Smoking and surgery

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Key points

Smokers have an elevated risk of perioperative respiratory distress and of transfer to intensive care.
Tobacco smoke substantially alters the healing process and constitutes a documented risk factor for postoperative complications (anastomotic leakage, delayed healing etc.).
Risk of postoperative infection is also higher in smokers.
When patients stop smoking 6 to 8 weeks before surgery, the incidence of complications related to tobacco smoke drops nearly to zero.
Even stopping for a short period reduces the risk of complications, although the benefits of stopping increase with length of time.
Preoperative smoking cessation should take place as early as possible. The general practitioner and the surgeon both have essential roles to play.
Identification of smokers must be accompanied by measures to help the patient stop smoking, including advice, and if necessary, nicotine substitutes.
Anxiety levels are higher in smokers than nonsmokers. Nonetheless smoking cessation for hospitalization does not increase these levels, even without nicotine substitutes.
There is no interaction between anesthetic agents and nicotine substitutes: the latter may be continued through the morning of surgery and reinitiated in the immediate postoperative period.
Patients who stop smoking for surgery should be encouraged to continue to stop, permanently. The general practitioner’s support is essential for this.
The smoking rate in the general French population is estimated at approximately 30%. Based on estimates of the number of patients who receive anesthesia annually, it would appear that nearly 2 million surgical procedures involve smokers. Smoking cessation is especially important for these individuals because, as has long been recognized, smoking is a major risk factor for postoperative respiratory complications. Nonetheless until recently, there was no strong consensus in favor of urging patients to stop smoking before surgery. The conclusions of the expert conference on perioperative smoking, held in September 2005 [1], radically changed this attitude. They stressed not only the consequences of smoking on the cardiorespiratory system, but also the considerable negative impact it has on the entire healing process and thus on the risk of postoperative complications. This conference also reviewed methods that can improve smoking cessation success rates. Surgery is a propitious moment for patients to revise their health behaviors. On such occasions, patients and their families are especially receptive to changing behavior to reduce surgical risk to the lowest possible level.

Risks associated with smoking in the perioperative period

Smoking is one of the principal risk factors for heart failure and chronic bronchopulmonary diseases. A smoker with heart disease or chronic bronchitis has an elevated risk of perioperative mortality, not directly linked to smoking, but related to the risk of each of these diseases. Equally important during the perioperative period, smoking affects the healing process and defenses against infection.

Respiratory complications

Smoking has long been identified as a risk factor for postoperative pulmonary morbidity, which remains a major problem in cardiothoracic and upper abdominal surgery. In a prospective study, Bluman et al. [2] found an incidence of pulmonary respiratory complications of 22% in smokers, 12.8% in former smokers and 4.9% in patients who had never smoked. The postoperative respiratory risk appears to rise in patients who smoked for more than 20 pack-years.

Cardiovascular morbidity

Smoking sharply increases the concentration of carbon monoxide and therefore of HbCO. This reduces the blood’s oxygen transport capacity. Smokers have a mean HbCO level of approximately 7% and it can exceed 15% by the end of the day in heavy smokers. Although its elimination half-life is fairly short, several days of tobacco detoxification are necessary before it reaches undetectable levels in the blood [3]. This impairment of oxygen transport can be clinically observed and the risk of ST-segment depression increases when the exhaled CO exceeds 35 ppm. Moreover, the hemodynamic consequences of endotracheal intubation are more pronounced in smokers than nonsmokers and heart rates rise more. Thus, active smoking not only harms pulmonary function, but also compromises cardiovascular function. Nonetheless current literature contains no analyses that assess the combination of the pulmonary and cardiovascular complications associated with smoking, nor the effects of smoking cessation.

Infectious complications

Smoking alters tissue healing and promotes infection of surgical wounds. Tobacco smoke is a complex aerosol containing more than 4000 components, most of them pharmacologically active. Nicotine and carbon monoxide are the 2 principal substances that inhibit healing and predispose to wound infection. CO decreases oxygen transport to tissues by competitive inhibition of hemoglobin binding sites. Shifting the oxygen dissociation curve to the left reduces the quantity of oxygen delivered to the tissues. Nicotine directly and indirectly induces vasoconstriction by producing catecholamines and thromboxane A2 and by inhibiting prostaglandin I2 secretion. Nicotine also promotes platelet aggregation and affects the quality of healing by decreasing collagen production. Other components of tobacco smoke induce reduced erythrocyte deformability and lesions in the vascular endothelium and can block repair processes. They also promote platelet aggregation and thromboxane A2 release. Finally, some toxins inhibit the leukocyte function involved in the inflammatory process. Together these elements maintain a state of tissue hypoxia and encourage bacterial growth at the surgical site [4]. An increase in soft tissue healing disorders has been shown to occur in numerous types of surgery, especially in plastic and reconstructive surgery in active smokers (flap necrosis, defective cutaneous healing, other surgical wound complications). For example, the risk of postoperative infectious complications in breast surgery is 3 to 3.5 times higher in active smokers who do not stop smoking before surgery [5]. After sternotomy, the risk of infection in deep mediastinal and superficial soft tissues is twice as high in smokers undergoing coronary bypass [6]. Smokers also have 3 times more soft tissue infections of the chest wall than nonsmokers. The incidence of infection for parasacral cutaneous biopsies of volunteer subjects is higher in smokers (12%) than in nonsmokers (2%) [7].

Risk of surgical complications

The risk of surgical complications in smokers, like the risk of infection, is directly associated with the toxic action of numerous components of tobacco smoke. The risk of complications in healing with orthopedic surgery is 5% in nonsmoking subjects versus 31% in smokers [8]. Similarly, after hip or knee arthroplasty, smoking is the most important risk factor for the occurrence of complications in the surgical area, including hematoma, infection, and subfascial fluid collection, which are themselves responsible for significant prolongation of hospitalization [9].
Surgical complications are especially important when it comes to healing of skin grafts or muscle flap transfers. Similarly, in plastic surgery, the rate of complications among smokers after, for example, abdominoplasty is approximately 50% while it is only 15% in nonsmokers [10]. In breast surgery, smoking is closely associated with complications of healing, including infections, epidermolysis or necrosis of skin flaps. Specialists in microsurgery deal directly with the harmful effects of smoking. Such negative effects are also seen in lower limb vascular bypass surgery. A recent meta-analysis showed that the risk of bypass thrombosis is tripled in patients who continue smoking. This study also found a relation between the bypass flow rate and quantitative smoking indicators. Postoperative smoking cessation restores a flow rate close to that found in nonsmokers, while continued smoking is responsible for nearly 60% of all failures [11].

Smoking is also implicated in bone healing problems for some patients. For diaphyseal fractures of the leg, the mean time to healing is 270 days for smokers compared with 136 for nonsmokers. Similarly, for open leg fractures, healing takes 32 weeks for smokers and 28 weeks for nonsmokers; repeat procedures to aid healing is more frequent in smokers [12]. Smoking triples the risk of pseudarthrosis after hindfoot arthrodesis and increases the risk of nonunion after spinal fusion: 14.2% in nonsmokers versus 26.5% in patients who continue smoking after surgery. In that study, smoking cessation for more than 6 months after surgery lowered the rate of nonunion to a level approaching that of nonsmokers [13]. This suggests that postoperative smoking cessation reverses the harmful effects of smoking on spinal fusion.

Smoking triples the risk of anastomotic leakage after colorectal surgery [14]. The risk of abdominal wall hernia is 4 times higher in smokers than in nonsmokers after laparotomy [15].

In summary, smoking considerably increases the risk of postoperative surgical complications by increasing the complication rate of surgical wounds, including scar dehiscence, fat necrosis, and hematomas. It contributes to partial necrosis in cases of tissue detachment and mobilization (flaps, skin grafts) and prolongs the period of healing for long bone fractures, increasing the risk that secondary procedures will be required for grafts and for incomplete union after surgical fusion. Finally, it increases the risk of gastrointestinal anastomotic leakage, especially in the colorectal area. These complications significantly contribute to prolonging hospitalizations in surgery departments and probably help to double the risk of unplanned postoperative transfers to intensive care.

Benefits of smoking cessation

Effect on the respiratory system

The anesthetic effect of tobacco smoke on the bronchial mucous membrane enables smokers to tolerate substantial quantities of airway secretions without coughing. When they stop smoking, the congestion provokes a violent cough that decongests and cleans the airways. Moreover, the volume of bronchial secretions is higher in patients who stopped smoking one to two months earlier, compared with current smokers [16]. Coughing, bronchial hypersecretion, and congestion are all recognized risk factors of postoperative respiratory complications, and these observations explain, at least in part, the increase in respiratory complications reported among patients who either cut back or stopped smoking shortly before surgery. Nonetheless, other more recent studies do not find significantly excess levels of respiratory morbidity in patients who stopped smoking more than 2 months before surgery [17]. In any case, this potential excess risk in the first weeks of detoxification must be balanced with all of the clearly documented benefits of cessation, even for a short period.

Tobacco smoke has a proinflammatory effect that exacerbates bronchial and upper airway reactivity. This has been described not only in smokers but also in children exposed to their parents’ secondhand smoke before surgery. This upper airway hyperreactivity starts to decrease by the second day of smoking cessation and disappears within 10 to 14 days [18]. Excess respiratory morbidity has been clearly documented among children who receive anesthesia and whose parents smoke and expose them to the tobacco smoke.

A decrease in carbon monoxide (CO) levels and the beneficial consequences of smoking cessation on oxygenation, especially on the myocardium and the surgical site, are among the many benefits of smoking cessation, even if recent. The risk of bronchial infection or pneumonia is higher in smokers than in nonsmokers and does not differ between smokers and those who stopped smoking fewer than 56 days before surgery [18]. These data suggest that complete restoration of antimicrobial defenses requires substantial time, and this point is confirmed by persistent changes in macrophage function in patients who stopped smoking 2 to 6 months earlier [19].

Overall, reports from the literature consistently suggest that when patients stop smoking 6 to 8 weeks before surgery, their risk of postoperative respiratory complication falls to the level of nonsmokers. Nonetheless, benefits to stopping even closer to surgery remain significant in terms of minimizing the risks associated with bronchial hyperreactivity and with defective tissue oxygenation by decreasing HbCO.

Surgical risk and time from cessation to surgery

After orthopedic surgery in smokers, the rate of postoperative surgical complications is 18% for patients who stop smoking 6 to 8 weeks before surgery and 52% for the smokers who continue [9]. In ENT surgery, not only does smoking cessation decrease the risk of surgical site complications but the extent of the improvement is greatest the earlier the patient stops smoking. Nonetheless benefits are noticeable even when cessation started less than 3 weeks earlier [20]. There are no data about early cessation before surgery for bone healing, but the benefit of postoperative cessation is clearly documented. At 4 weeks,
cutaneous healing in smokers abstaining and using nicotine patches is associated with a cutaneous infection rate approaching that of nonsmokers [8]. Overall, postoperative healing and tissue repair processes improve very soon after smoking cessation. While a period of 4 to 6 weeks is probably necessary to obtain the full benefits of detoxification on repair processes, even a shorter period of abstinence will have a favorable effect on the postoperative course.

Other effects of smoking cessation

The only positive effect of smoking is that it reduces postoperative nausea and vomiting. This protective effect is not due to any direct antemetic effects but to the induction of cytochrome P450 isoenzymes by tobacco smoke components [21]. These accelerate hepatic biotransformation of the anesthetic agents that cause postoperative nausea. A practical consequence of the increase in hepatic metabolic capacity is that smokers need more analgesics than nonsmokers, because morphine compounds break down faster and/or endogenous opioid stimulation disappears. These pharmacodynamic effects return to normal 6 to 8 weeks after patients stop smoking. Tobacco detoxification has moderate effects on stress around surgery. While baseline anxiety is higher in smokers, it does not increase in those who stop smoking because of pending surgery, even when they do not use nicotine substitutes [22]. The increased risk of gastric aspiration is often mentioned to justify preoperative detoxification. The effects of nicotine on gastric volume and acid secretion are, however, very controversial. Neither the volume nor the pH of these gastric secretions changes if the patient stops smoking the day before or 30 min before the surgery [23]. Moreover, nicotine substitutes such as patches do not affect gastric volume or pH. According to the experts, smoking shortly before surgery is not a formal contraindication to anesthesia.

How to help the patient stop smoking

The expert conference recommended that all surgical departments implement procedures for managing smokers. The first step involves identifying healthcare professionals who meet the patient more than 6 to 8 weeks before surgery. This is most often the surgeon and it is therefore at the surgical consultation that patients who smoke must be identified and measures initiated to help them stop. The objective is to disseminate “stop smoking” messages to all presurgical patients as often as possible at least 6 to 8 weeks before surgery to minimize the excess risk of smoking-associated complications.

Early identification of smokers

It is usually sufficient to question patients in order to identify the smokers. The relevant question is: “Do you currently smoke, even only occasionally? I ask you this question because smoking is associated with a risk of complications at the surgical site three times higher than in nonsmokers”. If the patient does smoke, the doctor should deliver the first ‘smoking message’, which contains 4 points:

- Smokers have 3 times more healing complications, remain hospitalized for longer periods and have greater risks of requiring intensive care than nonsmokers;
- smoking cessation 6 to 8 weeks before surgery and during recovery eliminates the excess risks due to smoking;
- seeking help increases the chances of stopping successfully;
- stopping later or simply cutting back with nicotine substitutes reduces the excess risk but does not eliminate it.

Giving the patient a brochure about perioperative smoking is recommended but is not sufficient.

Organization of cessation management

In this preoperative phase smokers need counseling and assistance to help them stop smoking quickly. Furthermore, this process must be integrated into the preparation for surgery. Each surgical department should organize smoking management as it considers appropriate. There are several possible approaches, which can be combined. It is most important that this organization be defined and known for each center:

- a nurse (if possible, trained in nicotine use disorders and withdrawal) may organize a weekly 1-hour group session of smokers at the hospital, with additional individual interviews if necessary;
- an anesthesiologist or other member of the surgery department may organize nicotine withdrawal sessions for upcoming patients, with an initial consultation of 30 to 45 min and then weekly follow-up of 15 to 20 min up to the time of surgery and once thereafter;
- patients may be referred to a collaborating smoking treatment center for immediate consultation, close follow-up and contacts to exchange information about smoking and surgery;
- in the absence of onsite services or affiliation with a smoking center, patients may be sent with a form letter to their general practitioners or specialists for follow-up of smoking cessation;
- staff involved in surgery (surgeon and anesthesiologists) may receive some minimal training for managing smokers themselves, especially for simpler cases, so that they can combine smoking management with surgical preparation;
- a smoking cessation telephone hotline (Tel.: 08 25 30 93 10) can provide additional support for the other approaches or can be used alone in surgery departments that cannot otherwise organize smoking management. Patients can also be referred to specialists in smoking cessation.

Evaluation of dependence and appropriateness of substitution

Fagerström’s tolerance test (sidebar 1) allows us to measure this dependence. The time from waking up until the first cigarette is
an especially important question. Together with the quantity smoked, it accounts for 60% of the score. *Table I* summarizes the types of substitution available according to levels of dependence. Subjects who are moderately or strongly dependent benefit the most from medical assistance in smoking cessation.

**Available nicotine substitutes, initial dosage and dose adjustment in the perioperative period**

Nicotine substitutes are available as patches for 16 hours (15 and 10 mg) and 24 hours (21 and 14 mg), nicotine gum in strips of 2 and 4 mg and in different flavors, tablets, and inhalers. These nicotine substitutes generally increase temporary abstinence and reduce the signs of withdrawal and the quantity of inhaled smoke. Substitutes also limit aggression in smokers who have abstained for more than 8 hours. The initial dose must be appropriate (*table I*) and should be re-evaluated frequently as a function of symptoms.

**Sidebar 1**

**Fagerström’s test**

1. **How soon after you awake do you smoke your first cigarette?**
   - In the first 5 minutes: 3
   - Between 6 and 30 minutes: 2
   - Between 31 and 60 minutes: 1
   - After 60 minutes: 0

2. **Do you find it difficult to refrain from smoking in places where it is forbidden?**
   - Yes: 1
   - No: 0

3. **Which of all the cigarettes you smoke in a day is the most satisfying?**
   - The first one in the morning: 1
   - Any other than the first one in the morning: 0

4. **How many cigarettes a day do you smoke?**
   - 10 or fewer: 0
   - 11 to 20: 1
   - 21 to 30: 2
   - 31 or more: 3

5. **Do you smoke more during the morning than during the rest of the day?**
   - Yes: 1
   - No: 0

6. **Do you smoke when you are so ill that you are in bed most of the day?**
   - Yes: 1
   - No: 0

Add up your responses to all the items.
- **Between 0 and 2:** not dependent
- **Between 3 and 4:** slight dependence
- **Between 5 and 6:** moderate dependence
- **Between 7 and 8:** strong dependence
- **Between 9 and 10:** very strong dependence

Use of the patch does not rule out simultaneous use of oral nicotine substitutes. Signs of excessive nicotine substitution include headaches, a feeling of having “smoked too much”, coated tongue, nausea, vomiting, and tachycardia. Signs of inadequate nicotine substitution are the same as withdrawal symptoms: craving and agitation. Patients should have gum of either 2 or 4 mg strength for use as needed. The 2-mg doses are for smokers who do not smoke within a half hour of waking up. The 4-mg doses are for patients who usually do smoke within a half hour of waking up and who experience withdrawal symptoms despite chewing 2-mg gum. Smokers must receive adequate information about using these nicotine substitutes. They should be encouraged to take the quantity necessary to alleviate withdrawal symptoms. They should chew gum very slowly, alternating mastication and resting it against the cheek; they should also keep track of the amount used and adapt the patch dose accordingly.

Nicotine tablets (1.5, 2, or 4 mg) are available on request. These microtabs are placed under the tongue where they melt in approximately 20 minutes, inducing a slight tingling sensation. The patient must also receive advice about patch placement. This transdermal patch must be applied in the morning on clean hairless skin after removal of the previous patch, the evening before (16-hour patch) or that morning (24-hour patch). The size of the patch determines the nicotine dose. The patch must be placed on a different site each day. If the patient does not succeed in stopping, reduction should be suggested. Alternating nicotine substitutes and cigarettes to reduce smoking is another option to complete cessation. It is definitely better than not cutting back, since it probably reduces excess risk even though it does not eliminate it. For smokers whose surgery cannot wait 6 to 8 weeks, smoking management and nicotine substitution are still justified and should meet the same criteria.

**Peri- and postoperative management**

During the perioperative period, there are few interactions between anesthetic agents and nicotine substitutes. The pharmacokinetics of transdermal nicotine are different from those of inhaled nicotine (no concentration peak) and thus less subject to major hemodynamic modifications. Nonetheless, minor disruptions have been described during intubation, including an increase in systolic blood pressure and heart rate in healthy patients wearing nicotine patches [24]. It might therefore be recommended to stop nicotine substitutes before anesthesia in heart patients.

After the intervention, tobacco abstinence should ideally continue throughout the healing phase. The patient should be reminded of this before discharge, and it is advisable to plan an appointment to reinforce motivation following discharge, which is often accompanied by resumption of smoking. Everything must be done to facilitate the progression from cessation for sur-
gery to definitive cessation of tobacco abuse. Moreover, the physician must remain vigilant during the postoperative period to recognize withdrawal syndromes that may appear in heavy smokers who stopped cold turkey without nicotine substitutes. The literature includes reports of agitation and confusion associated with the withdrawal syndrome, which resolve favorably with substitution treatment.

In conclusion, complete smoking cessation should now be part of preoperative management strategy for surgical teams. The surgeon’s role in early identification of patients who smoke and in helping to detoxify them must be stressed and formalized. All members of the medicosurgical teams must receive information on this topic to promote the establishment of effective procedures to meet these goals.

Conflicts of interest: none

References


