The Influence of Upper Respiratory Tract Surgery on Respiratory Function Evaluated by Oxygen Saturation

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To evaluate the influence of upper respiratory tract surgery on respiratory function, we used a pulse oximeter to measure the arterial oxygen saturation in 40 patients (ASA 1 or 2) during surgery under local anesthesia. The patients were divided into four groups: a control group of 10 patients who underwent surgery not involving the upper respiratory tract, and three upper respiratory tract surgery groups of 10 patients each underwent surgery on the nasal cavity alone (group 1), on the oral cavity alone (group 2), and on both the oral and nasal cavities (group 3). Groups 1 and 2 showed little desaturation compared to their baseline levels and the control group, while group 3 showed a mild desaturation even at the beginning of surgery and this gradually turned to a moderate or severe desaturation. This was due to both the extension of the surgical zone to the nasal and oral cavities and to ventilatory distress produced by massive bleeding and aspiration of secretions. Thus, the pulse oximeter is a useful monitor for upper respiratory tract surgery involving both general and local anesthesia. It allows the identification of hypoxia so that remedial therapy can be instituted. (Key words: upper respiratory tract surgery, respiratory function, oxygen saturation)

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Local anesthesia is used most frequently for head and neck surgery but sometimes leads to complications, with hypoxia being the most dangerous intraoperative problem. Because head and neck surgery frequently involves the upper respiratory tract, hypoxia may be easily induced by ventilatory distress due to the aspiration of blood or secretions and the operative procedure itself. Hypoxia may be not reflected immediately by change in the blood pressure, heart rate, and respiratory status[1], but in poor risk patients serious consequences may occur rapidly.

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A pulse oximeter is capable of measuring the arterial oxygen saturation instantaneously, noninvasively and continuously[2], and so appears to be quite suitable for monitoring the ventilatory status and arterial oxygenation during surgery.

In this study, we evaluated the influence on respiratory function of upper respiratory tract surgery performed under local anesthesia, as measured by the arterial oxygen saturation ($\acute{S}a_{O_2}$) determined with a pulse oximeter.

Materials and Methods

Forty nonsmoking and nonobese adults (ASA 1 or 2), scheduled for upper respiratory tract surgery under local anesthesia, were the subjects. The significant medical conditions were as follows: mild hyperten-

Table 1. Patient Characteristics, Blood Loss, Duration of Surgery, and Dose of Local Anesthetic

Group (n)	Age (yr)*	Sex (M/F)	Body Weight (kg)*	Blood Loss (ml)*	Duration of Surgery (min)*	Dose of Local Anesthetic (ml)*
Control (10)	48.8 ± 16.7	6/4	53.0 ± 6.2	50.6 ± 29.2	361.0 ± 82.4	20.9 ± 7.6
Group 1 (10)	44.2 ± 17.7	5/5	56.5 ± 7.1	5.5 ± 1.9	68.0 ± 16.5	6.1 ± 3.9
Group 2 (10)	50.4 ± 10.2	6/4	54.7 ± 7.1	4.8 ± 2.1	59.0 ± 16.1	4.3 ± 1.8
Group 3 (10)	48.6 ± 10.6	5/5	56.7 ± 8.8	290.2 ± 88.4	202.5 ± 55.1	36.1 ± 12.5

*Values are expressed as means ± SD.

tion in five patients, mild diabetes mellitus in three patients, and chronic hepatitis in one patient. None of the patients had any respiratory disease. Patients subjected to tympanoplasty served as the control group. Patients undergoing deviatomy, which involved only the nasal cavity, were classified as group 1. Patients undergoing extraction of the third molar, which involved only the oral cavity, were classified as group 2, and patients undergoing radical surgery on the maxillary sinus (which involved both the nasal and oral cavities) were classified as group 3.

Atropine sulfate 0.01 $mg \cdot kg^{-1}$ was administered intramuscularly one hour prior to surgery, and 1% lidocaine containing epinephrine (1/100,000) was used as the local anesthetic. The Sa_{O_2} was measured with the patient in the supine position using a Nellcor N-100 pulse oximeter with a probe attached to a fingertip of the patient. The baseline Sa_{O_2} value was obtained 30 min prior to surgery. Then the Sa_{O_2} was measured every 10 min during the operation and also at 30 min after surgery. The postoperative value was obtained 10 min after completion of the surgery, with the patient resting comfortably. The results were continuously recorded on a strip chart.

The mean and standard deviation (SD) of the measured values were obtained and the decrement of Sa_{O_2} was classified into three grades: mild desaturation (a 2–4% decrease from baseline), moderate desaturation (a 4–6% decrease from baseline), and severe desaturation (a more than 6% decrease from baseline).

No oxygen was administered to the patients usually, but six patients who complained of nausea and dizziness during surgery (two from group 2 and four from group 3) received high flow rate oxygen (5 $l \cdot min^{-1}$) by face mask, which did not attach to surgical area, after the discontinuance of operation. The extent of desaturation at the onset of symptoms ranged from mild to severe, but after oxygen administration the Sa_{O_2} returned swiftly to the baseline level and then operation was started again. At the end of the operation, the amount of blood loss, the duration of surgery and dose of local anesthetic were determined for each group.

Results

No significant difference was observed between the control group and the upper respiratory tract surgery patients regarding age, sex, or body weight (table 1). The blood loss in group 3 was much greater than in the control group (about 6-fold greater). The duration of surgery was longer in the control group (over 360 min) than in all the upper respiratory tract surgery groups, but no significant desaturation was observed in the controls. The total dose of local anesthetic was highest in group 3 (table 1).

The Sa_{O_2} data for groups 1 and 2 showed no desaturation as was the case for the control group, whereas a tendency for desaturation was noted in group 3 even 30 min after the start of surgery, followed by a further deterioration of the Sa_{O_2} as surgery progressed (fig. 1). No significant desaturation was observed in group 1, and only mild desaturation was observed after 60 min of

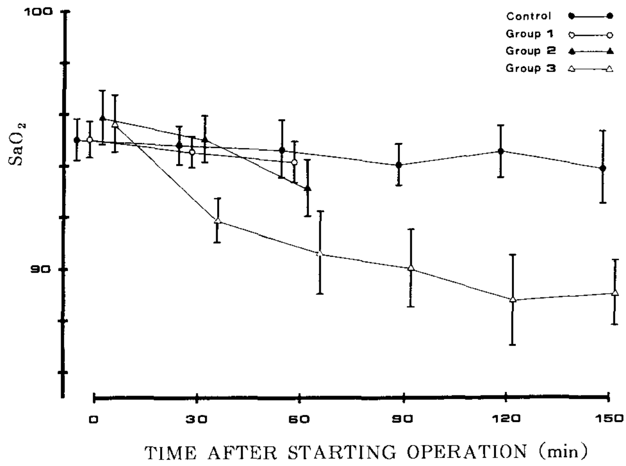

Fig. 1. Little desaturation was observed in groups 1 and 2. In group 3, mild desaturation was observed at 30 min after starting surgery and was followed by deterioration to moderate and severe desaturation.

surgery in group 2. In contrast, group 3 showed mild desaturation at 30 min, moderate desaturation at 60 and 90 min, and severe desaturation at 120 and 150 min after the start of surgery (fig. 1). When deep breathing was encouraged after surgery, a quick recovery of the Sa_{O_2} to the baseline was observed in all the patients with desaturation.

Discussion

During upper respiratory tract surgery under local anesthesia, a variety of complications are observed frequently, including abnormal changes of the circulatory dynamics, mental excitation, arrhythmias, and nausea. In the past, these were explained as being mainly due to sympathicotonia arising from pain and/or anxiety, and they could generally be treated by adequate analgesia or sedation. In some cases, however, the complications were more serious, suggesting the existence of other important factors inducing such symptoms. We explored the possible occurrence of hypoxia during surgery in this study, by investigating the influence of upper respiratory tract surgery on ventilation and oxygenation using a pulse oximeter.

The Sa_{O_2} in groups 1 and 2 did not vary significantly from the baseline value. Since the operative area was limited to either the nasal or oral cavities in these groups, this left one of the two cavities for unimpaired ventilation. Also, the blood loss was less and the duration of surgery was shorter compared to group 3. The Sa_{O_2} in group 3 was already significantly decreased at 30 min after the beginning of surgery, and it subsequently decreased further with progression to severe desaturation after 120 min. This was probably because the surgical zone included both the oral and nasal cavities and because ventilatory distress was compounded by the longer duration of surgery and much bleeding in this group. In addition, in order to obtain analgesia over a wide area, a far higher dose of local anesthetic was necessary in this group. The analgesia was delivered to an area which has an abundant vascular supply, so an inhibitory effect on the central nervous system of the local anesthetic may also have contributed to impaired ventilation.

Sedatives may be necessary for anxiety during surgery, but they can further aggravate respiratory distress in patients having airway surgery[3,4]. No sedatives were used in this study. Because hypoxia may also occur during transportation to the recovery room after surgery[5], it is necessary for careful attention to be paid to patients during the immediate postoperative period. Desaturation may be treated with frequent suction and oxygen administration, and this can achieve a dramatic improvement. According to Brown et al.[6], inspired oxygen will increase the transcutaneous oxygen tension about two-fold after 1 min and about fivefold after 5 min.

Among the various kinds of upper airway surgery under local anesthesia, radical operations on the maxillary sinus most profoundly influenced respiratory function, suggesting that intraoperative ventilatory distress led to hypoxia in these patients. Careless sedation may induce more serious hypoxia in such patients. Even in upper respiratory tract surgery confined to either the oral or nasal cavity, hypoxia may occur rapidly in patients without an adequate cardiopulmonary reserve[7], and it may be aggravated by sedation.

Monitoring for hypoxia during surgery is necessary in such patients, and a pulse oximeter is a noninvasive method of measuring the Sa_{O_2} continuously that appears to be quite useful for patients undergoing upper respiratory tract surgery under local anesthesia, especially those with poor cardiopulmonary that function.

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