Sinonasal Undifferentiated Carcinoma: A 15-Year Single Institution Experience

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Abstract

Objective Sinonasal undifferentiated carcinoma (SNUC) is an aggressive neoplasm, with conflicting existing literature regarding prognosis and treatment due to the rarity of disease. Characterization of optimal SNUC management is necessary for improved outcomes.

Study Design Case series with planned data collection and analysis.

Setting Hospital of the University of Pennsylvania and Pennsylvania Hospital.

Participants Patients with pathologically confirmed SNUC treated within a 15-year period were identified, and records were obtained and evaluated for several demographic characteristics.

Main Outcomes Measures Disease-specific survival from diagnosis was the primary endpoint, while disease recurrence was a secondary endpoint of the study.

Results Twenty-seven patients with established SNUC were included in this cohort, with a median age of 55 years. Eighty-five percent of patients were surgically treated, and 85% of patients presented with stage IV disease. Two-year disease-specific survival was 66% and 5-year disease-specific survival was 46%. Ninety-six percent of patients received both chemotherapy and radiation as adjuvant treatment. Nodal disease at presentation and disease recurrence both significantly decreased patient survival (p < 0.05).

Conclusions The majority of patients at this institution presented with clinically advanced disease, and most were managed with a multimodal approach of surgical resection, chemotherapy, and radiation. Extent of disease at presentation and progression of disease following treatment are poor prognostic signs and may merit a more aggressive approach, while early detection and treatment may improve survival and decrease patient morbidity.
**Introduction**

Sinonasal undifferentiated carcinoma (SNUC) is a rare, highly aggressive malignancy that lacks clearly defined treatment protocols and concrete stage-based survival data. Overall SNUC mortality rates are high, with 5-year survival ranging from 20 to 63% in the literature.\(^1\)–\(^3\) SNUC is extremely locally destructive,\(^9\) frequently invading and eroding adjacent structures early on in the disease course.\(^10\) Additionally, it most often presents at American Joint Committee on Cancer (AJCC) stage IV.\(^1\)–\(^3\), \(^6\)–\(^8\), \(^11\)–\(^12\) The reasons for advanced disease at presentation are multifactorial, but delay in diagnosis is a principal feature, as symptoms of SNUC are more readily attributed to benign causes early on.\(^13\)–\(^15\) Often, a patient with a locally advanced SNUC will present at evaluation for nasal congestion, sinusitis, or symptoms of facial pressure. The large potential space of the sinuses also offers an opportunity for unimpeded initial growth, further contributing to high preliminary T stage of the tumor.\(^16\)

SNUC is a unique neoplasm, distinguished from esthesio-neuroblastoma (ENB) by a lack of periodic Homer-Wright rosettes and intercellular fibrils commonly associated with ENB. It also differs from Epstein–Barr virus-related nasopharyngeal-type undifferentiated carcinoma, which is a distinct entity with superior outcomes.\(^17\) There is also an overexpression of p16 in SNUC, related to human papillomavirus (HPV) infection in many, but not all, cases.\(^18\) SNUC was previously described as an anaplastic malignancy, and it can be epithelial or nonepithelial in origin.\(^11\)–\(^19\) Treatment for SNUC is generally surgery, radiation, chemotherapy, or some combination of these modalities; a consensus on timing and sequence of treatment has not yet been established. Some studies have argued superiority of surgery alone, chemoradiation alone, or the use of neoadjuvant or adjuvant chemoradiation.\(^5\)–\(^7\), \(^17\) However, no uniform agreement on survival advantage with any particular treatment modality has been established.\(^13\)

Several case series have been published since SNUC was first identified as an independent entity in 1986,\(^1\) but the number of patients in each series is quite limited due to the infrequency of SNUC occurrence. This study, conducted at the University of Pennsylvania hospitals, is one of the largest single-institution case series to date, comprised of 27 patients over a 15-year period. It is our hope that this contribution to the literature will provide useful additional data for discerning optimal management and prognostication of this disease.

**Methods**

**Patient Selection**

Approval was obtained from the University of Pennsylvania Institutional Review Board for a retrospective cohort study of SNUC patients from January 1992 to December 2017 treated at the Hospital of the University of Pennsylvania or Pennsyl-

**Results**

A total of 27 patients with SNUC were treated and followed at the Hospital of the University of Pennsylvania or Pennsylvania Hospital between 1992 and 2017. Demographic data for these patients, as well as tumor characteristics, are listed in Table 1. Examples of SNUC histopathology in this case series, including a positive cytokeratin stain and negative S100 protein and synaptophysin stains, can be seen in Fig. 1. A majority of patients (63%) were male, and a majority also had a history of smoking or regular alcohol
required orbital exenteration either during or after the primary surgery.

Disease-specific survival of both surgical and nonsurgical patients was 66% at 2 years and 46% at 5 years (Fig. 3). Notably, disease-specific survival and overall survival were equivalent in our cohort. When examining seven patient and tumor characteristics for effects on survival (Table 3), neck disease at presentation was associated with increased mortality (p < 0.05, hazard ratio, 4.5, 95% confidence interval, 1.04–19.2; Fig. 4); median survival of patients with neck disease was 20 months, compared with 126 months for individuals without initially positive neck nodes. The secondary outcome of disease recurrence was also independently associated with decreased survival (p < 0.01, log-rank Mantel–Cox test). Metastasis before or following treatment was associated with an especially poor median survival, with mortality in half of these patients in the 13 months following presentation.

**Discussion**

This study is an overview and analysis of a 27-patient SNUC cohort, and is one of the largest single-institution case series published to date. SNUC is a highly aggressive and uncommon neoplasm, with incompletely defined prognostic indicators and treatment strategies. Most patients in this cohort presented with clinically advanced disease, and almost all were managed with a multimodality approach of surgical resection, chemotherapy, and radiation. Five-year overall and disease-specific survival was 46%, and neck disease at presentation and disease recurrence following treatment were associated with increased mortality.

To understand the data in our patient population, it is best presented in the context of other similar case series that have been published in the past 15 years. Table 4 presents a list of all United States SNUC case series in the literature that are comprised of greater than 10 patients, with data extracted and compared with this study. Several notable trends are apparent. Patient age is very similar among all cohorts, with presentation in the 5th decade of life. Percentage of patients presenting with T4 disease varies from two-thirds to almost all patients, corroborating what is known about the SNUC disease course. Interestingly, our cohort had significantly higher levels of nodal disease at presentation than those reported at other United States institutions. The reasons for this discrepancy are unclear, but may partially account for the relatively high proportion of patients undergoing multimodality therapy with surgery, chemotherapy, and radiation at our institution. Furthermore, both our study and previous reports have identified nodal disease at presentation as a very poor prognostic indicator, which has important implications for survival. Despite this, 2- and 5-year survival in our subjects is comparable to the average of what has previously been reported.

Two meta-analyses and two national database reports have been published for SNUC in the past 5 years, and these provide important information that affects the evaluation of this disease.
A meta-analysis by Reiersen et al in 2012 found that while only 20% of all patients treated for SNUC received surgery, radiation, and chemotherapy, a combination of any of these therapies was strictly superior in offering improved survival when compared with any single modality. Among the treatment modalities, surgery had the largest effect, while adjuvant therapy was most beneficial in patients with advanced local or neck disease. In the context of our current case series, 81% of our patients received all three therapies, and the available evidence points to aggressive multimodal management as the recommended approach. Surgery, especially when GTR is achieved, is highly predictive of local disease control.\textsuperscript{28,29} This is further corroborated by reports showing that 70% of patients with SNUC will still have viable tumor at surgical resection following chemoradiation, highlighting the insufficiency of nonsurgical management.\textsuperscript{4}

While surgery is clearly a critical component of SNUC treatment, adjuvant therapy plays a demonstrable role. SNUC neoplasms tend to be microscopically invasive, and even negative margins should be further treated with radiation and chemotherapy. Cisplatin, 5-fluorouracil, and...
paclitaxel have an overall response rate of 80% in SNUC, and these are the most frequently used therapies in practice. At our institution, cisplatin or carboplatin were the first line agents of choice. Mean radiation dose across the majority of studies is 63.9 Gy, comparable to the median value of 63 Gy in our cohort. Most radiation treatments given in our series were postsurgical, and radiation’s role in downstaging patients prior to surgical treatment is still unclear. However, even in patients without demonstrated nodal disease at presentation, prophylactic neck irradiation has proven effective for preventing development of regional disease. Once cervical lymphadenopathy is present on physical exam, greater than 90% of patients will have regional or distant metastases. In considering SNUC management, clinicians must assess the need for elective prophylactic surgical or radiation treatment of the neck to improve prognosis.

Table 2 Treatment and outcomes

<table>
<thead>
<tr>
<th>Treatment</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgery</td>
<td>23 (85%)</td>
</tr>
<tr>
<td>Gross total resection</td>
<td>13 (57%)</td>
</tr>
<tr>
<td>Endoscopic</td>
<td>13 (57%)</td>
</tr>
<tr>
<td>Comb. neurosurgical</td>
<td>10 (43%)</td>
</tr>
<tr>
<td>Complications</td>
<td>4 (17%)</td>
</tr>
<tr>
<td>Radiation</td>
<td>26 (96%)</td>
</tr>
<tr>
<td>Chemotherapy</td>
<td>26 (96%)</td>
</tr>
</tbody>
</table>

Fig. 2 Flow diagram of treatment for the SNUC patients in the overall cohort.
A meta-analysis by Chambers et al, a study in the Surveillance, Epidemiology, and End Results database, and a study in the National Cancer Database provide other important demographic and survival considerations for SNUC.\textsuperscript{25–27}

There is a 2:1 predilection to SNUC in males, which is also borne out in our cohort (63%). Older age, advanced stage, metastatic disease, and Asian race were all significantly associated with decreased survival, while combination surgery with adjuvant therapy was again more effective than single-modality treatment. Notably, a large majority of patients who died of their disease did so within 20 months of treatment,\textsuperscript{25} suggesting that there is a time during which surveillance is most critical.\textsuperscript{31,32}

Like many other sinonasal cancers, a proportion of SNUC is related to HPV infection, although p16 is often overexpressed in SNUC even in the absence of HPV.\textsuperscript{18} Both HPV positive and p16 positive SNUC patients showed improved survival in a preliminary study.\textsuperscript{20}

The long timespan covered by this case series makes for a diagnostic challenge. The updated 2017 World Health Organization criteria for histopathological diagnosis of head and neck tumors describes SNUC as a diagnosis of exclusion, without squamous or glandular differentiation present.\textsuperscript{33}

### Table 3 Survival by patient and tumor characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Hazard ratio (95% CI)</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>1.80 (0.47–6.88)</td>
<td>0.39</td>
</tr>
<tr>
<td>Age</td>
<td>1.01 (0.95–1.07)</td>
<td>0.84</td>
</tr>
<tr>
<td>Smoking history</td>
<td>0.83 (0.24–2.86)</td>
<td>0.77</td>
</tr>
<tr>
<td>Alcohol history</td>
<td>0.68 (0.20–2.28)</td>
<td>0.53</td>
</tr>
<tr>
<td>Neck metastasis</td>
<td>4.47 (1.04–19.20)</td>
<td>0.04\textsuperscript{a}</td>
</tr>
<tr>
<td>Distant metastasis</td>
<td>3.82 (0.76–19.06)</td>
<td>0.10</td>
</tr>
</tbody>
</table>

Abbreviation: CI, confidence interval.\textsuperscript{a} p < 0.05.

A meta-analysis by Chambers et al, a study in the Surveillance, Epidemiology, and End Results database, and a study in the National Cancer Database provide other important demographic and survival considerations for SNUC.\textsuperscript{25–27}

### Table 4 Published SNUC case series in the United States

<table>
<thead>
<tr>
<th>Study</th>
<th>Penn</th>
<th>Mayo</th>
<th>UCSF</th>
<th>UVA</th>
<th>UM</th>
<th>Harvard</th>
<th>Einstein</th>
<th>UCD</th>
<th>MD And.</th>
<th>UF</th>
<th>UC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients (#)</td>
<td>27</td>
<td>40</td>
<td>21</td>
<td>20</td>
<td>19</td>
<td>19</td>
<td>18</td>
<td>16</td>
<td>16</td>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td>Age</td>
<td>55</td>
<td>57</td>
<td>47</td>
<td>58</td>
<td>51</td>
<td>52</td>
<td>52</td>
<td>50</td>
<td>48</td>
<td>57</td>
<td>54</td>
</tr>
<tr>
<td>F/u (mo)</td>
<td>47</td>
<td>83</td>
<td>58</td>
<td>80</td>
<td>21</td>
<td>26</td>
<td>81</td>
<td>81</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T4 (%)</td>
<td>85</td>
<td>80</td>
<td>81</td>
<td>73</td>
<td>84</td>
<td>100</td>
<td>67</td>
<td>94</td>
<td>69</td>
<td>100</td>
<td>63</td>
</tr>
<tr>
<td>Node + (%)</td>
<td>33</td>
<td>8</td>
<td>10</td>
<td>13</td>
<td>21</td>
<td>16</td>
<td>22</td>
<td>25</td>
<td>0</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Surgery (%)</td>
<td>85</td>
<td>83</td>
<td>90</td>
<td>55</td>
<td>53</td>
<td>63</td>
<td>83</td>
<td>63</td>
<td>63</td>
<td>66</td>
<td>64</td>
</tr>
<tr>
<td>XRT (%)</td>
<td>96</td>
<td>100</td>
<td>100</td>
<td>95</td>
<td>100</td>
<td>100</td>
<td>83</td>
<td>63</td>
<td>100</td>
<td>93</td>
<td>86</td>
</tr>
<tr>
<td>Chemo (%)</td>
<td>96</td>
<td>68</td>
<td>62</td>
<td>80</td>
<td>84</td>
<td>100</td>
<td>83</td>
<td>63</td>
<td>47</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>2y OS (%)</td>
<td>66</td>
<td>47</td>
<td>61</td>
<td>75</td>
<td>45</td>
<td>48</td>
<td>33</td>
<td>63</td>
<td>67</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>5y OS (%)</td>
<td>46</td>
<td>44</td>
<td>43</td>
<td>20</td>
<td>22</td>
<td>45</td>
<td>48</td>
<td>33</td>
<td>63</td>
<td>67</td>
<td>36</td>
</tr>
</tbody>
</table>

Abbreviations: Einstein, Yeshiva University and Albert Einstein College of Medicine; f/u, median follow-up; Mayo, Mayo Clinic in Rochester, MN; MD And, MD Anderson Cancer Center; OS, overall survival; Penn, University of Pennsylvania; SNUC, sinonasal undifferentiated carcinoma; UC, University of Cincinnati;\textsuperscript{3,4,6–8,12,20–23} UCD, University of California, Davis; UCSF, University of California, San Francisco; UF, University of Florida; UM, University of Michigan; UVA, University of Virginia; XRT, radiation therapy.
Furthermore, distinction of SNUC from large cell neuroendocrine carcinoma is difficult. Diagnoses of exclusion can be susceptible to sampling error and a definitive classification cannot always be ensured; our case series is not immune to this potential pitfall. Specific stains, such as the integrase interactor 1 protein stain and the nuclear protein in testis stain were not performed on some patients in the case series, as these stains have only recently been commonly utilized by pathologists for SNUC diagnosis. Other limitations of our study are related to sample size; a total of 27 patients precludes robust regression analyses or power to detect differences in all variables examined in our cohort. However, the rarity of SNUC ensures that no single institution will have a large enough group for adequate statistical considerations, and it is unlikely that a randomized controlled trial evaluating SNUC therapies would be possible even with a multi-institutional effort. The infrequency of SNUC cases makes case series valuable, both for future meta-analyses and appraisal of homogenous, single-institution data.

Overall, this study assesses demographics, tumor characteristics, and clinical management of a relatively large cohort of SNUC patients over a 15-year period. Long-term survival of SNUC patients is universally poor, as almost all patients present with very advanced disease. Neck metastases were present in a high proportion of our patient population, and were associated with decreased survival time. There was a heavy emphasis on a multimodal approach of surgical resection with adjuvant chemoradiotherapy in almost all patients, regardless of disease extent, and the literature is largely supportive of this methodology. Persistence of disease following treatment was a very poor prognostic sign and highly predictive of mortality. Identification of optimal strategies to prevent disease progression is a high priority for developing improved treatments for SNUC.

References


