HISTOLOGICAL AND RADIOLOGICAL EFFECTS OF TOTAL LARYNGECTOMY ON UPPER AIRWAY

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SUMMARY: In this study it was investigated whether abolished nasal airflow affected the nasal mucosal structure or paranasal sinuses in laryngectomised patients. At first, nasal mucosal biopsies were taken from 10 subjects preoperatively, and 17 subjects postoperatively in succession and secondly paranasal sinuses were examined using plain x-ray films in occipitomental (or Water's) and occipitofrontal (or Caldwell) projections on 12 patients.

All histological parameters except fibrosis and inflammatory cell reaction significantly differed between preoperative and postoperative specimens, and there appeared to be an obvious negative correlation between the duration after operation and number of layers of pseudostratification (NLPS), and a very high correlation between NLPS and number of capillary vessels (NCV).

In radiological evaluation of the paranasal sinuses, no important changes were ascertained.

Therefore, it is concluded that abolished nasal air current has a role on histologic patterns of nasal mucosa and this effect becomes more apparent in time. But, these changes are not so drastic to create pathological conditions.

Key Words: Total Laryngectomy, Nasal Mucosa

INTRODUCTION

The respiratory membrane of the nose consists of a pseudo-stratified columnar epithelium resting on a basement membrane which separates it from the underlying submucosa or lamina propria. The epithelium consists of ciliated columnar cells, non-ciliated columnar cells, goblet cells and basal cells. Goblet cells constitute the glandular element of the epithelial layer. These are unicellular mucous glands with a basal nucleus. All the columnar cells are covered by a sort of finger-like projections on their superficial surfaces called microvilli. The main components of the submucosa—which is a fairly loose connective tissue with some collagen and very few elastic fibrils—include various glands, serous and seromucinous glands, and blood vessels. Additionally, mast cells and the numerous extrascular cells, which have important immunological functions are found among all layers of the submucosa (Brain, 1989).

Normal breathing occurs through the nose, which has the task of filtering, warming and humi-
difloyment the inspired air, which is later delivered to
the lungs in an optimal state. Nasal breathing has a
marked effect on the lining mucous membrane of
the respiratory region of the nose (Brain, 1989).
Therefore, the alterations of the nasal airflow ef-
fects histological structure of the mucosal lining of
the respiratory region. A series of studies had pro-
ved this effect. Bende (1983) reported that the nasal
functions were discontinued, with abolished air
current; and because of the decrease in nasal blood
flow, morphological changes occurred after total
laryngectomy. Havas (1987) demonstrated the al-
terations in nasal cycle after laryngectomy. Hilding
and Hilding (1970) studied rabbits which were sub-
jected to closure of one nostril, and pointed out that
an increase in ciliogenesis and goblet cell popula-
tion occurred.

In this study, firstly, we investigated the respira-
tory epithelium of the nose in patients that have un-
dergone total laryngectomy in order to show whe-
ther the duration of the nasal airflow absence effects
the histologic structure or the radiological appear-
ance of the paranasal sinuses.

MATERIALS AND METHODS

Seventeen subjects (16 male and 1 female) aged
34-65 (mean 45.1) years who have undergone total
laryngectomy between 1989 and 1990, were inves-
tigated in the first study. They were all heavy smok-
ers (more than 20-30 cigarettes per day, for at least
20 years).

Nasal mucosa surface characteristics were stu-
died in biopsies obtained just before total laryn-
gectomy and neck dissection and 2-24 months after
laryngectomy. The biopsies taken for pathological
examination were fixed in 10 % formalin and then
were embedded in paraffin. The blocks were cut in
5 microns and subsequently stained with hemato-
xylen & cosin. The slides were evaluated in terms of
number of layers of pseudostratified epithelium
(NLPS), goblet cells (NGC) and capillaries (NCV).
The number of goblet cells and capillaries were co-
unted per 10 high - power fields (x 450) and an ave-
rage of these figures was obtained. The biopsies
were also evaluated for the presence of fibrosis and
inflammatory reaction and arbitrarily categorised
into nil, slight, moderate or severe.

For the first study the specimens were allocated
into 3 groups, preoperative ones (Group A), the spe-
cimens obtained in 2 - 6 months (Group B) and the
ones obtained later than 7 months (Group C), posto-
peratively (Table 1). The averages of the param-
eters were statistically analysed between these two
patients by Student's t- test, and additionally, the cor-
relation of the parameters was investigated, using
Microstat (1984 by Echosoft, Inc) statistical analy-
sis program.

<table>
<thead>
<tr>
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<th>n</th>
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<th>C</th>
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Table 1: Results of the parameters investigated in three groups
(Group A, Preoperative biopsies; Group B and C, biopsies
2-6 months and later than 7 months after laryngectomy,
respectively; n, number of the biopsies; NLPS, number of la-
yers of pseudostratification; NCV, number of capillary ves-
sels, NGC, number of goblet cells).

In the second study we investigated the radiolog-
ical appearance of the paranasal sinus of larynge-
tomised patients. Paranasal sinus x - rays in occipi-
tomental (or Water's) view and occipitofrontal (or
Caldwell) view were obtained from 12 preoperati-
ve subjects and 9 more than 3 months postoperati-
vely. All x - rays were evaluated twice in order to
prevent personal errors.

RESULTS

In table 1, NLPS, NCV and NGC values are given
in three groups. These values were significantly
different for each parameter between all the groups
(Table 2), and there appeared to be an obvious ne-
gative correlation between the duration after opera-
tion and NLPS, and a very high correlation between
NLPS and NCV (Table 3). Additionally, signifi-
cant correlation were present between other param-
eters, except the one between NGC and time elaps-
ed after operation (TEAO). In the biopsies of both
groups no fibrosis and inflammatory reaction were
revealed, compared to the control group. In each of
the 3 groups mucosal specimens showed nil or
slight mononuclear inflammatory cell reaction ex-
cept for 2 patients who had had maxillary sinusitis
preoperatively. Moderate mononuclear inflamma-
tory cell reaction was found in those 2 patients (Fig 1).

In 2 of 12 patients, x-rays taken preoperatively
revealed bilateral maxillary sinusitis and one of
them also had bilateral ethmoidal sinusitis. There
was a mucosal retention cyst in the left maxillary si-
nus and bilateral ethmoidal sinusitis in a third pati-
<table>
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Table - 2 : Statistical analysis of the parameters between three groups (T, Student's t - test; Group A, Preoperative biopsies; Group B and C, biopsies 2-6 months and later than 7 months after laryngectomy, respectively; SD, standard deviation; n, number of the biopsies; NLPS, number of layers of pseudostratification; NCV, number of capillary vessels; NGC, number of goblet cells; *, < 0.01; **, < 0.05).

<table>
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<th>NCV</th>
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<tr>
<td>NGC</td>
<td>-0.053</td>
<td>0.66</td>
<td>0.66</td>
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Table - 3 : The correlation analysis of the parameters (TEAO, time elapsed after operation; NLPS, number of layers of pseudostratification; NCV, number of capillary vessels; NGC, number of goblet cells).

Patient. Therefore, the paranasal sinus x-rays of these 3 subjects were not investigated postoperatively. Since 3 of the rest had unilateral maxillary retention cysts, their postoperative x-rays were evaluated for the healthy sinuses, and none of the postoperative x-rays showed any abnormal changes in maxillary, frontal or ethmoidal sinuses except for a retention cyst in the right maxillary sinus of a laryngectomised patient after 6 months.

**DISCUSSION**

Dixon (1949) reported that mucosal changes in the nasal cavity appeared in the third month after operation. Basterra and Martorell (1983) pointed out that these changes appeared in 2 months - 2 years postoperatively. In our first study nasal mucosa was investigated in 2 months - 2 years period and structural differences were shown after laryngectomy.

Nieto (1972) emphasized that mucosal changes were closely related to the postoperative period. In our study, significant differences between group B (2-6 months) and C (after 7 months), together with high negative correlation between all the parameters and duration after laryngectomy supported the finding that the mucosal changes become more apparent in the period after operation. Basterra and Martorell (1983) pointed out that glands became atrophied and mucosal fibrosis appeared postoperatively, but we could not ascertain mucosal fibrosis in any group which were operated upon. Contradictorily, some authors reported glandular hyperplasia (Dixon et al. 1949; Puskas, 1970)).

Bende (1983) emphasized that mucosal blood flow became decreased after laryngectomy and all of the structural changes depended on mucosal blood flow. Our results support this relation, as there was a positive correlation between the number of capillary vessels and other structural changes.

Fig. 1 : A nasal mucosal biopsy obtained two years after the laryngectomy. Note the reduced number of goblet cells, capillaries and the one-layered surface epithelium.

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Dixon (1949) and Nieto (1972) showed that aging had an important role on histological changes and vascular pattern of the nasal mucosa, did not find a difference between old healthy subjects and laryngectomised ones, but showed a significant difference between 2-3 months postoperative group and the group that was followed for more than 4 months. In this study we compared the results of preoperative biopsies of the same patients in addition to 2 postoperative groups, and there was no significant age difference between preoperative and postoperative ones. Therefore, it is thought that abolished nasal air current has a role on histologic patterns of nasal mucosa and this effect becomes more apparent in the course of time.

Havas (1987) emphasized that loss of the nasal cycle was the first physiological alteration to take place after laryngectomy and suggested that further investigation was required to clearly delineate the connection between loss of the nasal cycle and other changes that were manifestations of the gross alteration in nasal physiology following laryngectomy. But we found no changes in paranasal sinuses after total laryngectomy. Therefore, although we could not evaluate nasal airflow and ciliary activity, we propose that the changes in these functions are not so serious to create pathological conditions. Further investigations are necessary to delineate whether these alterations causing no nasal and paranasal diseases will effect the treatment or not.

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