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CLINICAL INVESTIGATION **Head and Neck**

A PROGNOSTIC INDEX FOR PREDICTING LYMPH NODE METASTASIS IN MINOR SALIVARY GLAND CANCER

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Purpose: Large studies examining the clinical and pathological factors associated with nodal metastasis in minor salivary gland cancer are lacking in the literature.
Methods and Materials: Using the Surveillance, Epidemiology, and End Results (SEER) database, we identified 2,667 minor salivary gland cancers with known lymph node status from 1988 to 2004. Univariate and multivariate analyses were conducted to identify factors associated with the use of neck dissection, the use of external beam radiation therapy, and the presence of cervical lymph node metastases.
Results: Four hundred twenty-six (16.0%) patients had neck nodal involvement. Factors associated with neck nodal involvement on univariate analysis included increasing age, male sex, increasing tumor size, high tumor grade, T3–T4 stage, adenocarcinoma or mucoepidermoid carcinomas, and pharyngeal site of primary malignancy. On multivariate analysis, four statistically significant factors were identified, including male sex, T3–T4 stage, pharyngeal site of primary malignancy, and high-grade adenocarcinoma or high-grade mucoepidermoid carcinomas. The proportions (and 95% confidence intervals) of patients with lymph node involvement for those with 0, 1, 2, 3, and 4 of these prognostic factors were 0.02 (0.01–0.03), 0.09 (0.07–0.11), 0.17 (0.14–0.21), 0.41 (0.33–0.49), and 0.70 (0.54–0.85), respectively. Grade was a significant predictor of metastasis for adenocarcinoma and mucoepidermoid carcinoma but not for adenoid cystic carcinoma.
Conclusions: A prognostic index using the four clinicopathological factors listed here can effectively differentiate patients into risk groups of nodal metastasis. The precision of this index is subject to the limitations of SEER data and should be validated in further clinical studies. © 2010 Elsevier Inc.

Lymph nodes, Minor salivary glands, Risk factors, SEER program, Radiation therapy.

INTRODUCTION

Minor salivary gland cancers represent a rare group of epithelial malignancies. The most common site is the hard palate, but tumors can also arise throughout the oral cavity, as well as the pharynx, larynx, nasal cavity, and paranasal sinuses. Tumors of the minor salivary glands are 2 to 3 times more likely to be malignant than parotid and submandibular gland tumors (1–3). Overall, 25% of salivary gland cancers arise in minor salivary glands.

Cervical lymph node involvement is associated with decreased survival in both major (4–10) and minor salivary gland cancers (11, 12). Clinically positive lymph nodes are removed by surgical neck dissection, often followed by neck irradiation. Patients belie ved to be likely to harbor occult nodal metastasis are treated with an elective neck dissection or neck irradiation. Clear, evidence-based guidelines that demonstrate which patients will present with lymph node metastasis are currently lacking in the literature, although it is known that certain histological types such as adenoid cystic and acinic cell carcinomas are associated with less risk of neck metastasis (10, 13). Tumor size and grade of malignancy have also been shown to predict for the risk of nodal metastasis in smaller studies (14).

We used the Surveillance, Epidemiology, and End Results (SEER) database to compile a large, population-based data set of malignant minor salivary gland cancers. We describe demographic, clinical, and pathological characteristics of these tumors including the distribution of histological type by the site of the primary malignancy. We chose patient

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and tumor characteristics that would be known by a clinician faced with the decision to treat the cervical lymph nodes and examined their associated with neck metastasis both by univariate analysis and while controlling for other variables. A simple prognostic index is derived to predict the presence of nodal metastasis using the four most important factors.

METHODS AND MATERIALS

We queried the National Cancer Institute's SEER registries database to select minor salivary gland malignancies from 1988 to 2004. Minor salivary gland malignancies were defined by primary site and histological criteria as follows. Primary site criteria included cancers of the oral cavity, pharynx, nasal cavity, and larynx. The oral cavity included the lips (C00.0–C00.9), tongue (C020–C023, C028–C029), gingiva (C030–C039, C062), floor of mouth (C040–049), hard palate (C050), and buccal mucosa (C060–C061). The pharynx included the base of tongue (C019), tonsils (C024), soft palate (C051–C052), and all other pharyngeal sites (C090–C139). The larynx included all laryngeal sites (C320–C329). Finally, the nasal cavity was grouped with the nasal cavity itself (C300), the middle ear (C301), and paranasal sinuses (C310–C319). Pathological criteria included the salivary gland malignancies described in the World Health Organization International Histological Classification of Tumors (15). Seventy-four cases were excluded from analysis because they were not the patient's first known head and neck malignancy. When considering the distribution of histological types in the various primary sites, we included patients whether or not their lymph node status was known. In all subsequent analyses, 1,259 cases with unknown or unrecorded lymph node status were excluded leaving a final data set of 2,667 patients. Complete characteristics are presented for this final set of patients.

All staging information including lymph node involvement represents the information available on the initial workup or upon the completion of the first primary directed surgery(ies). Because the SEER program did not record T stage before 2004, we used information recorded in the SEER program on tumor size and extension (16) to assign T stage as defined by the American Joint Committee on Cancer (AJCC) Cancer Staging Manuel, 6th edition, 2002. This method resulted in T-stage assignment that was identical to that found in SEER's derived AJCC T stage variable that is available only for 2004.

Clinical and pathological factors potentially associated with neck lymph node metastasis were identified and included patient sex, age, race, site of primary malignancy, tumor grade, tumor size, T stage, and year of diagnosis. Grade information was grouped into low-grade (well differentiated to moderately differentiated) and high-grade (poorly differentiated or undifferentiated/anaplastic) categories. All variables were examined individually using the Pearson double-sided chi-square test for their effect on lymph node involvement. Statistically significant factors were then included in a multivariate logistic regression model. Because more extensive nodal sampling or neck dissection may lead to a higher probability of finding positive lymph nodes, we included an independent variable for the number of nodes examined. Interactions between explanatory variables were also considered. We searched for interaction terms by forcing entry of all variables individually and allowing entry of interaction terms in forward stepwise fashion with a likelihood ratio significance cutoff of 0.05. Finally, the four most significant factors were combined into a categorical variable of 16 groups representing all possible permutations of the presence or absence of these four factors. This categorical variable was then reentered in the logistic regression with the same covariate controls. Groups with similar odds ratios were combined to construct an index predictive of the presence or absence of lymph node involvement in minor salivary gland cancers. This index was then validated using 10-fold cross-validation.

The earlier-mentioned variables were also examined for their association with neck dissection and external beam radiation (EBRT) by logistic regression. A neck dissection was defined as any case with four or more lymph nodes examined by a pathologist. The Hosmer-Lemeshow goodness-of-fit statistic was used to evaluate regression outputs. A receiver operator curve was generated for the prognostic index of lymph node involvement in minor salivary gland cancer.

Finally, we generated Kaplan-Meier survival curves for patients with and without lymph node metastasis respectively.

Univariate analysis, multivariate logistic regression, Hosmer-Lemeshow tests, receiver operator curves, and Kaplan-Meier survival curves were computed using SPSS version 16 (SPSS, Chicago, IL). Cross-validation was computed using the R programming language with the Zelig package (17).

RESULTS

The distribution of histological type by primary tumor site is listed in Table 1. Patient and tumor characteristics and the results of univariate analysis of the effects of each clinical or pathological factor individually on lymph node metastasis are shown in Table 2. Overall, lymph node metastasis was found in 426 (16.0%) of cases. In patients who underwent surgery and were staged by pathology, 54.2% had lymph node metastasis. In patients who were staged clinically, 8.8% had lymph node metastasis.

To arrive at a model that illustrates the relative importance of factors commonly available to physicians considering neck dissection, neck irradiation, or both, we included clinical and pathological factors found to be significant on univariate analysis in a multivariate logistic regression on lymph node involvement (Table 3). An interaction was found between grade and histology such that adenocarcinomas and mucoepidermoid carcinomas were more likely to present with lymph node metastasis when they were high grade. However, grade had no effect on nodal involvement for other histological types or subtypes. We therefore considered low- and high-grade malignancies separately for adenocarcinomas and mucoepidermoid carcinomas but not for the other histological types. Controlling for all factors listed, male sex, pharyngeal primary site, T3 or T4 stage, and high-grade adenocarcinoma or high-grade mucoepidermoid carcinoma are statistically significant predictors of regional nodal metastasis. When these four variables were combined into a single categorical variable of 16 groups representing all possible permutations of their presence or absence, they resulted in the odds ratios listed in Table 4. Groups based loosely on these odds ratios were delineated, which corresponded with the number, zero through four, of the four variables present. Because of this, a predictive index for lymph node involvement is proposed on the basis of the

Table 1. Location of 4,616 cases of minor salivary gland cancer by histological type

	Oral cavity (%)	Pharynx and tonsils (%)	Nasal cavity, sinuses, middle ear (%)	Larynx (%)	Total (%)
Adenocarcinoma	654 (29.9)	350 (38.9)	280 (41.4)	100 (62.1)	1384 (35.3)
Mucoepidermoid carcinoma	991 (45.3)	262 (29.1)	62 (9.2)	18 (11.2)	1333 (34.0)
Adenoid cystic carcinoma	436 (19.9)	249 (27.7)	307 (45.4)	30 (18.6)	1022 (26.0)
Acinic cell carcinoma	60 (2.7)	14 (1.6)	7 (1.0)	0 —	81 (2.1)
Miscellaneous carcinoma	48 (2.2)	25 (2.8)	20 (3.0)	13 (8.1)	106 (2.7)
Total *(% of total in site)*	2189 *(55.8)*	900 *(22.9)*	676 *(17.2)*	161 *(4.1)*	3926

Percentages in parentheses represent the percentage of cancers in the site that are the histological type in question. Percentages in the bottom row represent the percentage of the total found in that site.

number present of the following four factors: male sex, pharyngeal primary site, T3 or T4 stage, and high-grade adenocarcinoma or mucoepidermoid carcinoma (Table 5). The area under the receiver operator curve (95% confidence interval) using this index was = 0.757 (0.724–0.790). If one uses a positive test cutoff of one factor present, the sensitivity and specificity were 95.4% and 28.4%. Using two factors as the positive test cutoff results in a sensitivity and specificity of 66.9% and 72.2%, using three factors results in a sensitivity and specificity of 35.6% and 94.0%, and using all four factors results in a sensitivity and specificity of 10.0% and 99.4%. When the predictive capability of the logistic regression model that uses the number of factors present examined using 10-fold cross validation, the average squared prediction error was 0.0923, indicating accurate prediction of the presence or absence of lymph node involvement when dividing the data into training and validating sets differently 10 times.

Multivariate logistic regressions were conducted to determine the factors associated with a patient's receiving a neck dissection or EBRT. Patients with T2–T4 stage tumors were more likely to receive neck dissection than patients with T1 stage tumors. Patients more likely to receive a neck dissection were those with T2–T4 tumors, those with high-grade tumors, and those living in Connecticut. Patients with tumors occurring in the sinuses, nasal cavity, and middle ear were less likely to receive neck dissection.

Forty-six percent of patients received EBRT. Patients who received surgical neck dissection were more likely to receive EBRT. Patients with adenoid cystic carcinoma were more likely to receive EBRT, as were older patients, those with T2–T4 stage, and those with high-grade tumors. Patients less likely to receive EBRT were those with tumors occurring in the oral cavity, those living in Los Angeles, and those diagnosed in the later years of the study.

Finally, survival curves were generated to depict the relative survival of patients with nodal metastasis vs. those with no nodal metastasis (Fig. 1). For patients who were lymph node negative on presentation, the 5-, 10-, and 15-year Kaplan-Meier overall survival (standard error in parentheses) was 78.4 (1.2), 61.3 (1.9), and 52.5 (2.4), respectively. For patients with lymph node involvement on presentation, the 5-, 10-, and 15-year Kaplan-Meier overall survival was 42.4 (3.4), 25.7 (3.9), and 11.9 (5.0), respectively.

DISCUSSION

We present the largest population-based data set on the distribution of histological type by primary site to date. The oral cavity was the most common site and the hard palate the most common subsite. We report a larger proportion of mucoepidermoid carcinoma than adenoid cystic carcinoma overall as opposed to others' findings that adenoid cystic carcinoma is the most common type (1, 2, 18). Adenoid cystic carcinoma was the most prevalent sinonasal minor salivary gland malignancy, mucoepidermoid was most prevalent in the oral cavity, and adenocarcinomas were common in the pharynx and larynx. Polymorphous low-grade adenocarcinomas were diagnosed only in the later years of the study period from 2000 to 2004, and a total of 141 of these tumors were diagnosed during that time. Mixed pleomorphic carcinoma is a diagnosis that has come into usage only in the later years of the study (2).

Grade was predictive of nodal metastasis for adenocarcinoma and mucoepidermoid carcinoma but not for other histological types and subtypes. There was no statistically significant difference in the rate of lymph node metastasis between low and high-grade adenoid cystic carcinoma (ACC). Spiro and colleagues (1, 19) have similarly found that dividing ACC by grade was unhelpful for determining prognostic information for these tumors. It is important to note that lymph node metastasis is generally considered less important than local and distant control in ACC, and distant metastases occurs commonly even without neck nodal involvement in adenoid cystic carcinoma (20–23). All but one acinic cell carcinomas in this study were low grade. Similarly, all myoepithelial carcinomas were low grade, as were many adenocarcinoma subtypes. Other histological types for which grade was not a statistically significant predictor of metastasis included mixed malignant tumor and pleomorphic carcinoma. The sample size may be insufficient to detect an interaction between grade and some histological subtypes, including oxyphilic adenocarcinoma, ductal carcinoma, and carcinosarcoma.

Although our reported rate of lymph node involvement of 16.0% is approximately commensurate with other published studies, a large, in-depth case series may more accurately pinpoint the actual rate than SEER data. However, because

Table 2. Patient characteristics and clinical and pathologic factors and their effect on nodal involvement in univariate analysis

Baseline characteristic	Total no. (%)	Incident nodal involvement (%)	p value*
Sex			< 0.001
Female	1423 (53.4)	11.4	
Male	1244 (46.4)	21.2	
Race			0.052
Caucasian	2101 (79.6)	15.6	
African American	324 (12.3)	20.4	
Other	216 (8.2)	13.4	
Histological type			< 0.001
Adenoid cystic carcinoma	695 (26.1)	10.2	
Acinic cell carcinoma	41 (1.5)	2.4	
Mucoepidermoid carcinoma	929 (34.8)	15.8	
Adenocarcinoma	929 (34.8)	21.3	
Miscellaneous carcinoma	73 (2.7)	12.3	
Grade			< 0.001
Low grade	1299 (73.8)	8.5	
High grade	461 (26.2)	39.9	
Primary site			< 0.001
Mouth	1493 (56.0)	9.7	
Pharynx, including tonsil	667 (25.0)	32.5	
Nasal cavity, sinuses, middle ear	397 (14.9)	6.8	
Larynx	110 (4.1)	33.6	
T stage			< 0.001
T1	945 (44.1)	6.1	
T2	401 (18.7)	20.4	
T3	190 (8.9)	20.5	
T4	514 (24.0)	21.6	
Neck dissection (> 3 nodes examined)			< 0.001
Yes	391 (14.8)	54.2	
No	2257 (85.2)	8.8	
EBRT			< 0.001
Yes	1125 (43.4)	28.5	
No	1466 (56.6)	6.2	

	Total no.	LNs involved mean (SE)	No LNs involved mean (SE)	
Age	2667	57.7 (0.4)	60.9 (0.7)	< 0.001
Year of diagnosis	2667	1999	1998	0.005
Tumor size (mm)	1828	24.6 (0.7)	32.9 (1.1)	< 0.001
No. of nodes examined	2667	1.4 (0.1)	15.7 (1.1)	< 0.001

Abbreviations: EBRT = external beam radiation; LN = lymph node; SE = standard error.

The T stage is unknown for 92 patients who had distant metastasis because distant metastasis overrides tumor extension data in Surveillance, Epidemiology, and End Results coding.

* Pearson Chi square test double-sided p value.

Table 3. Multivariate logistic regression of clinico-pathological factors on regional nodal metastasis

Variable (comparison group for categorical variables)	Odds ratio (95% confidence interval)	p value
Histological type and grade (vs. adenoid cystic carcinoma)		< 0.001
Acinic cell carcinoma	0*	
Mucoepidermoid carcinoma, low grade	1.06 (0.56–2.02)	0.858
Mucoepidermoid carcinoma, high grade	4.04 (2.09–7.80)	< 0.001
Adenocarcinoma, low grade	1.91 (1.04–3.51)	0.037
Adenocarcinoma, high grade	6.72 (3.48–13.00)	< 0.001
Miscellaneous	1.73 (0.40–7.44)	0.461
Primary site (vs. mouth)		< 0.001
Pharynx including tonsil	3.54 (2.27–5.54)	< 0.001
Nasal cavity, sinuses, and middle ear	0.71 (0.30–1.69)	0.443
Larynx	1.55 (0.55–4.40)	0.407
T Stage (vs. T1)		0.030
T2	1.68 (0.95–2.97)	0.074
T3	2.57 (1.19–5.55)	0.017
T4	2.25 (1.26–4.04)	0.006
Male sex (vs. female)	2.16 (1.42–3.30)	< 0.001
Tumor size (mm)	1.00 (0.99–1.01)	0.947
Age	1.01 (1.00–1.02)	0.161
Race (vs. Caucasian)		0.268
African American	1.61 (0.91–2.87)	0.105
Other	1.08 (0.49–2.36)	0.852
Controls		
Year of diagnosis	0.99 (0.95–1.04)	0.698
Number of nodes examined (vs. none)		< 0.001
1–3	5.43 (2.69–10.97)	< 0.001
> 3	24.01 (14.99–38.46)	< 0.001

Analysis includes 1,533 patients. The p value is listed for the odds ratio of each variable and for the Wald statistic for inclusion of complete categorical variable groups. Cases with distant metastasis are excluded from this analysis because T stage was not recorded or was unknown when there was distant metastasis. The Hosmer-Lemeshow test for this regression had a p value of 0.023. The Nagel-Kerke R^2 is 0.526.

* The number of lymph node positive cases is too small for analysis.

minor salivary gland cancers are relatively rare, a case series this large may not be forthcoming in the immediate future.

Occult nodal metastasis for major salivary malignancies is between 12% and 20% (24–26). In a study of adenoid cystic carcinomas of the major and minor salivary glands, Spiro and colleagues (27) reported a rate of lymph node involvement of 7.4% on initial presentation with an additional 7.0% developing positive lymph nodes subsequently. Occult nodal metastasis in high-grade adenocarcinoma was 40% in a small study by Sheahan and colleagues (28). They found occult disease in two of five necks dissected electively. High tumor grade was also correlated with occult metastasis in a study by Rodriguez-Cuevas and colleagues (14). In 36 elective neck dissections for major salivary gland cancers, 50% of high-grade tumors had occult metastasis, whereas no low-grade tumors

Table 4. Odds ratios of combinations of the presence or absence of four factors (N = 1,805)

Variable	Lymph Node Positive: Cases lymph node positive	Lymph Node Positive: Proportion (95% confidence interval)	Logistic Regression: Odds ratio (95% confidence interval)	Logistic Regression: p value
All factors absent	9/457	0.02 (0.01–0.03)		
One factor present				
Male	17/326	0.05 (0.03–0.08)	2.18 (0.92–5.19)	0.078
T3–4	22/219	0.10 (0.06–0.14)	3.77 (1.62–8.77)	0.002
Pharynx	18/163	0.11 (0.06–0.16)	3.99 (1.65–9.62)	0.001
High grade ADC or MEC	8/45	0.18 (0.07–0.30)	5.562 (1.79–17.33)	0.003
Two factors present				
Male and T3–4	19/191	0.10 (0.06–0.14)	3.69 (1.55–8.81)	0.003
Male and pharynx	15/99	0.15 (0.08–0.22)	6.08 (2.38–15.55)	< 0.001
T3–4 and high grade ADC or MEC	6/31	0.19 (0.05–0.33)	6.64 (1.88–23.52)	< 0.001
T3–4 and Pharynx	7/35	0.20 (0.07–0.33)	6.94 (2.12–22.76)	0.001
Male and high grade ADC or MEC	15/41	0.37 (0.22–0.51)	11.70 (4.14–33.07)	< 0.001
Pharynx and high grade ADC or MEC	10/20	0.50 (0.28–0.72)	16.29 (4.58–57.92)	< 0.001
Three factors present				
All but pharynx	20/60	0.33 (0.21–0.45)	17.25 (6.65–44.75)	< 0.001
All but high grade ADC or MEC	13/40	0.33 (0.18–0.47)	21.03 (7.39–59.87)	< 0.001
All but male	8/15	0.53 (0.28–0.79)	29.64 (7.09–123.98)	< 0.001
All but T3–4	19/30	0.63 (0.46–0.81)	49.65 (16.04–153.75)	< 0.001
All four factors present				
All	23/33	0.70 (0.54–0.85)	79.16 (26.07–240.35)	< 0.001

Abbreviations: ADC = adenocarcinoma; MEC = mucoepidermoid carcinoma.
Odds ratios compare groups to the group with no factors present.

had occult metastasis. Because of limitations inherent to SEER data, it is not possible to determine which node-positive patients had clinically occult nodal metastasis discovered in the operating room. However, our results have implications for these patients. Because the data represent a wide range of disease progression on presentation, patients who presented late with clinical nodal metastasis but who would have been clinically metastasis free had they presented earlier are included. Three of the four factors found to be predictive of nodal metastasis in our analysis are characteristics that do not change over the progression of the malignancy such as histological type, primary site, and gender. Therefore, it is reasonable to think that clinically N0 patients presenting with these factors are likely to go on and develop lymph node metastasis or already have occult metastasis at presentation. Our results should be validated in a set of patients with clinically N0 disease who also undergo neck dissection for pathological staging.

Although we do not assert that the percentages presented in the prognostic index are directly predictive of occult nodal metastasis, we do recommend consideration of the four factors listed when considering elective lymph node treatment. We would advocate that patients with three or four of the factors in the index should receive elective neck treatment. Patients with two of the factors should also be strongly considered for elective neck treatment with neck dissection, adjuvant radiation therapy, or both. It is also worth cautioning that even patients with only one of the factors in the index may be appropriate candidates for elective therapy, especially if the one factor is high-grade adenocarcinoma or mucoepidermoid carcinoma. Because SEER data fail to capture neck relapses in patients who were N0 for the first 4 months after diagnosis, figures hovering around the cutoff range for elective treatment in the patients with one or two factors may actually be appropriate candidates. However, if pretreatment staging with high-resolution CT and ultrasound

Table 5. Predictive index of lymph node involvement in minor salivary gland cancer

Variable	Predictive index: Cases lymph node positive	Predictive index: Proportion (95% confidence interval)	Logistic regression: Odds ratio (95% confidence interval)	Logistic regression: p value
Number of factors (vs. 0)				
0	9/457	0.02 (0.01–0.03)		< 0.001
1	65/753	0.9 (0.07–0.11)	3.29 (1.56–6.93)	0.002
2	72/417	0.17 (0.14–0.21)	6.15 (2.91–13.04)	< 0.001
3	60/145	0.41 (0.33–0.49)	24.47 (10.96–54.61)	< 0.001
4	23/33	0.70 (0.54–0.85)	81.64 (26.71–249.54)	< 0.001

The logistic regression includes the covariate controls listed in Table 3. Hosmer-Lemeshow statistic p value is 0.133, indicating no difference between predicted and observed values. NagelKerke R^2 is 0.464.

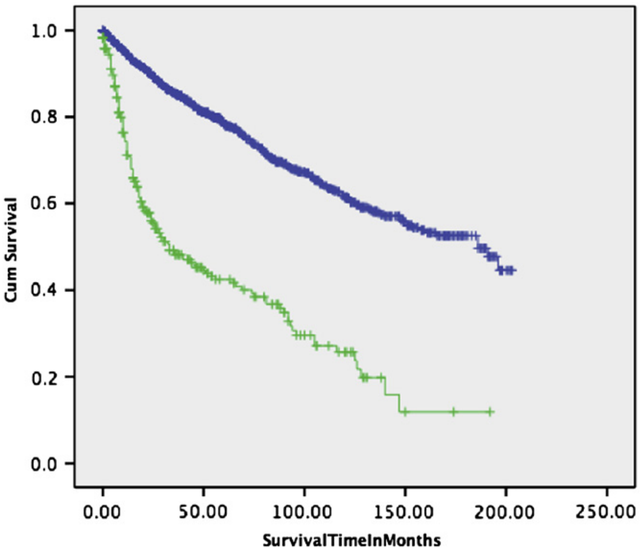

Fig. 1. The upper curve represents patients who were lymph node negative on presentation, and the lower curve represents patients with lymph node involvement on presentation.

has failed to reveal regional lymphadenopathy and the clinician feels the risk of occult metastasis is low, the model may also be used to identify patients who should have close follow-up for regional progression. As with any prognostic tool, this index will not find complete applicability for each patient. Elective treatment of the neck even in high-risk patients may not convey local regional control or survival benefit.

It is interesting to note that increasing size of the primary tumor was correlated with a patient receiving a neck dissection, whereas it was not predictive of nodal metastasis while controlling for other factors. In some sites such as the sinuses and nasal cavity, tumors can attain large sizes before they present clinically. In the case of the sinuses or nasal cavity, lymphatic involvement is less likely.

The SEER program has a standard rate of case ascertainment of 98% (29). However, staging and tumor grade information is often incomplete. Of 3,926 patients identified with minor salivary gland tumors, lymph node metastasis was only recorded for 2,667. Furthermore, stage and grade information was not recorded for many patients such that the data set of patients with no missing data pertinent to lymph node metastasis was only 1,533. We excluded cases with missing data from multivariate logistic regression analysis.

CONCLUSIONS

We present a population-based survey of minor salivary gland malignancy and an analysis of the predictors of lymph node metastasis. African Americans with minor salivary gland cancer may present with more advanced disease. Grade was a significant predictor of metastasis for adenocarcinoma and mucoepidermoid carcinoma but not for adenoid cystic carcinoma and other subtypes. Tumor size is often considered in the decision to perform neck dissection, yet it was not a significant predictor of nodal metastasis on multivariate analysis. We present a prognostic index of lymph node involvement for minor salivary gland cancer that uses the presence or absence of four factors—male sex, pharyngeal primary site, T3 or T4 stage, and high-grade adenocarcinoma or mucoepidermoid carcinoma. This index effectively differentiates patients into risk groups for nodal metastasis.

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