oropharyngeal, or laryngeal cancers. Patients with laryngeal and hypopharyngeal cancer displayed a more severe degree of pharyngeal impairment than did patients with oral cavity or oropharyngeal cancer. The severity of the pharyngeal and esophageal impairment in the laryngeal and hypopharyngeal cancer groups is reflected by the significantly higher percentage of these groups showing aspiration during swallowing. When one considers the functional anatomy of the middle and lower constrictor muscles, it is not surprising that impairment of these muscles would result in bolus aspiration into an incompletely protected larynx. One would expect the sites with the higher degree of aspiration (hypopharynx and
larynx) or the larger tumors (higher T stage) to have a significant association with a higher SPSS score (more severe impairment). This concept was supported by our data in that larynx and hypopharyngeal sites were associated with higher SPSS scores. In addition, when the OPM study is broken down into its component parts (oral, pharyngeal, and esophageal phases of swallowing and presence of aspiration), significant site-specific levels of dysfunction are also found.

More patients with oral cavity and oropharyngeal cancer had a mild to moderate degree of oral impairment compared with patients with hypopharyngeal and laryngeal cancer. These findings are quite logical when one considers the site of the cancer and the site of dysfunction.

Most of the patients with stage III and IV disease showed no or mild impairment on the SPSS score. This appears to be a logical figure when one looks at the SPSS for the entire group: 61% of entire group had normal to mild impairment, 96% had normal to moderate impairment. The high percentage of patients with stage III or IV disease with no to mild impairment on SPSS scores most likely reflects averaging of SPSS scores within the overall stage grouping.

The OPM study and its database reporting system have been shown to provide invaluable information in documenting swallowing dysfunction.2-5 Our present results show that the OPM study is a useful, valid tool for defining site-specific dysfunction as well as overall swallowing function via its SPSS score. We chose to exclude patients with preexisting tracheotomies because of the known adverse effect on swallowing.6 Excluding these patients provides a more clear “untainted” analysis of site-specific swallowing dysfunction.

Although the above data are suggestive, the limitations of the study caution against generalizations. First, patient numbers in some groups were small. For example, there were only 7 patients in the oral cavity group and 10 patients in the hypopharyngeal group. Our comparison group of patients with unknown primary tumors and with sinus and salivary tumors showed dysfunction in several parameters (aspiration, 1 patient; esophageal impairment, 1 patient with moderate to severe dysfunction; oral impairment, 3 patients with mild to moderate dysfunction; pharyngeal impairment, 1 patient with moderate to severe dysfunction; and SPSS score, 1 patient with moderate to severe dysfunction) and clearly not normal. A group of healthy controls would perhaps have given our data stronger significance. Another limitation of our study may lie in our classification of aspiration. Patients were grouped either as “presence” or “absence” of aspiration. Exact cause (decreased laryngeal elevation, poor oral control) of aspiration is not addressed in this study because the etiology of aspiration can be multifactorial. The degree and type of aspiration may also be affected by odynophagia, overall weakness of the patient, medication use, and other factors that are not easily quantified in the OPM record. Known variables of aspiration were controlled by eliminating patients with tracheotomies from our study. Finally, pretreatment measurements such as weight loss or Karnofsky scale scores were not incorporated into the analysis and therefore how these parameters might have affected our results was not evaluated.

This study is important in highlighting the need to document well-defined pretreatment baseline site-specific parameters of swallowing dysfunction in patients with head and neck cancer. Such information is critical for a meaningful analysis of functional treatment outcome. Posttreatment speech and swallowing dysfunction may more clearly be a result of pretreatment cancer bulk, pain, and overall dysfunction. These parameters can help identify patients with swallowing abnormalities so that intensive rehabilitation can be targeted to the specific area of dysfunction and initiated before, during, and after treatment. Pretreatment OPM studies may predict the severity and duration of posttreatment dysfunction. Improved knowledge for both the patient and treating physician may be gained regarding informed consent, posttreatment severity of dysfunction, and likelihood of the need for tube feeding. Therefore, the results of the OPM studies may affect the treatment choices presented to the patient. Finally, the OPM study represents a critical tool for monitoring functional treatment success in organ-preservation protocols. Identifying pretreatment dysfunction may make organ preservation strategies more meaningful. Ongoing studies are focused on site- and stage-specific swallowing function after treatment with concomitant chemoradiotherapy. Future studies would be aimed at implementing site-specific therapeutic regimens for the successful rehabilitation of patients with head and neck cancer undergoing organ preservation therapy. Finally, the next logical step in assessing this unique group of patients will be to objectively evaluate speech and voice production before and after concomitant chemoradiotherapy.

### CONCLUSIONS

The following conclusions can be drawn from the present study.

1. Patients with hypopharyngeal and laryngeal cancer have a considerable degree of aspiration. This may be reflected by the severity of pharyngeal and esophageal impairment seen in this group of patients.

2. Patients with hypopharyngeal and laryngeal cancer show a high percentage of pharyngeal and esophageal impairment. Impairment of the constrictor muscles may be the critical factor in the severity of aspiration observed in this group of patients.

3. The SPSS score is a good global measure of dysfunction in this group of patients with head and neck cancer. In addition, significant site-specific dysfunctions are also found when the OPM study is analyzed via its separate parameters, namely, aspiration status, pharyngeal impairment, and esophageal impairment.

4. The extent of pretreatment cancer bulk, pain, and overall dysfunction prior to treatment may contribute to posttreatment speech and swallowing impairment. It is therefore critical that posttreatment function is compared with baseline pretreatment dysfunction.
The article, “Swallowing Function in Head and Neck Cancer Patients Prior to Treatment” by Stenson et al., is an important addition to the body of literature. The major contribution of this study is the uniqueness of the data. As clinicians and researchers have identified, dysphagia is a multifactorial problem. In this study, the authors documented the potential contribution of pretreatment tumor factors as a cause of dysphagia. Consistent with prior results, different components of dysphagia are a consequence of the site of the primary tumor. Moreover, the authors evaluated the results in patients who underwent nonsurgical management of advanced squamous cell carcinoma of the upper aerodigestive tract. In these organ-sparing treatment approaches it is important not to equate organ preservation with normal swallowing function, as dysphagia after successful treatment has been documented in this patient population.

The study underscores the need for a centralizing paradigm in the field of swallowing science and dysphagia. The authors used video fluoroscopy to record oropharyngeal motility, as well as a simple, single-step quality of life measure, the Swallowing Performance Status Scale. Although the results of video fluoroscopy appear to be applicable and provide reproducible results, they lack the specificity and mechanistic understanding provided by the oropharyngeal swallowing efficiency study. Due to the availability of other methods of swallowing assessment, such as scintigraphy and fiberoptic endoscopic evaluation of swallowing, there continues to be a lack of consensus for the assessment of swallowing function and quantification of dysphagia, which will allow for meaningful standardization and comparison between researchers and varying patient populations.

By identifying patients who have significant pretreatment swallowing dysfunction, the authors identified which patients had the greatest nutritional shortcomings during treatment and would be best served by placement of a gastrostomy tube. Ultimately, these data must be used in terms of correlating pretreatment and posttreatment function to determine if pretreatment dysfunction will predict posttreatment dysphagia. Meaningful rehabilitation strategies for dysphagia will hopefully arise from this work and allow for restoration of swallowing function after aggressive treatment of advanced head and neck cancer.

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