Clean-Contaminated Neck Surgery

Risk of Infection by Intrinsic and Extrinsic Factors

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Objective: To evaluate the risk of surgical wound infection (the most common complication in neoplastic clean-contaminated neck surgery) due to 10 intrinsic risk factors and 5 extrinsic risk factors.

Design: Retrospective clinical study.

Setting: Academic tertiary referral medical center.

Patients: The study group included 115 patients with laryngeal carcinomas referred to our department from January 1, 1996, to August 31, 2002.

Intervention: Fifty-seven patients underwent total laryngectomy and 58 underwent subtotal laryngectomy.

Main Outcome Measures: The association between surgical wound infection due to 10 intrinsic risk factors and 5 extrinsic risk factors was evaluated with multivariate models.

Results: Surgical wound infection occurred in 27 patients (23.5%). There was no significant increase in the incidence of infection in patients with extensive tumors (P > .20) and in patients undergoing total laryngectomy and subtotal laryngectomy (P > .20). The incidence of infection was significantly higher in patients with stage IV disease (P < .01), in patients who underwent neck dissections (P < .05), and in those presenting with lymph node metastases (P < .001). Multivariate analysis showed that the presence of higher tumor stage is the best predictor of infection because it is the only significant factor (P < .03) even when adjusting for others. The association between infection and the other factors considered in this study (age [P > .10], underweight [P = .26], anemia [P = .84], lymphocytopenia [P = .79 by Fisher exact test], number of preoperative hospitalizations [P < .10], preoperative radiotherapy [P = .57 by Fisher exact test], diabetes mellitus [P = .70 by Fisher exact test], cirrhosis, resection margins infiltrated by the tumor [P = .57 by Fisher exact test], and myocutaneous flap reconstructions [P = .82]) was not significant.

Conclusion: The risk of surgical wound infection is correlated with a higher tumor stage and lymph node metastases; it is not associated with the extent of surgery or other factors considered.


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In neoplastic clean-contaminated neck surgery, antibiotic prophylaxis does not always prevent infection of the surgical wound. This can be attributed to various intrinsic and extrinsic risk factors. The intrinsic risk factors are linked to the patient and, therefore, not all can be modified; the extrinsic factors can be modified because they depend on the hospital environment and procedures adopted preoperatively, intraoperatively, and postoperatively.

Our study considers some intrinsic risk factors for infection: being older than 65 years, being underweight (body mass index [BMI] [calculated as weight in kilograms divided by the square of height in meters], < 18.5), preoperative and postoperative anemia (hemoglobin level, < 11.0 g/dL), lymphocytopenia (lymphocytes, < 1.0 × 10⁹/µL), diabetes mellitus, cirrhosis, preoperative radiotherapy (failure of definitive radiotherapy on tumor, 65 Gy), and index of neoplasm spreading (stage, tumor type, and node involvement). Among the extrinsic risk factors considered were the extent of surgical damage, surgery on the tumor or node, resection margins infiltrated by the tumor, and...
METHODS

From January 1, 1996, to August 31, 2002, 115 subjects with laryngeal carcinoma underwent surgery: 57 underwent total laryngectomy (TL) and 58 underwent subtotal laryngectomy, including cricohyoidopexy and cricohyoidoepiglottopexy. This study group was used for a retrospective analysis, taking into account the following intrinsic and extrinsic elements. The intrinsic risk factors for infection in clean-contaminated neck surgery related to the patient’s general condition include the following: being older than 65 years, being underweight (BMI, <18.5), preoperative and postoperative anemia (hemoglobin level, <11.0 g/dL), lymphocytopenia (lymphocytes, <1.0 × 10^3/µL), diabetes mellitus, cirrhosis, preoperative radiotherapy (failure of definitive radiotherapy on the tumor, 65 Gy), tumor progression as defined by stage, tumor extent, and the presence of lymph node metastases (N+). Extrinsic risk factors included type of laryngectomy, number of neck dissections (NDs), resection margins infiltrated by the tumor, the use of myocutaneous flaps when required to repair surgical defects, and time spent in the hospital (>3 days).

Of the 115 patients who underwent surgery, infection was found in 27 (23.5%). There was no significant (P>1.0) difference among the various cases of infection with reference to the type of antibiotic protocol used. The association between infection and the factors considered in this study was not significant (age >65 years, underweight, preoperative and postoperative anemia [hemoglobin level, <11.0 g/dL], lymphocytopenia, diabetes mellitus, cirrhosis, myocutaneous flaps, time spent in the hospital (>3 days), preoperative radiotherapy [only 4 patients in our study underwent previous radiation therapy and in 1 we found surgical wound infection], and positive resection margins) (Table 1).

The association between infection and stage proved statistically significant (P<0.01) (Table 2); more spe-
cifically, the most infections were found in patients with stage IV disease. A statistically significant association with infections was also shown in those patients who had undergone NDs ($P < .05$) and in the patients in whom neoplastic metastases were evident ($N^+ (P < .001)$ (Table 3).

There was no statistically significant association between infection and tumor extent ($P > .20$) (Table 4) nor between infection and type of surgery (TL vs subtotal laryngectomy) (Table 5). However, the association between infection and type of surgery in patients who underwent laryngectomy in addition to ND, compared with those who underwent laryngectomy alone, proved to be statistically significant ($P < .05$). Paradoxically, infection was more frequent in patients who underwent unilateral ND than in those who underwent bilateral ND (Table 6).

The 3 significant variables at the univariate level (stage [$P < .01$], $N^+$ [$P < .001$], and ND [$P < .05$]) were then included in the multivariate analysis. In this analysis, the unilateral and bilateral ND subgroups were considered as a single element. Initially, the following logistic model was applied: logit (probability of infection) = ND + ($N^+$ + stage).

None of the 3 variables proved to be significant when adjusting for the other 2 (Table 7). Considering that the $N^+$ and stage variables give us substantially the same information, the stage variable alone, which expresses a more complete evaluation in relation to the progression of the neoplasia and consequently the deficiency of the immune system, was maintained and considered in the logistic model. Therefore, the model was modified as follows: logit (probability of infection) = ND + ($N^+$ + stage).

Table 7 shows how ND proves not to be significant when considering the stage, whereas stage proves significant even when taking ND into account. This stresses the importance of stage in determining the onset of infection, excluding damage incurred by surgery as expressed by ND.

Finally, a logistic model with only 1 variable was considered by recoding stage as follows: S0 indicates stages I, II, and III; and S1, stage IV. The model was as follows: logit (probability of infection) = stage.

In fact, although risk of infection can be considered equivalent for stages II and III (Table 2), stage I has been pooled with the other stages because of the few cases.

The results of this model show that the odds of contracting infection in patients belonging to the S0 group (point estimate, 0.22; 95% confidence limit, 0.08, 0.56 by the Wald statistic) are lower than for those in the S1 group; in other words, the odds of contracting infection in the S1 vs S0 group are 4.58.

Then, multivariate analysis was repeated with all 3 variables, applying stage as previously encoded. Therefore, when rendered dichotomous, this variable (stage) was significant ($P < .03$) even when adjusting for ND and $N^+$.

**COMMENT**

Results brought to light a statistically significant association between infection of the surgical wound and the presence of neck metastases ($N^+$) and between infection of the surgical wound and stage. Specifically, the odds of contracting infection for patients with stage IV disease are 4.58 times greater than for patients with other stages of disease. These findings show that the progression of the tumor (expressed by stage) is a risk factor for the onset of surgical wound infection and that stage is the most valid predictor variable.

By using univariate analysis, a statistically significant association has been demonstrated between ND and infection of the surgical wound. However, multivariate analysis put this finding into perspective by showing how ND was not significant when considering stage. We decided to analyze the relationship between ND and surgical wound infection because ND would inevitably imply more extensive damage during surgery, longer duration of anesthesia, bleeding, and

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**Table 5. Infection by Type of Laryngeal Surgery**

<table>
<thead>
<tr>
<th>Type of Laryngeal Surgery</th>
<th>No. (%) of Patients</th>
<th>Cases of Infection</th>
<th>Infection by Type of Laryngeal Surgery, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>TL</td>
<td>57 (49.6)</td>
<td>16</td>
<td>28.1</td>
</tr>
<tr>
<td>STL</td>
<td>58 (50.4)</td>
<td>11</td>
<td>19.0</td>
</tr>
<tr>
<td>Total</td>
<td>115 (100.0)</td>
<td>27</td>
<td>NA</td>
</tr>
</tbody>
</table>

**Table 6. Infection by ND**

<table>
<thead>
<tr>
<th>ND Status</th>
<th>No. (%) of Patients</th>
<th>Cases of Infection</th>
<th>Infection by ND Status, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>No ND</td>
<td>44 (38.3)</td>
<td>5</td>
<td>11.4</td>
</tr>
<tr>
<td>Bilateral ND</td>
<td>32 (27.8)</td>
<td>9</td>
<td>28.1</td>
</tr>
<tr>
<td>Unilateral ND</td>
<td>39 (33.9)</td>
<td>13</td>
<td>33.3</td>
</tr>
<tr>
<td>Total</td>
<td>115 (100.0)</td>
<td>27</td>
<td>NA</td>
</tr>
</tbody>
</table>

**Table 7. Significance of the Contribution of Each Variable, Also Considering the Effect of Others**

<table>
<thead>
<tr>
<th>Variable</th>
<th>$\chi^2$ Value</th>
<th>$P$ Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model Logit (Probability of Infection) = ND + ($N^+$ + Stage)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ND</td>
<td>1.25</td>
<td>.26</td>
</tr>
<tr>
<td>$N^+$</td>
<td>1.56</td>
<td>.21</td>
</tr>
<tr>
<td>Stage</td>
<td>4.86</td>
<td>.18</td>
</tr>
<tr>
<td>Model Logit (Probability of Infection) = ND + Stage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ND</td>
<td>2.03</td>
<td>.15</td>
</tr>
<tr>
<td>Stage</td>
<td>9.12</td>
<td>.03</td>
</tr>
</tbody>
</table>

Abbreviations: NA, data not applicable; ND, neck dissection.

*For the analysis, $\chi^2 = 1.32, P > .20$. 

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more surgical drainages; all of these factors can be considered to cause increased risk of infection. However, in our study group, these risk factors expressed by ND did not prove to be statistically significant, nor was there any association between infection and other risk factors considered, such as being older than 65 years, preoperative and postoperative anemia (hemoglobin level, <11.0 g/dL), diabetes mellitus, cirrhosis, mycoticaneous flaps, time spent in the hospital (>3 days), positive resection margins, and preoperative radiotherapy. Only 4 patients in our study underwent preoperative radiotherapy. These patients were operated on after failure of definitive radiotherapy of the tumor (65 Gy). Among these 4 patients, 1 had infection of the surgical wound. The number of cases was too few, and for this reason there is no significant statistical association between infection and preoperative radiotherapy. Brown et al., in agreement with our findings, found no statistically significant correlation between infection of the surgical wound and diabetes mellitus, preoperative radiotherapy, or tracheotomy performed before surgery. Thus, all our findings confirm this interesting relationship between tumor progression and infection, a relationship that does not seem to be influenced by alternative risk factors that proved not to be significant. In the study presented by Brown et al, concerning 245 patients affected by carcinoma of the head and neck, a statistically significant correlation was found between tumor stage and the onset of infection, bringing to light a higher incidence of infection of the surgical wound in patients with stage IV disease. The researchers assert, but did not investigate, that this could be attributed to the dysphagic nutritional deficit caused by the neoplasia or, alternatively, to the more extensive surgical destructiveness implicit in the complex reconstructive surgical technique. In our study, we calculated the BMI; 25 patients were underweight (BMI, <18.5), 42 were a normal weight (25.0< BMI<18.5), and 21 were overweight (BMI, >25.0). The association between infection and being underweight was not significant.

On the other hand, our study also included the analysis of patients who had undergone subtotal laryngectomy, in whom dysphagia was not present and the surgical technique was not destructive. In our opinion, in this subgroup of patients, the percentage of infection was noticeably inferior (19.0%) compared with those who had undergone TL (28.1%) because the percentage of patients with stage IV disease (22.4%) and N+ (13.7%) was lower compared with those who underwent TL (stage IV disease, 63.1%; and N+, 40.3%). Our study, like that of Brown et al, was not diriment, because the evaluation of the patient’s nutritional status at hospital admission was missing.

However, in our opinion, the link between neoplastic disease and infection could be the deficit of the immune system in patients affected by neoplasia. In the literature, mention has been made—although with conflicting findings—of the qualitative and quantitative disorders of the immune system, which would seem to be the cause of an insufficient response to the tumor. More specifically, some researchers found a relationship between an insufficient immune response and the degree of progression of the neoplasia. In our study, however, the association between infection and lymphocytopenia was not significant.

In conclusion, based on the findings of this study and in agreement with data present in the literature, we conclude that the progression of neoplasia causes a greater risk of infection of the surgical wound compared with the extent of surgery and other risk factors linked to the patient preoperatively and postoperatively. In conclusion, the most correct evaluation of risk of infection in the presence of neoplasia can be based on the definition of stage. Stage IV increases the odds for infective processes by almost 4½ times compared with the other stages. Despite the fact that the presence of metastases (N+) was also a highly significant variable (P<.001), stage was preferred because more information was offered in relation to the progression of the neoplasia.

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REFERENCES


