International Journal of Surgery 71 (2019) 110–116

Contents lists available at ScienceDirect

International Journal of Surgery

journal homepage: www.elsevier.com/locate/ijsu

Original Research

Laparotomy closure techniques: Do surgeons follow the latest guidelines? Results of a questionnaire

A. Bloemen[a,b,*], R.J.C.M.F. De Kleijn[b], S. Van Steensel[b], F. Aarts[a], M.H.F. Schreinemacher[b], N.D. Bouvy[b]

[a] Department of Surgery, VieCuri Medical Centre, Venlo, the Netherlands
[b] Department of Surgery, Maastricht University Medical Centre, Maastricht, the Netherlands

ARTICLE INFO

Keywords:
Abdominal wall closure technique
Incisional hernia
Survey
Prevention
Guideline
Quality improvement

ABSTRACT

Purpose: Incisional hernias after laparotomy are associated with significant morbidity and increased costs. Recent research on prevention of incisional hernia formation suggests that a laparotomy closure technique using a slowly absorbable monofilament suture with small fascial steps and bites in a continuous, single layer with a suture length to wound length (SL/WL) ratio of at least 4:1 is effective in lowering morbidity. Little is known about application of this evidence in daily practice. Therefore, a survey was performed among Dutch surgeons.
Methods: All members of the Dutch Surgical Society were invited to participate in a 24-question online survey on techniques and materials used for abdominal wall closure after midline laparotomy. Subgroup analysis was performed based on surgical subspecialty, type of hospital and experience.
Results: Response rate was 26% (402 respondents), representing 97% of all Dutch surgical departments. More than 90% of participants closed the abdominal wall in a single mass layer, using a slowly absorbable monofilament running suture The SL/WL ratio of > 4:1 is practiced by only 35% of participants and preferred suture size was variable among participants. Risk factors for incisional hernia development were generally identified correctly but more than half of the participants were unaware of the incidence and time of occurrence of incisional hernia. Subgroup analysis found that gastrointestinal and oncologic surgeons preferred smaller diameter sutures and higher suture-length to wound-length ratios. Trauma, vascular and pediatric surgeons had lower estimates of incidence of incisional hernia than other subspecialties. Surgeons employed in academic hospitals were more likely to use small fascial steps and smaller suture sizes than their colleagues in non-academic hospitals. Correct estimates of incisional hernia incidence decreased when surgeons perform less than 10 laparotomies annually.
Conclusion: Implementation of the latest evidence regarding closure techniques of the abdominal wall is not widespread. Only 35% of surgeons close the abdominal fascia using a suture length to wound length ratio of 4:1, which is recommended based on the latest evidence. Surgical trainees, gastrointestinal and oncological surgeons are most familiar with the recommended technique and use it in their daily practice. Efforts should be directed at improving spreading of this technique.

1. Introduction

The midline laparotomy is a common technique for fast and avascular open access to the abdominal cavity. Optimal closure of the abdominal wall after laparotomy is essential to prevent short-term complications such as surgical site infections or wound dehiscence (burst abdomen) and formation of incisional hernias during long-term follow-up. These complications increase morbidity and mortality, and negatively affect health care costs due to prolonged length of hospital stay, re-admissions and re-interventions [1].

Over the last decades, various groups have published a significant amount of research on optimal closure techniques and materials of the abdominal wall after midline laparotomy to prevent incisional hernia formation. As first described by Israelsson et al. and later confirmed in other randomized clinical trials, a continuous, single layer suturing technique with a suture length to wound length (SL/WL) ratio at least 4:1, using a slowly absorbable monofilament suture with small fascial steps and bites and a self-locking knot appears to minimize the risk of incisional hernia development [2–5]. Based on available evidence, the European Hernia Society (EHS) published a guideline on abdominal

* Corresponding author. Department of Surgery, PO Box 5800, 6202 AZ, Maastricht, the Netherlands.
E-mail addresses: arthurbloemen@hotmail.com (A. Bloemen), n.bouvy@mumc.nl (N.D. Bouvy).

https://doi.org/10.1016/j.ijsu.2019.09.024
Received 8 July 2019; Received in revised form 25 August 2019; Accepted 19 September 2019
Available online 24 September 2019
1743-9191/

wall closure in 2015, which recommends using this technique in elective settings [6]. Two recent retrospective cohort studies also found a decrease in wound dehiscence and incisional hernia when a similar structured closure technique is adopted in emergency laparotomies [7,8]. Since publication of the guideline, additional research has been published on the optimal technique for abdominal wall closure which further supports the small bites technique and which suggest using prophylactic mesh reinforcement in high risk patients [4,9,10].

Little is known on the implementation of these techniques and evidence in daily surgical practice. Previous surveys investigating this were generally small, reported in the author's native languages and were published before the 2015 guideline [11–13].

We therefore conducted a national survey among Dutch surgeons in order to investigate current knowledge and techniques of abdominal wall closure used in relation to the current best available evidence and the EHS guideline. The secondary purpose of the survey was to perform subgroup analysis to investigate possible differences in practice between surgical subspecialties, between the types of hospital and between the number of laparotomies performed annually.

2. Methods

2.1. Design

A web-based survey was constructed using professional survey software (Surveymonkey, Palo Alto, USA). The survey questions were designed by two independent authors (AB and RK) and edited by a third author (NB). The survey was formulated in the Dutch language. The translated questions are listed in appendix A. In the web survey, each question was listed on a separate page. Participants were able to review and change their answers before finalizing their responses.

Prior to distribution, five surgical trainees tested the survey for unambiguity and their feedback was incorporated in the final version of the survey. The survey was in concordance with the CHERRIES checklist, which is a checklist to ensure quality of the reporting of web-based surveys, analogous to the CONSORT and QUORUM checklists for reporting randomized trials and systematic reviews [14].

No approval from an Institutional Review Board was needed for this study. Participants were informed about the goals, expected time to complete the questions and identity of the research group before starting the survey. This study was registered in the publicly accessible database of the United States National Library of Medicine (accessible at www.ClinicalTrials.gov, identifier NCT04013009).

The survey consisted of 24 multiple choice and open questions on experience, technique and suture materials used for closure after a laparotomy. Questions on technique focused on layers of closure, type of knot used to secure the suture, the size of fascial bites and steps between consecutive bites of the sutures. A fascial bite is the distance from fascial edge to where the needle pierces through the tissue. The size of bites and steps was defined as small (< 5 mm), intermediate (6–10 mm) or large (> 10 mm). Four questions were asked to test the surgeon's knowledge on risk factors and incidence of incisional hernia. Participants were not queried on the use of prophylactic mesh placement in high-risk patients because the evidence became available after distribution of this survey [9]. Based on currently available evidence, the following statements were considered correct:

- A transverse incision has the lowest risk of incisional hernia development, when compared to oblique and midline incisions (RR = 1.77; 95% CI:1.09–2.87) [15].
- The incidence of incisional hernia is highest in the second postoperative year [2,16].
- The weighted mean incisional hernia rate is 13% at 2 years after surgery [17].
- The following patient related risk factors have been identified to increase the development of an incisional hernia: Postoperative surgical site infection, obesity, abdominal aortic aneurysm, male gender and age [6,16].

2.2. Participants

A database was created of all listed members of the Dutch Society for Surgery (Nederlandse Vereniging voor Heelkunde) containing both surgeons and surgical trainees. We have excluded surgeons registered outside the Netherlands, surgeons without contact details and members who were retired or changed professions. Subsequently, we excluded surgeons who, after a prior survey using the same database requested not to be contacted again for future surveys [18].

Following this exclusion we sent a participation request by e-mail to the remaining members. Responses were collected over a period of 6 weeks during which reminder e-mails to non-respondents were distributed. In order to stimulate response, ten portable smartphone chargers were raffled among respondents. After this period the online survey was no longer accessible and the recorded responses were anonymized. Responses were protected from unauthorized access by password control.

Respondents were asked to provide their subspecialty and the main type of hospital in which they work, as well as the estimated number of annual laparotomies performed. The following subspecialties were available to choose from: surgical trainee, general surgeon or one of the following subspecialties: gastrointestinal, oncologic, trauma, vascular or pediatric surgeon. Later, gastrointestinal and oncologic surgeons were grouped together because both subspecialties perform abdominal surgery in the Netherlands. Likewise, trauma surgeons, vascular surgeons and pediatric surgeons were grouped together because of expected less affinity or experience with abdominal wall surgery. Participants had to choose from the following type of hospitals: academic (university) hospital, non-academic teaching hospital and non-academic non-teaching hospital.

2.3. Analysis

Surveys that were completed for at least eighty percent were included in the analysis and missing values were excluded. Subgroup analysis was performed to investigate differences between surgical subspecialties, type of hospital in which the respondent works and between the number of laparotomies performed each year.

For categorical data, Pearson's Chi-squared test and Fisher's exact test were performed. Due to plurality of questions in the study, a Bonferroni correction was applied, the cutoff value for assessing statistical significance was set at 0.05/24 = 0.002. For variables where a significant difference was found, multinomial logistic regression analysis was performed to estimate the strength of the association.

Percentages are reported in rounded figures. Statistical analysis was performed using the SPSS software package®, version 22 for Windows (SPSS Inc., Chicago, IL, USA).

3. Results

3.1. Participants

A total of 1577 surgeons and trainees were invited by e-mail in July 2016. After six weeks and three reminder e-mails, 402 complete responses (26%) were received. The respondents represent 97% of all hospitals in the Netherlands. The participant characteristics are listed in Table 1.

The largest group of participants consisted of gastro-intestinal and oncologic surgeons (38%), followed by trauma, vascular and pediatric surgeons (27%), surgical trainees (19%) and general surgeons (15%). Most respondents (57%) were employed in a non-academic teaching hospital. Median work-experience of the participants was 7 years (interquartile range 4–15). Most respondents (89%) performed more than

Table 1
Characteristics of participants.

	Surgical trainee	Gastrointestinal/oncologic surgeon	Trauma/vascular/pediatric surgeon	General surgeon/other	Total
Number of respondents (%)	78 (19)	153 (38)	110 (27)	61 (15)	402 (100)
Median work experience in years (interquartile range)	5 (4–6)	8 (4–15.5)	10 (5–17)	15 (6.5–29.5)	7 (4–15)
Type of hospital (%)					
- academic	25 (32)	23 (15)	28 (26)	5 (9)	81 (21)
- non-academic teaching	52 (67)	92 (52)	57 (52)	27 (49)	228 (58)
- non-teaching	1 (1)	24 (22)	24 (22)	23 (42)	85 (22)
Number of laparotomies annually (%)					
- < 10	13 (17)	11 (7)	38 (35)	13 (24)	75 (19)
- 10 to 30	41 (53)	62 (41)	53 (49)	25 (46)	181 (46)
- > 30	24 (31)	78 (52)	18 (17)	16 (30)	136 (35)

Table 2
Responses on technique of abdominal wall closure after midline laparotomy.

	Trainee	Gastrointestinal/oncologic surgeon	Trauma/vascular/pediatric surgeon	General surgeon/other	Total	P-value
Peritoneal closure (%)						
-yes	6 (8)	11 (7)	12 (11)	8 (17)	37 (10)	0.259
-no	68 (92)	137 (93)	93 (89)	40 (83)	375 (90)	
Layers of closure (%)						
- one	70 (93)	146 (98)	100 (95)	46 (96)	362 (96)	0.310
- two	5 (7)	3 (2)	5 (5)	2 (4)	15 (4)	
Running suture (%)						
-yes	75 (100)	146 (99)	104 (98)	47 (96)	372 (98)	0.332
-no	0 (0)	2 (1)	2 (2)	2 (4)	6 (2)	
Type of knot (%)						
- surgical	52 (69)	101 (68)	70 (67)	34 (70)	275 (68)	0,72
- aberdeen	16 (21)	24 (16)	23 (22)	7 (15)	70 (19)	
- other self-locking	7 (9)	23 (16)	12 (11)	7 (15)	49 (13)	
Fascial bite (%)						
- 0–5 mm	13 (17)	28 (19)	14 (13)	7 (14)	62 (17)	0.407
- 6–10 mm	52 (69)	98 (67)	66 (62)	30 (63)	246 (65)	
- 11–20 mm	10 (13)	20 (13)	22 (21)	10 (21)	62 (17)	
- > 20 mm	0 (0)	1 (1)	4 (4)	1 (2)	6 (1)	
Fascial steps (%)						
- 0–5 mm	27 (36)	36 (24)	22 (21)	7 (15)	92 (24)	0.005
- 6–10 mm	45 (60)	89 (61)	61 (57)	30 (62)	225 (60)	
- large (> 10 mm)	3 (4)	22 (15)	23 (22)	11 (23)	59 (16)	
Preferred suture-length: wound-length ratio (%)						
- none	36 (48)	42 (29)	64 (60)	20 (41)	162 (43)	0.001
- 1:1	1 (1)	5 (3)	5 (4)	1 (2)	12 (3)	
- 2:1	8 (11)	9 (6)	7 (7)	4 (8)	28 (7)	
- 3:1	7 (10)	20 (14)	6 (6)	6 (12)	39 (10)	
- 4:1	22 (29)	69 (47)	24 (23)	18 (37)	133 (35)	
- 5:1	1 (1)	1 (1)	0 (0)	0 (0)	2 (1)	
Technique changed since training (%)						
-Yes	7 (9)	49 (37)	32 (33)	26 (55)	114 (32)	< 0.001
-no	71 (91)	82 (63)	66 (66)	21 (45)	240 (68)	

10 laparotomies annually.

3.2. Abdominal wall closure technique and materials

Responses to the questionnaire on the technique used to close of the abdominal fascia after midline incision are shown in Table 2. The majority of respondents (96%) indicated that they used a single mass closure of the abdominal fascia. Most respondents (98%) routinely used running sutures for closure of the abdominal fascia and 68% use a surgical knot to secure the fascial suture.

Responses to questions on the size of fascial bites and steps used and the resultant suture-length to wound-length ratio varied more. Most (65%) participants reported an intermediate fascial bite size and 60% use steps of 6–10 mm between fascial bites. 43% of the participants did not prefer a suture length to wound length ratio and 35% seek a ratio of 4:1. Other participants preferred other ratios. 68% of participants reported that they did not change technique and materials for closure of the abdominal wall since surgical training.

Concerning the material used for closure of the abdominal wall, nearly all (93%) respondents preferred a slowly absorbable suture. 96% preferred a monofilament, rather than a braided, multifilament suture thread and most participants (81%) preferred a sharp-tipped needle for closure of the fascia and all participants used a curved needle (Table 3). The preferred suture size for closure of the abdominal fascia was variable among respondents: Suture size 1 is most often used (42%), followed by 0 (23%) and 2-0 (18%). The majority of participants (62%) used a loop suture. Nearly half of the participants (47%) reported using two suture threads and the other half (53%) used one suture thread for closure of the abdominal wall.

3.3. Incisional hernia knowledge

The responses to the questions on opinions on incisional hernia are summarized in Table 4. The majority of respondents (79%) correctly indicated a midline laparotomy to be most at risk for incisional hernia development. 32% of participants correctly estimated the risk of

Table 3
Responses on material used for abdominal wall closure after midline laparotomy.

	Trainee	Gastrointestinal/oncologic surgeon	Trauma/vascular/pediatric surgeon	General surgeon/other	Total	P-value
Number of sutures (%)						
- one	38 (51)	77 (42)	59 (57)	24 (51)	198 (53)	
- two	27 (49)	72 (48)	44 (43)	23 (49)	176 (47)	0.715
Loop suture (%)						
- yes	48 (64)	95 (64)	76 (74)	30 (64)	249 (67)	
- no	27 (36)	54 (36)	17 (26)	17 (36)	125 (33)	0.715
Type of suture (%)						
- slowly absorbable	65 (87)	140 (94)	102 (96)	47 (96)	354 (93)	
- non-absorbable	10 (13)	9 (6)	4 (4)	2 (4)	25 (7)	0.092
Type of suture (%)						
- monofilament	75 (100)	146 (98)	98 (93)	43 (90)	362 (96)	
- braided	0 (0)	3 (2)	8 (7)	5 (10)	16 (4)	0.003
Needle tip (%)						
- sharp	70 (93)	134 (90)	86 (83)	36 (74)	326 (87)	
- blunt	5 (7)	15 (10)	18 (17)	13 (26)	51 (13)	0.006
Suture size (%)						
−2	8 (11)	13 (9)	12 (12)	5 (10)	38 (10)	
−1	25 (34)	66 (44)	52 (51)	27 (55)	170 (45)	
−0	22 (29)	44 (29)	16 (15)	10 (21)	92 (25)	
-2-0	19 (26)	25 (17)	21 (20)	7 (14)	72 (19)	
-3-0	0 (0)	1 (1)	2 (2)	0 (0)	3 (1)	0.168

incisional hernia to be 11–15%.

Just over half the participants (52%) estimated the time till diagnosis of incisional hernia to be within the first postoperative year and most other (46%) participants estimated this to be within five years after surgery. Almost no participants (2%) thought that an incisional hernia could develop more than five years after surgery. The five factors deemed to be most important for the development of incisional hernia were: surgical site infection, obesity, COPD, steroid use and impaired nutritional state (Fig. 1). The responses are summarized in Fig. 1.

3.4. Subgroup analysis

Subgroup analysis of the surgical subspecialties found significant differences in responses on SL/WL ratio and estimated incidence of incisional hernia (Tables 2 and 4).

Multinomial logistic regression analysis with the gastro-intestinal and oncologic surgeons as reference group found that the odd's ratio for preference of SL/WL ratio of 4:1 for trainees was 0.37 [95% confidence interval 0.19–0.72]. In trauma, vascular and pediatric surgeons the odd's ratio was 0.23 [95% CI 0.13–0.42] and in general surgeons this was 0.55 [95% CI 0.26–1.15]. In other words; when compared with gastrointestinal and oncological surgeons, trainees were three times less likely to use a SL/WL ratio of 4:1. Trauma, vascular and pediatric surgeons were four times less likely to use this ratio and the odds of a general surgeon preferring the 4:1 ratio were half those of gastro-intestinal and oncologic surgeons.

Responses between the subspecialties on incidence of incisional hernia were significantly different ($P < 0.001$); General surgeons were most likely to reply the correct incisional hernia incidence (42%). Multinomial logistic regression analysis defining the general surgeons as reference group found that the odd's ratio for correct estimation of incisional hernia was 1.17 [95% CI 0.46–2.46] for trainees, 0.39 [95% CI 0.18–0.81] for gastro-intestinal and oncologic surgeons and 1.25 [95% CI 0.56–2.83] for trauma, vascular and pediatric surgeons. Gastro-intestinal and oncologic surgeons were more likely to estimate a higher incidence of incisional hernia while trauma, vascular and pediatric surgeons were more prone to lower estimations. No significant differences in responses on type of incision, time of occurrence or risk factors for development of incisional hernia were found.

Multinomial regression analysis was performed to detect differences between subspecialties in changes in technique during the active career of participants. Since 91% of trainees did not change their technique during their career, they were excluded from this analysis. No significant difference was observed between subspecialties in this analysis ($P = 0.027$).

After Bonferroni correction, no significant differences were found during subgroup analysis of preferences of material between the subspecialties.

Table 4
Incisional hernia knowledge.

	Trainee	Gastrointestinal/oncologic surgeon	Trauma/vascular/pediatric surgeon	General surgeon/other	Total	P-value
Incision most at risk for development of incisional hernia (%)						
-midline laparotomy	57 (80)	131 (93)	89 (86)	42 (88)	319 (88)	
-transverse	8 (11)	2 (1)	5 (5)	1 (2)	16 (4)	
-oblique	6 (9)	8 (6)	10 (9)	5 (10)	29 (8)	0.04
Estimate of incidence of incisional hernia						
-1-5%	4 (6)	2 (1)	12 (11)	2 (4)	20 (5)	
-6-10%	15 (21)	17 (12)	34 (33)	7 (15)	23 (20)	
-11-15%	27 (39)	35 (25)	33 (32)	20 (42)	115 (32)	
-16-20%	16 (23)	50 (36)	14 (13)	14 (29)	94 (26)	
-20-25%	8 (11)	25 (18)	8 (8)	2 (4)	43 (12)	
- > 25%	0 (0)	11 (8)	3 (3)	3 (6)	17 (5)	< 0.001
Time of diagnosis of incisional hernia						
- < 6 weeks postop	2 (3)	2 (1)	3 (3)	0 (0)	7 (2)	
- 1st year	30 (42)	74 (53)	53 (51)	25 (52)	182 (50)	
-1-5 years	35 (49)	62 (44)	45 (44)	23 (48)	165 (46)	
- > 5 years	4 (6)	3 (2)	2 (2)	0 (0)	9 (2)	0.668

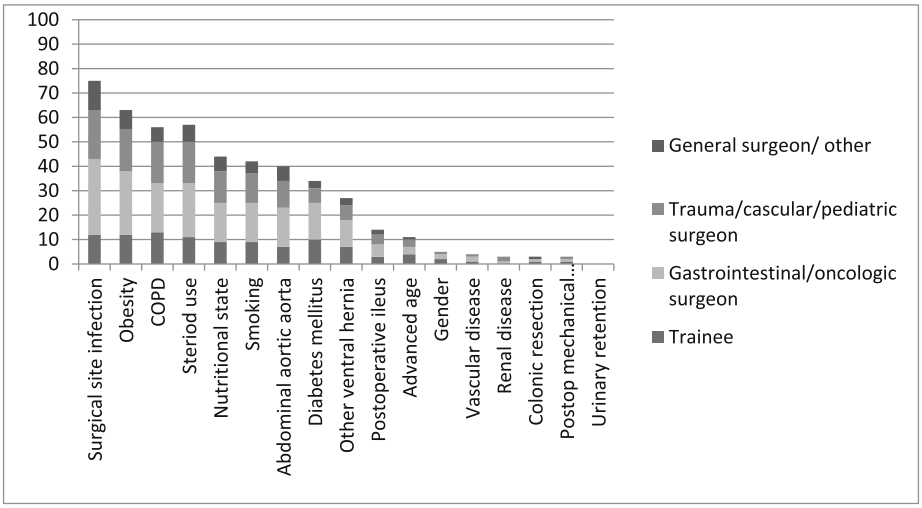

Fig. 1. Reported risk factors for development of incisional hernia in percentages.

Subgroup analysis based on the type of hospital in which participants work found differences in responses on the questions on fascial step size (P = 0.001) and suture size (P = 0.001). The responses to the other questions on technique, materials and incisional hernia knowledge did not vary among the type of hospital.

Multinomial logistic regression analysis with the participants from academic hospitals as reference group found that the odds ratio for preference of small fascial step size (< 5 mm) was 0.39 for participants from teaching hospitals (95% confidence interval 0.14–1.04) and for participants from non-academic non-teaching hospitals the odds ratio was 0.10 [95% CI 0.03–0.32]. Participants from academic hospitals were 2.5–8 times more likely to prefer small steps than participants from other hospitals.

When compared with participants from academic hospitals at multinomial logistic regression analysis, the odds ratio for participants from teaching hospitals to use a suture size other than 2-0 was 3.17 (95% CI 1,75–5.74) and 3.64 (95% CI 1.67–8.00) for non-academic, non-teaching hospitals. Surgeons working in non-academic hospitals were more likely to use sutures other than 2-0 for closure of the abdominal wall.

When participants were grouped according to the annual number of midline laparotomies performed, a significant difference was detected in the estimation of the incidence of incisional hernias (p < 0.002).

Multinomial logistic regression analysis found that the odds ratio for participants who perform less than 10 laparotomies to estimate the correct incidence of incisional hernia was 1.05 (95% CI 0.24–4.57), when compared with participants performing more than 30 laparotomies yearly as reference. The odd's ratio for participants performing 10–30 laparotomies was 0.82 (95% CI 0.25–2.55). These findings suggest that an increased number of laparotomies is associated with better knowledge on incisional hernia incidence.

4. Discussion

The surgical technique used for closure after laparotomy is one of the most important risk factors for developing incisional hernia. Unlike other patient related factors, it is also one of the few factors that can be influenced by the surgeon in order to decrease the incidence of incisional hernia. Previously, little was known on the implementation and use of current evidence in clinical practice on this subject among surgeons.

The results from this survey provide insight in current practice patterns of abdominal wall closure of different surgical subspecialties. The main findings are that most interviewed surgeons used a single layer mass closure technique with a running slow absorbable suture. Only 35% of surgeons closed the abdominal fascia using a SL/WL ratio of 4:1 and 19% use a size 2-0 suture. Gastro-intestinal and oncologic surgeons were two to four times more likely to use the 4:1 ratio and surgeons in academic hospitals were more likely to use small steps and a 2-0 suture. Over two thirds of participants did not change this technique since training. Risk factors for incisional hernia development were generally identified correctly but the correct incidence of incisional hernia was known by only 32% of participants. Also, while evidence suggest that most incisional hernias develop during the second postoperative year, half of the participating surgeons thought most incisional hernias develop within the first postoperative year. This suggests that surgeons may be insufficiently vigilant for later development of incisional hernias.

Previous studies on implementation of evidence for incisional hernia prevention found similar results to our survey. In 2009, Rahbari et al. reported a lack of consensus of abdominal wall closure in a cohort analysis of 157 patients [11]. Pereira et al. found similar results in a Spanish survey among 131 surgeons and surgical trainees in 2013 [12]. More recently, Fischer et al. reported on a web-based survey among members of hernia societies and found that, in this selected population of ‘abdominal wall enthusiasts’ 63% of participants practiced but not measured the suture length to wound length ratio of 4:1 and only 15% of participants currently use prophylactic mesh reinforcement of the abdominal wall in high risk patients [20]. Although in their survey more surgeons use incisional hernia prevention techniques when compared to the present study, even among this targeted population of surgeons, adaptation to best practice is still not ubiquitous.

There are several possible explanations for the discrepancy in findings between literature recommendations and reported current practice:

First, probably not all surgeons are aware of current findings. Surgeons who perform less laparotomies were found to be more likely to estimate the rate of incisional hernia formation incorrectly. This may reflect a lower affinity with techniques of closure of the abdominal wall for these surgeons. If these specialists do not encounter incisional hernias (because these patients are referred to other colleagues), they may not feel the need to change their current technique since it seems to be sufficient.

Secondly, it is possible that not all surgeons are convinced by the literature. Two recent meta-analyses on abdominal wall closure concluded that available evidence is of moderate quality and the Cochrane analysis by Patel et al. advised larger, higher quality trials [21,22]. In this survey, over half of the respondents did not change their technique of closure of the abdominal wall since their surgical training. Perhaps the respondents feel that the available evidence does not balance out

against years of personal experience. Adoption of new techniques by individual surgeons may also be hindered by intercollegiate agreements to have all team members in a hospital use identical techniques and materials. Because responses were anonymized to ensure participants privacy, no analysis could be performed to investigate this.

A third explanation is that the results of this survey represent a snapshot of current practice and does not show changes in practice over the years. It is possible that the new evidence has yet to be incorporated in daily practice and that this is an ongoing process. Historical techniques of abdominal wall closure, such as interrupted sutures in separate layers, which are almost gone in this survey, used to be standard practice in previous decades and have since changed [23]. A repeat of this survey in 10 years could find very different results in practice than the current survey.

Notable is that, although the 'small step, small stitch'-technique has not yet been universally adopted, the gastro-intestinal and oncologic surgeons seem to use these techniques and materials relatively more often than other participants. These 'early adopters' of new techniques could be the catalysts to introduce these new insights in their local surgical departments and stimulate their colleagues to adjust their technique. Surgeons who work in academic (university) hospitals also seem to be adapting to this technique, as evidenced by the increased percentage of participants from these hospitals who use smaller suture sizes and smaller fascial steps. This offers a good opportunity for implementing evidence-based closure techniques in practice; as these surgeons are involved in training future surgeons, a trickle-down effect may follow.

Grol et al. and Grimshaw et al. studied strategies for successful implementation of new evidence in medical practice and found many different approaches, ranging from financial interventions, audit and feedback strategies to the distribution of educational materials [19]. None of the available strategies appeared superior to others in all situations. The authors concluded that, in order to effectively change practice and implement new evidence, a strategy should be tailor-made, well prepared in advance with clear indicators for measurement of success. The approach should be feasible within available budgets and possibilities. Relevant people should be involved early and progress should be monitored regularly.

Surgeons operating on patients with increased risk of incisional hernia development should be a focus of these strategies. One subspecialty at which efforts should be directed is vascular surgery. Patients with aortic aneurysms are considered to have an impaired connective tissue turnover and at increased risk of incisional hernia development. Surgeons operating on obese patients, such as bariatric surgeons are another group which should be encouraged to adopt evidence-based techniques, because obesity is another risk factor for incisional hernia development.

There are some limitations to this survey. The response rate of 26% is relatively low and a selective response bias might have occurred because of this. However, the 402 completed surveys represent 97% of all surgical departments in the Netherlands. The completed surveys therefore seem to reflect current practice in the Netherlands adequately. Although this survey was conducted in the Netherlands, the results are likely to be generalizable to surgeons worldwide because the materials and techniques discussed for abdominal wall closure and incisional hernia treatment are widely available and midline laparotomy is a common approach for access to the abdominal cavity. Finally, a survey is inherently a snapshot if the current practice and does not show changes in practice over time.

5. Conclusions

In this survey, which evaluates current practice of abdominal wall closure after midline laparotomy among Dutch surgeons with incisional hernia prevention in mind, most participants prefer a single layer mass closure with a running slow absorbable suture. Only 35% of surgeons close the abdominal fascia using a suture length to wound length ratio of 4:1. Gastro-intestinal and oncologic surgeons are most likely to use this technique. Over two-thirds of participants did not change their abdominal closure technique since training. Risk factors for incisional hernia development are generally identified correctly but knowledge on incidence and time of occurrence of incisional hernia is lacking. Efforts should be directed at improved adoption of the evidence based technique.

Ethical approval

Not applicable. No patients were involved in this survey.

Funding

None.

Author contribution

Bloemen, A
- Conceptualization
- Data curation
- Formal analysis
- Investigation
- Validation
- Writing draft
- Revision draft.
- Project administration

De Kleijn, R.J.C.M.F.
- Data curation
- Software management
- Investigation
- Writing draft
- Project administration

Van Steensel, S.
- Formal analysis
- Validation
- Methodology
- Revision draft

Aarts, F.
- Supervision
- Validation
- Revision draft

Schreinemacher, M.
- Conceptualization
- Methodology
- Investigation
- Supervision
- Reviewing draft

Bouvy, N.D.
- Conceptualization
- Methodology
- Supervision
- revision and review of draft

Conflicts of interest

None.

Research registration number

1. Name of the registry: ClinicalTrials.gov.
2. Unique Identifying number or registration ID: NCT04013009.
3. Hyperlink to the registration (must be publicly accessible): https://www.clinicaltrials.gov/ct2/results?cond=&term=NCT04013009&cntry=&state=&city=&dist=

Guarantor

A Bloemen.

Data statement

Participants of the survey were assured that their responses would remain confidential. Raw data files will therefore not be made available.

Provenance and peer review

Not commissioned, externally peer reviewed.

Acknowledgements

F. Van Osch. PhD (department of clinical epidemiology, VieCuri Medical Centre, Venlo, The Netherlands) provided statistical assistance.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijsu.2019.09.024.

References

[1] J.F. Gillion, D. Sanders, M. Miserez, F. Muysoms, The economic burden of incisional ventral hernia repair: a multicentric cost analysis, Hernia 20 (6) (2016) 819–830.
[2] A. Bloemen, P. Van Dooren, B.F. Huizinga, A.G.M. Hoofwijk, Randomized clinical trial comparing polypropylene or polydioxanone for midline abdominal wall closure, Br. J. Surg. 98 (5) (2011) 633–639.
[3] L.A. Israelsson, D. Millbourn, Prevention of incisional hernias. How to close a midline incision, Surg. Clin. N. Am. 93 (5) (2013) 1027–1040.
[4] E.B. Deerenberg, J.J. Harlaar, E.W. Steyerberg, H.E. Lont, H.C. Van Doorn, J. Heisterkamp, et al., Small bites versus large bites for closure of abdominal midline incisions (STITCH): a double-blind, multicentre, randomised controlled trial, Lancet 386 (10000) (2015) 1254–1260.
[5] L.A. Israelsson, T. Jonsson, Physical properties of self locking and conventional surgical knots, Eur. J. Surg. 160 (6–7) (1994) 323–327.
[6] F.E. Muysoms, S.A. Antoniou, K. Bury, G. Campanelli, J. Conze, D. Cuccurullo, et al., European Hernia Society guidelines on the closure of abdominal wall incisions, Hernia 19 (1) (2015) 1–24.
[7] T. Thorup, M.B. Tolstrup, I. Gögenur, Reduced rate of incisional hernia after standardized fascial closure in emergency laparotomy, Hernia 23 (2) (2019) 341–346.
[8] M.B. Tolstrup, S.K. Watt, I. Gögenur, Reduced rate of dehiscence after implementation of a standardized fascial closure technique in patients undergoing emergency laparotomy, Ann. Surg. 265 (4) (2017) 821–826.
[9] A.P. Jairam, L. Timmermans, H.H. Eker, R.E.G.J.M. Pierik, D. van Klaveren, E.W. Steyerberg, et al., Prevention of incisional hernia with prophylactic onlay and sublay mesh reinforcement versus primary suture only in midline laparotomies (PRIMA): 2-year follow-up of a multicentre, double-blind, randomised controlled trial, Lancet 390 (10094) (2017) 567–576.
[10] F.E. Muysoms, O. Detry, T. Vierendeels, M. Huyghe, M. Miserez, M. Ruppert, et al., Prevention of incisional hernias by prophylactic meshaugmented reinforcement of midline laparotomies for abdominal aortic aneurysm treatment: a randomized controlled trial, Ann. Surg. 263 (4) (2016) 638–645.
[11] N.N. Rahbari, P. Knebel, M.K. Diener, C. Seidlmayer, K. Ridwelski, H. Stöltzing, et al., Current practice of abdominal wall closure in elective surgery - is there any consensus? [Internet], BMC Surg. 9 (2009) 8, https://doi.org/10.1186/1471-2482-9-8 [cited 2019 Jul 14] available from: http://www.biomedcentral.com/1471-2482/9/8.
[12] J.A. Pereira, M. Lopez-Cano, F. Marsal, X. Feliu, [Results of a national survey on abdominal wall closure], Cir. Esp. 91 (10) (2013) 645–650.
[13] S. Dabrowiecki, [Abdominal wall closure techniques–the results of the Polish surgeons' survey], Pol. Merkur. Lek. 19 (113) (2005) 646–650.
[14] G. Eysenbach, Improving the quality of web surveys: the checklist for reporting results of internet E-surveys (CHERRIES), J. Med. Internet Res. 29 (3) (2004) e34 6.
[15] K.A. Bickenbach, P.J. Karanicolas, J.B. Ammori, S. Jayaraman, J.M. Winter, R.C. Fields, et al., Up and down or side to side? A systematic review and meta-analysis examining the impact of incision on outcomes after abdominal surgery, Am. J. Surg. 206 (3) (2013) 400–409.
[16] J. Höer, G. Lawong, U. Klinge, V. Schumpelick, Factors influencing the development of incisional hernia. A retrospective study of 2,983 laparotomy patients over a period of 10 years, Der Chir 73 (5) (2002) 474–480.
[17] D.C. Bosanquet, J. Ansell, T. Abdelrahman, J. Cornish, R. Harries, A. Stimpson, et al., Systematic review and meta-regression of factors affecting midline Incisional hernia rates: analysis of 14 618 patients, PLoS One 10 (9) (2015) e0138745.
[18] M.H.F. Schreinemacher, R.P. Ten Broek, E.A. Bakkum, H. Van Goor, N.D. Bouvy, Adhesion awareness: a national survey of surgeons, World J. Surg. 34 (12) (2010) 2805–2812.
[19] R. Grol, J. Grimshaw, From best evidence to best practice: effective implementation of change in patients' care, Lancet 362 (9391) (2003) 1225–1230.
[20] J.P. Fischer, H.W. Harris, M. López-Cano, W.W. Hope, Hernia prevention: practice patterns and surgeons' attitudes about abdominal wall closure and the use of prophylactic mesh, Hernia 23 (2) (2019) 329–334.
[21] S.V. Patel, D.D. Paskar, R.L. Nelson, S.S. Vedula, S.R. Steele, Closure methods for laparotomy incisions for preventing incisional hernias and other wound complications, Cochrane Database Syst. Rev. 11 (2017) CD005661.
[22] N.A. Henriksen, E.B. Deerenberg, L. Venclauskas, R.H. Fortelny, M. Miserez, F.E. Muysoms, Meta-analysis on materials and techniques for laparotomy closure: the MATCH review, World J. Surg. 42 (6) (2018) 1666–1678.
[23] R.M. Zollinger, The atlas of surgical operations: Elliott Carr Cutler and Robert Zollinger, Am. J. Surg. 186 (3) (2003) 211–216.