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ORIGINAL ARTICLE

Strategies of smoking cessation intervention before hernia surgery—effect on perioperative smoking behavior

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Abstract
Background Although it is now generally accepted that patients should be advised to quit smoking before surgery, the effect of low-intensive smoking cessation intervention, both on preoperative smoking behavior and on risk reduction, remains unclear. Our objective was to study the effect on perioperative smoking behavior and on postoperative wound infection of different types of low-intensive intervention before herniotomy.
Methods Between October 1998 and October 2000, 180 consecutive smokers scheduled for elective herniotomy were advised to quit smoking perioperatively and subsequently allocated randomly to three low-intensive smoking cessation groups: a standard (control) group, a telephone group, which was reminded by telephone, and an outpatient group, which was reminded by means of an outpatient talk and demonstration of nicotine replacement drugs. Spontaneous perioperative smoking behavior was recorded for 64 consecutive non-advised smokers. Postoperative wound infection was evaluated by independent assessors.
Results Of the advised patients, 19% (29/149) stopped smoking before surgery compared with 2% (1/64) in the non-advised cohort ($P < 0.01$). In the standard group 13% (6/48) quit smoking compared with 23% (23/101) in the pooled telephone and outpatient group (NS). In the last group 64% (65/101) reduced or stopped smoking compared with 42% (20/48) in the standard group ($P < 0.05$). Predictors of failed perioperative cessation of smoking were a CO breath-test at inclusion above 20 ppm (OR: 0.11; 0.02–0-57) and low motivation to quit smoking (OR: 0.25; 0.09–0.70). Wound infection occurred in 6% (13/213) and there was no difference between the groups.
Conclusion Low-intensive smoking cessation intervention helps approximately one fifth of patients to stop smoking perioperatively. Patients who are reminded in addition to preoperative advice are more likely to stop or reduce smoking. Failure to stop smoking is greater if the patients are not motivated and if the CO breath test is high at the time of the preoperative advice.

Keywords Smoking · Hernia · Postoperative complications · Smoking cessation · Randomized controlled trial

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Introduction

Several studies have shown that the risk of postoperative wound complications is significantly greater for smokers than for non-smokers, irrespective of surgical procedure [1–8] and that months to years after laparotomy and inguinal herniotomy the risk of incisional hernia and hernia recurrence is two to four times greater for smokers than for non-smokers [9–11].

Abstinence from smoking from 4 to 8 weeks before surgery has been shown to reduce wound infection, in particular [12, 13], and many surgeons recommend that smokers quit before surgery. A shorter preoperative period of abstention of 2–3 weeks does not seem to reduce postoperative complications [14, 15], but nevertheless seems to be safe, because previous observational findings of increased

pulmonary complications after preoperative cessation of smoking have been not been confirmed by controlled trials [13, 15–17].

Numerous studies conducted to evaluate the effect of different types of intervention to encourage patients and population cohorts to cease smoking have shown that highly intensive intervention—with or without a combination of individual or group counseling and nicotine-replacement therapy—is more effective than less intensive intervention [18–21]. Because similar studies have not been conducted for patients undergoing surgery, it is unclear which type of intervention is the most cost-effective [22]. The objective of this study was to assess the effect, on perioperative smoking behavior and on postoperative wound infection, of different types of low-intensive smoking cessation intervention before herniotomy.

Material and methods

One-hundred and eighty daily smokers scheduled for elective open incisional or inguinal day-case herniotomy were included in the study at the Department of Surgery, Bispebjerg Hospital, University of Copenhagen, after giving written informed consent in accordance with the Helsinki II declaration. The Ethical Committee of Copenhagen approved the study (KF 01–097/98).

After being given information about the operation, the patients were given standard advice to stop smoking perioperatively, at least 1 month before the scheduled time of surgery and until removal of skin sutures 10 days after. The standard advice comprised information about the hazardous effect of smoking on postoperative complications and an appeal to stop smoking. The patients were subsequently allocated randomly to three types of preoperative intervention, by means of computer-generated random numbers drawn from sealed, opaque, and consecutively arranged envelopes. Patients allocated to a standard (control) group were given the standard advice and were not contacted until the day of surgery. Patients allocated to a telephone group were given the standard advice and were reminded by the study nurse 1 month before surgery during a 10 min telephone conversation. Patients allocated to an outpatient group were given the standard advice and were reminded 1 month before surgery during a 20 min meeting with a study nurse in the outpatient clinic. At the end of this meeting the patient was advised to use nicotine replacement drugs until 24 h before surgery and a sample of different types (Nicorette Patch (10 and 15 mg), Nicorette Chewing Gum (2 and 4 mg), Nicorette Resoriblet (2 mg), Nicorette Inhalator (10 mg), or Nicorette Nasal Spray (500 µg per dose); Pfizer, Copenhagen, Denmark) was offered for a few days use according to the patients preference. Individual dosage was guided by The Fagerstrom Nicotine Dependent Score [23].

At inclusion the patients completed an extensive quantitative questionnaire covering demographic data, social network, smoking habits, and lifestyle, based on a validated questionnaire from the MONICA population study of risk factors for cardiovascular disease [24]. The patient's actual perioperative smoking habits were recorded by use of interview-administered questionnaires on the day of operation and on skin suture removal. Three months after surgery a self-administered questionnaire was sent by mail to record data on postoperative smoking habits. Data on co-morbidity and the operation was collected prospectively on data sheets and from the questionnaire and the patient's medical record.

Compliance with the assigned group was evaluated by self-reported smoking on the day of surgery, on the day of skin suture removal, and in the follow-up questionnaire. A CO breath test (Micro Smokerlyzer, Bedfont Instruments, UK) was conducted during all encounters between the study nurse and the patients. Sputum samples for analysis of cotinine were collected at inclusion and on the day of surgery and analyzed by gas chromatography as described elsewhere [25]. At the same time a linear analogue self-assessment (LASA) scale was used to assess the patient's motivation to cease smoking. The scale were anchored at "no wish or consideration to quit smoking" to "absolute wish to quit smoking" based on a similar principle to linear analogue self-assessment scales developed for serial assessment of utility values [26].

Sixty-four consecutive smokers who also underwent inguinal and incisional herniotomy were not advised to quit smoking, in agreement of the current policy at that time. These patients were identified on the day of surgery and included after surgery on the day of skin suture removal, to assess spontaneous perioperative smoking behavior. Of these patients, 46 were operated on during a six-month period before the trial period, and 18 were operated on during a three-month period afterwards. Inclusion of these patients was split in two periods to control for a potential period effect, which may have been caused by in-hospital smoking prohibition, introduced in January 2000, and by increasing focus on smoking-related health hazards in the media during the study period. The data obtained were similar to those for the advised patients, except for the CO breath test, sputum samples for cotinine analysis, and the linear analogue self-assessment scale on motivation stop smoking.

Postoperative wound infection was evaluated at skin suture removal, initially by the study nurse and, in the event of clinical signs of wound infection, by independent surgeons unaware of the patient's group assignment. Postoperative wound infection was defined as a swollen, red, hot, painful wound with or without pus discharge and postoperative clinical intervention including antibiotics, extensive wound care, or re-operation.

The sample size of the study with cessation of smoking as endpoint was calculated on the basis of three assumptions:

- a minimum relevant difference of 25% in expected cessation of smoking among intervention groups;
- 0.80 as the power of the study; and
- $P < 0.05$ as the level of significance (MEDSTAT, version 2.11, Herlev County Hospital, University of Copenhagen, Denmark).

Secondary endpoints, for example postoperative wound infection, were not subject to sample-size calculations.

The data were analyzed by intention-to-treat according to the patients' group assignment. Data from patients who withdrew or whose operation was cancelled and data from patients who did not answer questions on perioperative smoking behavior were not included in the analysis. Drop-out analysis was performed for patients who completed the study and those whose operation was cancelled or who dropped out. Within each group and between the groups the data were analyzed descriptively and comparatively by use of the χ^2 test (binomial data) and the Mann–Whitney U test (delta values of continuous data). The cohort of advised patients was compared with the non-advised cohort. The telephone and outpatient group were initially compared in accordance with the protocol but because there was no difference between these groups they were pooled for comparison with the standard group and for presentation.

Multiple logistic regression analysis was used to assess variables associated with preoperative cessation of smoking. First, the odds ratio of each variable listed in Tables 1 and 2 was estimated. On the basis of this model a forward-selection procedure was conducted in which variables likely to be associated with perioperative cessation of smoking ($P \leq 0.2$) were included in a multivariate model. In this model, all variables not significantly associated with cessation of smoking ($P > 0.05$) were discarded by use of a backward-elimination procedure. Finally, tests for linearity and interaction terms between variables were examined. All results were described with odds ratios and 95% confidence intervals. All data were analyzed by use of SPSS for Windows 11.0 (SPSS, Chicago, IL, USA). The level of significance was $P \leq 0.05$.

Results

Between October 1998 and October 2000, 180 out of 198 eligible smokers were included in the advised cohort, 60 in each group. One-hundred-and-forty-nine patients (83%) completed the trial, and twelve patients dropped out, because they subsequently decided they did not wish to participate.

Table 1 Characteristics of patients and treatment

	Advised cohort				Non-advised cohort ($n = 64$)	
	Standard group ($n = 48$)		Reminder group ($n = 101$)			
Baseline						
Age (median, interquartile range)	54	(42–64)	54	(45–65)	56	(46–66)
Male sex	44	(88)	91	(90)	45[c]	(70)
BMI (mean, standard deviation)	25.1	(3.9)	24.9	(4.2)	24.6	(3.6)
Diabetes	1	(2)	5	(5)	2	(3)
Hypertension	9	(18)	19	(19)	11	(17)
Chronic obstructive lung disease[a]	20	(40)	28	(28)	11[c]	(17)
Drinks per week (median, interquartile range)[b]	8	(0–25)	10	(3–16)	7	(2–20)
Living alone	10	(21)	31	(31)	23	(36)
Sense of loneliness	7	(15)	16	(16)	13	(20)
Poor contact with friends	10	(10	28	(28)	14	(22)
Poor contact with family	20	(42)	43	(43)	23	(36)
Operative						
Local anaesthesia	19	(38)	37	(37)	18	(28)
Specialized surgeon	28	(58)	60	(60)	35	(58)
Secondary hernia	10	(20)	13	(13)	8	(13)
Inguinal hernia	39	(82)	81	(81)	44	(69)
Incisional hernia	9	(18)	20	(20)	20	(31)

Values are the number of patients (with percentages in parentheses) unless stated otherwise

[a] Defined as coughing and expectorating for 3 months per year for a minimum of 2 years

[b] Defined as the sum of bottles of beer, glasses of wine, and measures of spirits, each containing 9–13 g alcohol

[c] Different from the advised cohort ($P < 0.05$)

Table 2 Perioperative smoking behavior

	Advised cohort				Non-advised cohort (n = 64)	
	Standard group (n = 48)		Reminder group (n = 101)			
Day of inclusion						
Smoking (grams per day)[a]	15	(6–20)	15	(8–20)	20	(6–20)
CO breath test (ppm)	16	(10–25)	17	(10–27)	–	–
Cotinine (ng mL^{-1})	288	(197–461)	268	(134–417)	–	–
Fagerstrom nicotine-dependence score	4	(2–5)	4	(2–6)	–	–
LASA motivation score[c]	43	(13–88)	52	(22–82)	–	–
LASA expectation of success score[c]	45	(16–75)	48	(20–82)	–	–
Day of surgery						
Patients who stopped smoking before operation (%)	6	(13)	23	(23)	1[d]	(2)
Patients who reduced or stopped smoking before surgery[b] (%)	20	(42)	65[c]	(64)	9[d]	(14)
Preoperative smoking (grams per day)[a]	15	(3–20)	10[c]	(1–18)	20	(6–20)
Preoperative CO breath test (ppm)	9	(5–14)	9	(6–14)	–	–
Preoperative cotinine (ng mL^{-1})	294	(161–428)	255	(120–398)	–	–
Days from advice to operation	84	(43–130)	97	(54–134)	–	–
Days from advice to reminder	–	–	58	(21–102)	–	–
Days from reminder to operation	–	–	30	(27–31)	–	–
Preoperative LASA motivation score[c]	28	(4–82)	47	(27–82)	–	–
Day of removal of skin sutures						
Patients who maintained cessation of smoking (%)	6	(13)	21	(21)	1[d]	(2)
Patients who maintained smoking reduction or cessation[b] (%)	16	(33)	53	(52)	6[d]	(9)
Postoperative smoking (g per day)[a]	11	(2–20)	8	(0–15)	15	(10–20)
Postoperative CO breath test (ppm)	16	(11–27)	12[e]	(5–20)	–	–
Days from operation to removal of sutures	10	(9–11)	10	(9–12)	–	–
Postoperative LASA motivation score[c]	35	(9–94)	60	(25–85)	–	–
Three months after surgery						
Patients who did not resume smoking (%)	4	(8)	13	(13)	–	–
Days from operation to follow-up	136	(102–192)	143	(111–178)	–	–

Values are medians (interquartile range) unless stated otherwise

[a] Defined as the sum of the tobacco content of a cigarette (1 g), a cheroot (2 g), a cigar (5 g), and a pipe fill (3 g)

[b] Defined as abstaining or reduction by more than half of daily tobacco smoking

[c] Linear analogue self-assessment scale (0–100)

[d] Different from the advised cohort ($P < 0.05$)

[e] Different from the standard group ($P < 0.05$)

Fourteen patients were excluded because of cancellation of the operation, as were five patients who had not answered questions about their perioperative smoking behavior. Before and after the trial, from February to July 1998 and from January to March 2001, 46 and 18 consecutive smokers, respectively, were included in the non-advised cohort.

The patient's demographic characteristics, social network, co-morbidity, and lifestyle were similar for all groups of the advised cohort (Table 1). The non-advised cohort contained significantly more women and patients without chronic obstructive lung disease.

All patients were heavy smokers on the day of inclusion (Table 2). Before surgery 19% of the patients in the advised cohort had stopped smoking in the perioperative period compared with 2% in the non-advised cohort. In the advised cohort there was no significant difference between cessation of smoking in the pooled reminder group and that in the standard group, although significantly more patients reduced or stopped smoking. Accordingly, patients who were reminded reduced the median number of cigarettes significantly compared with patients who were only advised once to quit smoking. In the non-advised cohort the number of cigarettes smoked per day was unchanged, as in the standard group.

Although at the time of skin suture removal one abstainer in each of the reminder groups had resumed

smoking, CO levels for the reminder groups were significantly lower than for the standard group. Of all patients who reduced smoking before surgery, 25% admitted they increased smoking postoperatively but the median number of cigarettes smoked per day after surgery did not change. Three months after surgery, 11% of all patients who had been advised to quit and who abstained in the perioperative period had not resumed smoking.

The patients waited 3 months for herniotomy. For the standard group a median of 84 days passed from advice to operation; 88 days passed for the reminder group. The reminder for the latter group was given 30 days before herniotomy as in the protocol. After the preoperative advice the patients were equally motivated to quit smoking. This score was marginally reduced on the day of surgery but no significant difference was found during the course of the study within or between groups.

Multivariate analysis of variables possibly associated with perioperative smoking cessation revealed that for patients advised to stop smoking, cessation of smoking was significantly associated with their wish to do so (Table 3). Likewise, the higher the patient's CO level on the day of inclusion the less likely they were to stop smoking. Other variables, for example the daily number of cigarettes or Fagerstrom Nicotine Dependence Score, were associated with cessation of smoking in the univariate analysis but were not significant in the final model.

Postoperative wound infections were recorded for 13 patients. No significant difference was found between the advised (7%; 10/149) and non-advised (5%; 3/64) cohorts or between the standard (8%; 4/48) and the reminder (6%; 6/101) group.

Data analysis did not reveal any difference between the telephone group and the outpatient group or between the two groups of patients in the non-advised cohort. Likewise, dropout analysis did not reveal any significant difference between the included patients and those who dropped out or were excluded because their operation was cancelled (data not shown).

Table 3 Variables associated with perioperative cessation of smoking among patients advised to quit smoking—the final model (controlled for age, gender, drinks per week, BMI, comorbidity, and social network)

	n	Univariate		Multivariate	
		OR	95% CI	OR	95% CI
Smoking at inclusion					
1–19 g per day	75	1	–	–	–
20 g per day or more	76	0.40	0.17–0.97	–	–
Fagerstrom nicotine dependence score					
Score 1 or 2	39	1	–	–	–
Score 3–5	57	0.50	0.18–1.35	–	–
Score 6 or more	35	0.16	0.03–0.81	–	–
CO breath test at inclusion					
1–12 ppm	38	1	–	1	–
13–20 ppm	47	0.89	0.36–2.23	0.77	0.28–2.13
20 ppm or more	43	0.12	0.03–0.56	0.11	0.02–0.57
Wish to quit score[a]					
0–49	65	0.27	0.10–0.74	0.25	0.09–0.70
50–100	69	1	–	1	–

Number of cases in the final analysis 128, missing cases 26; Hosmer–Lemeshaw goodness-of-fit test $P = 0.39$

[a] Linear analogue self-assessment scale (0–100 mm)

Discussion

One fifth of patients scheduled for incisional or inguinal herniotomy stopped smoking perioperatively when advised to do so and more than half of these patients remained abstinent three months after. Patients who were reminded to stop smoking in addition to the preoperative advice were more likely to stop or reduce smoking. In contrast, patients who were not advised continued to smoke in the preoperative period.

Our findings reveal that a reminder given by telephone or in the outpatient clinic encouraged even more patients to stop or reduce smoking, confirming other studies [27]. The change in smoking habits among reminded patients was confirmed by a significant reduction in self-reported number of cigarettes smoked per day and validated by a significant lower postoperative CO breath test score [28]. Postoperatively, only a few resumed smoking and the self-reported increment in daily smoking among patients, who smoked less, could not be validated by the actual number of smoked cigarettes, CO breath test, or cotinine concentration.

Abstention achieved after our three types of low-intensive smoking cessation intervention was similar to that achieved after other instances of perioperative smoking cessation intervention which offered standard advice to quit smoking [20, 29, 30]. In more intensive smoking cessation intervention, including two to four sessions of individual counseling and nicotine replacement therapy, we previously achieved a 37% smoking cessation rate from 2 to 3 weeks before colorectal surgery [15]. After a 6–8 week period before knee and hip arthroplasty, a 64% quit rate was achieved by means of a highly intensive intervention program including nicotine-replacement therapy and up to thirty sessions of individual counseling [31] (N. Villebro 2004, personal communication).

The reason for the relatively low perioperative quit rate is unclear, but apart from the low-intensive smoking cessation intervention, which was chosen because of its low cost

and feasibility in a daily clinical setting, the patients may have been less motivated to stop smoking before minor surgery, for example herniotomy, as opposed to major surgery, for example colorectal surgery and hip and knee arthroplasty [13, 15]. Another explanation is the detrimental effect of the three-month delay from the day the operation was scheduled and the advice was given until the operation was performed. This was not confirmed by the patient's motivation scores, however, which were only marginally reduced from advice to operation. Nevertheless, our findings support the view that highly intensive smoking cessation intervention seems to be necessary to achieve high smoking cessation rates if the perioperative period is long whereas low-intensive intervention may be enough to achieve acceptable cessation rates if the abstention period is short [30, 32].

Our finding of an inverse association between CO level at the time of the advice and cessation of smoking is in accordance with results from previous studies [33, 34]. In this study the CO level was a better predictor of perioperative cessation of smoking than the Fagerstrom Nicotine Dependence Score and number of cigarettes smoked per day. Similarly, the patients' motivation to quit smoking was a significant predictor for perioperative smoking cessation, as shown by others [20]. In contrast with another report, we did not find that men or patients with a good social network were more likely to cease smoking in the perioperative period [31].

No difference between the groups was found with regard to baseline characteristics and treatment, except for the cohort of non-advised patients in which significantly more women and patients without chronic obstructive lung disease were unintentionally included. Despite our attempt to validate the patients' perioperative smoking habits by measuring CO and cotinine, we cannot eliminate the possibility of some error in self-reporting [34]. The preoperative CO and cotinine illustrate this, because levels were equal in the standard and pooled reminder groups and only marginally reduced compared with levels at inclusion in the study. The lack of a difference probably reflects the testing of fasting patients on the day of surgery. Similarly, significant confounders may have affected the preoperative cotinine level. Cotinine is sensitive to environmental smoke and may remain unchanged in smokers who reduce the number of cigarettes smoked, because some tend to smoke each of the remaining cigarettes more intensively than before [35, 36].

Low-intensive intervention to encourage cessation of smoking had no effect on postoperative wound infection. The probable explanation is a type-II error. Valid data on post-herniotomy wound infection in smokers and non-smokers became available only after patient enrollment was terminated [1]. A post-hoc sample-size calculation based on these data disclosed that 7,314 patients should have been included in the study to show an effect on postoperative wound infection. On the basis of the 19% compliance with cessation of smoking found in this study, a sufficiently powered study on postoperative wound infection would have required five times more patients.

In conclusion, simple preoperative advice to stop smoking before herniotomy helps approximately one fifth of patients to stop smoking perioperatively. If subsequently reminded also, the patients are more likely to stop or reduce smoking. Failure to stop smoking is greater if the patients are not motivated and if the CO breath-test is high at the time of the preoperative advice. These factors may help to identify patients who need more intensive counseling and individual support to stop smoking.

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