ORIGINAL ARTICLE

NO REDUCTION IN COMPLICATION RATE BY STAY IN THE INTENSIVE CARE UNIT FOR PATIENTS UNDERGOING SURGERY FOR HEAD AND NECK CANCER AND MICROVASCULAR RECONSTRUCTION

Emeka Nkenke, MD, DDS, PhD,[1] Elefterios Vairaktaris, MD, DDS, PhD,[2] Florian Stelzle, MD, DDS,[1] Friedrich W. Neukam, MD, DDS, PhD,[1] Michael St. Pierre, MD[3]

[1] Department of Oral and Maxillofacial Surgery, University of Erlangen-Nuremberg, Glueckstr. 11, D-91054 Erlangen, Germany. E-mail: emeka.nkenke@uk-erlangen.de
[2] Department of Maxillofacial Surgery, University of Athens Medical School, Attikon Hospital, Rimini 1 Haidari, GR-12464 Athens, Greece
[3] Department of Anesthesiology, University Hospital Erlangen, Krankenhausstrasse 12, D-91054 Erlangen, Germany

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Abstract: *Background.* The aim of this prospective cohort study was to determine whether an immediate postoperative period of deep sedation and artificial respiration in an intensive care unit (ICU) leads to fewer complications and a reduced failure rate of microvascular flaps compared with a situation in which patients are allowed to breathe spontaneously without sedation in a recovery room.

Methods. Each group comprised 50 patients. General medical complications and flap donor and recipient site complications were documented.

Results. Significantly, more patients had problems with weaning from ventilation in the ICU group ($p = .022$). More cases of respiratory insufficiency ($p = .240$) and pneumonia ($p = .081$) occurred in the ICU group compared with the recovery room group without statistically significant differences. The number of flaps lost was comparable in both groups ($p = .646$).

Conclusions. Admission to an ICU did not reduce complications after microvascular reconstruction and, therefore, has only to be considered for selected cases. © 2009 Wiley Periodicals, Inc. *Head Neck* **31:** 1461–1469, 2009

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Correspondence to: E. Nkenke

Microvascular reconstruction of defects caused by tumor ablation is time consuming and results in additional morbidity in the form of donor sites and potential complications affecting the flap. Although free tissue transfer with microvascular anastomosis is a well-established reconstructive technique, it has been stated that it requires close postoperative monitoring.[1] Undoubtedly, the immediate postoperative care of patients after head and neck resections for cancer and microvascular reconstruction is concerned with the preservation of the airway, blood pressure, and other vital signs.

Table 1. Review of the literature on the length of stay in intensive care units for patients undergoing head and neck tumor resection and microvascular reconstruction.

Authors	No. of patients	Length of stay in intensive care unit, d ± SD
Pohlenz et al, 2007[5]	540	3.4*
Klug et al, 2006[6]	455	10.3 ± 10.2
Klug et al, 2005[7]	303	11.0 ± 9.6
McCrory et al, 2002[8]	65	1.2 ± 1.1
De Melo et al, 2001[9]	110	2.1 ± 4.7
Ryan and Hochman, 2000[10]	97	3.0 ± 1.2
Lydiatt et al, 2000[11]	64	5.7 ± 3.4
Godden et al, 1999[4]	58	1*
Tsue et al, 1997[12]	58	4.4 ± 3.6

Abbreviation: SD, standard deviation.
Note: Studies performed on more than 50 patients were included.
**, standard deviation not specified.*

After microvascular surgery, the flap must be monitored for anastomotic failure. To avoid possible mechanical strain to the transplanted tissues caused by spontaneous movements, major head and neck reconstructive surgery is often followed by a period of postoperative deep sedation (Richmond Agitation-Sedation Scale [RASS] −4 or −5).[2] Sedation can decrease the systemic blood pressure and may lead to decreased flap perfusion pressures increasing the risk of hypoperfusion and flap necrosis. The management of such patients is complicated. As a consequence, some centers routinely transfer their patients to intensive care units where close attention can be paid in the immediate postoperative period before transfer to the ward.[3]

The disadvantages of routine use of intensive care units include cancellation of an operation because there is no intensive care unit bed available, the expense of intensive care, and the risk of contracting a nosocomial infection in the intensive care unit.[4] The average length of stay in intensive care units varies considerably according to different authors. Up to 11 days have been reported in Table 1. However, it is not specified in these studies how long deep sedation and artificial respiration lasted. Actually, to date, there are no prospective trials available that compare complication rates and flap survival rates after deep sedation and artificial respiration in the immediate postoperative period and an immediate postoperative period without deep sedation and artificial respiration. Therefore, the aim of this prospective cohort study was to find out if an immediate postoperative period of deep sedation and artificial respiration for 24 hours in an intensive care unit leads to fewer complications and a reduced failure rate of microvascular flaps compared with a situation in which the patients are allowed to breathe spontaneously without sedation immediately after surgery in a recovery room.

PATIENTS AND METHODS

A prospective cohort study was carried out on patients who received free flap reconstruction for primary oral squamous cell carcinoma of the mandible and/or tongue at the Department of Oral and Maxillofacial Surgery, University of Erlangen-Nuremberg, Germany, between January 2006 and July 2008. The microvascular reconstructions were carried out by a single surgeon (E.N.). The study was approved by the institutional ethics committee. All patients gave their informed consent to participation in the study.

After surgery, the first 50 patients were transferred to the intensive care unit and the second 50 patients to the recovery room. Respiratory care followed a standardized pathway. During the transfer to the intensive care unit, the recovery room patients received pressure controlled ventilation. In the intensive care unit, patients were sedated with propofol (target concentration 1–2.5 μg/mL) and remifentanil (0.1–0.3 μg/kg/min) to allow spontaneous respiration, which was supported with pressure support ventilation. After 24 hours of the induction of general anesthesia, analgosedation was terminated, and patients regained consciousness and were extubated. If patients did not have preoperative pulmonary pathology (eg, COPD), no routine nebulized treatment was applied. In the recovery room, sedation with propofol was continued to allow pressure support ventilation until patients met the criteria for extubation (normothermia, no residual neuromuscular blockade, p_aO_2 >100 mm Hg with $F_iO_2 = 0.4$). Days in the intensive care unit and necessity of readmission to the intensive care unit were recorded.

Patients' age, sex, and comorbidity level according to the American Society of Anesthesiology (ASA) status were documented. Demographic data consisted of patient age, tumor T and N classification, kind of resection defect (bony, soft tissue, combined defect), and history of previous irradiation or bony reconstructive surgery.

Patients whose ASA status exceeded III, who had received radiation in the head and neck region before surgery, or who had undergone chemotherapy were excluded from the study. Recurrence of oral squamous cell carcinoma, coronary insufficiency, and advanced chronic pulmonary disease requiring strict cardiopulmonary monitoring also were exclusion criteria.

The 2 patient groups were matched for age, sex, tumor T and N classification, ASA score, and kind of microvascular reconstruction. Between the pairs, a difference in age of 5 years was accepted. For the N classification, N_0 and $N_{>0}$ were distinguished.

In all cases, decision regarding the extent of the tumor resection was based on clinical findings associated with panoramic radiographs or CT evaluation as well as macroscopic and microscopic (incisional biopsies) evaluation by the time of surgery. Region and extent of tumor resection were documented.

Perioperative antibiotic prophylaxis was carried out with 10 million IE penicillin intravenously. Antibiotic administration was repeated every 3.5 hours. In cases of intolerance of penicillin, the patients received 600 mg clindamycin intravenously.

When a segmental resection of the mandible was necessary, reconstruction plates were contoured to the original mandible and used as template for modeling the vascularized bone graft. The cutaneous portion of the flaps was used to restore intraoral lining.

All patients received a modified radical neck dissection on the ipsilateral side including 5 levels and a suprahyoidal neck dissection including 3 levels on the contralateral side.

Based on the resection defect, the microvascular reconstruction was carried out either with a radial forearm flap, a latissimus dorsi flap, or a subscapular system flap. At the end of surgery, in all patients, a tracheostomy was carried out. Duration of surgery was determined as the difference between the time entering the operating room and the time of exit.

Blood transfusions were carried out during surgery when the hemoglobin value fell below 8 mg/dL. Blood products used either intraoperatively or during hospitalization, crystalloids and colloids used intraoperatively, were recorded. During the first 72 hours after surgery, the target systolic blood pressure was set at 100 mm Hg. If necessary, a combination of low dose norepinephrine (0.025–0.15 μg/kg/min) and dobutamine (0.5–5 μg/kg/min) was used to maintain systolic arterial blood pressure above 100 mm Hg. After surgery, all patients received anticoagulation with daily single doses of low-molecular-weight heparin, which was administered subcutaneously.

Outcome measures were complications that occurred during 30 days after surgery. General medical complications and complications that were directly linked with flap donor and recipient sites were distinguished.

General medical complications were perioperative death, paroxysmal atrial fibrillation, myocardial infarction, cardiac arrest, renal failure, peptic ulceration, pulmonary embolus, pneumothorax, pneumomediastinum, chest infection, respiratory insufficiency (blood oxygen saturation below 90%), pneumonia, adult respiratory distress syndrome (ARDS), sepsis, methicillin resistant Staphylococcus aureus (MRSA) infection, acute alcohol withdrawal delirium, status epilepticus, postoperative psychosis, and problems with weaning from ventilation.

Flap donor site complications were hemorrhage, hematoma, seroma, infection, wound breakdown, and dehiscence.

Flap recipient site complications were total flap necrosis, partial flap necrosis, venous congestion, arterial insufficiency, hemorrhage, hematoma, seroma, infection, wound breakdown, dehiscence, and fistula formation.

Flap monitoring was carried out by checking for capillary return and bluish staining every 4 hours during the first 3 postoperative days to exclude arterial and venous compromise. Salvage surgery was carried out when arterial or venous compromise of a flap was apparent.

All additional interventions that were necessary to manage complications were documented.

Statistics. For statistical analysis, group means and standard deviations were calculated for each parameter using the SPSS software (version 15, SPSS, Chicago). Data were compared using the chi-square test or Mann-Whitney U test for independent samples. A p value smaller or equal to .05 was considered statistically significant.

RESULTS

In both groups, 43 men and 7 women were included. The mean age in the intensive care

Table 2. T and N classification in both the study groups.

No. of patients	Tumor classification
11	T_2N_0
6	$T_2N_{>0}$
4	T_3N_0
3	$T_3N_{>0}$
18	T_4N_0
8	$T_4N_{>0}$

Table 3. Microvascular flaps used in both the study groups.

No. of patients	Kind of microvascular flap
22	Radial forearm flap
17	Subscapular system flap
11	Latissimus dorsi flap

unit group was 62.8 ± 9.7 years and 63.5 ± 9.5 years ($p = .733$). In all patients, R_0 resections could be performed. In each group, 17 patients with T_2 classification, 7 with T_3 classification, and 26 patients with T_4 classification were included (Table 2). The distribution of the microvascular flaps is given in Table 3.

The average operation time lasted 8.8 ± 2.1 hours for the intensive care unit group and 9.3 ± 2.1 hours for the recovery room group ($p = .166$). Catecholamines were give during surgery to 15 patients in the intensive care unit group and to 12 patients in the recovery room group during surgery ($p = .068$) (Table 4).

Tracheostomy caused no complications in any of the patients during the observation period.

During their stay in the intensive care unit and the recovery room, respectively, 13 patients received catecholamines during the first 24 hours in the intensive care unit, whereas 9 patients received catecholamines in the recovery room group. After the first 24 hours, none of the patients in the recovery room group received catecholamines. In the intensive care unit group, 4 patients received catecholamines longer than 24 hours and up to 7 days after surgery (Table 4).

All patients who were transferred to the recovery room could leave it after 24 hours. In the intensive care unit group, 34 patients could leave the intensive care unit after 24 hours. Five patients stayed for 48 hours, 5 for 72 hours, and 6 for more than 72 hours. The mean length of stay on the intensive care unit was 3.5 ± 10.9 days in this group, before they could be transferred to the general ward (Table 4).

During the further observation period, 2 patients of the recovery room group, and 3 patients of the intensive care unit group were readmitted to the intensive care unit (Table 4). Reasons for the readmission were cardiac problems, respiratory insufficiency, pneumonia, and sepsis.

During the follow-up period, complications occurred in 23 patients of the intensive care unit group and in 19 of the recovery room group ($p = .418$).

The general medical complications that were observed during the observation period are given in Table 5. More cases of respiratory insufficiency ($p = .240$) and pneumonia ($p = .081$) occurred in the intensive care unit group compared with the recovery room group. Significantly, more patients had problems with weaning from ventilation in the intensive care unit group ($p = .022$). In 1 patient in the intensive

Table 4. Perioperative care of the patients.

	Operation time, h (mean ± SD; range)	No. of blood units transfused per patient, mean ± SD; range	Administration of catecholamines intra- and postoperatively (no. of patients affected)	Length of stay in the intensive care unit, d (mean ± SD; range)	Readmittance to the intensive care unit (no. of patients affected)
Recovery room group (total no. of patients = 50)	9.3 ± 2.1; 6.6–14.2	4.2 ± 2.3; 0–11	9	0	2
Intensive care unit group (total no. of patients = 50)	8.8 ± 2.1; 6.6–13.9	4.4 ± 2.6; 0–13	17	3.5 ± 10.9; 1–76	3
p value	.166	.768	.068	<.0005	.646

Table 5. General medical complications.

(a)	Perioperative death (no. of patients affected)	Paroxysmal atrial fibrillation (no. of patients affected)	Myocardial infarction (no. of patients affected)	Cardiac arrest (no. of patients affected)	Renal failure (no. of patients affected)	Peptic ulceration (no. of patients affected)	Pulmonary embolus (no. of patients affected)	Pneumo-thorax (no. of patients affected)	Pneumo-mediastinum (no. of patients affected)	Chest infection (no. of patients affected)
Recovery room group (total no. of patients = 50)	0	3	0	0	0	0	0	0	0	0
Intensive care unit group (total no. of patients = 50)	1	3	0	0	0	0	0	0	0	0
p value	.315	1	–	–	–	–	–	–	–	.240

(b)	Respiratory insufficiency (no. of patients affected)	Pneumonia (no. of patients affected)	Adult respiratory distress syndrome (no. of patients affected)	Sepsis (no. of patients affected)	MRSA infection (no. of patients affected)	Acute alcohol withdrawal delirium (no. of patients affected)	Status epilepticus (no. of patients affected)	Postoperative psychosis (no. of patients affected)	Problems with weaning from ventilation (no. of patients affected)
Recovery room group (total no. of patients = 50)	2	2	0	0	1	1	0	1	0
Intensive care unit group (total no. of patients = 50)	5	7	0	1	3	3	0	0	5
p value	.240	.081	–	.315	.307	.307	–	.315	.022

Table 6. Flap donor site complications.

	Hemorrhage (no. of patients affected)	Hematoma (no. of patients affected)	Seroma (no. of patients affected)	Infection (no. of patients affected)	Wound breakdown (no. of patients affected)	Wound dehiscence (no. of patients affected)
Recovery room group (total no. of patients = 50)	2	2	3	2	2	2
Intensive care unit group (total no. of patients = 50)	0	0	4	2	2	2
p value	.153	.153	.695	1	1	1

care unit group, perioperative death occurred because of rhabdomyolysis of unknown origin.

The complications of flap donor and recipient sites are given in Tables 6 and 7. There were no statistically significant differences between the 2 groups for hemorrhage, hematomas, insufficiency of arterial and venous anastomoses.

Salvage surgery had to be carried out because of arterial or venous compromise of flaps in 5 patients of the recovery room group and 8 patients of the intensive care unit group. Three flaps in the recovery room group and 5 flaps in the intensive care unit group could be saved. However, partial flap necrosis occurred in 2 of the re-explored flaps in both of the groups. There were no statistically significant differences for partial ($p = 1$) and total flap necroses ($p = .646$) between the 2 groups. All flaps that were lost were radial forearm flaps.

DISCUSSION

Free flap surgery helps meeting the oncological principle of radicality, because resection limits are not compromised by the uncertainty of reconstruction.[13] However, the surgical treatment of head and neck cancer is often limited by the risk of operative and postoperative complications.[14] Therefore, in some centers, patients receiving head and neck tumor resections and microvascular reconstructions are routinely transferred to intensive care units after surgery.[3] There are guidelines from the British Association of Head and Neck Oncologists that state that there should be "onsite intensive care und high dependency unit facilities" in centers where head and neck cancer surgery is performed.[15] The reasons for this dependence on intensive care units are not clear, but it seems that issues such as lack of availability of experienced nursing staff on a general ward play a major role. A further aspect is that the access to intensive care unit facilities has become easier in recent years and, therefore, could be adopted as a convenient option.

Potential disadvantages of the routine use of intensive care units include increased cancellation of operations because of lack of beds in the intensive care and increased costs.[4,16] Therefore, it has been claimed in retrospective studies that it is safe to nurse patients, who have received head and neck cancer resection and microvascular reconstruction, outside the intensive care unit, provided that this is done in an appropriate environment and with adequately trained nursing staff.[4,13] By using the specialist head and neck ward with its appropriately trained staff and a regular specialist anesthesiologist, it seemed to be possible to do major resections and reconstructions on carefully selected patients without the need for the intensive care unit. It was concluded that this management strategy was cost-effective and efficient without having an adverse effect on care or violating established guidelines.[17,18]

It seems that the current literature is not conclusive concerning the question whether patients undergoing head and neck tumor resection and microvascular reconstruction should be monitored in an intensive care unit immediately postoperatively or do not require a postoperative regimen that is different of that of other patients with head and neck cancer.

Therefore, it was the aim of this prospective cohort study to determine whether an immediate postoperative period of deep sedation and artificial respiration in an intensive care unit for 24 hours leads to fewer complications and a reduced failure rate of microvascular flaps

Table 7. Flap recipient site complications.

	Total flap necrosis (no. of patients affected)	Partial flap necrosis (no. of patients affected)	Venous congestion (no. of patients affected)	Arterial insufficiency (no. of patients affected)	Hemorrhage (no. of patients affected)	Hematoma (no. of patients affected)	Seroma (no. of patients affected)	Infection (no. of patients affected)	Wound breakdown (no. of patients affected)	Wound dehiscence (no. of patients affected)	Fistula formation (no. of patients affected)
Recovery room group (total no. of patients = 50)	0	3	0	0	0	0	0	0	0	0	1
Intensive care unit group (total no. of patients = 50)	1	3	0	0	0	0	0	0	0	0	2
p value	.315	1	–	–	–	–	–	–	–	.240	.558

compared with a situation in which the patients are allowed to breathe spontaneously without sedation immediately after surgery.

Independent of the question whether or not patients should be transferred to an intensive care unit, it is mandatory to secure the patients' airway. Using temporary tracheostomy on a routine basis has proved to be an effective means.[1,4] However, the value of routine tracheostomy has been questioned as it has been said to carry an appreciable morbidity.[19–21] A complication rate of up to 11% has been reported. The most common complication was postoperative chest infection in 8% of the cases. Even a pneumomediastinum has been described secondary to tracheostomy.[4] Complications have been found in 8% of the patients with a mean duration of retention of 10 days.[22] Despite the drawbacks of tracheostomy, it guarantees an airway that can be compromised after resections of the oral cavity. In this study, no complications of tracheostomy in both of the groups could be identified. Tracheostomy seemed to be a safe technique. Besides securing the airway, it provided access for bronchial and pulmonary toilet and, therefore, was beneficial to the patients. Neither in the intensive care unit nor in the recovery room airway problems occurred.

It has been described previously that when patients were monitored in an intensive care unit without performing routine tracheostomy, more than 50% of the patients did not require a tracheostomy during an average stay in an intensive care unit of 11 days.[7] However, in 25% of the patients, secondary tracheostomy was necessary. It seems that this pronounced necessity for secondary tracheostomy was 1 of the reasons for the prolonged stay in the intensive care unit. A rate of 25% of secondary tracheostomy is not acceptable, when it is intended to transfer patients to a general ward as soon as possible. A large number of emergency situations would be the result. Therefore, because of its low morbidity found in this study, it seems acceptable to use primary tracheostomy on a routine basis. It is a key point that allows avoiding the intensive care unit.

The number of blood units transfused in this study was not influenced by the kind of postoperative care. A transfusion trigger of 8 mg/dL was chosen.[23] Although the number of blood units transfused seemed high, it was comparable to what has been described in the literature previously.[11]

Among the numerous potential postoperative complications, even death has been reported after head and neck cancer surgery.[4] Cardiac arrest secondary to a myocardial infarction is 1 of the main reasons and a well-recognized complication of any major operation. It was put into question if nursing on an intensive care unit raises the chances of survival of affected patients.[4] In this study, 1 patient who stayed in the intensive care unit developed rhabdomyolysis of unclear origin with fatal outcome. Obviously, the stay in the intensive care unit did not help to avoid this problem.

Flap survival rates after microvascular surgery between 87% and 98% have been reported for patients who were not transferred to an intensive care unit after surgery.[1,4] This fact suggests that, provided the technique has been sound, the postoperative location of the patient does not influence survival of flaps significantly. The flap survival rates found in this study were comparable to accepted rates published previously.[24] They seemed not to be influenced by the aspect if a patient had been admitted to the intensive care unit or not.

It has been assumed that the avoidance of composite reconstructions may contribute to the high success rate.[1] Previous studies reported more complications when composite reconstructions were compared with fasciocutaneous flaps.[25] In this study, the overall flap survival rate was 94% for patients in the intensive care unit group and 96% for the group that was transferred to the recovery room breathing spontaneously. Most often, the scapular system flap was used in both of the groups. Failures of this kind of flap did not occur. It seems that using an intensive care unit does not have an influence on flap survival, which was in a normal range even for composite flaps when patients only had access to the recovery room.

One of the more frequent complications is the development of postoperative pulmonary insufficiency and pneumonia.[14] In this study, pneumonia was found more often in the patients who were admitted to the intensive care unit. However, the difference compared with the recovery room group was not statistically significant.

The range of general complications found in this study is representative of that which may be encountered in any group of patients having major operations.[1] During the study period, 54% of the patients in the intensive care unit group and 62% in the recovery room group recovered without complications. These rates are comparable to previous studies.[1]

An MRSA infection rate in both of the groups was less than described previously.[26] It had been reported that 45% of patients undergoing operations for head and neck cancer became colonized by MRSA. The low rate of MRSA infection in this study can be explained by the improved hygiene standards on modern intensive care units.

An additional important aspect should not be ignored. The choice of the postoperative location significantly affects the cost of treatment. It has been shown previously that using an intensive care unit leads to fivefold increased cost.[1] Moreover, when cancellation of operations is avoided because there is no longer a dependence on a bed in the intensive care unit, this is a benefit to the hospital because resources are not wasted.

CONCLUSION

Admission to an intensive care unit immediately postoperatively did not reduce complications after head and neck tumor resection and microvascular reconstruction in this study. Compared to a group of patients nursed in a recovery room, more cases of pneumonia were found in the intensive care unit group during the postoperative course. However, the difference was not statistically significant. When tracheostomy is used on a routine basis, it seems safe to monitor patients after major head and neck tumor resection and microvascular reconstruction in a recovery room without reducing the flap survival rate. In addition, the cost-benefit ratio is improved by not using the intensive care unit.

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