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Development of a Risk Model for Abdominal Wound Dehiscence

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Abstract

Objectives: To identify independent risk factors for abdominal wound dehiscence and develop a risk model to recognize high risk patients. **Methods:** The samples studied were patients who underwent midline laparotomy in the department of surgery, SMHS Hospital Srinagar from March 2009 to April 2015. For each case of abdominal wound dehiscence, three controls were selected from a group of patients who had undergone open abdominal surgery as close as possible in time. Preoperative, perioperative, and postoperative variables and in-hospital mortality were studied for all patients. Cases were compared with controls using the chi-square test or the Mann–Whitney U-test for categorical or continuous data, respectively. Subsequently, multivariate stepwise logistic regression with backwards elimination test used to identify main independent risk factors of abdominal wound dehiscence. The resulting regression coefficients for the major risk factors were used as weights for these variables to calculate a risk score for abdominal wound dehiscence. **Results:** 140 cases of abdominal wound dehiscence were reported and compared with 420 selected controls. All variables that were significant in univariate analyses were entered in a multivariate stepwise logistic regression to determine which variables were significant independent risk factors. Major independent risk factors were male gender, chronic pulmonary disease, corticosteroid use, smoking, obesity, anemia, jaundice, ascites, and sepsis, type of surgery, postoperative coughing, and wound infection. Based on these findings, a risk model was developed. **Conclusions:** The model can give an estimate of the risk of abdominal wound dehiscence for individual patients. High-risk patients may be planned preventive wound closing with reinforcements as mesh.

Keywords

Abdominal Wound Dehiscence, Risk Factors, Risk Model, Abdominal Complications

1. Introduction

Abdominal wound dehiscence is among the most dreaded complications faced by surgeons and is of greatest concern because of the risk of evisceration, the need for immediate intervention, and the possibility of repeat dehiscence, wound infection, and incisional hernia formation. It refers to postoperative separation of the abdominal musculoaponeurotic layers. It also entails increased patient treatment cost due to reoperations, postoperative complications and prolonged hospital stay [1]-[8]. The mortality rate following wound dehiscence has ranged from 9% - 43%, with a recent review reporting a mortality rate of 16% [9].

Historically, dehiscence rates of up to 10% have been reported. The incidence, as described in the literature, ranges from 0.4% to 3.5% [10]-[23]. In about 20% - 45% of cases, evisceration becomes a significant risk factor, which is associated with death during the peri-operative period [24] [25]. Dehiscence may occur anytime after surgery from 1 to more than 20 days. The mean time to wound dehiscence is 8 - 10 postoperative days [26] [27].

A multitude of factors may contribute to wound dehiscence. It is often related to technical errors in placing sutures too close to the edge, too far apart, or under too much tension. Several important risk factors for wound dehiscence have been revealed: age (>65 years), hypo-albuminemia, wound infection, ascites, obesity, steroid use, chronic obstructive pulmonary disease, pneumonia, cerebrovascular accident with residual deficit, anemia (hematocrit < 30), prolonged ileus, post-operative coughing, emergency operation, operative time greater than 2.5 hours, and postgraduate year 4 resident as surgeon [17] [28].

Our study aimed to evaluate non-technical risk factors for abdominal wound dehiscence and to frame a risk model which can be used to assess the risk for individual patients, and help advocate preventive strategies in high-risk patients.

Aims and Objectives

To evaluate risk factors for abdominal wound dehiscence and to design a risk model based on independent risk factors.

2. Materials and Methods

The study entitled "Development of a Risk Model for Abdominal Wound Dehiscence" was conducted in Post-Graduate Department of Surgery Government Medical College, Srinagar from March 2009 to April 2015. We developed an observational, longitudinal, analytical and prospective study where the sample studied were patients who underwent midline laparotomy during the study period. Patients operated for ventral hernias, incisional hernias, or other types of laparotomy were not included, as were those who underwent surgery in other departments of the hospital.

The ratio of cases to controls in our study was 1:3. Controls were not matched for age, sex, or type of surgery. Patients who underwent open abdomen treatment were not included in our surgery. Patient and surgery-related variables before, during and after

surgery and the mortality during hospital stay were studied for whole study population. Documentation of purulent discharge or wound site infection before the diagnosis of dehiscence, or the wound site exploration done on suspicion of infection with culture growing pathogens within 30 days of operation was considered as wound infection.

Comparison of cases and controls was done using chi-square test and the Mann-Whitney U-test respectively for categorical and continuous data. Multivariate stepwise logistic regression with backwards elimination test was used to recognize chief unfettered risk factors of abdominal wound dehiscence. The ensuing regression coefficients for the major variables were used as their weights to calculate a risk score for abdominal wound dehiscence. Patient data confidentiality was maintained throughout the study.

3. Results

140 (109 male and 31 female) cases of abdominal wound dehiscence were reported and compared with 420 (252 male and 168 female) selected controls. Mean age for both groups was 57.86 years (range 18 - 95). Abdominal wound dehiscence was reported at a mean of 10th postoperative day (range: 5 - 35 days). Hospital stay of cases was significantly prolonged ($P < 0.001$) as compared to control group. Mortality during the hospital stay was 25% and 9%; respectively for the two groups of study population ($P < 0.001$). 119/140 required surgical intervention for the treatment of abdominal wound dehiscence and 9/119 patients developed recurrence within 30 days of reoperation (7.56%). None of them developed second recurrence. There was no statistically significant difference between the conservatively treated patients and those treated operatively in terms of hospital stay [median 32 days versus 36 days ($P = 0.439$)], age ($P = 0.359$), mortality ($P = 0.398$), and comorbidity (all $P < 0.04$).

Table 1 depicts the results of the univariate analysis. Following variables were significantly more prevalent in cases as compared to those in the control group: old age, male gender, obesity (BMI > 27) hypertension, chronic pulmonary disease, ascites, anemia, jaundice, sepsis, emergency surgery, postoperative coughing, wound infection, smokers (>20 pack years) early stage malignancy and type of surgery (all $P < 0.001$) corticosteroid use (0.004). The variables ASA score ($P = 0.145$), albumin level, ($P = 0.020$), uremia ($P = 0.049$), diabetes mellitus (0.745), previous laparotomy (0.883), operative time (0.131), disseminated malignancy (0.141) and postoperative vomiting (0.500) were not found to be significant risk factors.

Statistically significant variables of univariate analysis were entered in a multivariate stepwise logistic regression to find out significant independent risk factors as shown in Table 2. Surgery on abdominal wall being clean was chosen as the reference category for the evaluation of type of surgery. Age less than 30 years was taken as reference category for the evaluation of variable "age". In comparison with the significant risk factors, none of the other variables age, hypertension, and malignant disease with no distant metastasis was statistically insignificant.

We developed a risk model for abdominal wound dehiscence. The risk scores, weighing the various factors by using the resulting regression coefficients in the logistic

Table 1. Characteristics of the two groups in the study.

S. No	Variable	Abdominal wound dehiscence group (n = 140)	Control group (n = 420)	Pearson Chi-square	*P*-value
1	Age (years)			33.969	<0.001
	<30	1.4% (2)	7.4% (31)		
	30 - 39	5.7% (8)	17.6% (74)		
	40 - 49	11.4% (16)	!5.0% (63)		
	50 - 59	20.7% (29)	20.0% (84)		
	60 - 69	28.6% (40)	25.0% (105)		
	70 and above	32.1% (45)	15.0% (63)		
2	Sex			13.910	<0.001
	Male	77.9% (109)	60.5% (254)		
	Female	22.1% (31)	39.5% (166)		
3	Body mass index			19.934	<0.001
	≤27	45.7% (64)	66.9% (281)		
	>27	54.3% (76)	33.1% (139)		
4	ASA Score			3.741	0.154
	I	91.4% (128)	85.0% (357)		
	II	5.7% (8)	10.0% (42)		
	III	2.9% (4)	5.0% (21)		
	IV	0% (0)	0% (0)		
5	Ascites	24.3% (34)	5.0% (21)	44.094	<0.001
6	Jaundice	60.7% (85)	8.3% (35)	171.111	<0.001
7	Anemia	62.1% (87)	34.8% (146)	32.401	<0.001
8	Uremia	31.4% (44)	23.1% (97)	3.871	0.049
9	Albumin level (mg/dl)			5.431	0.020
	<3	23.6% (33)	15.0% (63)		
	≥3	76.4% (107)	85.0% (357)		
10	Sepsis	20.0% (28)	4.8% (20)	31.111	<0.001
11	Previous laparotomy	44.3% (62)	45.0% (189)	0.022	0.883
12	Emergency surgery	42.9% (60)	23.3% (98)	19.761	<0.001
13	Type of surgery			21.748	<0.001
	1) Abdominal wall	7.9% (11)	26.7% (112)		
	2) Liver/Gallbladder /bile Duct/pancreas	21.4% (30)	16.9% (71)		
	3) Vascular/Kidney/ Adrenal gland/ Spleen	24.3% (34)	18.6% (78)		
	4) Esophagus/ Gastro-duodenal/ Small-bowel/ Large–bowel	46.4% (65)	37.9% (159)		
14	Operative time			2.286	0.131
	<150 min	32.1% (45)	39.3% (165)		
	>150 min	67.9% (95)	60.7% (255)		

Continued

15	Smoking (≥20 pack years)	46.4% (65)	15.0% (63)	58.819	<0.001
16	Corticosteroid use	31.4% (44)	19.8% (83)	8.150	0.004
17	Diabetes- mellitus	9.3% (13)	10.2% (43)	0.106	0.745
18	Hypertension	39.3% (55)	13.3% (56)	44.499	<0.001
19	Coughing (post-op)	17.9% (25)	5.0% (21)	23.021	<0.001
20	Vomiting (post-op)	2.9% (4)	1.9% (8)	0.454	0.500
	Malignancy				
21	Local disease	35.0% (49)	19.8% (83)	13.533	<0.001
	metastasis'	13.6% (19)	19.0% (80)	2.164	0,141
22	Wound infection	53.6% (75)	10.0% (42)	120.609	<0.001
23	Chronic obstructive pulmonary disease	30.0% (42)	15.0% (63)	15.508	<0.001

[Data are presented as percentages, with numbers in parentheses]; [Data are presented as percentages, with numbers in parentheses, or as mean ± SD (range)].

Table 2. Results of multivariate logistic regression analysis.

S. No	Variable	Regression coefficient	Standard error	Wald	*P*-value	Odds ratio	95% C.I for Odds ratio	
							Lower limit	Upper limit
1	Male gender	1.209	0.409	8.719	0.003	3.349	1.501	7.469
2	Chronic pulmonary disease	1.548	0.461	11.288	0.001	4.704	1.906	11.607
3	Corticosteroid use	1.179	0.419	7.925	0.005	3.251	1.431	7.388
4	Smoking	2.454	0.429	32.771	0.000	11.637	5.023	26.963
5	Obesity	1.721	0.408	17.754	0.000	5.590	2.510	12.448
6	Anemia	1.564	0.406	14.827	0.000		2.155	10.586
7	Jaundice	3.197	0.444	51.953	0.000	24.452	10.252	58.321
8	Ascitis	2.411	0.563	18.338	0.000	11.142	3.696	33.584
9	Sepsis	2.422	0.625	14.999	0.000	11.273	3.308	38.410
	Type of surgery Liver/Gallbladder/bile duct/pancreas	3.281	0.717	20.958	0.000	26.603	6.530	108.391
10	Vascular/spleen/ adrenal/Kidney	3.062	0.726	17.770	0.000	21.374	5.147	88.759
	Esophagus/ Gastro-duodenum/ Small bowel/Large bowel	1.786	0.604	8.731	0.003	5.965	1.825	19.500
11	Coughing	1.387	0.573	5.858	0.016	4.004	1.302	12.313
12	Wound infection	3.251	0.480	45.886	0.000	25.818	10.079	66.139

[a]Reference category age < 30 years; [b]Overall P value; [c]Reference category abdominal wall.

regression analysis, are shown in Table 3. No points are given if risk factors are absent. A higher value of the score predicts a higher risk.

Table 3. Risk score for abdominal wound dehiscence.

S. No		Variable	Risk score
1		Male gender	1.209
2		Chronic pulmonary disease	1.548
3		Corticosteroid use	1.179
4		Smoking	2.454
5		Obesity	1.721
6		Anemia	1.564
7		Jaundice	3.197
8		Ascitis	2.411
9		Sepsis	2.422
10	Type of surgery	Liver/Gallbladder/bile duct/pancreas	3.281
		Vascular/spleen/adrenal/ Kidney	3.062
		Esophagus/Gastro-duodenum/Small bowel/Large bowel	1.786
11		Coughing	1.387
12		Wound infection	3.251

Minimum score = 0 maximum score = 25.7.

4. Discussion

Abdominal wound dehiscence is a morbid postoperative complication. The mortality rate following wound dehiscence ranges from 9% - 43% [9]. Prevention is therefore an important issue, and a cornerstone of this is meticulous surgical technique. It is of immense importance that patients be fully informed beforehand about the complications that can be expected to occur in relation to any surgical procedure. The designed model is intended to predict the risk of wound dehiscence and plan preventive wound closing with mesh.

In our study wound infection was the most important risk factor which is also depicted by most of the studies on this topic [16]-[19]. Bacterial colonization causes intrusion and activation of polymorph nuclear leucocytes and increase in the levels of degradative matrix metallo proteinase's (MMPs). This results in wound degradation in the absence of sufficient tissue inhibitors of MMPs. Moreover, in the wounds of patients with abdominal wound dehiscence, it has been observed that the rate of degradation of collagen exceeds that of its synthesis which adversely affects breaking strength. Low breaking strength can lead to abdominal wound dehiscence especially in presence of increased intra-abdominal pressure and abnormal inflammatory response. Perioperative stress, need for blood transfusion and decreased tissue oxygenation due to anemia affect the immune system and subsequently the process of wound healing. Sepsis leads to hypoperfusion and the patients usually have associated wound infection due to hematogenous seeding. It has been regarded as a risk factor for wound dehiscence by many studies [29]-[31]. Smoking causes vasoconstriction thereby hampering tissue

oxygenation and hence wound healing.

Men are found to have more risk of wound dehiscence as compared to women in our study. The possible reason may be the confounding variable smoking as most smokers tend to be males. In addition men build up higher abdominal wall tension than women. Increased intra-abdominal pressure results in higher strain on wound edges, predisposing sutures to cut through the muscle and fascia. Ascites and coughing also increase intra-abdominal pressure and increase the risk of wound dehiscence. Delayed wound healing and high incidence of wound dehiscence have been observed in jaundiced patients undergoing surgery. Patients with jaundice have decreased activity of propylhydroxylase in their skin which is necessary for incorporation of proline amino-acid into collagen.

Corticosteroids cause immunosuppression and delay wound healing. Steroid use has been observed as risk factor for abdominal wound dehiscence in our study. This is at par with previous studies [21] [29].

Chronic obstructive pulmonary (COPD) disease increases the risk due to systemic tissue hypoxia. COPD is a frequent disease in elderly and consequently incidence of wound dehiscence is more in elderly. Obesity is observed to be a risk factor for abdominal wound dehiscence in our study. Because of poor nutritional habits and reduced mobility overweight individuals have increased risk of wound dehiscence and hernia formation.

The factors "emergency surgery, old age, hypertension and malignancy" were significant in univariate analysis but not in multivariate analysis in this study. Patients who undergo emergency surgery are generally in worse condition and nutritional state, and the chance of contamination of the surgical field is higher than in elective surgery. Moreover, the performance of the surgeon might be affected at night, which could lead to suboptimal closure of the abdomen at the end of the operation. Patients who undergo emergency surgery are generally in worse condition and nutritional state, and the chance of contamination of the surgical field is higher than in elective surgery. Moreover, the performance of the surgeon might be affected at night, which could lead to suboptimal closure of the abdomen at the end of the operation. The risk model can be used to identify patients at risk. Preventive measures, e.g., the use of mesh and special suture techniques and materials, aimed at decreasing tension on the wound edges, can be investigated and used in these patient groups. We therefore hope that the results of this study will lead to better, evidence-based treatment options for abdominal wound dehiscence and, eventually, a lower incidence of this severe complication.

Limited number of variables related to patient was studied .Other factors like those related to technique of surgery and suture material used were not investigated in this study. Moreover the risk model was not validated .This would have drastically improved the predictive value of the model in identification of patients at risk. Preventive measures, e.g., the use of mesh and special suture techniques and materials, aimed at decreasing tension on the wound edges, can be investigated and used in these patient groups.

5. Conclusion

We observed male gender, chronic pulmonary disease, corticosteroid use, smoking, obesity, sepsis, ascites, jaundice, anemia, type of surgery, coughing, and wound infection as independent risk factors for abdominal wound dehiscence. The risk model framed can give an estimate of the risk of developing abdominal wound dehiscence for individual patients and minimally invasive alternatives or preventive wound closing with reinforcements may be planned wherever desired necessary.

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