

## SMOKING AND FLAP SURVIVAL: A COMPREHENSIVE SYSTEMATIC REVIEW

<sup>1</sup>Shabrina Nur Afati, <sup>2</sup>Dini Marini

<sup>1</sup>*Faculty of Medicine, Trisakti University, Jakarta Capital Special Region, Indonesia*

<sup>2</sup>*Faculty of Medicine, Muhammadiyah University of Jakarta, Jakarta Capital Special Region, Indonesia*

**Correspondence Author:**

[Nurafati.shabrina@gmail.com](mailto:Nurafati.shabrina@gmail.com)

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### ABSTRACT

**Background:** Free flap reconstruction of complex and/or large wounds, whether traumatic, following cancer resection, or for other reconstructive needs has become a commonly accepted practice. Multiple different types of free flaps are utilized for varying needs based on the individual patient and the defect that requires coverage. active smokers who underwent a nonelective traumatic reconstruction with a perforator-based fasciocutaneous flap (anterolateral thigh [ALT] flap) will have a higher incidence of smoking-related complications compared to the use of a muscle-only flap.

**The aim:** The aim of this study to show about smoking and flap survival.

**Methods:** By the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020, this study was able to show that it met all of the requirements. This search approach, publications that came out between 2014 and 2024 were taken into account. Several different online reference sources, like Pubmed, SagePub, and Google Scholar were used to do this. It was decided not to take into account review pieces, works that had already been published, or works that were only half done.

**Result:** In the PubMed database, the results of our search get 9 articles, whereas the results of our search on SagePub get 441 articles, on Google Scholar 4830 articles. Records remove before screening are 2771, so we get 2509 articles for screening. After we screened based on record exclude, we compiled a total of 10 papers. We included five research that met the criteria.

**Conclusion:** Smoking decreases the alveolar oxygen pressure and subcutaneous wound tissue oxygen, and nicotine causes vasoconstriction, smokers are more likely to experience flap loss, hematoma, or fat necrosis than non-smokers. Preoperative and post-operative abstinence period of at least 1 week is necessary for smokers who undergo flap operations.

**Keyword:** *Smoking, flap, surgery, wound.*

## INTRODUCTION

A recent study showed a prevalence of 46.5% of smokers among adult males. A relationship between ill effects on the heart, carcinogenicity, and also wound healing with smoking has been well established by many authors. The negative effects of smoking in other type of flaps (free flaps and pedicle-based flaps) has been shown in the past; however, evidences are not totally conclusive. There are limited studies done on the effects of exposure to passive smoke on fasciocutaneous flap. No study focuses on the effects of cigarette smoke exposure on a reverse sural fasciocutaneous flap in a rabbit model.<sup>1,2</sup>

Sural fasciocutaneous flap was developed according to the distribution of the sural nerve. It was first mentioned in literature in 1981 by Pontén. He concluded that it was a safe flap with an easy design for lower limb tissue defects. A reverse sural fasciocutaneous flap relies on retrograde blood supply through multiple distal perforators. This flap was introduced in 1983 and was based on the concept of reverse flow established by Botswick et al way back in 1976. It has gained wider usage in the reconstruction of tissue defects around the ankle, especially over the malleolus and heel. The versatility of the flap in this region with sparse blood supply is remarkable. These days some authors have even extended the reach of the flap until the forefoot.<sup>1</sup>

The analysis of risk factors affecting flap healing is an important task for surgeons. Relevant studies on exploring the influencing factors related to flap necrosis have been conducted. Some scholars concluded that a higher body mass index (BMI) or obesity is detrimental to normal flap healing, while Crippen et al argued that obesity had a protective effect on flaps in some cases. Smoking and lower protein levels were more consistently identified as risk factors for flap healing. Other factors considered to be associated with flap prognosis include radiation history, diabetes, age, defect site and flap size, and hypertension.<sup>3</sup>

Cigarette smoking within a year of surgery has been associated with adverse or suboptimal wound healing. In addition to the known medical issues that can arise from cigarette smoking, smokers are at risk of greater postoperative complications, including wound healing issues and pulmonary compromise. The most frequently implicated cigarette components in wound healing are nicotine, carbon monoxide, nitric oxide, and hydrogen cyanide. The main effects of nicotine on wound healing come from its peripheral vasoconstrictive properties, which can reduce blood flow profoundly in digital arteries specifically. And, as nitric oxide is a known relaxant of smooth muscle, it causes bronchodilation and vasodilation of pulmonary capillaries, effectively increasing the absorption of nicotine. Carbon monoxide decreases the oxygen available to tissues by shifting the oxygen-hemoglobin saturation curve, and hydrogen cyanide impairs innate cellular pathways for tissue repair.<sup>4</sup>

## METHODS

### Protocol

By following the rules provided by Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020, the author of this study made certain that it was up to par with the requirements. This is done to ensure that the conclusions drawn from the inquiry are accurate.

### Criteria for Eligibility

For the purpose of this literature review, we compare and contrast of smoking and flap survival. It is possible to accomplish this by researching or investigating of smoking and flap survival. As the primary purpose of this piece of writing, demonstrating the relevance of the difficulties that have been identified will take place throughout its entirety.

In order for researchers to take part in the study, it was necessary for them to fulfil the following requirements: 1) The paper needs to be written in English, and it needs to determine about smoking and flap survival. In order for the manuscript to be considered for publication, it needs to meet both of these requirements. 2) The studied papers include several that were published after 2014, but before the time period that this systematic review deems to be relevant. Examples of studies that are not permitted include editorials, submissions that do not have a DOI, review articles that have already been published, and entries that are essentially identical to journal papers that have already been published.

### Search Strategy

We used "smoking and flap survival." as keywords. The search for studies to be included in the systematic review was carried out using the PubMed and SagePub databases by inputting the words: *((("Flap surgery"[MeSH Subheading] OR "Flap reconstruction"[All Fields] OR "Smoking" [All Fields]) AND ("Risk of smoking"[All Fields] OR "Smoking and complications of flap survival" [All Fields]) AND ("Smoking and flap survival"[All Fields]) OR ("Complications of flap surgery cause of smoking" [All Fields]))* used in searching the literature.

### Data retrieval

After reading the abstract and the title of each study, the writers performed an examination to determine whether or not the study satisfied the inclusion criteria. The writers then decided which previous research they wanted to utilise as sources for their article and selected those studies. After looking at a number of different research, which all seemed to point to

the same trend, this conclusion was drawn. All submissions need to be written in English and cannot have been seen anywhere else.

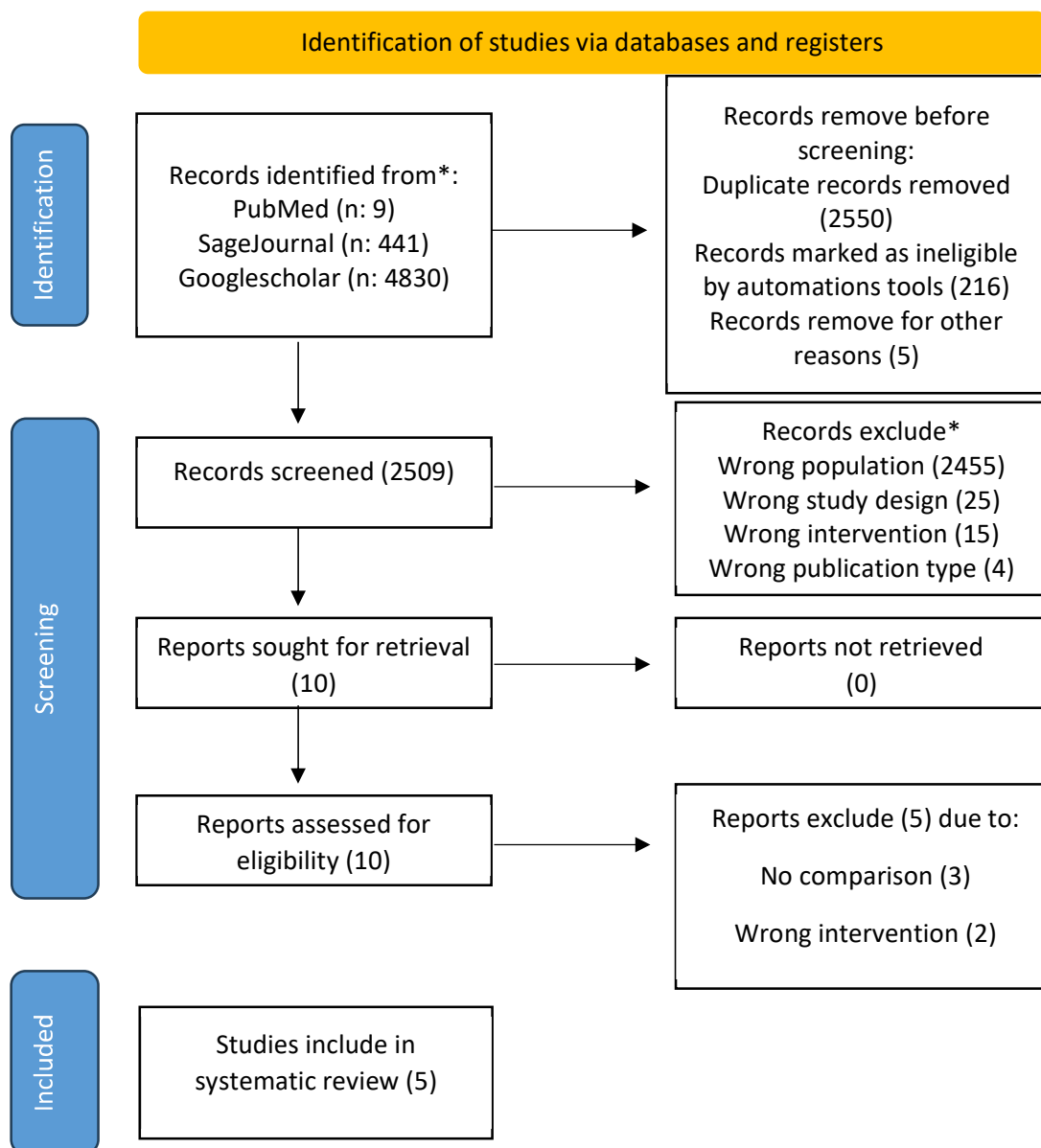


Figure 1. Article search flowchart

Only those papers that were able to satisfy all of the inclusion criteria were taken into consideration for the systematic review. This reduces the number of results to only those that are pertinent to the search. We do not take into consideration the conclusions of any study that does not satisfy our requirements. After this, the findings of the research will be analysed in great detail. The following pieces of information were uncovered as a result of the inquiry that was carried out for the purpose of this study: names, authors, publication dates, location, study activities, and parameters.

**Quality Assessment and Data Synthesis**

Each author did their own study on the research that was included in the publication's title and abstract before making a decision about which publications to explore further. The next step will be to evaluate all of the articles that are suitable for inclusion in the review because they match the criteria set forth for that purpose in the review. After that, we'll determine which articles to include in the review depending on the findings that we've uncovered. This criteria is utilised in the process of selecting papers for further assessment. in order to simplify the process as much as feasible when selecting papers to evaluate. Which earlier investigations were carried out, and what elements of those studies made it appropriate to include them in the review, are being discussed here.

**RESULT**

From the PubMed database, the results of our search get 9 articles, whereas the results of our search on SagePub get 441 articles, on Google Scholar 4830 articles. Records remove before screening are 2771, so we get 2509 articles for screening. After we screened based on record exclude, we compiled a total of 10 papers. We included five research that met the criteria.

Karamanos, E et al (2021)<sup>5</sup> showed that selecting a muscle-only flap in active smokers who undergo nonelective traumatic extremity reconstruction is associated with fewer smoking-related complications compared to a perforator fasciocutaneous flap. When smoking cessation is not feasible, selecting a muscle-only flap may result in a lower incidence of flap related complications. Further research is warranted.

Chiang, YHF et al (2023)<sup>6</sup> showed smoking status is related to increased perioperative risk for wound complications following major surgical procedures. The current literature review has shown that smoking harms wound healing. Our study adds to existing evidence and improves our understanding of healing complications in smoking surgical cases. Wound complications are associated with other adverse outcomes and have a significant impact on patient quality of life and health care budgets. Therefore, patients who smoke should be informed about the potentially increased risks of complications before surgery. Our results encourage smoking cessation prior to surgery, although the data do not allow us to evaluate the effects of smoking cessation.

**Table 1. The literature include in this study**

| Author                                       | Origin | Method             | Sample Size | Result  |
|--|--------|--------------------|-------------|---|
| <b>Karamanos, E et al., 2021<sup>5</sup></b> | USA    | Case control study | 118         | A total of 118 flaps were identified during the study period. Out of those, 52 were perforator-based fasciocutaneous flaps, while 66 were muscle flaps. Active smoking status resulted in a statistically significant increase in the incidence of major and minor complications in the perforator flap group (36% vs. 4%, adjusted odds ratio, AOR [95%CI]: 2.31[1.48,19.30], adj-p = 0.021 and 32% vs. 17%, AOR [95% CI]: 1.23[1.11,14.31], adj-p = 0.034) but had no impact in the muscle group.   |
| <b>Chiang, YHF et al., 2023<sup>6</sup></b>  | Taiwan | Cohort study       | 1156002     | A total of 1 156 002 patients (578 001 smokers and 578 001 nonsmokers) were included in the propensity score matching analysis. Smoking was associated with a significantly increased risk of postoperative wound disruption (OR 1.65, 95% CI 1.56-1.75), surgical site infection (OR 1.31, 95% CI 1.28-1.34), reintubation (OR 1.47, 95% CI 1.40-1.54), and in-hospital mortality (OR 1.13, 95% CI 1.07-1.19) compared with nonsmoking. The length of hospital stay was significantly increased in smokers compared with nonsmokers. Our analysis indicates that smoking is associated with an increased risk of surgical site infection, wound disruption, and postoperative pulmonary complications. The results may |

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|---|-------------|-------------------------------|------|--|
|   |             |                               |      | drive the clinicians to encourage patients to quit smoking before surgery.   |
| <b>Ooms, M et al., 2022<sup>7</sup></b>   | Germany     | Case control study            | 370  | A total of 370 patients reconstructed with a radial free forearm flap (RFFF) or anterolateral thigh flap (ALTF) in the head and neck region between 2011 and 2020 were retrospectively analyzed. Flap perfusion measurements with the O2C tissue oxygen analysis system were compared between nonsmokers, light smokers (< 20 pack-years), and heavy smokers (≥ 20 pack-years). The blood flow was intraoperatively equal in RFFFs (84.5 AU vs. 84.5 AU; <i>p</i> = 0.900) and increased in ALTFs (80.5 AU vs. 56.5 AU; <i>p</i> = 0.001) and postoperatively increased in RFFFs (114.0 AU vs. 86.0 AU; <i>p</i> = 0.035) and similar in ALTFs (70.5 AU vs. 71.0 AU; <i>p</i> = 0.856) in heavy smokers compared to nonsmokers. The flap survival rate was similar in nonsmokers, light smokers, and heavy smokers (97.3%, 98.4%, and 100.0%). Smoking partially increases rather than decreases microvascular free flap perfusion, which may contribute to similar flap survival rates in smokers and nonsmokers. |
| <b>Puyana, S et al., 2022<sup>8</sup></b> | USA         | A retrospective cohort study  | 1030 | A total of 1030 forehead flaps cases were analyzed and separated into 2 cohorts based on current smoking status: 789 (76.6%) nonsmokers versus 241 (23.4%) smokers. No significant differences in rates of wound complications were found for nonsmokers versus smokers (2.7% vs 4.1%; <i>P</i> = .0807), including when adjusted for comorbidities in a multivariate logistic regression model (adjusted odds ratio, 1.297 [95% confidence interval, 0.55-2.9]; <i>P</i> = .5174).  |
| <b>Min, SH et al., 2022<sup>9</sup></b>   | South Korea | A randomized controlled trial | 79   | RIC consisted of four cycles of 5-min ischemia and 5-min reperfusion applied to the upper or lower extremity. The primary endpoint, tissue oxygen saturation of the flap, was measured by near-infrared spectroscopy on the first postoperative day. Organ-  |

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|--|--|--|---|
|  |  |  | <p>protective effects of RIC were evaluated with infarct size of rat hearts perfused with plasma dialysate from patients received RIC or sham-RIC. Between April 2018 and July 2019, 50 patients were randomized (each n=25) and 46 were analyzed in the RIC (n=23) or sham-RIC (n=23) groups. Tissue oxygen saturation of the flap was similar between the groups (85 ± 12% vs 83 ± 9% in the RIC vs sham-RIC groups ; P=0.471). Myocardial infarct size after treatment of plasma dialysate was significantly reduced in the RIC group (44 ± 7% to 26 ± 6%; P=0.018) compared to the sham-RIC group (42 ± 6% to 37 ± 7%; P=0.388). RIC did not improve tissue oxygenation of the transferred free flap in head and neck cancer reconstructive surgery. However, there was evidence of organ-protective effects of RIC in experimental models.</p> |
|--|--|--|---|

Ooms, M et al (2022)<sup>7</sup> showed smoking has only a minor and smoking-amount-dependent impact on microvascular free flap perfusion in RFFF and ALTF. Increased or at least unrestricted flap blood flow could contribute to similar flap survival rates in smoking and nonsmoking patients. However, this should not affect the general recommendation for preoperative smoking cessation.

Puyana, S et al (2022)<sup>8</sup> showed smoking has previously been demonstrated to be a risk factor for plastic surgery procedures. In forehead flap facial reconstruction, our study showed that smokers did not have worse outcomes compared with nonsmokers. Though it is still advised to counsel patients on smoking cessation given the multiple health benefits, a history of past or current smoking status should not preclude a patient in need of undergoing a forehead flap based on the theoretical increased risk of complications alone.

Min, SH et al (2022)<sup>9</sup> showed Remote ischemic conditioning (RIC) did not improve flap tissue oxygenation after head and neck cancer reconstructive surgery. There was evidence of a myocardial-protective role of RIC in the ex vivo I/R injury model using plasma dialysate from patients.

**DISCUSSION**

The viability of cutaneous flaps and grafts is dependent on adequate circulation and perfusion. Smoking, excessive tension or pressure, arterial insufficiency, and venous congestion are factors that can contribute to flap failure due to poor perfusion. Early identification of tissue ischemia and its intervention can improve flap survival. Tadalafil is a phosphodiesterase-5 (PDE5) inhibitor that increases blood flow by vasodilation of the peripheral vasculature as well as inhibition of platelet aggregation. Although current indications for tadalafil by the US Food and Drug Administration are for erectile dysfunction and pulmonary hypertension,<sup>1</sup> its mechanism of action is theoretically beneficial in increasing blood perfusion in patients who are at risk of flap or graft ischemia due to poor circulation. The following case series presents the successful off-label use of tadalafil in preventing tissue ischemia in high-risk patients and treating patients with early signs of tissue necrosis.<sup>10</sup>

Tobacco cessation is often thought of as the domain of primary care physicians, but there is an ever-increasing amount of evidence that urologists are optimally positioned to screen patients for tobacco use and provide both counseling and cessation treatment. Studies have found smokers counseled on smoking cessation by their urologist increased their likelihood of success more than 4 times over those that were not counseled, and patients cite counseling from their urologist as the leading motivator in cessation attempts.<sup>11,12</sup>

Proximity flap transfer is an effective method for repairing body surface soft tissue defects; however, its postoperative complications include infection, dehiscence, bleeding, subcutaneous effusion, fat liquefaction, arteriovenous crisis, and tissue necrosis, which result in poor health outcomes and increased health care costs. In contrast to short-term complications, long-term complications of the flap are often related to the appearance of the flap, such as scar contracture, hyperpigmentation, and flap bloat, and this is also a topic worth investigating; however, the focus of this study was on short-term complications to aid in early intervention.<sup>3</sup>

In a recent retrospective study of patients undergoing laparoscopic cholecystectomy, smoking was found to be a significant independent contributing factor among many covariates influencing the length of hospital stay. Another retrospective cohort study of patients undergoing total laryngectomy also concluded that smoking was directly related to increased postoperative complications, which delayed patient recovery. Combining what we have learned from outside literature as well as our own analysis, one of the most likely explanations for this relationship stems from the decrease in wound healing often observed in active smokers. In addition, the increase in pulmonary and infectious complications discussed previously also likely contributes to lengthier hospital stays for these patients.<sup>13</sup>

## CONCLUSION

Smoking decreases the alveolar oxygen pressure and subcutaneous wound tissue oxygen, and nicotine causes vasoconstriction, smokers are more likely to experience flap loss, hematoma, or fat necrosis than non-smokers. Preoperative and post-operative abstinence period of at least 1 week is necessary for smokers who undergo flap operations.

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