Effect of preoperative smoking intervention on postoperative complications: a randomised clinical trial

Ann M Møller, Nete Villebro, Tom Pedersen, Hanne Tønnesen

Summary

Background Smokers are at higher risk of cardiopulmonary and wound-related postoperative complications than non-smokers. Our aim was to investigate the effect of preoperative smoking intervention on the frequency of postoperative complications in patients undergoing hip and knee replacement.

Methods We did a randomised trial in three hospitals in Denmark. 120 patients were randomly assigned 6–8 weeks before scheduled surgery to either the control (n=60) or smoking intervention (60) group. Smoking intervention was counselling and nicotine replacement therapy, and either smoking cessation or at least 50% smoking reduction. An assessor, who was masked to the intervention, registered the occurrence of cardiopulmonary, renal, neurological, or surgical complications and duration of hospital admittance. The main analysis was by intention to treat.

Findings Eight controls and four patients from the intervention group were excluded from the final analysis because their operations were either postponed or cancelled. Thus, 52 and 56 patients, respectively, were analysed for outcome. The overall complication rate was 18% in the smoking intervention group and 52% in controls (p=0.0003). The most significant effects of intervention were seen for wound-related complications (5% vs 31%, p=0.001), cardiovascular complications (0% vs 10%, p=0.08), and secondary surgery (4% vs 15%, p=0.07). The median length of stay was 11 days (range 7–55) in the intervention group and 13 days (8–65) in the control group.

Interpretation An effective smoking intervention programme 6–8 weeks before surgery reduces postoperative morbidity, and we recommend, on the basis of our results, this programme be adopted.

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Introduction

About a third of all patients who undergo surgery are smokers. Smoking has repeatedly proved an important risk factor for intraoperative and postoperative complications.1–4 Smokers have an increased frequency of pulmonary, circulatory, and infectious complications, impaired wound healing,5,6 and postoperative admiss to the intensive-care unit.7

The mechanism leading to this increased risk could include smoking-induced chronic pulmonary changes—such as increased closing capacity, reduced clearance of pulmonary secretions, and chronic obstructive lung disease—and impaired cardiovascular function,1 immune function,8,9 and collagen production.9 Findings of physiological studies have shown that most of the smoking-induced changes are reversible to some degree, and that the period needed for a substantial improvement is about 6–8 weeks.10–15 Warner and colleagues16,17 showed that patients who stopped smoking 8 weeks before cardiac surgery had fewer pulmonary complications than smokers. The effect of preoperative smoking intervention on the postoperative complication rate, however, needs to be established. We postulated that smoking intervention from 6–8 weeks before surgery could reduce the frequency of postoperative complications after elective surgery. Our objective was to investigate postoperative morbidity and mortality in patients undergoing elective knee and hip replacement.

Patients and methods

Patients

Patients scheduled for primary elective hip or knee alloplasty at three university-affiliated hospitals in Copenhagen were invited to enter the study. All daily smokers were eligible for the study. Exclusion criteria included patients with a weekly alcohol intake greater than 35 units.18 The ethics committee for all hospitals in Copenhagen and Frederiksberg approved the study and patients gave oral and written informed consent. The intervention period was 6–8 weeks before and 10 days after operation.

Procedures

Patients were randomly assigned—by block randomisation—to either the control (standard care) or smoking intervention group by opaque sealed envelopes containing treatment allocation. Equal distribution of patients between the three hospitals and hip and knee surgery was assured by stratification (table 1). A project nurse, trained in smoking cessation techniques, was attached to the study. All patients who agreed to enter the study had an introductory meeting with the project nurse, at which the study was explained in detail. At the meeting, the patient’s height, weight, and forced expiratory volume in 1 s were recorded. The controls received standard care, which meant little or no information about the risk of tobacco smoking or smoking cessation counselling.

The patients in the intervention group were offered a meeting every week with the project nurse. At the first meeting a Fagerstöm test19 was done, to estimate the magnitude and profile of nicotine dependence. A
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Loss of Collagen and of Immune Capacity, Reduced Oxygenation of Peripheral Tissues, and Vasocostriction Induced by Nicotine.

In our study, we recorded a very low frequency of postoperative pulmonary complications (2%) in both groups. Joint replacement surgery is generally associated with a low risk of pulmonary complications, probably because of the distance of the operation site from the diaphragm and early mobilisation. In abdominal and gynaecological surgery, smokers have been shown almost consistently to have an increased risk of pulmonary complications, and the possible effect on these patients should be assessed. When analysed per protocol, we reported an even greater difference between patients who stopped smoking and those who were smokers than when the data were analysed by intention-to-treat, and we saw no beneficial effect of smoking reduction. These data must be interpreted very carefully, since this analysis is based on non-randomised material, and these patients probably have very different baseline risk—motivation for smoking cessation is determined by many factors that act as confounders in this analysis, such as health status, social life, and age.

Length of stay in the orthopaedic department did not differ between the groups (table 2). One patient in the intervention group and six controls were admitted to other departments. The proportion of days spent in non-orthopaedic departments was 6·0% (49/816) in the control group and 0·3% (2/752) in the intervention group (p=0·0001).

In the per protocol analysis, we recorded a significant difference in complication rate between patients who stopped smoking and those who did not, whereas those who reduced their cigarette use did not differ from the smokers (table 3).

Discussion

The results of our trial show that postoperative complications can be substantially reduced by smoking intervention 6–8 weeks before hip or knee replacement. The reduction in postoperative complications was most evident for wound-related complications, and, to a lesser extent, cardiovascular complications. The pathophysiological background for these findings could be the reversibility of the effect of tobacco smoking on the vascular system and delayed wound healing.30–32

Cessation of smoking for 3 weeks was shown to improve wound healing in an experimental study. The mechanism probably involves recovery of the amount or structure of collagen and of the immune capacity, reduced oxygenation of peripheral tissues, and vasocostriction induced by nicotine. In our study, we recorded a very low frequency of postoperative pulmonary complications (2%) in both groups. Joint replacement surgery is generally associated with a low risk of pulmonary complications, probably because of the distance of the operation site from the diaphragm and early mobilisation. In abdominal and gynaecological surgery, smokers have been shown almost consistently to have an increased risk of pulmonary complications, and the possible effect on these patients should be assessed.31 When analysed per protocol, we reported an even greater difference between patients who stopped smoking and those who were smokers than when the data were analysed by intention-to-treat, and we saw no beneficial effect of smoking reduction. These data must be interpreted very carefully, since this analysis is based on non-randomised material, and these patients probably have very different baseline risk—motivation for smoking cessation is determined by many factors that act as confounders in this analysis, such as health status, social life, and age.

Length of hospital stay is, first of all, dependent on hospital practice, and might not suggest a difference in minor complication rate or mobilisation. We did show that the controls stayed on average 2 extra days in the orthopaedic department; furthermore, they spent many more days in other departments than did the intervention group. More than two-thirds of these days were spent in the intensive-care unit. This longer time means increased costs, if we extrapolate the data to the entire population of smoking patients presenting for joint replacement surgery. The data for intensive care admittance should be...
interacted with caution because of the low numbers. Nevertheless, the data point to potentially great savings in patient morbidity and costs, since postoperative complications are expensive to treat.26,27

The reduction in complication rate is a result of the smoking intervention programme. All parts of the intervention (smoking cessation and smoking reduction, use of nicotine replacement, increased information, and personal relation to the project nurse) could have contributed to the positive effects. A successful smoking intervention could also change other lifestyle factors, such as exercise, eating, or drinking habits, which are all factors that might contribute to the results.

46 (28%) of the 166 eligible patients refused to participate in the study, for various reasons. We do not know whether these patients had a different baseline risk to the included patients, or in what way they would have changed the study findings if they had been included. The results might have been changed in either direction, dependent on an increased benefit from, or a reduced compliance to, smoking intervention.

Smoking is a risk factor for wound infection and cardiovascular complications in almost any type of surgery; smokers make up a considerable proportion of the total number of postoperative complications. If preoperative smoking intervention can reduce these complications, the savings in personal suffering and financial expense should be substantial. The results of our study should be interpreted with caution because of the low numbers.

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Table 3: Per protocol analysis

<table>
<thead>
<tr>
<th></th>
<th>Smokers Reduced cigarette use</th>
<th>p*</th>
<th>Stopped smoking</th>
<th>p†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wound</td>
<td>12 (26%)</td>
<td>0</td>
<td>0.0004</td>
<td></td>
</tr>
<tr>
<td>Any</td>
<td>20 (44%)</td>
<td></td>
<td>0.001</td>
<td></td>
</tr>
</tbody>
</table>

*Difference between smokers and those who reduced their cigarette use. †Difference between smokers and those who stopped smoking.

Contributors
A M Møller and N Villevrå designed and managed the study, recruited the patients, and obtained, recorded, and analysed data. T Pedersen obtained, recorded, and analysed data. H Tønnesen analysed data. All researchers wrote the report.

Conflict of interest statement
None declared.

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2 Morton HJV. Tobacco smoking and pulmonary complications after operation. Lancet 1944; 1: 368–70.
15 Capewell S, Morrison CE, McMurray JJ, et al. Effect of modern smoking intervention programme. All parts of the smoking intervention can reduce these complications, the savings in personal suffering and financial expense should be substantial. The results of our study should be consolidated by a health technology assessment, to test applicability and cost benefit when the intervention is implemented in general practice.

An effective smoking intervention programme applied 6–8 weeks before surgery more than halved the frequency of postoperative complications, with the greatest effect on wound-related and cardiovascular complications. Although the exact duration of smoking abstinence necessary cannot be concluded from these data, we recommend cessation of smoking for at least 6 weeks on the basis of our results.

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