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Risk factors for the development of flank hernias and bulges following surgical flank approaches to the kidney in adults

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KEYWORDS

Abdominal hernia;
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Hernia;
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Postoperative hernia

ABBREVIATIONS

BMI, body mass index;
ECOG, Eastern Cooperative Oncology Group;
IQR, interquartile range;

Abstract ***Objectives:*** To evaluate the incidence and risk factors for the development of flank incisional hernias or bulges following surgical flank approaches to the kidney.

Patients and methods: In all, 100 consecutive adult patients who underwent variable renal surgeries via flank approaches were included in this prospective study. The incidence and risk factors for flank hernias and bulges were studied at 1- and 6-months postoperatively.

Results: At 6 months postoperatively, the incidence of flank bulge was 14% and for lumbar hernia was 10%. The univariate analysis showed 13 significant factors to be associated with the occurrence of a flank bulge or hernia following flank incisions. When the significant risk factors in the univariate analysis were studied by multivariate analysis, using a logistic regression analysis, four independent risk factors were identified. These were: body mass index (BMI) $\geq$26.3 kg/m^2 (P = 0.04), the use of a self-retaining retractor during surgery (P = 0.02), not preserving or identifying the neurovascular bundle (NVB) during surgery (P = 0.028), and postoperative

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NVB, neurovascular bundle;
OR, odds ratio

abdominal distention ($P = 0.001$). Moreover, all cases included in our study who underwent en masse wound closure, developed surgical wound infection or who had constipation developed postoperative flank bulge or hernia.

Conclusion: High BMI, the use of self-retaining retractor, not identifying or preserving the NVB, postoperative abdominal distention, en masse wound closure, surgical wound infection, and constipation are significant risk factors associated with postoperative flank hernia and bulge.

Introduction

Lumbar hernias occur infrequently and can be congenital, primary, post-traumatic or incisional. They are bounded by the 12th rib, the iliac crest, the erector spinae, and the external oblique muscle [1]. Hernia rates of 0.4–17% following flank incision have been reported [2].

Symptoms may be absent, present, or confusing because post-incisional neuralgia may be indistinguishable from pain caused by a lumbar hernia. A lumbar bulge is usually detectable, but occasionally the clinical diagnosis of hernia can be difficult in the obese and in the early postoperative period [3].

The risk factors for occurrence include factors related to patient's status, underlying disease, surgical technique, and postoperative complications. Surgical technique of wound closure might play a role [4]. Perioperative factors appear to have the most significant relation to incisional hernia formation, with wound infection being the most consistently reported risk factor. Other perioperative risk factors include deep abscesses, perioperative gastrointestinal complications, and early re-operations [5].

As the literature lacks clear identification of risk factors that might contribute to the occurrence of the postoperative frustrating flank bulge or hernias, we aimed to evaluate all the possible risk factors for the development of incisional hernia and bulges after surgical flank approaches to the kidney.

Patients and methods

A prospective study in which 100 consecutive adult patients who underwent variable renal surgeries via a flank approach at our centre between January 2014 to July 2016 were included, followed-up, and examined for the development of postoperative flank bulges or/and hernias. Only adults' aged $\geq$18 years were included. Patients with history of previous flank incision were excluded. We determined all the possible preoperative, intraoperative, and postoperative risk factors that might contribute to the occurrence of post-flank surgery bulge or incisional hernia. We recorded all these data then followed patients after flank surgeries to determine independent risk factors for the development of such complications.

Diagnosis and follow-up of flank bulge and hernia

All patients were initially examined and photographed in the erect position from an anterior view preoperatively. Follow-up visits were scheduled at 1, 3 and 6 months postoperatively, where patients were re-examined clinically and photographed in the erect position for bulge and hernia. The view, the illumination, and the dimensions of each photograph were fixed in each patient and at each occasion to allow accurate comparison between pre- and postoperative images.

A postoperative flank bulge was diagnosed when there was a noticeable abnormal contour at the site of surgery when compared to the preoperative photograph of the patient. A hernia was diagnosed when a flank bulge was associated with a palpable defect in the abdominal wall. If any doubt whether a defect was present or not, ultrasonography or CT examination was used to confirm the diagnosis. Ultrasonography was needed for diagnosis in nine patients, whilst CT was used to confirm the diagnosis in three patients.

The protocol was approved by the Institutional Review Board of Ain Shams University. An informed consent was obtained from each patient before enrolment in the study.

Statistical analysis

Data were collected, tabulated, and analysed using the Statistical Package for the Social Sciences (SPSS®; SPSS Inc., IBM Corp., Armonk, NY, USA), version 17.0, on an IBM compatible computer.

Two types of statistics were done: descriptive statistics [e.g. percentage (%), mean and standard deviation (SD)] and analytic statistics, which included the following univariate tests: chi-squared test, Fisher's exact test, independent *t*-test and Mann–Whitney *U*-test. Multivariate analysis was done using logistic regression. A $P < 0.05$ was considered statistically significant.

Results

The recorded perioperative data are summarised in Table 1.

Incidence of postoperative flank bulge or hernia

At 1-month postoperatively, flank bulge only was detected in 18 patients, whilst hernias were detected in six.

At 6 months postoperatively, flank bulges were found in 14 patients and hernias in 10. In four patients the bulge/hernia was asymptomatic. In all, 20 patients who developed bulge or hernia complained of an abnormal bulge at the site of surgery; of these 12 complained of a dull ache.

We noticed that four of the patients who presented initially at first follow-up with only flank bulge actually developed true hernias at later follow-up. Conversely, none of the patients who were 'normal' at the first follow-up developed bulges or hernias on subsequent follow-up examinations.

None of the patients who had a flank bulge or hernia at the first follow-up showed complete resolution on subsequent follow-up.

Univariate analysis

We studied the incidence of postoperative bulge and hernia in relation to all the recorded risk factors. The univariate analysis showed 13 statistically significant factors to be associated with flank bulge or hernia after flank incisions. These were: older age, high body mass index (BMI), poor Eastern Cooperative Oncology Group (ECOG) Performance Status, sedentary life style, constipation, lower haemoglobin level, higher serum creatinine level, longer incision, the use of self-retaining retractor, not preserving or identifying the neurovascular bundle (NVB), en masse wound closure, surgical site infection, and the presence of postoperative abdominal distension (Table 2).

Multivariate analysis

All risk factors that were found on univariate analysis to be significantly associated with postoperative flank bulge or hernia were studied with multivariate analysis using a logistic regression model except en masse wound closure, surgical site infection, and constipation (these factors were not statistically amenable for logistic regression analysis as all the few cases with these risk factors developed lumbar hernia or bulge). Continuous variables such as age, BMI and length of incision were categorised according to their median values. Haemoglobin and serum creatinine levels were inserted as continuous numerical variables due to their narrow range of values.

Table 1 Perioperative data.

Variable	Value
Total number of patients	100
Preoperative	
Mean (SD; range)	
Age, years, mean (SD; range)	40.82 (11.71; 19–69)
BMI, kg/m^2	26.2 (3.5; 18.82–33.3)
Haemoglobin, g/dL	12.1 (1.6; 8.3–15.0)
Albumin, g/dL	3.9 (0.4; 2.7–4.8)
Serum creatinine, mg/dL	0.9 (0.2; 0.6–1.4)
N	
Sex	
Male	89
Female	11
Smoking	
Yes	44
No	56
Life style	
Sedentary	14
Manual workers	86
Exercise	
No	12
Light	38
Moderate	42
Heavy	8
ECOG Performance Status	
0	58
1	30
2	10
3	2
Constipation	
Yes	12
No	88
Diabetes mellitus	
Yes	10
No	90
Intraoperative	
Mean (SD; range):	
Operative time, min	93.6 (30.1; 40–150)
Surgeon experience, years	24.6 (10.7; 6–33)
Length of incision, cm	12.4 (2.0; 8–16)
Voltage of diathermy	3.9 (0.6; 3–5)
N	
Indication	
Pyelolithotomy	62
Nephrectomy	16
Pyeloplasty	15
Upper ureterolithotomy	7
Use of self-retaining retractor	
Yes	44
No	56
Muscle division method	
Cutting	98
Coagulation	2
NVB	
Not identified	58
Not preserved	6
Identified and preserved	36

(*continued on next page*)

Table 1 (*continued*)

Variable	Value
Wound closure	
En masse closure (one layer)	10
Two layers	90
Suture technique	
Continuous	28
Continuous and interrupted	72
Suture material	
Absorbable (polyglactin 910, Vicryl®)	78
Non-absorbable (polypropylene, Prolene®)	22
Postoperative	
Ambulation, days, median (IQR)	3 (3–5)
Return to physical activity, days, mean (SD; range)	26.3 (9.4; 14–60)
Distension, *n*	
No	74
Yes	26

IQR, interquartile range.

After adjustment of all factors, it was shown that a BMI of $\geq$26.3 kg/m^2 (odds ratio [OR] 14.8, 95% CI 1.12–206.2; $P < 0.05$), the use of self-retaining retractor (OR 25.2, 95% CI 1.6–387.7; $P < 0.05$), not preserving or identifying the NVB (OR 90.25, 95% CI 1.6–4982; $P < 0.05$), and the presence of postoperative abdominal distension (OR 316, 95% CI 10.8–9239.7; $P < 0.05$), were independent factors associated with occurrence of postoperative hernia/bulge (Table 3).

Discussion

The risk factors for occurrence of postoperative flank hernias and bulges include factors related to patient's status, underlying disease, surgical technique, and postoperative complications [4].

In the present study; the estimated incidence rate for flank bulge without hernia was 14% at 6 months and for flank hernia was 10% at 6 months. Similar findings have been reported by other studies, with hernia rates of 0.4–17% following flank incision [2]. The incidence rate for incisional hernia after abdominal surgery was 5.2% at 12 months and 10.3% at 24 months [6]. Hernia rates ranged from 2% to 20% after laparotomy and were significantly higher for midline incisions in comparison to transverse incisions (11% vs 4.7%) [7].

In the present study, ultrasonography was used occasionally to document the presence of lumbar incisional hernia or bulge. CT is the diagnostic modality of choice to distinguish lumbar incisional hernias with fascial defects from abdominal wall musculature denervation atrophy with no fascial defect [1]. However, being more expensive, its use was reserved only when ultrasonography was inconclusive [8].

In the present study, older age was associated with the occurrence of postoperative flank bulge or hernia on the univariate analysis only. Old age is associated with atrophy of the abdominal wall and changes in connective tissue [8]. This may also be explained by delayed wound healing in older patients due to altered inflammatory response, such as delayed T-cell infiltration into the wound area with alterations in chemokine production and reduced macrophage phagocytic capacity [9]. Several studies have shown the correlation between old age and the development of postoperative hernias [6,7,10,11]. However, another study showed no correlation between the age of the patient and the rate of postoperative flank bulge following flank incision for radical nephrectomy [12].

In our present study, patient's sex showed no statistically significant difference for the development of postoperative flank bulge or hernia, which is in accordance with another study [11]. However, female sex was a risk factor for incisional hernia development after abdominal surgery in another study [6].

In the present study, smoking showed no statistically significant difference for the development of postoperative flank bulge or hernia. This finding agrees with another study [11]. However, chronic obstructive pulmonary disease was not studied in our present study and it was reported as a risk factor for the development of postoperative lumbar incisional hernia in another study [11].

In our present study, BMI was an independent risk factor for the development of postoperative hernia and bulge, which is in agreement with other studies [10,13]. Another study reached a similar conclusion regarding BMI and further included the thickness of subcutaneous tissue as an independent risk factor for incisional hernia development after abdominal surgery [6].

In the present study there was a correlation between haemoglobin drop and postoperative bulge and hernia on univariate analysis only. Various studies considered anaemia as a risk factor for the development of postoperative incisional hernia owing to delayed wound healing and defective tissue oxygenation [10,14].

In the present study, the presence of preoperative chronic constipation and postoperative abdominal distention showed statistically significant increased risk for the development of postoperative hernia and bulge. This may be attributed to increased intra-abdominal pressure that puts strain on the abdominal wall scar. The same finding was reported by another study [15]. Ileus is also considered as a risk factor for burst abdomen and incisional hernia [5,16].

The univariate analysis showed that a lengthy incision was a statistically significant factor in the group who developed postoperative hernia and bulge compared to the group who did not. However, it was not

Table 2 Univariate analysis of recorded risk factors in relation to development of postoperative flank hernia or bulge.

Variable	Studied cases		*P*
	Normal *n* = 76	Bulge/hernia *n* = 24	
Mean (SD; range):			
Age, years	38.8 (11.3; 20–69)	47.3 (10.9; 19–61)	**0.002**[*]
BMI, kg/m^2	25.4 (3.2; 18.82–33.3)	28.6 (3.4; 21.8–33.3)	**< 0.001**[*]
Haemoglobin level, g/dL	12.3 (1.4; 9.6–15.0)	11.1 (1.6; 8.3–14.0)	**0.001**[*]
Albumin level, g/dL	4.0 (0.4; 2.7–4.8)	3.8 (0.3; 3.4–4.5)	0.13[*]
Serum creatinine level, mg/dL	0.9 (0.2; 0.6–1.3)	1.0 (0.2; 0.75–1.4)	**< 0.001**[*]
Operative time, min	91.6 (30.2; 40–130)	100.0 (29.5; 50–150)	0.23[*]
Length of incision, cm, mean (SD; range)	12.0 (2.0; 8–15)	13.4 (1.8; 9–16)	**0.003**[*]
Voltage of diathermy, mean (SD; range)	3.9 (0.6; 3–5)	4.2 (0.6; 3–5)	0.11[*]
Surgeon experience, years, median (IQR)	29.5 (9–33)	29.0 (9–32)	0.17[#]
Surgeon experience (years), *n*/*N* (%)			0.606[‡]
< 10	20/28 (71.4)	8/28 (28.6)	
10–30	22/30 (73.3)	8/30 (26.7)	
> 30	34/42 (81.0)	8/42 (19.0)	
Ambulation, days, median (IQR)	3.0 (3–4)	4.5 (3–7)	0.06[#]
Return to physical activity, days, median (IQR)	30.0 (21–30)	25.5 (17.5–30)	0.83[#]
n/*N* (%):			
Sex			0.13[¶]
Male	70/89 (78.7)	19/89 (21.3)	
Female	6/11	5/11	
Smoking			0.11[‡]
Yes	30/44 (68.2)	14/44 (18.2)	
No	46/56 (82.1)	10/56 (17.9)	
ECOG Performance Status			**< 0.001**[¶]
0–1	72/88 (83.7)	16/88 (18.2)	
2–3	4/12	8/12	
Life style			**< 0.001**[¶]
Sedentary	4/14	10/14	
Worker	72/86 (83.7)	14/86 (16.3)	
Exercise			0.18[¶]
No	8/12	4/12	
Light	26/38 (68.4)	12/38 (31.6)	
Moderate	34/42 (81.0)	8/42 (19.0)	
Heavy	8/8	0/8	
Constipation			**< 0.001**[¶]
Yes	0/12	12/12	
No	76/88 (86.0)	12/88 (13.6)	
Diabetes mellitus			0.06[¶]
Yes	5/10	5/10	
No	71/90 (79.0)	19/90 (21.1)	
Approach			0.09[¶]
11th rib	1/3	2/3	
12th rib	51/69 (73.9)	18/69 (26.1)	
Subcostal	24/28 (85.7)	4/28 (14.3)	
Use of self-retaining retractor			**< 0.001**[‡]
Yes	26/44 (59.1)	18/44 (40.9)	
No	50/56 (89.3)	6/56 (10.7)	
Muscle division method			1.0[¶]
Cutting cautery	74/98 (75.5)	24/98 (24.5)	
Coagulation cautery	2/2	0/2	
NVB			**< 0.001**[¶]
Not identified or not preserved	44/64 (68.8)	20/64 (31.3)	
Identified and preserved	32/36 (88.9)	4/36 (11.1)	

(*continued on next page*)

Table 2 (*continued*)

Variable	Studied cases		*P*
	Normal *n* = 76	Bulge/hernia *n* = 24	
Wound closure			**< 0.001**¶
En masse (one layer; *n* = 10)	0/10	10/10	
Two layers (*n* = 90)	76/90 (84.4)	14/90 (15.6)	
Suture technique			0.71‡
Continuous	22/28 (78.6)	6/28 (21.4)	
Continuous + interrupted	54/72 (75.0)	18/72 (25.0)	
Suture material			0.124‡
Absorbable (polyglactin 910, Vicryl®)	62/78 (79.5.6)	16/78 (20.5)	
Non-absorbable (polypropylene, Prolene®)	14 (18.4)	8 (33.3)	
Surgical-site infection			**0.003**¶
Yes	0/4	4/4	
No	76/96 (79.2)	20/96 (20.8)	
Postoperative abdominal distension			**< 0.001**‡
Yes	6/26 (23.1)	20/26 (76.9)	
No	70/74 (94.6)	4/74 (5.4)	

IQR, interquartile range; *, *t*-test; #, Mann–Whitney *U*-test; ‡, chi-squared test; ¶, Fisher's exact test.
$P \leq 0.05$ considered significant (in bold).

Table 3 Multivariate analysis showing independent risk factors for the development of postoperative flank hernia or bulge.

Variable	*P*	OR (95% CI)
Age ≥40 years	0.585	3.13 (0.052–188.5)
BMI ≥26.3 kg/m^2	**0.044**	14.87 (1.12–206.2)
ECOG Performance Status 2–3	0.107	0.019 (0.000–2.363)
Sedentary lifestyle	0.75	1.62 (0.083–31.94)
Haemoglobin level	0.277	1.47 (0.732–2.96)
Serum creatinine level	0.703	4.10 (0.003–5775)
Use of self-retaining retractor	**0.021**	25.20 (1.638–387.7)
Length of incision ≥13 cm	0.92	1.215 (0.027–54.97)
NVB not preserved/not identified	**0.028**	90.25 (1.635–4982.15)
Postoperative abdominal distension	**0.001**	316.12 (10.816–9239.7)

OR, odds ratio for the development of postoperative flank hernia or bulge.
$P \leq 0.05$ considered significant (in bold).

an independent risk factor for this complication. Other studies have also reported a significant association between an increase in the length of the incision and the occurrence of incisional hernia [6].

The multivariate analysis showed that not preserving or identifying the NVB significantly increased the incidence of developing postoperative incisional hernia and bulge. Parallel findings were obtained by others who concluded that postoperative lumbar bulge following retroperitoneal incision is related to intercostal nerve injury, with subsequent paralysis of abdominal wall musculature [17]. Also, in a cadaveric and electrophysiological study, postoperative lumbar bulge was reported to likely be due to denervation of the abdominal musculature from injury to the T11 and T12 intercostal nerves [18].

For wound closure, our protocol was to close the muscle layers either en masse or with a layered closure according to the surgeon's preference. Running sutures were used in all cases, using either braided polyglactin or polypropylene sutures. In the present study, en masse wound closure in one layer significantly increased the incidence of developing postoperative hernia and bulge compared to the group who did not develop hernia/bulge on univariate analysis. Other studies have compared layered wound closure with en masse closure of the abdominal wall, which favoured en masse closure for a lesser incidence of incisional hernia occurrence [19]. Similarly, a continuous en masse closure with non-absorbable (nylon or polypropylene) or slow-absorbable (polydioxanone) monofilament sutures was reported to be the optimal technique for closure of the abdominal midline fascia to prevent incisional hernia [20]. These studies came to a different conclusion than our present study, which might be due to the fact that all these studies were on ventral midline incisions unlike ours on the flank approach that has a different anatomy and influence of intra-abdominal pressure. There was no difference in incisional hernia risk with different suture techniques (11.1% for running suture, 9.8% for interrupted sutures) [7].

In the present study, surgical site infection significantly increased the incidence of postoperative hernia and bulge. This may be attributed to tissue breakdown and necrosis caused by wound infection that severely impedes wound healing [8]. Similarly, wound infection

was identified as a statistically significant risk factor for incisional hernia in other studies [6,7,14,16].

In the present study, operative time showed no statistically significant difference for the development of postoperative flank bulge or hernia. However, another study reported that prolonged operative time was a statistically significant factor in the development of postoperative lumbar incisional hernia [11].

A limitation of the present study was that we could not differentiate which factor was related to the occurrence of flank bulges and which could result in hernia. This is probably due to the small number of cases.

Conclusion

A high BMI, chronic constipation, the use of a self-retaining retractor during surgery, not preserving or identifying the NVB during surgery, en masse wound closure, surgical wound infection, and postoperative abdominal distention were identified as significant risk factors for the occurrence of postoperative flank hernia and bulge.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the Institutional Research Committee and with the 1964 Helsinki Declaration and its later amendments. Informed consent was obtained from each patient before enrolment in the study.

Authors' contributions

T. Osman: Project development, Manuscript writing and editing.

A. Emam: Data collection, management, analysis, Manuscript writing and editing.

A. Farouk: Protocol development, data collection, management and cases performance.

K. ElSaeed: Manuscript editing and cases performance.

A.M. Tawfeek: Manuscript editing and cases performance.

A. AbuHalima: Data collection, management, analysis and Manuscript writing.

Conflict of interest

The authors declare that they have no conflict of interest. All authors have approved the final article.

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