

# Moisturization of the Surgical Field during Cancer Resection Reduces Perioperative Complications in Reconstruction Surgery

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**Background:** Intraoperative tissue desiccation is a risk factor for infection and wound necrosis. We hypothesized that maintaining a moist environment in the surgical field would reduce perioperative complications in free flap reconstruction for head and neck cancer surgery.

**Methods:** A total of 331 patients who underwent free flap reconstruction after head and neck cancer surgery from January 2013 to December 2017 at Osaka International Cancer Institute were included in the study. We classified patients into two groups: those in whom saline was sprayed only during reconstruction (control group: 162 patients) and those in whom saline was sprayed in the surgical field intermittently during cancer resection and reconstruction (moisturized group: 169 patients). We compared perioperative complications, including intraoperative arterial anastomotic thrombosis, between the two groups. Other candidate risk factors for intraoperative arterial thrombosis that were assessed included a history of preoperative irradiation, history of neck surgery, advanced age, and flap type.

**Results:** Rates of abscess formation and intraoperative arterial thrombosis were significantly lower in the moisturized group than in the control group (6.5% versus 12.7%,  $P < 0.05$  and 3.0% versus 11.1%,  $P < 0.01$ , respectively). Binomial logistic regression analysis revealed that, in addition to no moisturization during cancer resection, advanced age and jejunal flap use were significant risk factors for intraoperative arterial thrombosis.

**Conclusions:** Moisturization of the surgical field during cancer resection reduced the rate of perioperative complications in free flap reconstruction. Although simple, preventing desiccation of the surgical field by spraying saline solution intermittently had significant benefits on postoperative complications. (*Plast Reconstr Surg Glob Open* 2022;10:e4296; doi: [10.1097/GOX.0000000000004296](https://doi.org/10.1097/GOX.0000000000004296); Published online 2 May 2022.)

## INTRODUCTION

Desiccation of the surgical field can cause tissue damage to the wound surface, increasing the risk of infection

and wound margin necrosis.<sup>1</sup> In the case of free flap transfer, desiccation of the surgical field can damage vessels, potentially leading to anastomotic thrombosis. At our hospital, we have been applying saline solution intermittently in the surgical field to maintain a moist environment during free flap reconstruction after head and neck cancer resection. Since 2016, we have been using this procedure both during head and neck cancer resection and reconstruction. This study aimed to assess the effects of intermittent saline application in the surgical field not only during

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free flap reconstruction but also during head and neck cancer resection.

## PATIENTS AND METHODS

This study was approved by the institutional review board of Osaka International Cancer Institute. A total of 331 consecutive patients who underwent free flap reconstruction after head and neck cancer resection from January 2013 to December 2017 at Osaka International Cancer Institute were included in the study. Cancer resections were performed by several teams of head and neck surgeons. Immediately after that, reconstructions were performed by two plastic surgeons (H.T. and T.K.). Patients were divided into two groups: those in whom saline was sprayed only during flap elevation and reconstruction (control group: 162 patients, from January 2013 to December 2015) and those in whom saline was sprayed in the surgical field intermittently during cancer resection as well as flap elevation and reconstruction (moisturized group: 169 patients, from January 2016 to December 2017). Intermittent application of saline was performed by an assistant, using a 50-mL syringe with an intravenous catheter to spray 3–5 mL of saline over the entire surgical field every 3 minutes. [See Video (online), which displays the operative technique to apply saline to the surgical field.] Between resection and reconstruction, the surgical field was covered with a plastic film in all cases. In the control group, moisturization with wet gauze was not performed regularly, but rather only when the assistant noticed that the surgical field was dry. During the study period, no other changes were made in surgical/anesthesiological protocol, drugs, or instruments.

The frequency of perioperative complications (ie, total flap loss, partial flap necrosis, abscess formation, cervical skin necrosis, and intraoperative arterial thrombosis) was compared between the two groups using the Fisher exact test. In addition to the presence/absence of moisturization during cancer resection, preoperative irradiation, history of neck surgery, advanced age ( $\geq 75$  years), and grafted tissue type (jejunal or skin flap) were selected as candidate risk factors for intraoperative arterial thrombosis, and binomial logistic regression analysis was performed.

The significance level was set to 0.05 for statistical tests. Statistical analyses were performed using Excel 2007 (Microsoft, Redmond, Wash.) and Ekuseru-Toukei 2012 (Social Survey Research Information Co., Ltd., Tokyo, Japan).

## RESULTS

Patient background factors, including age, sex, preoperative irradiation, and history of neck surgery, did not significantly differ between the moisturized group and the control group (Table 1). With regard to flap type, there were a slightly higher number of free jejunum flap cases in the moisturized group relative to the control group (Table 2).

Perioperative complications are summarized in Table 3. Total flap loss occurred in one case (0.6%) in the control group and one case (0.6%) in the moisturized

## Takeaways

**Question:** Would maintaining a moist environment in the surgical field during cancer resection reduce perioperative complications in free flap reconstruction for head and neck cancer surgery?

**Findings:** Moisturization of the surgical field during cancer resection reduced the rate of perioperative complications in head and neck free flap reconstruction. Preventing desiccation of the surgical field by spraying saline solution intermittently had significant benefits on postoperative complications.

**Meaning:** Intraoperative moisturization should be performed not only during reconstructive surgery but also during cancer resection.

group. Partial flap necrosis occurred in nine patients (5.6%) in the control group and eight patients (4.7%) in the moisturized group, with no significant difference between the two groups ( $P = 0.73$ ). In contrast, the number of patients with abscess formation was significantly lower in the moisturized group than in the control group [11 (6.5%) patients versus 21 (12.7%) patients;  $P < 0.05$ ].

**Table 1. Patient Demographics**

Patient Characteristics	Control Group	Moisturized Group	<i>P</i>
No. patients	162	169	
Age (y)	64.4 $\pm$ 11.1	66.2 $\pm$ 11.5	0.75*
Gender			
Men	116	131	
Women	46	38	
Preoperative irradiation	36 (22.2%)	53 (31.4%)	0.52†
History of neck surgery	24 (14.8%)	29 (17.2%)	0.31†

\*Student *t* test.

†Fisher exact test.

**Table 2. Flap Type**

Flap Type	Control Group	Moisturized Group
Total	162	169
Anterolateral thigh flap	85	80
Rectus abdominis musculocutaneous flap	21	10
Fibula flap	3	4
Groin flap	1	1
Forearm flap	4	5
Jejunal flap	38	62
Jejunal flap + DIEP flap	10	7

DIEP, deep inferior epigastric artery perforator.

**Table 3. Outcome Measures**

Perioperative Complications	Control Group	Moisturized Group	<i>P</i> *
Total flap loss	162	169	
Partial flap necrosis	1 (0.6%)	1 (0.6%)	0.98
Abscess formation	9 (5.6%)	8 (4.7%)	0.73
Cervical skin necrosis	21 (12.7%)	11 (6.5%)	<0.05
Intraoperative arterial thrombosis	4 (2.5%)	4 (3.1%)	0.99
Intraoperative arterial thrombosis	18 (11.1%)	5 (3.0%)	<0.01

\*Fisher exact test.

The number of patients requiring reanastomosis due to intraoperative arterial thrombosis was also significantly lower in the moisturized group than in the control group [5 (3.0%) patients versus 18 (11.1%) patients;  $P < 0.01$ ]. Binomial logistic regression analysis revealed the following to be significant risk factors for intraoperative arterial thrombosis: no moisturization during cancer resection, advanced age, and jejunal flaps (Table 4).

## DISCUSSION

Although the success rate of free flaps has reached 96%–99%,<sup>2</sup> total flap loss from blood flow disturbances cannot be completely prevented. Internal factors, such as atherosclerosis, vasospasm, and damage to the vascular intima, are considered risk factors for arterial blood flow disorders, whereas external factors, such as compression and tortuosity of vessels, are considered the most common causes of venous blood flow disorders.<sup>3,4</sup> In reconstruction after head and neck cancer resection, elderly patients and those who received preoperative irradiation tend to have more postoperative complications.<sup>5,6</sup> The use of heparin<sup>7</sup> or papaverine<sup>8</sup> during reconstruction has been reported to prevent intraoperative thrombus formation at the anastomotic site. In the present study, moisturization during cancer resection was found to significantly reduce intraoperative arterial thrombosis. Although preoperative irradiation had no significant effect on the rate of intraoperative arterial thrombosis, advanced age was identified as a significant risk factor.

Vessels and surrounding tissue shrink when they dry out. When the critical point of water loss is exceeded, structural changes occur, reducing tissue compliance and elasticity.<sup>9</sup> This can result in tissue damage, which, in turn, affects the patency of anastomotic vessels.

Of the risk factors identified in this study, only intraoperative moisturization is intervenable. Although simple, preventing surgical field desiccation by intermittently spraying saline solution has significant benefits. Many plastic surgeons likely make efforts to prevent surgical field desiccation during reconstruction, but our findings suggest that it should be practiced during cancer resection as well.

The use of jejunal flaps was associated with a higher risk of intraoperative arterial thrombosis than the use of other flap types, likely due to the large caliber difference between jejunal and recipient arteries and the susceptibility of the jejunal artery to atherosclerosis.<sup>10</sup> Moreover, total laryngo-esophagectomy, for which jejunal flaps are indicated, tends to take a longer time than that needed for other operations, resulting in the tendency of tissue to

dry out intraoperatively. Prolonged surgery is also known to be associated with a risk of flap necrosis.<sup>11</sup>

In the present study, intraoperative arterial thrombosis required an average of 2 hours and 20 minutes of additional operative time for reanastomosis. Unexpected arterial occlusion requires various efforts, including identifying the site of thrombosis, removing the thrombus, and resecuring the recipient vessel. In such situations, recipient vessels are exposed to air for prolonged periods, sometimes even several hours, after being dissected and ligated during cancer resection. Although tissue that dries out intraoperatively may return to its original state when moisture is added, according to one report, drying of blood vessels in rabbit auricular veins for a prolonged period reduced the patency rate after anastomosis.<sup>12</sup> Given that tissue damage from desiccation accumulates even if the damage is not visible, efforts to prevent desiccation are important.

This study has several potential limitations. Importantly, because this study is a retrospective review with historical controls, it is possible that small changes in surgical technique or turnover in the surgical team may have influenced the outcome. On the other hand, our hospital performed 1235 head and neck reconstructions between July 1999 and December 2015, and total flap necrosis occurred in 10 cases (0.8%). Therefore, it is unlikely that the surgical technique itself has improved significantly since 2016. Future studies with appropriate controls are warranted to minimize the potential confounding factors.

## CONCLUSIONS

Intraoperative moisturization reduced the rate of intraoperative arterial thrombosis in head and neck free flap reconstruction. Our findings highlight the importance of preventing desiccation not only during reconstruction but also during cancer resection. Although simple, intraoperative moisturization has significant benefits and should be performed actively.

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All procedures conformed to the principles set forth in the Declaration of Helsinki. This study was approved by the Ethics Committee of Osaka International Cancer Institute, and written informed consent to publish personal and medical information was obtained from the patient.

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**Table 4. Binominal Logistic Regression Analysis of Factors Related to Intraoperative Arterial Thrombosis**

Risk Factor	P	Odds Ratio
Absence of moisturization	0.0011	6.04
Preoperative irradiation	0.98	0.99
History of neck surgery	0.45	1.66
Age ≥75 y	0.0076	0.27
Jejunal flap use	0.0021	4.35

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