Section: General and GI Surgery

Original Research Article

FACTORS INFLUENCING WOUND HEALING IN LAPAROTOMY CASES- A RETROSPECTIVE MULTIVARIATE ANALYSIS IN A TERTIARY CARE HOSPITAL

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Abstract

Background: To estimate the complex surgical wound healing rate and to identify the factors associated with the healing of the wounds among laparotomy cases in a tertiary care hospital. **Materials and Methods:** Retrospective observational study on patients who have underwent laparotomy for various surgical causes over a period of two years. Data was analyzed using the SPSS Software 24.0. Appropriate measures like frequency and proportions was used. Chi square test was used to find the association between exposure and outcome. Multivariate analysis was done to describe the analyses of multiple variables. **Result:** A total of 150 patients who underwent major abdominal surgery at PSG Institute of Medical Sciences & Research with and without the development of surgical site infections were included in the study. Unhealthy subjects who developed surgical site infections (52%) were the majority. The overall mortality rate of the study was 0.7% (1 patient). Overall, infected patients were older and more frequently men [43 (55.1%) with OR 0.734 times (95% Cl 0.345-1563)]. There was a statistically significant association between cigarette smoking (with and without concurrent alcohol usage) and SSI (p-value = 0.001)[15 (55.5%) with OR 3.474 times (95% Cl 0.601-20.060)]. Surgical site infection rate of 6.141 times (95% Cl 0.658-57.342) more common to occur in lower Hb levels of 11.3g/dl than in higher Hb levels of 12.7g/dl in healthy patients. Patients with hypoalbuminemia were 0.683 times(95% Cl 0.316-1477)more prone to surgical site infections. The highest rate of surgical site infection was found to be prominent in elective laparotomy[42 patients(53.8%)] followed by emergency laparotomy [53 patients (39.7%)]. **Conclusion:** The conducted study has brought light to many significant preoperative and postoperative factors which are responsible for the development of SSI in operated laparotomy cases. By methodically working on these factors, patient prognosis can be drastically enhanced by improving patient morbidity and mortality rate along with reducing hospital stays and economic burden.

INTRODUCTION

Post laparotomy wounds and the factors influencing its healing carry importance in terms of post operative morbidity and financial burden for the patients. It is estimated that 234 million surgeries are performed worldwide each year, with the majority of the SW resulting in healing by first intention1.Therefore, it is now more important than ever that clinicians follow evidence-based guidelines for wound care when developing personalized treatment plans for their patients undergoing laparotomy.[1-5]

Objective:

1. To estimate the complex surgical wound healing rate

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2. To identify the factors associated with the healing of the wounds among laparotomy cases in a tertiary care hospital.

MATERIALS AND METHODS

Study Design: Retrospective observational study
Study population: Patients who has underwent laparotomy for various surgical causes
Study Duration: Two years
Sample Size: All the patients who had undergone the surgery between March 2020 – December 2022
The following data will be collected through the secondary data such as

- Socio demographic characteristics - age, gender, religion, socio -economic status, Consumption of alcohol, Smoking status
- Other details such as type of diagnosis, Pre operative haemoglobin, albumin level, Primary/Secondary suture, Type of abdominal wall, Presence of any comorbidities, Nature of surgery such as emergency or elective, postoperative healing in terms of ICU stay, ward stay, Surgical site infections. Follow-up reviews from Post operative day 1 till the date of discharge will be collected to find any complications such as seroma, wound dehiscence and wound site infection post operatively will also be collected.

Operational Definition: Wound site infection - presence of warmth, erythema purulent discharge, were considered for wound site infection.
Inclusion Criteria

1. patients of both genders
2. Patients aged over 18 years
3. Patients who had undergone laparotomy between March 2020-December 2022

Exclusion Criteria

1. Patients on steroids / immunosuppressant / anticancer therapy
2. Patients whose respective records contained incomplete information on three or more study variables

Study area: PSG tertiary hospital, Coimbatore
Consent: Institutional human ethics committee approval obtained before conducting the study.
Data analysis: Data will be analyzed using the SPSS Software 24.0. Appropriate measures like frequency and proportions will be used. Chi square test will be used to find the association between exposure and outcome. Multivariate analysis will be done to describe the analyses of multiple variables.

RESULTS

Study population and Patient characteristics: A total of 150 patients who underwent major abdominal surgery at PSG Institute of Medical Sciences & Research with and without the development of surgical site infections were included in the study [Table 1]. Unhealthy subjects who developed surgical site infections (52%) were the majority. The overall mortality rate of the study was 0.7% (1 patient).
Age/Gender: The mean age of the study population was 46.5 years. The highest incidence of surgical site infection was prominent between 41-50 years (23.1%). Of these, 46.7% were female and 53.3% were male (Figure 1). Overall, infected patients were older and more frequently men [43 (55.1%) with OR 0.734 times (95% Cl 0.345-1563)].
Socioeconomic status: Patients involved were classified as good, moderate, and poor according to the modified B.G Prasad scale. Most patients that developed surgical site infections (55.1%) had their socioeconomic status within the good status, while 12.8% were of moderate status and 32.1% were of the poor status.
Predictors of SSI
History of substances abuse: It was noted that in this study, 18 (12.0%) patients had a history of cigarette usage. Of these, 9 patients (50%) developed SSI. 4 patients purely consumed alcohol of which 1(25%) had developed SSI. It was observed that 9 patients with a history of both alcohol and smoking habits, of them 6 patients (66.6%) had development of SSI. There was a statistically significant association between cigarette smoking (with and without concurrent alcohol usage) and SSI (p-value = 0.001) [15 (55.5%) with OR 3.474 times (95% Cl 0.601-20.060)]
Pre-operative factors associated with surgical site infection:
Hemoglobin levels: In the current study, using Mann Whitney U test, two independent groups of patients with varied hemoglobin levels were calculated and found to be 11.3g/dl (6.7g/dl-17.2g/dl) in patients population that developed SSI compared to 12.7g/dl(8.0g/dl-18.5g/dl) in the healthy population and an overall IQR range of 12.0g/dl (6.7g/dl-18.5g/dl). This is of statistical importance as patients with an Interquartile range of 11.3g/dl were at a greater risk of developing Surgical site infections as compared to those with a higher IQR of 12.7g/dl. This indicates a surgical site infection rate of 6.141 times (95% Cl 0.658-57.342) more common to occur in lower IQR Hb levels of 11.3g/dl than in higher IQR Hb levels of 12.7g/dl in healthy patients.
Albumin levels: Similarly using Mann Whitney U test, two independent groups of patients with varied albumin levels were calculated and found to be 3.8g/dl (1.70g/dl-5.00g/dl) in patients population that developed SSI compared to 4.0g/dl (1.70g/dl-4.90g/dl) in the healthy population. The overall IQR range was 3.9g/dl (1.70g/dl-5.00g/dl). This preoperative factor was found to be of great statistical significance as patients with hypoalbuminemia were 0.683 times (95% Cl 0.316-1477) more prone to surgical site infections.

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Intra-operative factors associated with surgical site infection

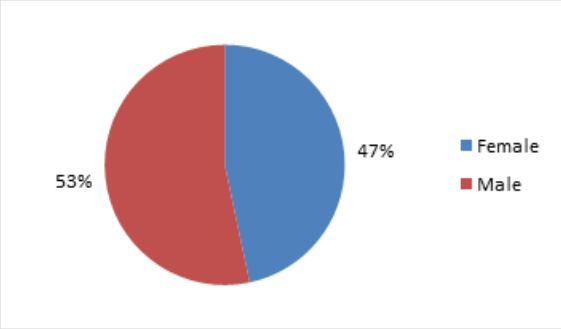

Figure 1: Pie chart showing the distribution of gender

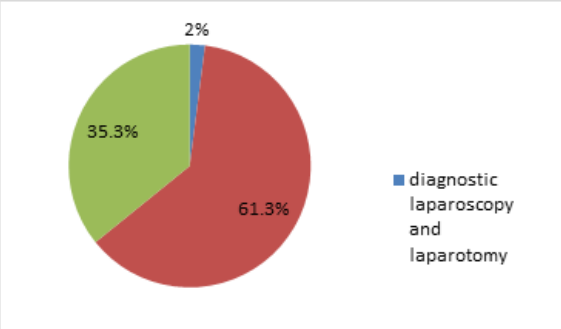

Figure 2: Distribution of nature of surgery

Nature of surgery: Patients in this study all underwent major abdominal surgery through 4 different procedures (Figure 2) which include diagnostic laparoscopy and laparotomy [3 patients (2%)], elective laparotomy [92 patients (61.3%)], emergency laparotomy [53 patients (35.3%)] and exploratory laparotomy [2 patients (1.3%)]. The highest rate of surgical site infection was found to be prominent in elective laparotomy [42 patients (53.8%)] followed by emergency laparotomy [53 patients (39.7%)].

Thickness of abdominal wall: Patients involved in this study were categorized into two groups based on the thickness of the abdominal walls i.e. Thick abdominal wall (34 patients, 22.7%) and Thin abdominal wall (116 patients, 77.3%). Overall, the predominance of surgical site infection was noted in patients with thin abdominal walls (63 patients,80.8%) but it is not of statistical significance.

Type of wound closure: Patients that underwent abdominal surgeries had their wounds closed based on any excessive tissue loss and/or based on the sutures usage. The majority of the patient's wounds were healed by primary wound healing (122,81.3%) and secondary wound healing took place in 28 patients (18.7%). Incidentally, it was observed that an increased rate of surgical site infection was noted in patients with primary wound healing [62 patients (79.5%)]. It is not of statistical significance.

Suture technique: Patients' wounds in this study were closed using either traditional prolene nonabsorbable suture material (143, 95.3%) or surgical grade staples (7,4.7%). A higher incidence was noted of SSI in patients where suture materials were used.

Table 1: Distribution of demographic and pre-operative risk factor variables of patients with and without surgical site infection (n=150)

Demographic Variables		Stay In Ward				Total		$\chi 2$ – Value P - Value
		Normal		Infection				
		n=72	%	n=78	%	n	%	
Age	< 30	11	15.3%	10	12.8%	21	14.0%	10.564 (0.059)
	31 - 40	17	23.6%	9	11.5%	26	17.3%	
	41 - 50	10	13.9%	18	23.1%	28	18.7%	
	51 - 60	18	25.0%	14	17.9%	32	21.3%	
	61 - 70	13	18.1%	15	19.2%	28	18.7%	
	> 70	3	4.2%	12	15.4%	15	10.0%	
Gender	Female	35	48.6%	35	44.9%	70	46.7%	0.210 (0.743)
	Male	37	51.4%	43	55.1%	80	53.3%	
Socioeconomic STATUS	Good	56	77.8%	43	55.1%	99	66.0%	13.557 (0.001)*
	Moderate	10	13.9%	10	12.8%	20	13.3%	
	Poor	6	8.3%	25	32.1%	31	20.7%	
Type of wound closure	Primary	60	83.3%	62	79.5%	122	81.3%	0.365 (0.676)
	Secondary	12	16.7%	16	20.5%	28	18.7%	
Abdomen wall	Thick	19	26.4%	15	19.2%	34	22.7%	1.094 (0.333)
	Thin	53	73.6%	63	80.8%	116	77.3%	
Nature Of Surgery	diagnostic laparoscopy and laparotomy	0	0.0%	3	3.8%	3	2.0%	6.210 (0.053)
	elective	50	69.4%	42	53.8%	92	61.3%	
	emergency	22	30.6%	31	39.7%	53	35.3%	
	exploratory laparotomy sand proceed	0	0.0%	2	2.6%	2	1.3%	
Mortality	Dead	1	1.4%	0	0.0%	1	0.7%	1.091 (0.480)
	No	71	98.6%	78	100.0%	149	99.3%	
HABITS	alcoholic	3	4.2%	1	1.3%	4	2.7%	1.904 (0.624)
	Alcoholic /Smoker	3	4.2%	6	7.7%	9	6.0%	
	Nil	57	79.2%	62	79.5%	119	79.3%	

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	Smoker	9	12.5%	9	11.5%	18	12.0%	
STAPLED/SUTUR	Stapler	0	0.0%	7	9.0%	7	4.7%	6.778 (0.014)*
	Suture	72	100.0%	71	91.0%	143	95.3%	
HB (IQR)		12.7 (8.0 – 18.5)		11.3 (6.7 – 17.2)		12.0 (6.7 – 18.5)		-3.479 (0.001)‡
Albumin (IQR)		4.0 (1.70 – 4.90)		3.8 (1.70 – 5.00)		3.9 (1.70 – 5.00)		-0.930 (0.352)‡

‡ Using Mann Whitney U test ** Statistically Significant at p<0.05*

Table 2: Multivariate logistic regression analysis of factors associated with surgical site infection

Risk Factor	OR	95% Confidence Interval for Exp(B)	
		Lower Bound	Upper Bound
Male sex	.734	.345	1.563
Albumin	.683	.316	1.477
Pre op Hemoglobin level	6.141	.658	57.342
HABITS (alcoholic, Alcoholic /Smoker, Nil)	3.474	.601	20.060
CI= confidence interval: OR= odds ratio			

DISCUSSION

Surgical site wound infections are infections of the tissue, organs, or spaces which have been manipulated during surgical intervention. It is a common postoperative complication due to the entry of pathogens into the exposed vulnerable operated tissue, the virulence of the inoculated pathogen, and the host factors such as co-morbidities such as diabetes and anemia, age, sex, smoking, etc.[6-11] Surgical site infections are a major factor in patient mortality and morbidity along with post-operative duration of stay and the requirement of higher antibiotic usage due to nosocomial infections. These infections lead to higher hospital expenses and increased burden to tackle such complicated cases by medical professionals.[1]

In this retrospective multivariate analysis study, SSI had developed in 72 patients (52%) which is a higher incidence rate compared to similar studies.[1-5] This variation in the incidence can be associated with the severity and criticality of the patient and the performed operations along with a high number of emergency cases conducted in our tertiary care hospital.

An analysis of the study population and patient characteristics shows that the highest incidence rate of surgical site infection occurred in patients in their 5th decade of life.[2] This could be linked to delayed collagen synthesis, increased probability of acute abdomen, and malignant cases in this age group.[11] The rate of surgical site infections was statistically significant in males [43 (55.1%)] compared to females [Table 2]. This is comparable to studies done in Punjab and Tanzania.[1,4] Such a phenomenon could be attributed to the increasing usage of tobacco smoking and alcohol consumption in the male sex.

It is well documented in multivariate studies that smoking has a direct negative impact on wound healing. In normal tissue repair, adequate tissue oxygenation is required for the whole reparative cascade which includes collagen synthesis, reduced fibroblast proliferation, white blood cell aggregation, and granulation tissue proliferation.[3,9] These stages and more are disrupted by tissue hypoxia caused due smoking due to its toxic compounds such as nicotine, carbon monoxide, and hydrogen cyanide. Nicotine has been shown to reduce blood supply due to vasoconstriction, carbon monoxide acts as a strong binder to hemoglobin producing carboxyhemoglobin which has an affinity of 200 times that of oxygen causing tissue hypoxia and hydrogen cyanide which disrupts the normal mitochondrial function of cellular oxygen metabolism.[9] In our study, there was a statistically significant association between cigarette smoking (with and without concurrent alcohol usage) and SSI (p-value = 0.001, [Table 2])[15 (55.5%) with OR 3.474 times (95% Cl 0.601-20.060)]. This is in correlation to another study conducted by Dazhen Liu and Long Zhu at Tianjin Medical University, Tianjin, China.[9]

Our study showed a disproportionately high incidence of surgical site infection in patients belonging to good socioeconomic status. This did not co-relate to the findings in a similar study.[12-14] Although various factors such as the increased risk of non-communicable diseases and co-morbidities along with other lifestyle disorders such as malignancies could be attributed to the increased incidence rate, there is no definitive clarity on the cause of such a disproportionate increase of SSI in this socioeconomic group.

Various studies conducted on SSI have shown the importance of pre-operative factors having a significant outcome in post-operative wound healing. Hemoglobin and albumin [Table 2] were two such factors analyzed in our study. In our study, patients with an IQR range of 11.3g/dl(6.7g/dl-17.2g/dl) of hemoglobin were at statically significant risk of developing SSI, this is likely linked to poor wound healing, wound dehiscence, and gapping due to deficient oxygenation of tissues.[1,2] Albumin levels were taken into account in our study and our data showed that having a preoperative low serum albumin concentration is linked with an increased incidence of SSI post-operation. Such higher infection incidences could likely be linked to delayed wound healing due to downregulated activation of EGFR which is essential for upregulating cell growth, differentiation, proliferation, and migration along with elevation of i-Nos production due to hypoalbuminemia which is responsible for the

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production of premature fibroblasts and delay skin epithelialization.[8]

In our study, various intraoperative factors such as the nature of the surgery, the thickness of the abdominal wall, the type of wound closure, the suture technique, and the material used were analyzed. One of the significant findings was the higher incidence of SSI in elective laparotomy [42 patients(53.8%)].[1,2] This could be linked to improper wound care post-operation, inadequate antibiotic usage, and increased drug-resistant microorganism prevalence in surgical wards. Another significant finding was the use of suture materials to close the wound, traditional prolene nonabsorbable suture material (143, 95.3%) and surgical grade staples (7,4.7%) was used. A higher incidence was noted of SSI in patients where suture materials were used. Suture materials can host bacteria by providing the microorganism a platform to adhere and produce biofilms which can increase the incidence of SSI.[13] Suture materials can also cut through the tissue in cases with severe edema or break causing wound dehiscence leading to increased risk of SSIs.[11] It was noted that predominately surgical site infection was noted in patients with thin abdominal walls (63 patients,80.8%) in our study but it is not of statistical significance and did not co-relate to other studies.[12] Our study showed that the majority of the SSI were seen in primary intention wound healing [62 patients (79.5%)], this could be because of the wound class II (clean/contaminated) or tight wound suturing leading to ischemia.[11] It was not of significance.

CONCLUSION

The conducted study has brought light to many significant preoperative and postoperative factors which are responsible for the development of SSI in operated laparotomy cases. By methodically working on these factors, patient prognosis can be drastically enhanced by improving patient morbidity and mortality rate along with reducing hospital stays and economic burden.

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