

Chondrosarcoma of the Larynx

A Clinicopathologic Study of 111 Cases With a Review of the Literature

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Chondrosarcomas of the larynx are rare tumors accounting for about 0.5% of all laryngeal primary tumors. A total of 111 laryngeal chondrosarcoma cases, diagnosed between 1970 and 1997, were retrieved from the Otorhinolaryngic-Head & Neck Tumor Registry of the Armed Forces Institute of Pathology. There was a 3.6:1 male/female ratio of patients 25–91 years of age (mean, 64.4 years). Patients presented most frequently with hoarseness (n = 72 patients) present for a mean of 28.2 months. The majority of tumors involved the cricoid cartilage (n = 77) with a mean size of 3.5 cm. All tumors were invasive and malignant by radiology and/or histology (into bone within the ossified laryngeal cartilages in 52 tumors). Most tumors were low-grade lesions: grade 1 (n = 51), grade 2 (n = 54); there were six grade 3 tumors. An associated benign chondroma with (n = 41 tumors) or without ischemia (n = 24 tumors) was noted. All patients had surgery and five had radiation therapy. Wide excision or voice-sparing surgery was used in 73 patients, whereas 37 patients had a laryngectomy. Recurrences occurred in 20 (18%) patients, 10 of whom underwent salvage laryngectomy. At the last follow-up, 102 patients had no evidence of disease (alive or dead, mean 11.2 years) and five patients had evidence of disease (alive, one patient, 6.5 years; dead, four patients, mean 6.4 years). The six patients with high-grade chondrosarcoma were all without disease at the last follow-up (mean, 15.1 years). There was no difference in clinical outcome based on grade (p = 0.210), location (p = 0.078), or treatment (p = 0.607) but was worse for patients with a myxoid-type chondrosarcoma (p = 0.044). Primary laryngeal chondrosarcomas are typically low- to moderate-grade lesions involving the cricoid cartilage, frequently associated with a chondroma. They usually portend an excellent overall long-term prognosis with initial conservative voice-sparing surgery.

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Chondrosarcoma is considered the fourth most common tumor of bone, where they tend to be bulky, lobular lesions that can arise anywhere, although with a preponderance in the lower appendicular skeleton and the pelvis. Only 2–5% of all chondrosarcomas arise in the head and neck, with the majority encountered in the maxilla.^{7,30,43,48} However, laryngeal chondrosarcomas, first described in 1816,⁵⁶ are rare tumors of the head and neck, accounting for <0.2% of all head and neck malignancies^{6,36,38,44} and up to 1% of all laryngeal tumors.^{26,30,31,41,43,49} Although a number of series of laryngeal chondrosarcomas are present in the literature (Table 1),^{1,5,7,17,20–22,24,29–32,36–38,42–47,49,51,54,55,57} critical review reveals that many cases are reported again and again based on the same patient base,^{21,22,36,38,43} or are only single case reports, thereby suggesting that perhaps chondrosarcoma of the larynx is indeed less common than the number of published cases suggests. Furthermore, a number of these reports focus on a particular feature, such as the clinical, radiographic, histologic, or therapeutic features, not necessarily correlating all of the findings into a thorough analysis. Therefore, it is the intention of this study to provide a comprehensive analysis of laryngeal chondrosarcomas, incorporating the use of clinical features, radiographic results, histologic findings (including grade and tumor location), and follow-up information (including staging and adjuvant therapies) applied to a group of 111 patients with this tumor.

MATERIALS AND METHODS

The records of 111 patients with tumors diagnosed as chondrosarcomas were identified in the files of the

TABLE 1. Laryngeal chondrosarcomas: review of the English literature with at least five cases and with clinical and histologic parameters reported^{1,5,21,22,31,32,36,38,43,45-47,51,55,57}

All cases (n = 146)	Parameter*
Gender	
Women	32 (21.9%)
Men	114 (78.1%)
Age at presentation (yr)	
Range, all	33-91
Average, all	61.0
Women (average)	59.7
Men (average)	61.3
Clinical presentation	
Hoarseness, dyspnea, dysphagia, stridor	46
Hoarseness only	15
Dyspnea only	10
Dysphagia only	5
Dysphonia	4
Painless mass	4
Other: odynophagia, cough, wheezing	3
Exact location	
Cricoid cartilage	109 (77.3%)
Thyroid cartilage	27 (19.2%)
Arytenoid cartilage	4 (2.8%)
Epiglottis	1 (0.7%)
Tumor size (cm)	
Range	1-12
Average	3.5
Pathology tumor grade	
I	78.4%
II	12.6%
III	6.3%
Dedifferentiated	2.7%
Treatment	
Surgery alone	108
Surgery and radiation	5
Radiation alone	1
Outcome	
Alive or dead, but no evidence of disease	109
Range of years survived	0.1-28
Mean survival (yr)	7.5
Dead, with disease	23
Range of years survived	0.1-11
Mean survival (yr)	5.8

* Parameter was not always stated in the report; therefore, the numbers do not necessarily equal the total values in the columns.

Otorhinolaryngic-Head & Neck Registry at the Armed Forces Institute of Pathology (AFIP) from 1970 to 1997. These 111 cases were identified in a review of 6939 patients (1.6%) with benign and malignant primary laryngeal neoplasms who were seen in consultation during this same time period. Inclusion in this study required the production of cartilage matrix in a cellular tumor by atypical, neoplastic chondrocytes with distinctive biologic activity and morphologic patterns (destruction of bone or invasion of soft tissue), i.e., chondrosarcoma, similar to those of axial skeleton.³⁹ Tumor grade was assigned based on a standardized grading scheme.¹³ Because we did not prosect the specimen, an accurate assessment of the margins of resection is impossible to report, and so no comment about the definitive nature of the resection can be made in this clinical report. We

TABLE 2. Clinical demographic findings of chondrosarcomas of the larynx

All patients (n = 111)*	No.
Gender	
Women	24
Men	87
Age at initial presentation (yr)	
Range	25-91
Mean	64.4
Women, mean	65.7
Men, mean	64.0
Type of presentation	
Hoarseness	72
Dyspnea, airway obstruction, or difficulty breathing	28
Mass lesion	15
Dysphagia or dysphonia	13
Voice changes or stridor	8
Shortness of breath	3
Pain	4
Duration of symptoms (mo)	
Range	1-240
Mean	28.2
Women, mean	24.5
Men, mean	29.2
Smoking history	34
Radiation exposure	None

* Parameter was not always known; therefore, the numbers do not necessarily equal the total values in the columns; patients frequently presented with more than one of the symptoms.

acknowledge that negative tumor margins correlated to an overall better patient survival (p = 0.019) in a reported series.⁴⁸ Ninety-eight cases were obtained from civilian sources, including foreign countries, nine cases were submitted from Veterans Administration medical centers, and four cases were received from military hospitals.

Materials within the files of the AFIP were supplemented by a review of the patient's demographics (gender, age, and ethnicity), symptoms at presentation (including duration), and past history (specifically, a history of previous radiation exposure and tobacco use). In ad-

TABLE 3. Macroscopic features of chondrosarcomas of the larynx

Feature	No.
Primary cartilage site	
Cricoid cartilage	77
Thyroid cartilage	10
Arytenoid	3
Mixed (more than one cartilage involved)	16
Not reported	5
Location	
Left	27
Right	23
Midline	61
Size (cm)	
Range	0.8-10
Mean	3.5
Women, mean	3.1
Men, mean	3.6

TABLE 4. *Microscopic features of chondrosarcomas of the larynx*

Feature	No.
Grade	
1	51
2	54
3	6
Specific type	
Dedifferentiated (CAMMC)	2
Myxoid	8
Overall tumor cellularity	
Low	55
Moderate	52
High	4
Bone invasion present?	
Yes	52
Absent	59
Necrosis present?	
Yes	26
Absent	85
Mitotic figures present?	
Yes	3
Absent/inconspicuous	108
Remaining tissue	
Chondroma	26
Chondroma with ischemia	41
Reactive bone present	13
Epithelial hyperplasia	5

CAMMC, chondrosarcoma with additional malignant mesenchymal component.

dition, we reviewed radiographic, surgical pathology, and operative reports and obtained follow-up information from oncology data services by written questionnaires or direct communication with the treating physician(s) or the patient. Follow-up data included exact tumor location, tumor size and stage, treatment methods, and current patient and disease status. It is important to add that we are a tertiary pathology review center, conducting a retrospective review of these patients, and we did not treat the patients. This clinical investigation was conducted in accordance and compliance with all statutes, directives, and guidelines of the Code of Federal Regulations, Title 45, Part 46, and the Department of Defense Directive 3216.2 relating to human subjects in research.

Our review of primary laryngeal chondrosarcomas in the English literature was based on a MEDLINE search from 1966 to 2001, with a few specific earlier articles included for balance and background. Because of the large number of single case reports, often from the same institution as those reporting larger series, we confined our review to reports with at least five laryngeal chondrosarcomas (not chondromas), including incidence, diagnostic guidelines, clinical management, and treatment information. These results are presented in tabular form (Table 1) and analyzed in conjunction with the present study.

Categorical variables were analyzed using χ^2 tests to compare observed and expected frequency distributions.

Comparison of means between groups were made with unpaired t tests or one-way analysis of variance, depending on whether there were two groups or more than two groups, respectively. Multiple comparisons were analyzed using the Tukey method. Linear regression was used to investigate two measured variables, and Pearson correlation coefficients were generated to measure the strength of the association. Confidence intervals of 95% were generated for all positive findings. The alpha level was set at $p < 0.05$. All analyses were conducted using Statistical Package for the Social Sciences (SPSS) software (version 8.0 for PC; Chicago, IL, USA).

RESULTS

Clinical

The patients included 87 men and 24 women (Table 2), who ranged in age from 25 to 91 years, with a mean age at presentation of 64.4 years. There was no difference in mean age at presentation between the genders (female, 65.7 years; male, 64.0 years). There was no significant difference in overall survival between the genders ($p = 0.907$). There was a significant decrease in overall survival for patients who were >60 years of age at initial presentation than those who were younger ($p = 0.002$). This may be partially accounted for by the advanced age of patients in general, but this factor could not be separately analyzed.

The patients presented clinical with a variety of symptoms referable to the tumor location in the larynx. As the airway is progressively narrowed or obstructed by the endolaryngeal growth, dyspnea results, whereas extralaryngeal growth more frequently produces dysphagia. Overall limited laryngeal mobility because of restriction of the vocal cords by a mass fixing the cricoarytenoid joint will result in hoarseness, although compression of the recurrent laryngeal nerve may also produce the same result. In general, the thyroid cartilage tumors are more likely to present as a mass lesion. The patients' symptoms are those to be expected from any tumor that slowly but progressively encroaches on the laryngeal lumen and include hoarseness ($n = 72$ patients), airway obstruction or difficulty breathing ($n = 28$ patients), a mass lesion ($n = 15$ patients), dysphagia or dysphonia ($n = 13$ patients), voice changes or stridor ($n = 8$ patients), shortness of breath ($n = 3$ patients), or pain ($n = 4$ patients) (Table 2). Many patients had more than one symptom at the time of initial presentation, but hoarseness was still the most frequently identified. Although unable to specifically correlate the clinical presentation with the tumor location or type of invasion, a neck mass was identified in eight of 10 thyroid cartilage neoplasms. Because of the overall indolent behavior of laryngeal chondrosarcoma, symptoms persisted from 3 weeks to 240 months, with a mean of 28.2 months. There was no difference in average

length of symptoms between the genders ($p = 0.673$) or between the various anatomic sites ($p = 0.827$). Approximately one third of patients reported using tobacco (usually cigarette smoking). No patients in this clinical series had a history of radiation exposure, either therapeutic or environmental. By definition, no patients with a syndrome-associated chondrosarcoma were included in the analysis.

Radiographic Studies

Radiographic studies were performed for the majority of patients in this review, although the actual films may have been returned to the contributing hospital before this study, allowing for only a review of the radiology report or radiologic facsimile copy. Most patients (especially in the cases before 1980) had plain x-ray films, whereas advanced imaging techniques, such as CT scans and/or MRI studies were added to the workup in most patients after 1980. In general, a mass lesion of variable density (compared with adjacent muscle) was identified as either endolaryngeal (confined by the outer margin of the cartilage of origin, growing inward) or extralaryngeal (growth extended beyond the outer circumference of the cartilage and into the adjacent soft tissue), demonstrating fine, punctate stippled to coarse ("popcorn") calcification within the tumor (Fig. 1). Nearly all of the tumors were noted to have some form of calcification. Tumors were noted to be well- or ill-defined with an expansile radiolucent mass, centered in and destroying the cartilage. Ossification of the laryngeal cartilages could be seen, with the tumor invading into and destroying the bony fragments. Soft tissue extension was frequently demonstrated. When a mucosal surface was obvious it was found to be intact.

Pathologic Features

Macroscopic Findings

The cricoid cartilage ($n = 77$ tumors) was affected most frequently (Table 3). When specified by the grossing pathologist, the tumors were described in the central or marrow portion of the partially ossified cartilage. In the mixed cases ($n = 16$ tumors), the tumor was generally large, obscuring the exact point of origin of the tumor. These cases were considered to be centered in the cricoid cartilage (involved in all cases), then expanding and invading into the adjacent cartilages (such as the thyroid, epiglottic, and arytenoid). The exact site of location was unknown in five patients (Table 3). The posterior lamina of the cricoid cartilage is larger than the rest of the cartilage and perhaps accounts for most of the tumors arising in the midline, although nearly half of the tumors involved a specific side (left 27, right 23). The

tumors ranged in size from 0.8 to 10 cm, with a mean of 3.5 cm. There was no statistically significant difference in the size of tumors between the genders (women, 3.1 cm vs men, 3.6 cm; $p = 0.288$) or between the various anatomic sites of involvement ($p = 0.378$). Furthermore, the overall size of the lesion did not significantly affect the overall outcome ($p = 0.102$). The majority of lesions were received as multiple, irregular fragments of bone and soft tissue, especially in the biopsy and wide excision specimens. The resection specimens (subtotal or total laryngectomy) frequently demonstrated soft tissue invasion. The tumors were described as "crunchy," lobular, and glistening on cut surface, with a blue-gray, semi-translucent, myxoid-mucinous matrix material identified (Fig. 2). When viewed laryngoscopically, a hard, round, smooth surfaced submucosal mass was noted in a subglottic location.

Microscopic Findings

All lesions, in all anatomic locations, demonstrated the typical features of chondrosarcoma, although the diagnostic fields were often small and temporally separated from one another in the specimen, exposing areas with different degrees of differentiation. All of the tumors in this series arose from hyaline cartilage and showed no evidence of elastic tissue (Fig. 3). The atypical, neoplastic chondrocytes were identified in a variable background of basophilic to metachromatic cartilaginous matrix material. There was an overall loss of normal architecture and distribution of the chondrocytes ("cluster disarray"³¹). Most of the laryngeal cartilages had undergone enchondral ossification. Destruction of cancellous bone ($n = 52$ tumors) was identified by the neoplastic cells invading into and replacing the bony tissues (Fig. 3), although the invasive component did not have an appreciable difference in tumor grade from the rest of the tumor. When the native cartilage was detected, there was usually a very abrupt transition from the normal to the neoplastic cartilage (Fig. 3). The tumor cytology varied based on the overall grade of the tumor from slightly cellular tumors composed of small, hyperchromatic nuclei surrounded by abundant cytoplasm to hypercellular neoplasms consisting of enlarged, binucleated and multinucleated atypical cells with an increased nuclear-to-cytoplasmic ratio, nuclear chromatin distribution irregularities, and prominent nucleoli (Figs. 4 and 5). There was less stroma between the lacunar spaces as the grade of tumor increased. Mitotic figures, including atypical forms, were only noted in the higher-grade tumors (Fig. 5). Tumor necrosis, usually focal and of limited geographic distribution, could be seen in a number of tumors ($n = 26$ tumors) but almost always in tumors of moderate to high grade.

Based upon the invasive nature of the tumors (either radiographically or histologically) and the presence of pronounced irregularity of the size of the cells and their nuclei, the presence of increased cellularity, nuclear hyperchromasia, and binucleated or multinucleated atypical nuclei, a diagnosis of chondrosarcoma was rendered.³⁹ The chondrosarcomas were then separated into grades based on increasing degrees of the aforementioned criteria.¹³ There were 51 well-differentiated (low-grade, grade 1) neoplasms, 54 moderately differentiated (intermediate-grade, grade 2) neoplasms, and six poorly differentiated (high-grade, grade 3) neoplasms. The grade of the neoplasm did not statistically affect the overall patient outcome ($p = 0.210$).

The vast majority of the tumors were chondrocytic chondrosarcomas ($n = 101$), but 10 tumors disclosed features that allowed them to be further subclassified. Eight tumors had a myxoid background matrix production with the neoplastic chondrocytes arranged in a "string of pearls"-like distribution, still accommodating all of the other features of a chondrosarcoma (Fig. 6). We required that >10% of the specimen (arbitrarily chosen irrespective of the type of specimen) demonstrate myxoid features to qualify for this designation. These tumors were included in the grade 2 category (by definition). A myxoid subclassification did statistically significantly affect the overall patient outcome ($p = 0.044$). Two neoplasms displayed an abrupt transition

into a malignant, highly cellular spindle cell proliferation, containing atypical spindle cells with spindle to oval atypical nuclei. A high mitotic count was identified (Fig. 7). These tumors were considered to be chondrosarcoma with additional malignant mesenchymal component (CAMMC), also known as dedifferentiated chondrosarcomas. Both of these tumors were placed in the grade 3 category.

One histologic feature deserves special attention, as it has only been suggested by one previous study.⁴⁶ In the majority of cases (62%) a benign chondroma was clearly identified intimately associated with and abruptly juxtaposed to the chondrosarcoma (Fig. 8). The chondroma had a more eosinophilic and paucicellular cartilage matrix, demonstrating large cells but without atypia. Furthermore, ischemia of the chondroma was noted in 41 tumors, usually in direct apposition to the chondrosarcoma interface (Fig. 9). It is important for us to stress the difference between *ischemia* and *infarction* because the distinction is important in the overall diagnosis. Ischemic change in cartilage manifests itself differently from other anatomic sites. The ischemic changes declare themselves as basophilic lines or granular calcific deposits in the matrix. Nuclei are still present, as an absence of chondrocytes would suggest infarction of the cartilage rather than ischemia. It is thought that the chondrocytes may be protected from ischemic changes by the matrix itself. The presence of erythrocytes in this illustration is related

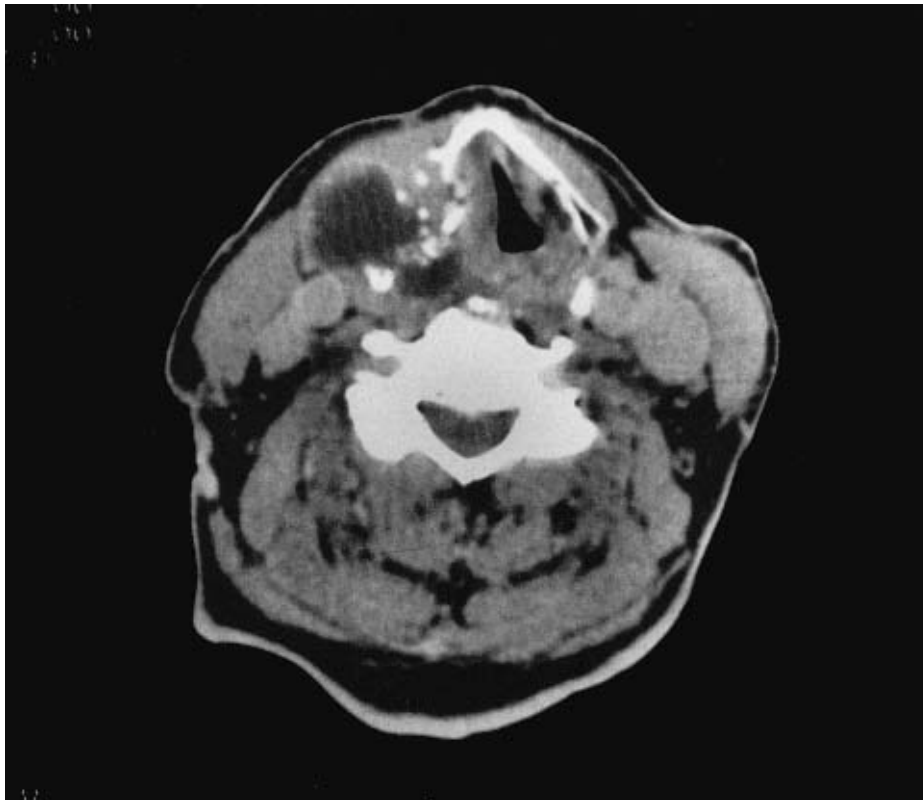


FIG. 1. A CT image of a mass lesion destroying the posterior portion of the thyroid cartilage and demonstrating stippled to coarse ("popcorn") calcifications within the tumor.

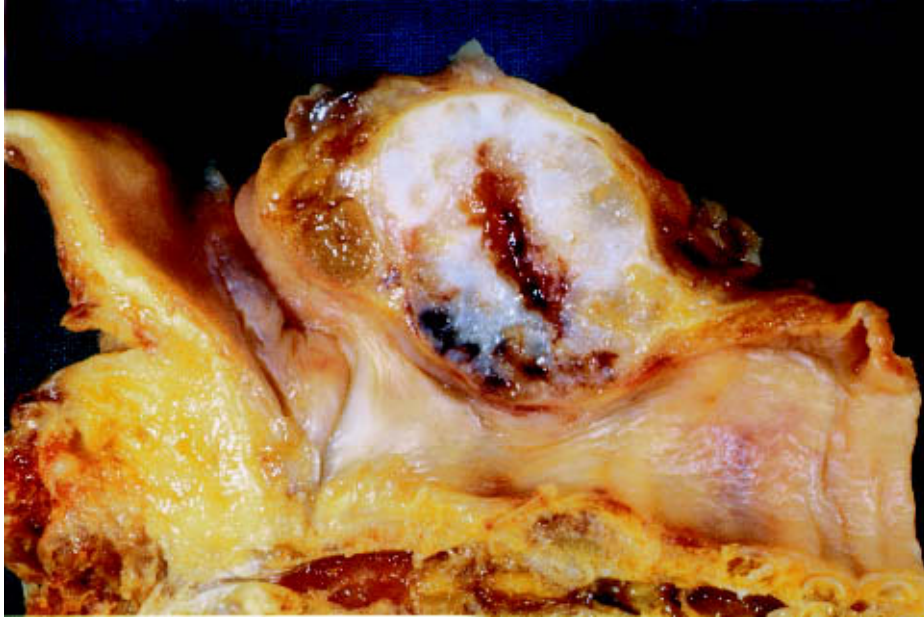


FIG. 2. A thin rim of bone is invaded by the cartilage neoplasm involving the cricoid cartilage. A firm, lobular growth is noted, with central degenerative change.

to the procedure and completely unrelated to the underlying process. Furthermore, one should note that there is no increased nuclear-to-cytoplasmic ratio, no binucleation, and only focal nuclear hyperchromasia, suggesting pyknosis.

Treatment and Follow-up

All patients were treated with surgical excision, either as an excisional biopsy or with a more radical procedure

(Table 5A). An excisional biopsy alone was used for four patients, although 12 patients received an excisional biopsy as their initial treatment and eight were subsequently treated with more radical procedures when recurrences developed. Wide excision was used for 49 patients, eight of whom underwent additional surgery at a later time for recurrence, and one patient had additional surgery for a wider margin. Nine patients were managed by a hemi- or partial laryngectomy, two of whom developed recurrences and were managed by additional sur-

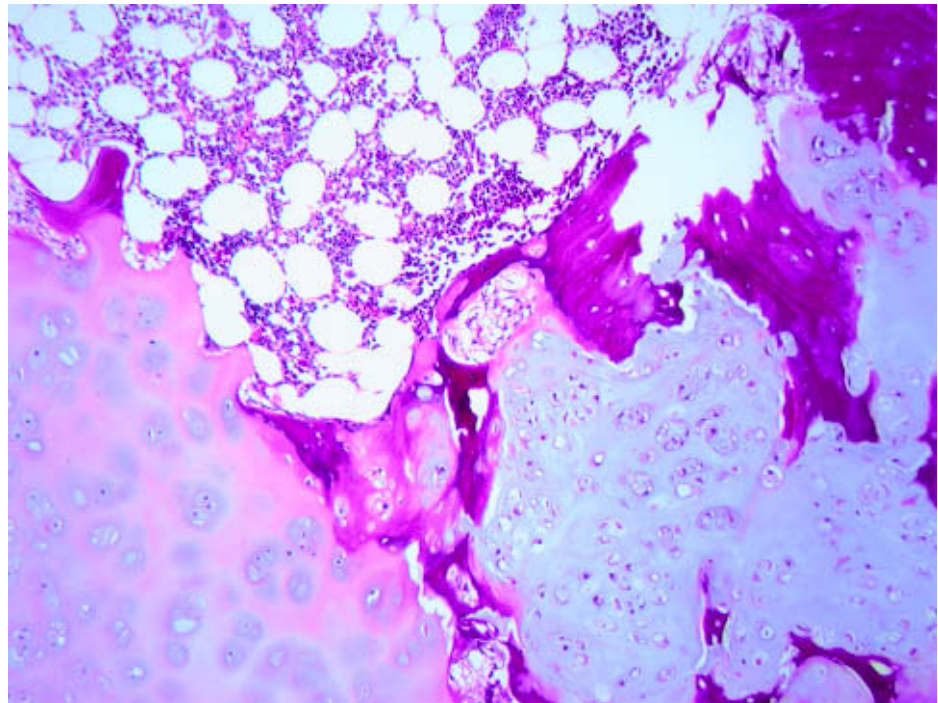


FIG. 3. Hyaline cartilage with enchondral ossification is seen (lower left) immediately adjacent to the invasive component of a low-grade (grade 1) chondrosarcoma (lower right). Bone marrow elements are noted in the upper portion of the field.

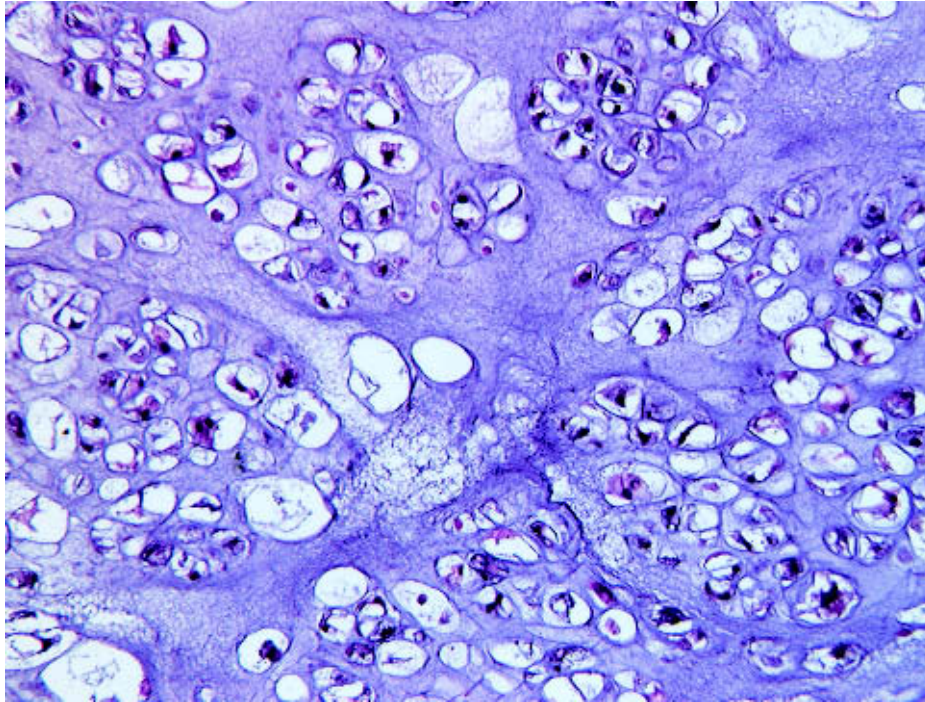


FIG. 4. A moderate-grade (grade 2) chondrosarcoma demonstrating increased cellularity, binucleation and multinucleation, and an increased nuclear-to-cytoplasmic ratio. A lobular arrangement is noted with stroma between the lacunar spaces.

gery. Finally, 37 patients were initially managed by a laryngectomy, two of whom developed recurrence and widely metastatic disease. There was no statistically significant difference in the mean size of tumors initially managed by wide excision alone (3.2 cm) versus those managed by laryngectomy (3.6 cm). Four of the 111 patients were lost to further follow-up. Five patients received adjuvant radiation therapy: all were men, two

with cricoid tumors and two with mixed tumors (one was unstated); four of them were grade 2 chondrosarcomas (two were myxoid type) and one was grade 1; four had an associated chondroma; two each were treated with wide excision or laryngectomy, and one patient had a partial laryngectomy; four patients developed recurrence, one of whom developed lung metastasis and the radiation therapy was used for the recurrence; adjuvant chemo-

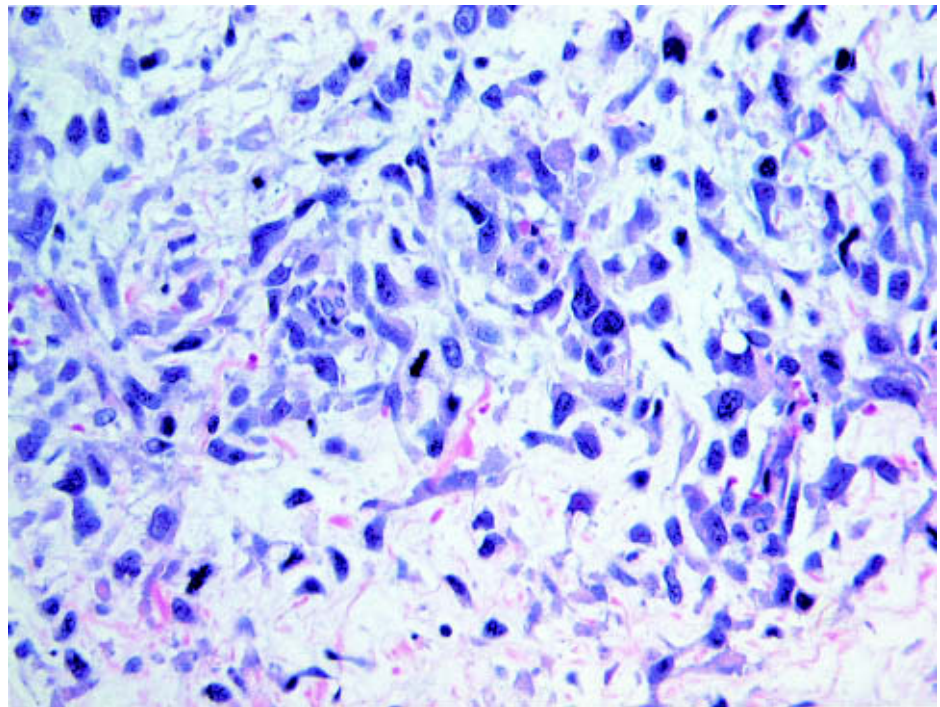


FIG. 5. A high-grade (grade 3) chondrosarcoma demonstrated remarkable nuclear pleomorphism, increased cellularity, mitotic figures, and necrosis (the latter not illustrated in this high-power image).

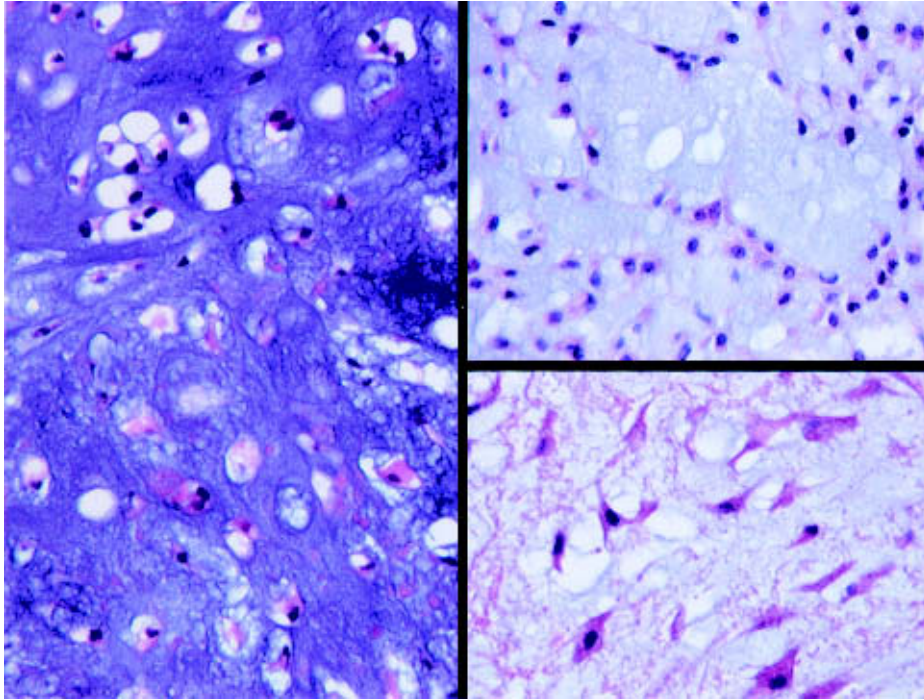


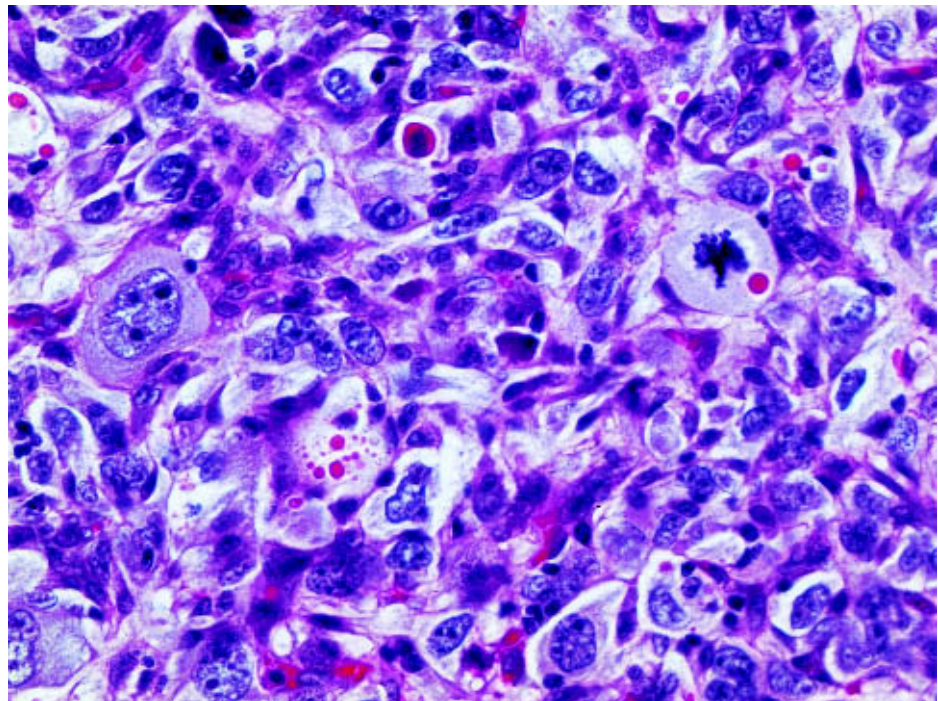
FIG. 6. A myxoid chondrosarcoma displays the chondroid matrix material (upper left), but a myxoid stroma predominates, separating the neoplastic chondrocytes. The classic "string of pearls" configuration is identified (upper right), whereas the more common myxoid change is illustrated in the lower right.

therapy was used for two of these patients after the radiation; and only one patient died of disease (with lung metastasis, 1.6 years after initial diagnosis), whereas the other four patients were without evidence of disease at last contact (mean, 11.8 years).

Overall, 20 patients (18%) developed recurrent and/or residual disease, anywhere from a few months up to 13 years after the original diagnosis (Table 5B). When re-

current disease was diagnosed, salvage laryngectomy was used for 10 patients; wide excision, including a hemilaryngectomy, was used for nine patients; and one patient had already developed disseminated disease and so no additional surgery was used. The primary tumors were of cricoid ($n = 15$), mixed ($n = 2$), arytenoid ($n = 1$), and unstated ($n = 2$) origin. Thirteen tumors were grade 2 tumors (including two myxoid tumors), with the

FIG. 7. An undifferentiated malignant mesenchymal neoplasm resulted in the diagnosis of a dedifferentiated chondrosarcoma (chondrosarcoma with additional malignant mesenchymal component [CAMMC]). Cytologic pleomorphism and increased mitotic activity are easily identified. This growth was identified immediately adjacent to areas of chondrosarcoma, usually of grade 1 or grade 2 type.



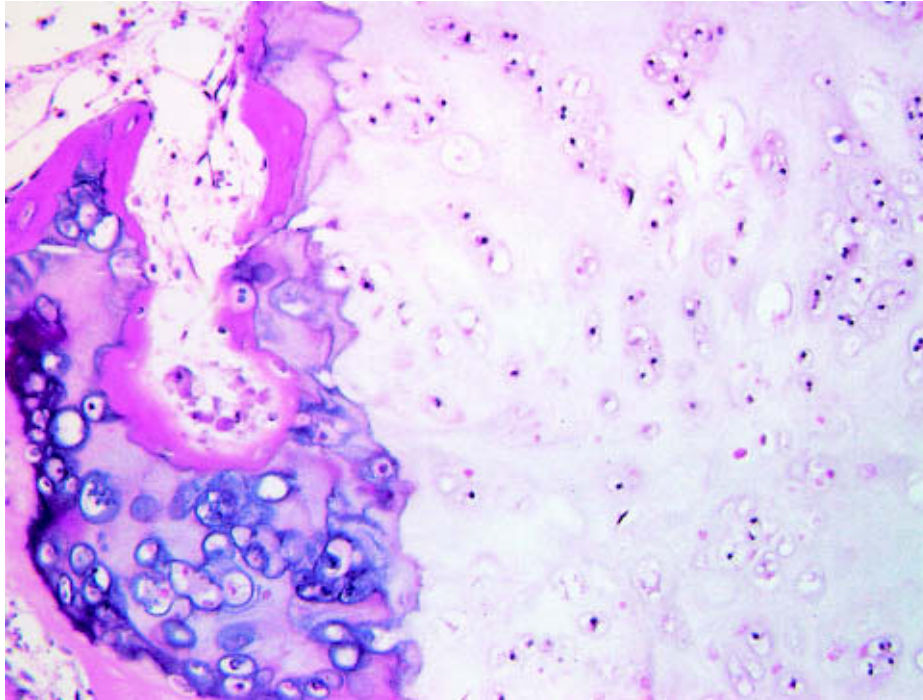


FIG. 8. The lower left portion of the illustration demonstrates a benign chondroma, in which there is an increased cellularity over the normal cartilage, disruption of the normal architecture, but no change in nuclear-to-cytoplasmic ratio and no cytologic atypia. A grade 1 chondrosarcoma is seen abutting this lesion (right side).

remaining seven diagnosed as grade 1 tumors. Of the 20 patients who developed recurrent disease, only five died with disease, an average of 5.1 years after initial diagnosis, whereas the remaining 15 patients were without disease at the last follow-up (mean, 15.6 years). One patient died in the immediate postoperative period, but the remaining four patients who died with disease died an average of 6.4 years after the original diagnosis.

Eight patients had myxoid tumors. One patient died in the immediate postoperative period, and one patient died from disease after 1.6 years. The remaining six patients were without disease at the last follow-up (mean, 4.4 years), with only one patient developing recurrent disease, managed by wide surgical excision. The six patients with grade 3 tumors (including the two CAMMC lesions) were all managed by wide excision ($n = 1$) or

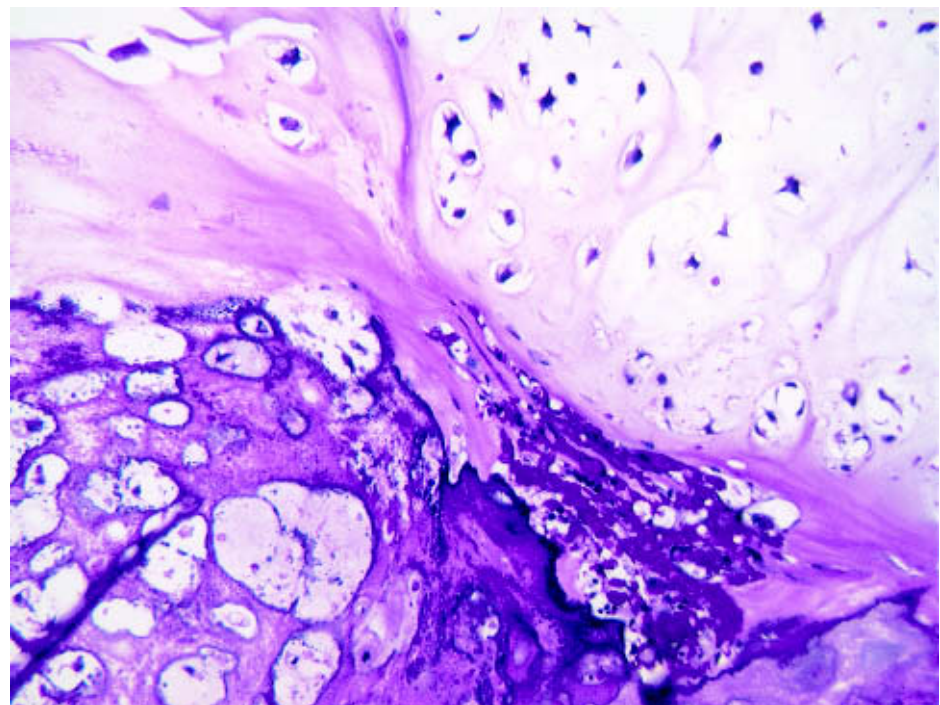


FIG. 9. A chondroma has undergone ischemia with eosinophilic, granular degeneration of the matrix material (lower left). A grade 1 chondrosarcoma is abruptly juxtaposed to the ischemic chondroma.

laryngectomy (n = 5). None of the patients developed recurrent or metastatic disease, and none received adjuvant therapy. All were without evidence of disease at the last follow-up, an average of 15.1 years after initial presentation (three were alive, mean 17.0 years; three were dead, mean 13.3 years). There was no statistical difference in outcome based on the tumor grade (p = 0.210), although there was a worse prognosis for patients with myxoid tumors (p = 0.044). Increasing tumor grade was associated with a higher chance of developing a recurrence (p = 0.009), but this did not affect the overall patient outcome.

Follow-up ranged from 3 weeks to 29.3 years, with a mean follow-up of 10.9 years. As a group, the overall patient survival was excellent, with 96.3% of patients surviving their disease. Whereas five patients (with adequate follow-up) died with disease, one died in the immediate postoperative period because of sepsis. This leaves four patients who actually died of disease (3.7%; mean 6.4 years). The remaining patients are alive without evidence of disease at the last follow-up (n = 54; mean 12.7 years) or had died of unrelated causes without evidence of disease (n = 48; mean 9.6 years).

These findings yield a 95.3% overall raw survival, a 79.4% 5-year raw survival, and a 52.3% 10-year raw survival. If one removes the patients who have not yet been followed for 5 years, there is a 78.9% 5-year disease-free survival and a 47.8% 10-year disease-free survival rate. Therefore, it can be seen that patients may develop recurrences, but it does not adversely affect the overall survival rate.

A number of variables were analyzed to determine if there was any affect on the patient outcome. There was no statistically significant difference in outcome based on gender (p = 0.907), tumor size (p = 0.102; irrespective of cutoffs used: <2.0 cm, <4.0 cm, <6.0 cm, and >6.0 cm), presence or absence of chondromas (p = 0.596), presence or absence of ischemia in a chondroma (p = 0.121), presence of bone invasion (p = 0.272), presence of necrosis (p = 0.582), increased tumor cellularity (p = 0.310), grade (p = 0.327), tumor location (p =

0.078), or initial treatment (p = 0.607). The presence of a myxoid chondrosarcoma did have a statistically significant adverse impact on patient outcome (p = 0.044). A higher-grade tumor seemed to indicate an increased chance of developing recurrent disease (p = 0.009). If patients were older than 60 years at initial presentation, there was a negative impact on patient outcome (p = 0.002). Although a curious result, if patients were diagnosed before 1980, there was a statistically significant worse outcome than in patients diagnosed after 1980 (p = 0.040).

DISCUSSION

Background, Incidence, and Etiology

Cancer of the larynx accounts for approximately 2% of all malignancies in the body, the vast majority of which are squamous cell carcinoma and their variants. Whereas chondrosarcoma is the most common sarcoma of the larynx, it still makes up only about 0.2% of all head and neck malignancies and approximately 1% of laryngeal malignant tumors.^{6,26,30,31,36,38,41,44,45,49,54} Given the referral nature of the AFIP, the 1.6% incidence in this series is probably slightly biased by inclusion of more problematic cases.

No definitive etiology for laryngeal chondrosarcomas is known, although the speculation most commonly accepted is an initial disordered ossification of the laryngeal cartilages.^{2,3,44,52} In many cases in this clinical series, ossification was found in the hyaline cartilages, which usually ossify in adults. The peak age at initial presentation of laryngeal chondrosarcoma coincides with a time when cartilage ossification is most likely to be present. The posterior cricoid cartilage lamina is the site of predilection for laryngeal chondrosarcomas, which matches the area of cartilage ossification (usually developing in areas of muscle insertion and attributed to the mechanical influence of the contracting muscles). The

TABLE 5A. Initial treatment based on patient outcome of chondrosarcomas of the larynx

Treatment	No. of patients (yr)	A, NED (yr)	A, D (yr)	D, NED (yr)	D, D (yr)
All patients (107 with follow-up)*	107 (10.9)	54 (12.7)	1 (6.5)	48 (9.6)	4 (6.4)
Excisional biopsy	12 (12.1)	6 (10.6)	N/A	5 (12.0)	1 (21.7)
Wide excision or debulking	49 (10.2)	24 (12.0)	1 (6.5)	23 (8.8)	1 (0.7)
Hemi- or partial laryngectomy	9 (13.8)	4 (15.8)	N/A	5 (12.1)	N/A
Laryngectomy	37 (11.1)	20 (13.6)	N/A	15 (9.1)	2 (1.6)

* One patient presented at autopsy with a tumor; therefore, treatment is not germane. A, NED, alive, no evidence of disease; A, D, alive with disease; D, NED, dead, no evidence of disease; D, D, dead, with disease; N/A, not applicable; years, mean years of follow-up or survival.

TABLE 5B. Outcome based on tumor grade, tumor location, and in patients who developed recurrences of chondrosarcomas of the larynx

Specific feature	No. of patients (yr)	A, NED (yr)	A, D (yr)	D, NED (yr)	D, D (yr)
Tumor grade					
Grade 1*	51 (10.3)	26 (11.8)	1 (6.5)	21 (9.0)	1 (0.7)
Grade 2*	54 (11.0)	25 (13.1)	N/A	24 (9.6)	4 (6.2)
Grade 3	6 (15.1)	3 (17.0)	N/A	3 (13.5)	N/A
Developed a recurrence	20 (13.1)	11 (14.8)	N/A	4 (14.5)	5 (5.1)
Tumor location (5 not recorded)					
Cricoid cartilage*	76 (11.0)	37 (13.2)	1 (6.5)	34 (9.3)	4 (6.4)
Thyroid cartilage	10 (9.8)	6 (10.9)	N/A	4 (8.1)	N/A
Arytenoid cartilage*	3 (9.5)	1 (1.0)	N/A	1 (18.1)	N/A
Mixed (more than one cartilage)	16 (9.4)	6 (9.5)	N/A	9 (10.4)	1 (0.1)

* Three foreign patients were lost to follow-up.

A, NED, alive, no evidence of disease; A, D, alive with disease; D, NED, dead, no evidence of disease; D, D, dead, with disease; N/A, not applicable; years, mean years of follow-up or survival.

disordered ossification may be associated with a pluripotential mesenchymal stem cell, which gives rise to chondrosarcoma.^{5,27,31,52}

Further, ischemic change in a chondroma may also contribute to the development of chondrosarcoma. This clinical study revealed that 60.4% of chondrosarcomas were superimposed on a preexisting benign chondroma. Of this 60.4%, 41 (61.2%) chondromas demonstrated ischemia. A similar ischemic change has been identified by members at our institution in chondromas of the axial skeleton, which are associated with chondrosarcoma. It has been previously suggested that axial skeleton chondrosarcomas may arise from preexisting (en)chondroma, referred to as a secondary chondrosarcoma.^{2,46} Therefore, it may be that true ischemic change in a chondroma subjected to mechanical trauma may be a precursor to malignant change or a more aggressive biologic behavior. It is interesting to note in reported series of laryngeal chondroma^{9,11,32,50,57} that they develop well over a decade earlier than chondrosarcomas, perhaps suggesting a

developmental continuum. This hypothesis is further supported by the frequent association in this clinical series and other reported cases⁴⁶ of a chondroma and chondrosarcoma. In summary, although we cannot prove that ischemia in a chondroma predisposes to the development of chondrosarcoma in the larynx, it is a topic that deserves further evaluation in a large series of patients with chondromas with or without ischemia and in patients with chondrosarcomas of the axial skeleton.

Finally, laryngeal chondrosarcomas have been described after Teflon injection,²⁶ radiation therapy,^{19,20} and in association with other neoplasms (spindle cell sarcomatoid carcinoma).⁵³ No previous radiation was identified in any of the patients in this study or in the majority of cases reported in the literature.⁵ Smoking was identified in 31% of patients in this clinical series and in higher percentages in other series.⁵ However, a specific etiologic link has not been definitively established. Therefore, the rarity of these associated findings suggest they are not a major etiologic factor.

TABLE 5C. Outcome of patients with specific histologic features of chondrosarcomas of the larynx

Specific feature	No. of patients (yr)	A, NED (yr)	A, D (yr)	D, NED (yr)	D, D (yr)
Chondroma in background*	24 (9.2)	12 (11.5)	1 (6.5)	10 (7.6)	1 (0.1)
Grade 1	12 (8.1)	5 (7.6)	1 (6.5)	6 (8.7)	N/A
Grade 2	12 (10.3)	7 (14.3)	N/A	4 (5.9)	1 (0.1)
Grade 3	N/A	N/A	N/A	N/A	N/A
Chondroma with ischemia†	41 (11.7)	24 (13.4)	N/A	15 (9.6)	1 (1.6)
Grade 1	14 (13.2)	9 (14.2)	N/A	5 (11.4)	N/A
Grade 2	23 (10.1)	12 (11.9)	N/A	10 (8.7)	1 (1.6)
Grade 3	3 (17.0)	3 (17.0)	N/A	N/A	N/A
No other pathology	44 (11.1)	18 (12.6)	N/A	23 (10.0)	3 (8.0)
Grade 1	23 (9.7)	12 (11.8)	N/A	10 (8.0)	1 (0.7)
Grade 2	18 (12.6)	6 (14.3)	N/A	10 (11.8)	2 (11.7)
Grade 3	3 (13.3)	N/A	N/A	3 (13.3)	N/A

* Two and one foreign patient, respectively, were lost to follow-up.

† N/A, not applicable.

Demographics

Chondrosarcomas of the larynx typically affect men much more frequently than women, with a ratio of 3.6:1, both in this clinical series and in a review of the literature.^{5,6,21,22,29-32,36,38,43-47,51,52,54,55} The mean age at presentation of laryngeal chondrosarcomas is between 60 and 64 years and seems to occur at an older mean age than patients with head and neck chondrosarcomas as a group (mean 45 years).⁷ As expected, if patients were older than 60 years at initial presentation, there was a negative impact on patient outcome ($p = 0.002$), a finding corroborating that already known in the literature.^{5,32,45,52}

Hoarseness is the most common presenting symptom, found in 64.9% of patients in this clinical study and in most patients in the cases reported in the literature. Dyspnea, dysphagia, dysphonia, voice changes, cough, neck mass, airway obstruction (stridor), and pain are associated complaints, depending upon how quickly the lesion develops and the anatomic location of the primary tumor. The symptoms are frequently present for a long duration (mean >2 years), supporting the notion of an indolent tumor.^{5,21,22,24,29,31,32,36-38,43-47,51,52,55}

In this clinical analysis, if patients were diagnosed before 1980 they experienced a statistically significant worse overall prognosis than patients diagnosed after 1980 ($p = 0.040$). This trend can perhaps be accounted for by three possible factors: 1) with the widespread application of head and neck CT examination after 1980, the exact extent of the tumor could be more easily evaluated, thereby guiding a more complete surgical excision^{28,48}; 2) surgical technique has improved in the past 20 years with the incorporation of the microscope, loops, and LASER techniques; and 3) patients were treated at an earlier stage of disease.

Radiology

Whether identified on plain films or CT examinations, coarse or stippled calcification within a tumor mass is probably the single most helpful radiographic feature to correctly identify a laryngeal cartilaginous neoplasm (although not necessarily separating a chondroma from a chondrosarcoma). This feature is seen in nearly all cases, not only in this clinical series but also in the cases reported in the literature, in general, irrespective of the grade of the tumor.^{5,6,38,44,45,54,55,57,58} Although MRI demonstrates the tumor extent, it does not identify the calcified matrix nearly as clearly or as accurately. After identifying the tumor as "cartilaginous," the remaining features are nonspecific, although most chondrosarcomas are centered in the cricoid cartilage, demonstrate a variable density, are frequently ill defined, can be cystic, and illustrate an impulse for invasion, both endolaryngeal

and extralaryngeal. The cartilages are frequently noted to be calcified, with clear evidence of cartilage and/or bone destruction. Almost uniformly, the overlying surface mucosa is smooth, intact, and uninvolved by the neoplasm. Radiographic imaging can help to define the extent and the overall classification (chondroid) of the neoplasm, but a biopsy is required for histologic confirmation of the specific tumor type and grade.

Pathology

The cricoid cartilage is affected far more frequently (72%) than other laryngeal cartilages, followed by the thyroid and arytenoid cartilages. The inner posterior plate or signet of the cricoid seems to be the most frequently specific site of involvement, related to areas of ossification and to the areas of muscle attachment.^{1,5,20,21,26,29-32,35,36,38,43-47,51,54,55,57,58}

Whereas chondrosarcomas of elastic cartilages of the larynx have been reported,^{23,33,35} there were none in this clinical series. Therefore, they must be exceedingly uncommon. Furthermore, in a review of the English literature (MEDLINE 1966-2001) and the files of the AFIP's Otorhinolaryngic-Head & Neck Tumor Registry, we were unable to uncover a single example of a primary pinna chondrosarcoma. Therefore, although chondrosarcomas of the elastic cartilages are possible, they are, for all intents and purposes, exceedingly rare.

The histologic diagnosis of laryngeal chondrosarcoma was based on criteria for malignant cartilaginous tumors elsewhere in the body, first set forth by Lichtenstein and Jaffe,³⁹ with tumor grading added at a later time.¹³ Chondrosarcomas are recognized by their increased cellularity, nuclear atypia including binucleation and multinucleation, and propensity to invade and destroy surrounding structures.^{3,5,7,12,22,30-32,45,52} Most chondrosarcomas seem to involve only a single cartilage with very little tendency to attempt to infiltrate adjacent cartilages. In this clinical series 16 tumors were considered mixed in location, in which the primary tumor expanded beyond the borders of the primary cartilage into the surrounding cartilages. Although this finding is not frequently reported, large tumors of up to 12 cm in greatest dimension have been identified, suggesting that other cartilages may be overcome by the neoplastic proliferation.^{5,21,22,31,32,36,38,43,45-47,51,52,55}

When the native cartilage was included in the biopsy, the cartilage was frequently ossified. Invasion into these areas of ossification was identified in 47% of cases. A number of authors have described ossification in laryngeal chondrosarcomas, and indeed, a few stated that bone could be found in the chondrosarcoma.^{5,21,22,31,32,36,38,43,45-47,51,52,55} It is our contention that these findings are more accurately interpreted as neoplastic chondrocytes invading into the ossified regions (i.e., bone). This is not a feature of a benign tumor

and is a diagnostic feature of chondrosarcomas of the axial skeleton. Bone invasion was lacking in the accompanying chondromas in this series, lending further support to the hypothesis that the identification of bone invasion is diagnostic of chondrosarcoma, irrespective of the nuclear features.

The vast majority of cases in this clinical series combined with those reported in the literature^{5,21,22,31,32,36,38,43,45-47,51,52,55} were grade 1, low-grade, or well-differentiated chondrosarcomas (64%), supporting the indolent nature of this neoplasm. An additional 28% were grade 2 neoplasms, with only a few grade 3 neoplasm (8%). The slightly higher percentage of grade 2 lesions in this clinical series may be accounted for by the referral nature of the AFIP and the inclusion of problematic cases, which tend toward a malignant tumor type. Well-differentiated lesions often only show focal areas that demonstrate the histologic criteria of malignancy, whereas the moderate- or high-grade tumors tend to have malignant features identified in a greater area of the biopsy. Therefore, it is imperative to have an adequate biopsy before attempting tumor grading. Thus, the question of what percentage of a given chondrosarcoma should demonstrate myxoid features to invoke a subclassification of myxoid chondrosarcoma is raised. We arbitrarily used 10% of the specimen area as a cutoff but must hasten to add that there were no tumors in this series in which the myxoid changes were noted only focally. Furthermore, when one suggests an arbitrary percentage, issues of specimen adequacy and the number of sections reviewed quickly follow. Because the presence of myxoid features automatically places the tumor into a grade 2 lesion, it is probably wise to think of grading and subclassifying tumors based on the "highest grade present" or "myxoid change" present irrespective of the quantitative nature of change.

CAMMCs occur in approximately 10% of axial skeletal chondrosarcomas and are aggressive and rapidly fatal tumors in those locations, with a 5-year survival of approximately 10%.^{4,10,18,34} It is important to add that the additional malignant component is never an osteosarcoma, the identification of which would change the whole tumor's designation to osteosarcoma. A number of single case reports of laryngeal CAMMCs have been documented. Whereas 62% of laryngeal CAMMCs have local recurrence or metastatic disease, only 22% of patients died of disease while the remaining patients (67.7%) were without evidence of disease at the last follow-up, 11.1 years after initial presentation. One patient is alive with evidence of disease at 3 years.^{1,4,5,14,26,42,45,49} Although this outcome is worse than laryngeal chondrosarcomas overall (>90% survival), it does not begin to approach the mortality of their axial skeleton counterparts. It is reasonable to postulate that the overall better survival for CAMMCs of the larynx in comparison to

their axial skeleton counterparts is the result of tumors probably presenting at an earlier stage of disease because of the airway obstructive symptoms, thereby sporting a smaller overall tumor bulk than those of the axial skeleton.

Differential Diagnosis

The differential diagnosis for chondrosarcomas of the larynx, although theoretically broad, in practical terms we have limited to chondroma, chondrometaplasia, and tracheopathia osteoplastica.

In general, true laryngeal chondromas are considered exceedingly rare, and a number of authors consider all laryngeal chondromas to be erroneous descriptions of low-grade chondrosarcomas. The skepticism pathologists have for this diagnosis is well founded based on the frequent recurrences and even metastases reported in the literature for these supposedly benign tumors. Based on this clinical series, accurate identification of benign chondromas was possible, separable from chondrosarcoma. However, given the very high association of chondroma with chondrosarcoma (60.4%) in this clinical series, it is possible that "biopsy" material in other clinical series was accurately classified as a chondroma, but the concurrent chondrosarcoma was never sampled. Therefore, adequate tumor sampling is critical to the accurate identification of tumor type as well as of tumor grade. Additionally, the biopsy area containing the "malignant" histology may be focal or limited in extent, requiring generous biopsy samples. Furthermore, the biopsy must contain the lesional cells rather than inconclusive epithelial biopsies.

Size has been suggested as a distinguishing trait between chondroma and chondrosarcoma. Because we did not specifically study only chondromas, we cannot unequivocally comment on size as a separator. However, the overall size of the chondrosarcoma did not influence the development of recurrence or the long-term patient prognosis in this clinical series ($p = 0.102$). Perhaps, by analogy, the overall size of cartilaginous lesions should not be used in isolation to separate chondromas from chondrosarcomas.

The microscopic separation of benign chondroma (terms such as *ecchondroma*, *enchondroma*, or *osteochondroma* are not applied to the classification of laryngeal cartilage tumors)^{32,44} from chondrosarcoma can be a very difficult one, often coming down to a matter of personal interpretation. Chondromas of the laryngeal cartilages will resemble normal cartilage, but the nuclei will be slightly larger.^{3,9,12,25,30,38,50} This feature, however, can be difficult to determine, and the presence of lobular architecture is a more reliable distinguishing feature. These chondrocytes will be uniform with single nuclei or, rarely, with multiple nuclei, similar to the criteria in long bones. Chondromas will lack nuclear atypia, mitotic

figures, and necrosis. We do not eschew the use of the term chondroma as evidenced by the frequent identification of a concurrent chondroma in this clinical study. However, because of the very high association of chondroma with chondrosarcoma, it is probably wise to consider the treatment of chondroma as indistinguishable from chondrosarcoma to assure the most conservative, but still meaningful, surgical management.

Chondrometaplasia of the larynx consists of elastic-rich cartilage nodules usually located on the vocal cords. Chondrometaplasia can be found in up to 2% of laryngeal specimens and is composed of small, uniform chondrocytes without nuclear abnormalities.^{3,15,32} These lesions are usually <1 cm in diameter, lack the characteristic lobular pattern of hyaline cartilage, and tend to be eosinophilic. The margins of the lesions are indistinct with a peripheral zone of transition between the cartilage and the surrounding tissues. Multifocality can sometimes be confused for recurrence. The lack of nuclear atypia and infiltrative growth pattern will distinguish these lesions from chondrosarcomas.

Tracheopathia osteoplastica is a very uncommon lesion, generally affecting the tracheal cartilage rings, formed from heterotopic bone or cartilage protrusions from the inner surface of the cartilages. The irregular bony spicules have thin walls surrounding fatty marrow. This process is most easily identified radiographically or laryngoscopically by the multiple calcific masses identified.⁴⁰

Treatment and Outcome

Laryngeal chondrosarcoma can, for the most part, be considered a relatively low-grade neoplasm, both histologically and by clinical aggressiveness.^{5,21,22,31,32,36,38,42,43,45-47,51,52,55} Whereas conservative surgery is the primary treatment of choice for laryngeal chondrosarcoma, the specific modality and technique performed have been the subject of many a treatise.^{5,21,22,24,29-32,36-38,43-47,51,52,54,55} This clinical series, along with the findings in the literature, supports conservative laryngeal function-preserving surgery, such as wide excision with a sufficient margin of normal, uninvolved cartilage achieved through endoscopic removal, laryngofissure, thyrotomy, or a partial laryngectomy. Most laryngeal chondrosarcomas involve the cricoid cartilage, which is considered critical to normal laryngeal function. Therefore, it is frequently difficult to adequately remove the tumor and still maintain vital structural integrity. However, thyrotracheal anastomosis over a stent, rib grafts, and other reconstruction techniques suggest that laryngeal framework and function can still be preserved while performing a complete excision of the tumor. When recurrences develop, wide excision can again be used, depending upon the extent of

the tumor, until functional compromise and the inability to reconstruct an adequate airway dictate the necessity for total laryngectomy. The voice-preserving surgeries allow for an improved quality of life and for a longer morbidity-free survival for up to 30 years from the time of original diagnosis. This approach does not adversely impact the long-term patient survival, either in this series ($p = 0.607$) or of those reported in the literature. Thus, a patient can benefit from extra years of (partial) laryngeal function until a total salvage surgery may become necessary with the development of a recurrence.

Adjuvant therapy, radiation and chemotherapy, generally seems to be ineffective in the management of laryngeal chondrosarcoma,^{5,24,26,31,32,38,42,44,50,54} as it is for chondrosarcomas in other anatomic sites. There are isolated case reports suggesting that adjuvant radiation has been used to treat a few patients, but with <10 cases in total reported, it is difficult to draw any reasonable conclusions.^{5,16,24,32,45} Adjuvant therapy, specifically radiation, should perhaps thus be offered only in cases in which the tumor is unresectable or surgical resection is not clinically feasible.

The literature suggests an overall recurrence rate of between 35% and 40%, although the recurrence rate was lower (18%) in this series. Recurrence or (more correctly in some cases) persistence may develop when the primary tumor was incompletely excised or if the tumor is of an increased grade. Incomplete excision is discussed above in the therapy alternatives. The recurrence rate, as would be expected, is dependent upon the grade of the tumor, with higher-grade tumors having a greater tendency to develop a recurrence ($p = 0.009$).

Metastases from laryngeal chondrosarcomas have been reported in up to 10% cases in the literature,^{5,21,22,31,32,36,38,43,45-47,51,52,55} whereas in our study only 1.9% of patients developed metastases (lung, bone, and liver). The two men who developed metastases were 66 and 62 years of age, respectively, with cricoid tumors measuring 4.5 and 1.5 cm each, both demonstrating bone invasion. One had necrosis and a myxoid histology. Both were grade 2 tumors managed by laryngectomy at initial presentation. The latter patient was given radiation (60 cGy) and chemotherapy, but both patients died with metastatic disease at 1.7 and 1.6 years, respectively, after initial presentation. This rapid clinical course is not unusual for patients reported in the literature who developed metastatic disease (<2 years), although longer intervals are known.^{8,38,43}

Death from disease is very uncommon and is usually the result of uncontrolled local growth into vital structures of the neck. Five of our patients died with disease (4.5%), although one patient died from sepsis in the immediate postoperative period. The overall 96.3% survival in this clinical series is similar to the values reported in the literature^{5,8,21,22,31,32,36,38,43,45-47,51,52,55}

and is a testament to the low-grade biologic behavior of laryngeal chondrosarcoma as a group. With a mean follow-up of 10.9 years, the overall survival of 96.3% is almost identical to reported age-matched control groups.^{36,38} Our 5-year disease-free survival of 78.9% and 10-year disease-free survival of 47.8% are similar to the findings of the Mayo Clinic cohort of 67.6% and 53.6%, respectively.³⁸ Therefore, the overall long-term clinical prognosis for conservatively managed chondrosarcoma of the larynx is excellent.

As a point of comparison, it would seem that laryngeal chondrosarcomas may have a different survival to their axial skeleton counterparts, although we do not know specifically if the survival is disease free. In this clinical series there is a 78% 5-year survival for grade 1 tumors, 79% for grade 2 tumors, and 100% for grade 3 tumors (no high-grade patients died with disease), which is different from those of the axial skeleton: grade 1, 90%; grade 2, 81%; and grade 3, 43%.¹³

A number of potential prognostic factors were statistically analyzed, yielding the results reported above. Specifically, gender ($p = 0.907$), length or type of symptoms ($p = 0.827$), tumor location ($p = 0.078$), tumor size ($p = 0.102$), tumor grade ($p = 0.210$), and type of initial treatment or tumor resectability ($p = 0.607$) did not affect the overall long-term clinical outcome. Older patients (>60 years) were more likely to experience an adverse clinical outcome ($p = 0.002$), as were patients with a myxoid chondrosarcoma histology ($p = 0.044$). Tumors with a higher grade were more likely to recur ($p = 0.009$), but this did not affect the overall long-term prognosis.

CONCLUSION

From this careful analysis and long-term clinical follow-up combined with the cases reported in the literature, laryngeal chondrosarcomas are uncommon tumors that present with hoarseness, dysphagia, or a neck mass, most frequently in older men who have had symptoms for about 2 years. There is a strong predilection for the cricoid cartilage, with the majority of tumors measuring on average 3.5 cm in greatest dimension. Many chondrosarcomas have a benign chondroma (with ischemia) present in the background and demonstrate invasion and destruction of the ossified cartilage. Most tumors are low to intermediate grade. Conservative surgical excision is recommended because of the overall indolent nature of laryngeal chondrosarcomas, using salvage laryngectomy when recurrences cannot be further managed by conservative surgery. With this type of management, cure rates exceed 90%. Metastases are exceedingly rare (about 2%). □

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