

Original Research Article

Incidence, risk factors and outcomes of surgical site infections following elective and emergency surgery – A hospital based Cross-sectional study

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ABSTRACT

Background - Wound Healing is the summation of a number of processes that follow injury. Despite immense advances in the technique of wound creation and closure, there continues to be an important percentage of patients undergoing abdominal operations, suffering from delayed wound healing and partial wound failure. The incidence of post-operative wound dehiscence was investigated in patients in several studies (e.g., 1.25 per 1,000 discharges at 0 to 17 years, 1.74 at 18 to 44 years, 2.65 at 45 to 65 years, and 3.77 at 65 or more years. Additionally, it was found that this complication resulted in an increased mean length of stay (by 21.1 days) and a tremendous increase in charges for affected patients, with 5.7 times higher odds of in-hospital mortality. Wound Infection rate varies from 6.8 percent to 21.4 percent depending on the procedure and other patient factors. **Aim of study** - To assess the various factors influencing post laparotomy wound healing. To identify the pre-operative, operative and post operative risk factors in patients having poor wound healing. **Materials and methods** - This prospective study was conducted in the Department of General Surgery, VIMSAR, Burla, Sambalpur. **Results** - A total of 100 patients undergoing laparotomies were studied. 40 patients were found to have delayed wound healing. The strongest association for delayed healing was found to be wound infection, followed by smoking, chronic cough, poorly controlled diabetes and alcohol. The incidence of delayed healing was found to be higher in present study with increased incidence of wound infection. Emergency laparotomies were associated with an increased incidence of wound infection and thereby delayed healing. **Conclusion** - Poor wound healing is also associated strongly with poor nutrition and uncontrolled diabetes. These factors should be taken into account and efforts have to be made to correct the risk factors pre or post-operatively.

KEY WORDS – Wound healing, Inflammation, Proliferation, Tissue remodeling.

INTRODUCTION

Normally, wound healing goes through the physiological phases of coagulation, inflammation, matrix synthesis and deposition. These are followed by angiogenesis, fibroplasias, epithelialization, contraction, and remodeling and scar maturation [1]. Low oxygen tension has a profoundly deleterious effect on all aspects of wound healing. Fibroplasia, although stimulated initially by the hypoxic wound environment, is significantly impaired by local hypoxia. Optimal collagen synthesis requires oxygen as a cofactor, particularly for the hydroxylation step. Increasing the fraction of inspired oxygen (F_iO_2) of inspired air for brief periods during and immediately after surgery; results in enhanced collagen deposition and in decreased rates of wound infection after elective surgery [2]. Hyperglycemia can interfere with uptake of Vitamin C, a vital component for hydroxylation of proline in collagen synthesis [3]. Wound infection is considered the major deterrent to wound healing. Surgery breaches the intact epithelium, allowing bacterial access to the deeper tissues and bloodstream. The incidence of wound infections bears a direct relationship to the degree of contamination that occurs during the operation from the disease process itself [4]. Elevation of intra-abdominal pressure due to sudden forceful acts such as coughing, sneezing, ileus, urinary retention, ascitis, fecal impaction, U.G.I endoscopy, retching are all known to be associated with increased incidence of wound failure [5]. The importance of nutrition in the recovery from surgical injury has been recognized by clinicians since the time of Hippocrates. The degree of nutritional impairment need not be long standing. Thus patients with brief pre-operative illnesses will demonstrate impaired fibroplasias [6].

AIM AND OBJECTIVE –

To assess the prevalence of the following risk factors in patients who have poor wound healing in post laparotomy period. Exa –in Pre-operative period (Age >65yrs, Sex, Diabetes mellitus, Steroid use, Asthma/COPD), Operative period (Emergency/ elective laparotomy, Type of incision), Post-operative period (Wound infection)

MATERIAL AND METHOD -

This prospective clinical study was conducted between October 2019 to September 2021, on patients admitted in general ward of Dept. of General Surgery, VIMSAR, Burla.

100 patients(Out of which Male = 75, Female = 25) undergoing laparotomy were enrolled for the study.

Patients are admitted in surgical ward through emergency / outdoor clinic and data collected regarding: clinical history, general physical and systemic examination and diagnostic investigations.

A prophylactic dose of antibiotics to be given in all elective / emergency cases along with extension of antibiotic as required. As a routine, in all cases the linea alba to be closed with non-absorbable monofilament, synthetic suture (polypropylene No.1).

Examination of wound will be started from third post-operative day onwards, and will include inspection for any redness, oedema or presence of discharge like pus or serosanguinous fluid.

Examination to be continued till, suture removal and scar formation. Wounds healed completely with removal of sutures by 10th post-operative day were deemed as normal healing. Any complication or delay was deemed as delayed wound healing.

Inclusion Criteria

Patients undergoing Abdominal Laparotomy (Emergency or Elective) having age more than 18yrs

Exclusion Criteria

Patients who are under going re-laparotomy, or known to be suffering from collagen vascular diseases

STATISTICS

Data was collected and processed using Excel software programmes. Observations are represented as bar diagrams and pie charts.

OBSERVATION AND RESULT -

A total of 100 patients (Male = 75, Female = 25) underwent abdominal laparotomy either under emergency or elective basis. 2 patients underwent re-laparotomy and were excluded from the final analysis.

AGE DISTRIBUTION

Out of 100 patients who underwent the study, 40 patients had delayed wound healing. Among the 40 patients with delayed healing the average age was 62.2 yrs.

Table 7: Age distribution

Age Groups	No. Of patients	Delayed wound healing	Percentage
18-30	4	1	25%
31-40	22	0	0 %
41-50	29	5	17.24%
51-60	17	6	35.29%
➤ 60	28	14	50%

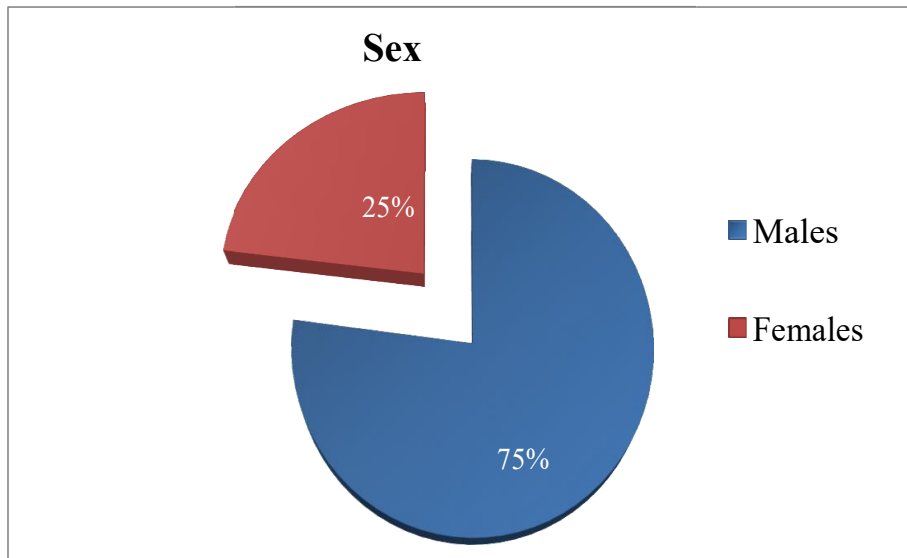
SEX DISTRIBUTION

Out of the 40 patients with delayed wound healing, 30 were males and 10 were females.

Table 8 :SexDistribution

Sex	ith Delayed healing	Percentage
Male	30	75%
Female	10	25%

Graph 2: SexDistribution



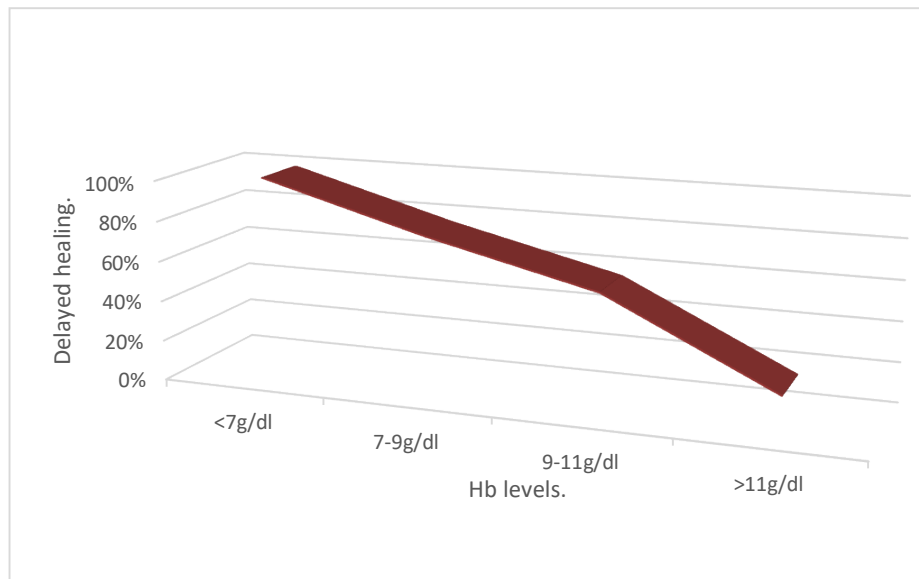
HEAMOGLOBIN LEVELS

The average haemoglobin among the patients with delayed wound healing was 9.7.

Table 9: Heamoglobin levels

Heamoglobin level	Patients with delayed healing	Percentage
<7	1	100%
7-9	7	77%
9-11	24	57.14%
>11	8	16.66%

Graph 3: Heamoglobin levels



NUTRITION

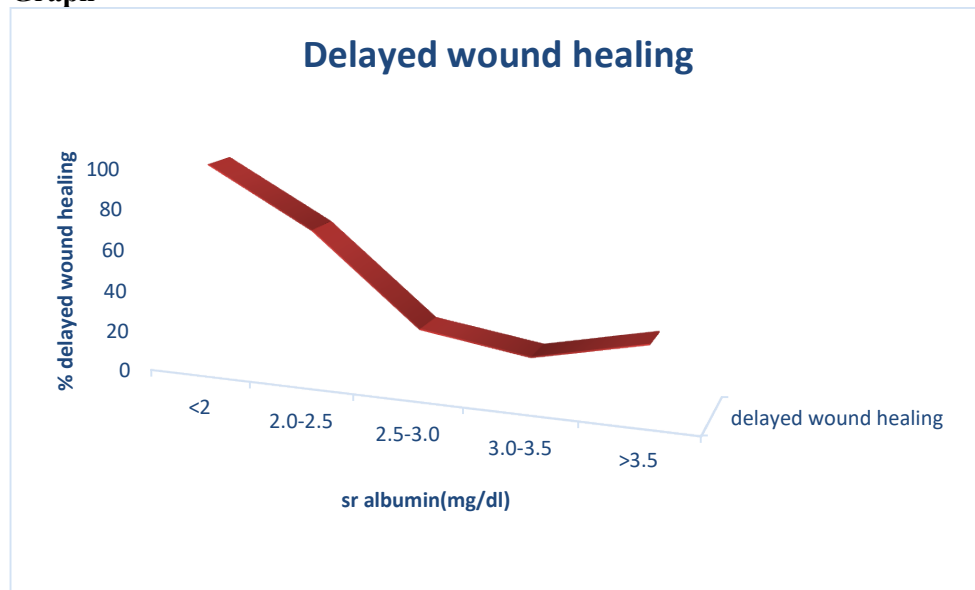
The average Serum Albumin among patients with delayed wound healing was 2.3 mg/dl.

Table 10:Nutrition

Sr. Albumin (mg/dl)	Patients delayed healing with wound	Percentage	Total number patients
< 2.0	4	100%	4
2.0 – 2.5	16	72%	22
2.5- 3.0	10	29.41%	34
3.0 – 3.5	5	21.7%	22
>3.5	5	33.33%	18

Graph

4:



JAUNDICE

Only 1 patient in the study group had raised Bilirubin levels and the particular patient had delayed wound healing.

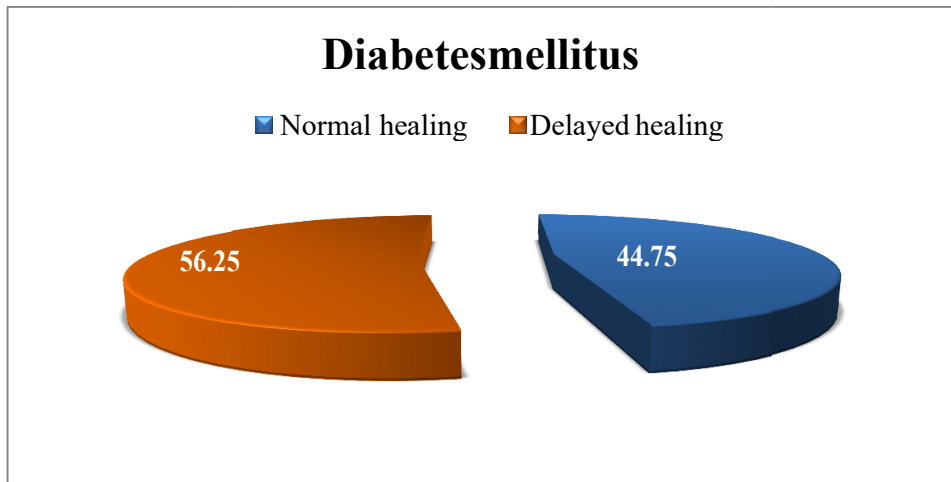
DIABETES MELLITUS

Out of the 100 patients in the study group, 32 patients had diabetes mellitus, of which 18 patients had delayed wound healing.

Table 11: DiabetesMellitus

No. Of patients with diabetes	No. Of diabetics with delayed wound healing	Percentage
32	18	56.25%

Graph 5: DiabetesMellitus



STEROID USE

Out of the 100 patients in the study group, only 4 patients were on steroids. All patients had delayed healing.

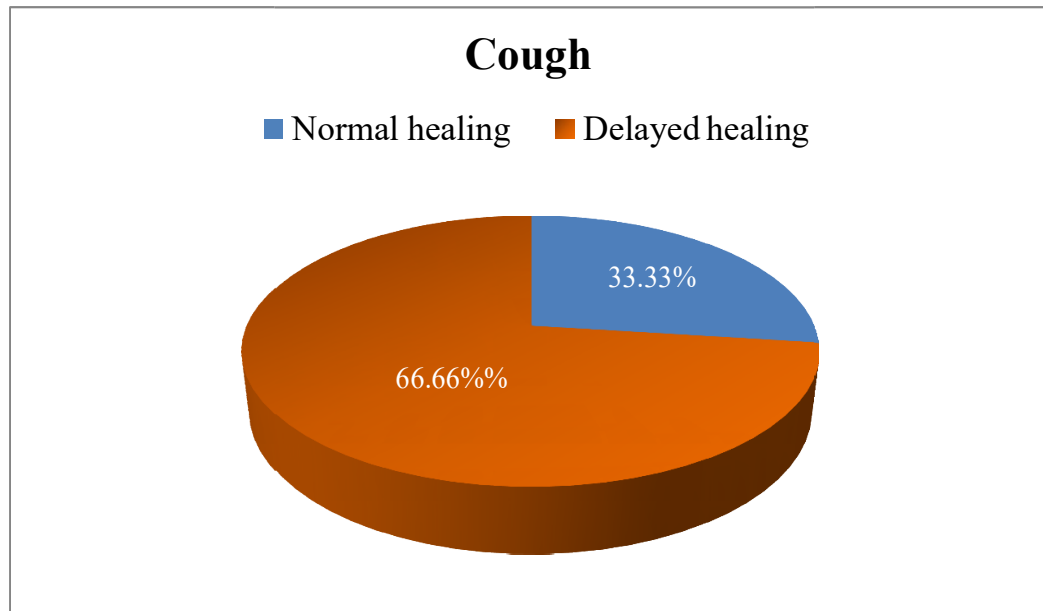
CHRONIC COUGH

Out of the 100 patients in the study group, 30 patients had chronic cough secondary to COPD or Asthma. Out of the 30, 20 had delayed wound healing.

Table 12: ChronicCough

No. Of patients with chronic cough	No. Of patients who had delayed wound healing	Percentage
30	20	66.66%

Graph 6: ChronicCough



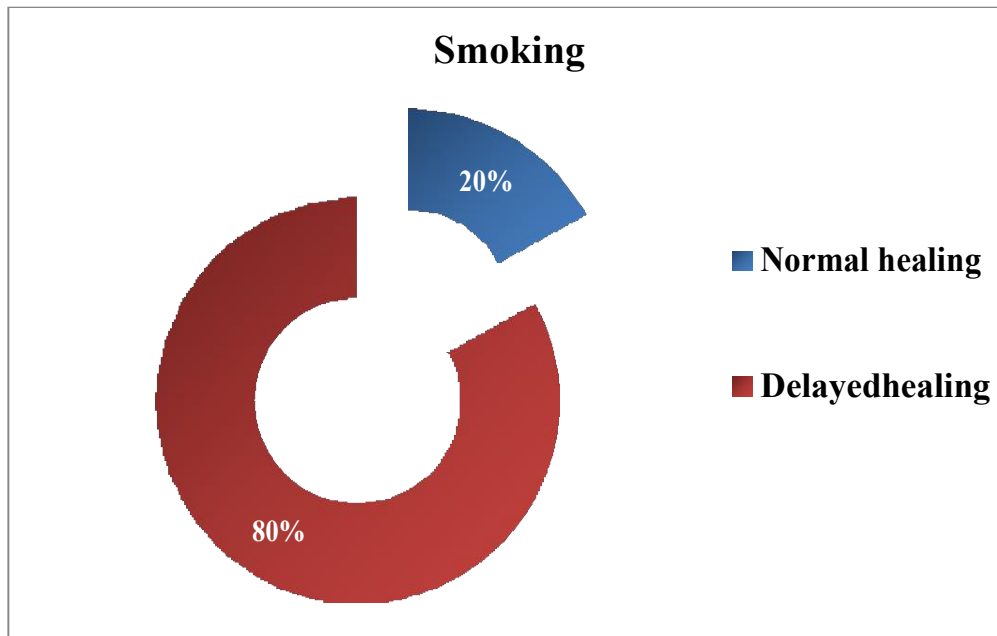
SMOKING

Out of the 100 patients in the study group, 25 patients were chronic smokers. Out of the 25, 20 had delayed wound healing.

Table 13:Smoking

No. Of patients who were smokers	No. Of smokers with delayed healing	Percentage
25	20	80%

Graph 7:Smoking



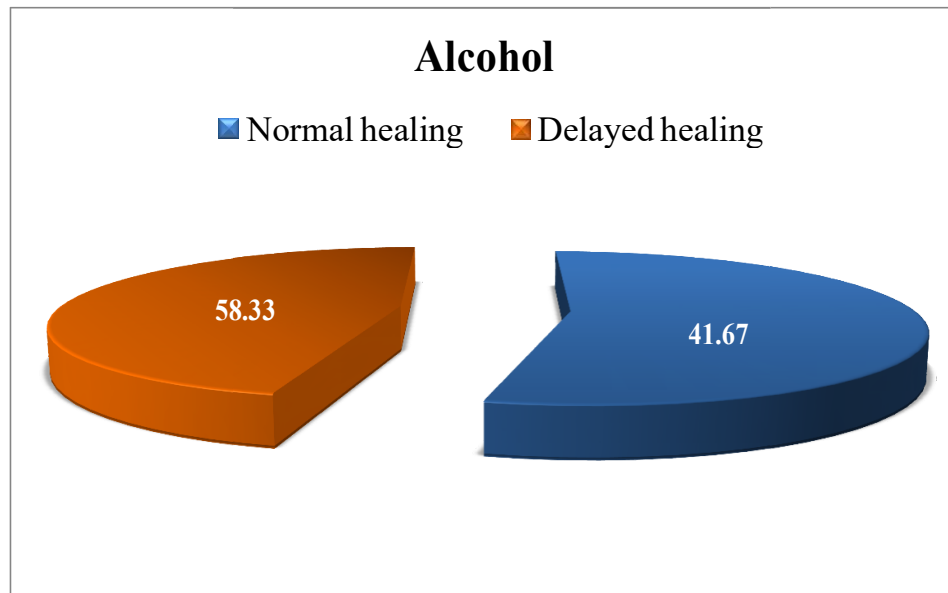
ALCOHOL

Out of the 100 patients in the study group, 24 patients were consuming alcohol on a regular basis. Out of the 24, 14 had delayed wound healing.

Table 14:Alcohol

No. Of patients consuming alcohol	No. Of alcoholics with delayed wound healing	Percentage
24	14	58.33%

Graph 8:Alcohol



LAPAROTOMY

Out of the 100 patients who were included in the study, 70 patients underwent emergency laparotomy, and 30 underwent elective laparotomy.

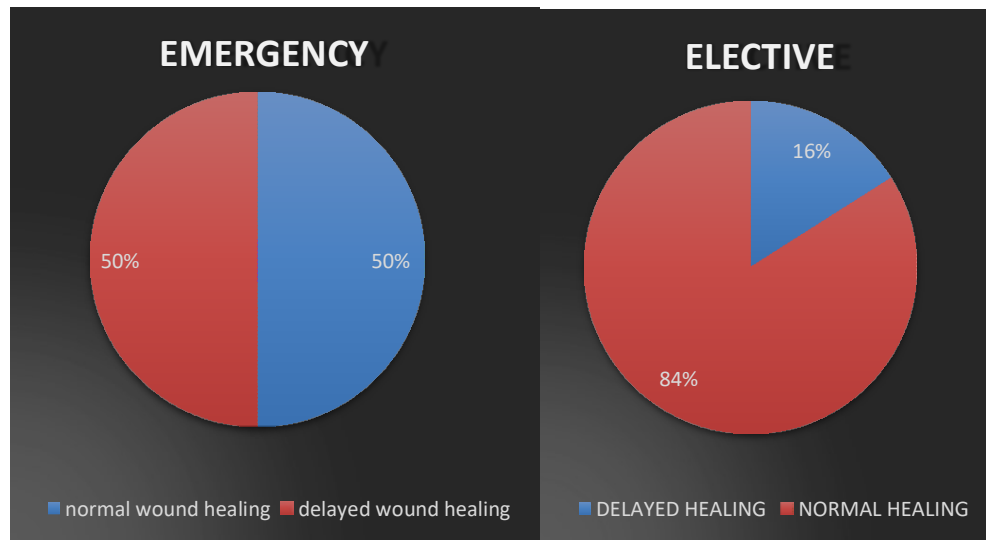
Out of the 70, undergoing emergency laparotomies, 35 had delayed wound healing.

Out of the 30, undergoing elective laparotomies, 5 had delayed wound healing.

Table 15:Laparotomy

Type of Laparotomy	No. of Cases	No. of pt's with delayed healing
Emergency	70	35 (50%)
Elective	30	5(16%)

Graph 9:Laparotomy

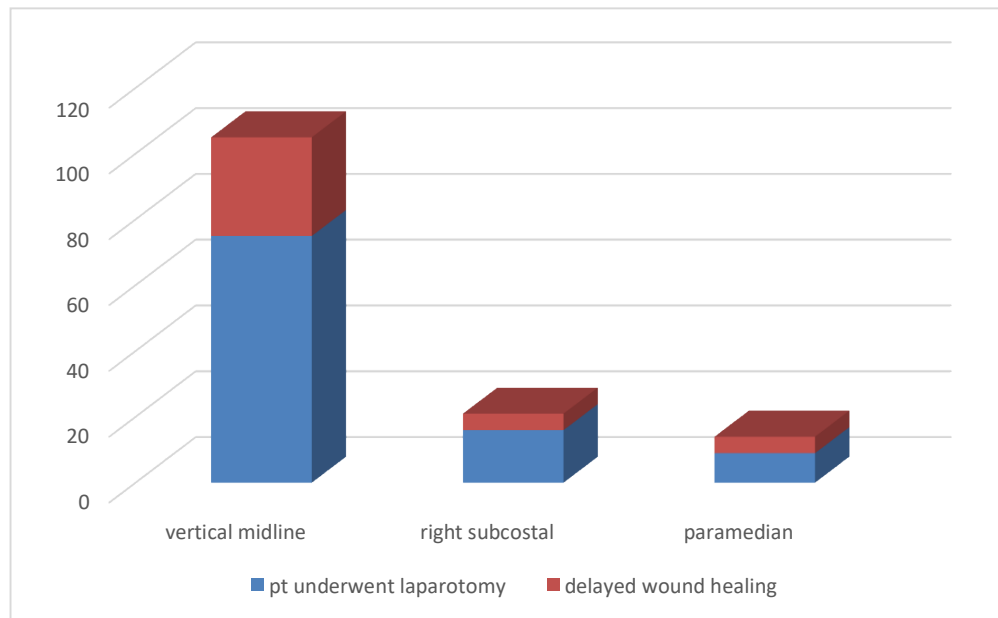


TYPE OF INCISION

Out of the 100 patients included in the study,

- 75 underwent laparotomy through vertical midline incision, in which wound healing was delayed in 30.
- 16 underwent laparotomy through right subcostal incision, in which wound healing was delayed in 5
- 9 patients underwent laparotomy through paramedian incisions in which wound healing was delayed in 5.

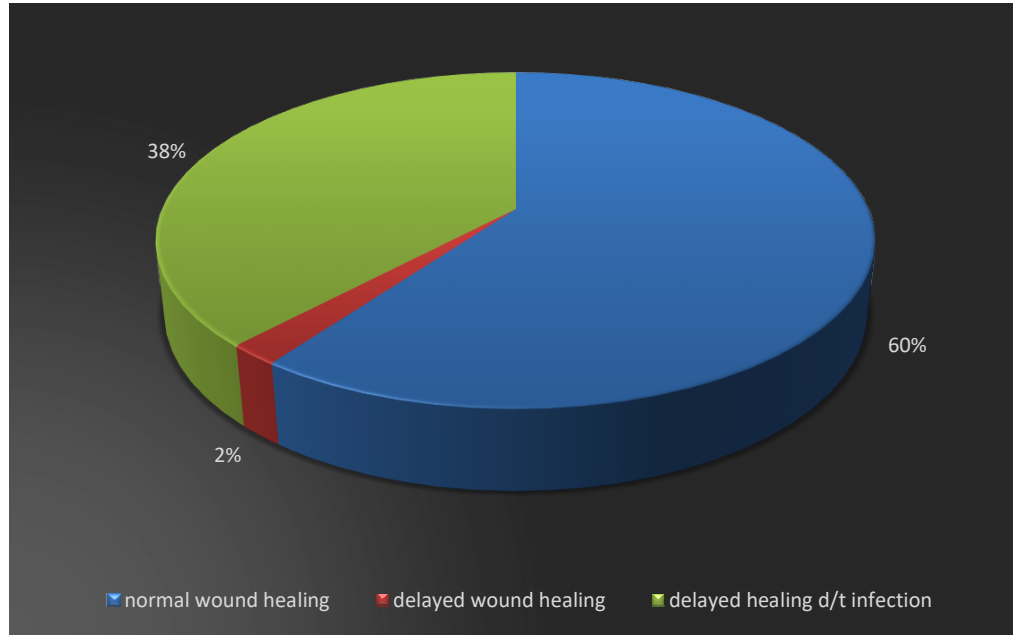
Graph 10: Type of Incision



WOUND INFECTION

Out of the 40 patients who developed delayed wound healing, 38 developed wound infection.

Graph 11: Wound Infection



DISCUSSION

In the present study, males were presenting with delayed wound healing almost three times as common as females (M: F 3:1). A study conducted in Manchester, by Gilliver SC, Ashworth JJ, Ashcroft GS showed a similar ratio of males presenting two and a half times more common than females (M:F2.5:1) [7].

Age Incidence

In the present study, the average age of patients with delayed wound healing was found to be 66.4 yrs.

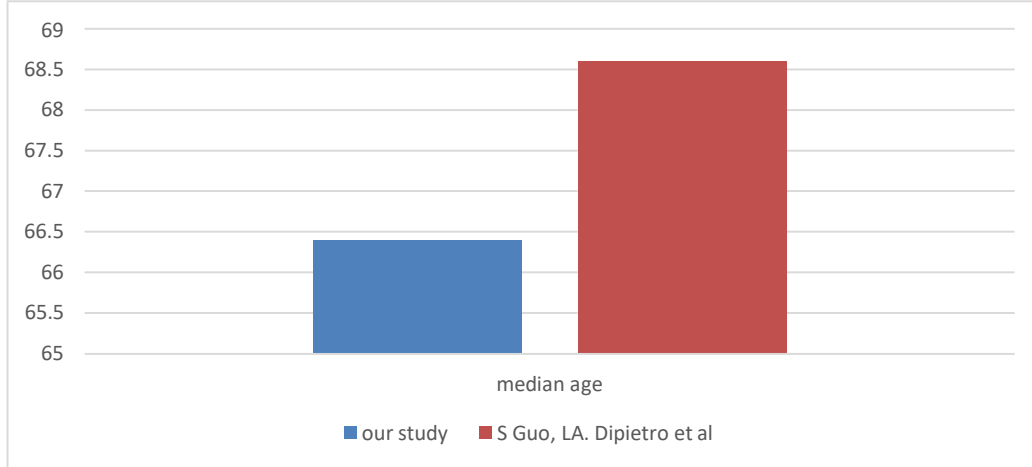
A prospective audit Done by S. Guo and L.A. DiPietro at the Center for Wound Healing and Tissue Regeneration, University of Illinois at Chicago showed a higher result, of the average age being 68.6 yrs [8].

Table 16: Comparison of average age of patients with delayed healing.

	Our study	. Guo and L.A. DiPietro et al.

Median Age (in yrs)	66.4	68.6
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Graph 12: Comparison of average age of patients with delayed healing.



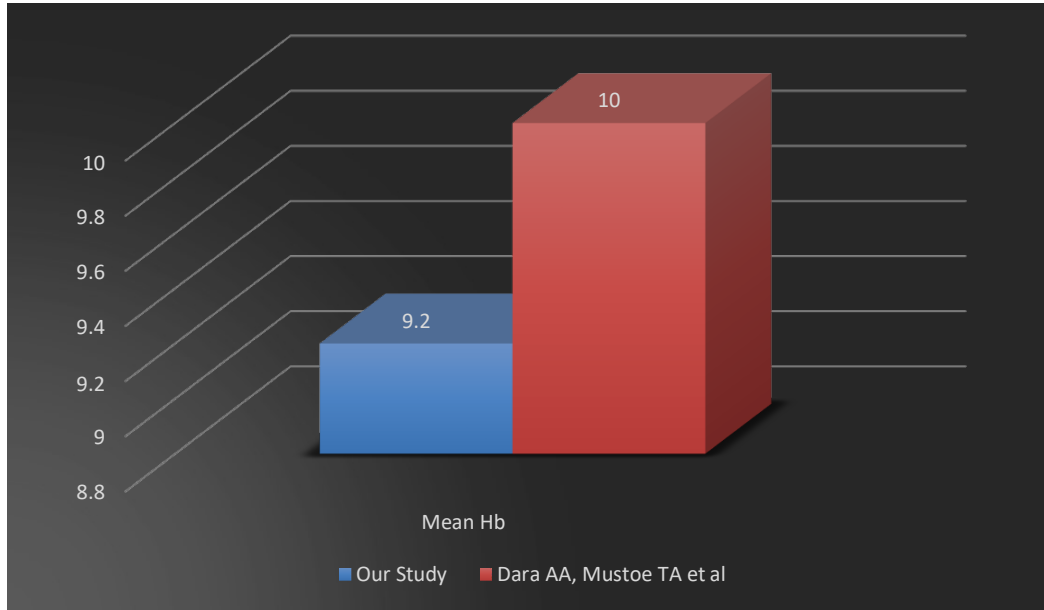
Haemoglobin Level

Table 17: Comparison of haemoglobin levels between our study and Dara et al

	Our Study	Dara AA, Mustoe TA et al
Mean Heamoglobin	9.2	<10

The avgHeamoglobin in the study patients was 9 g/dl. And this is Similar to the results published by Dara AA, Mustoe TA et al ., Northwestern University, Chicago. The study found a Heamoglobin less than 10 g/dl was associated with poor wound healing [9].

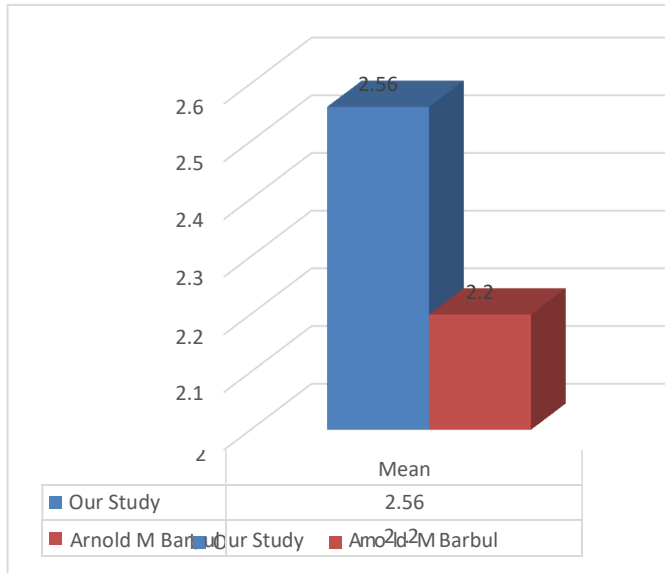
Graph 13: Haemoglobin level



Albumin level

The average Albumin in our study was found to be 2.56. This is similar to the results published by Arnold M, Barbul A et al. Johns Hopkins Medical Institutions, Baltimore, they found a mean albumin of 2.2 in their patients with delayed healing [10].

Graph 14: Comparison of Albumin levels



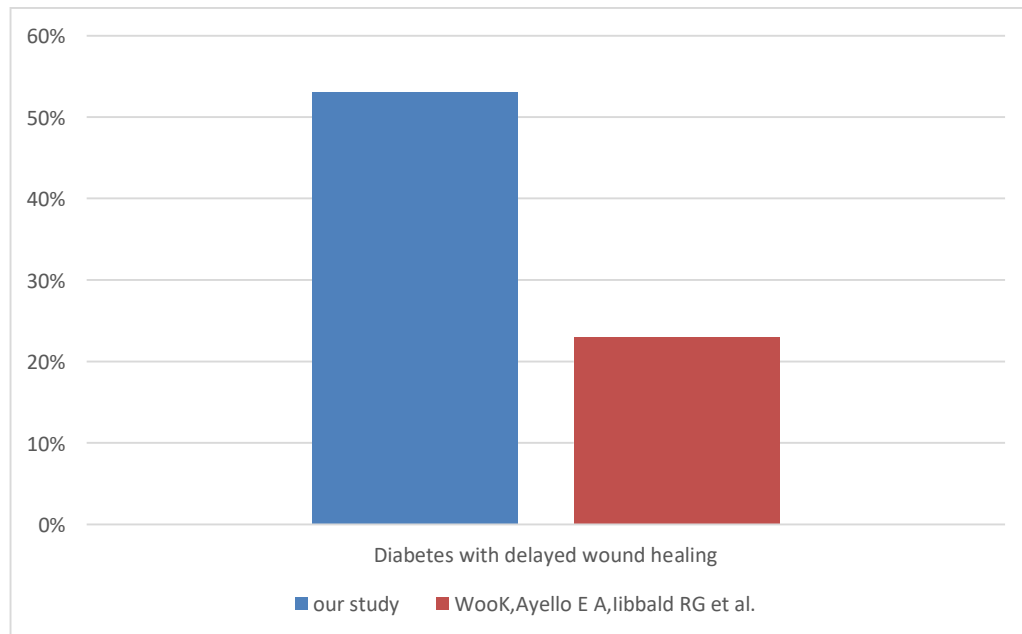
Diabetes Mellitus

In our study 56.25% of the diabetics suffered from delayed wound healing. This is more than there sults published by WooK, AyelloEA, Sibbald RG et al., The New Woman's Hospital, Toronto, Ontario, Canada who found a 23% incidence of delayed healing among diabetics [11].

Table 18: Diabetes Mellitus

	Our study	Woo K, Ayello EA, Sibbald RG et al
Diabetics with delayed healing	56.25%	23%

Graph 15: Diabetes Mellitus

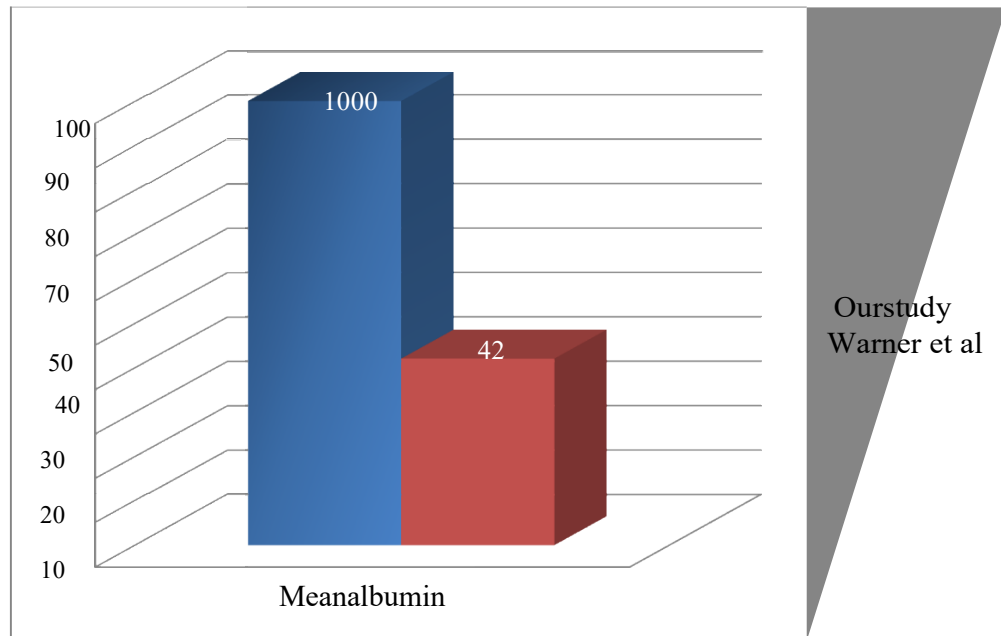


Glucocorticoids

In the present study, only 4 patients were taking glucocorticoids and had delayed healing. This is a lot more than the results published by Wagner AE, Huck G, Stiehl DP, Jelkmann W, Hellwig-Bürigel T .et al. University of Luebeck, Germany. They found 42% of their patients on steroids suffered from delayed wound healing

[12].

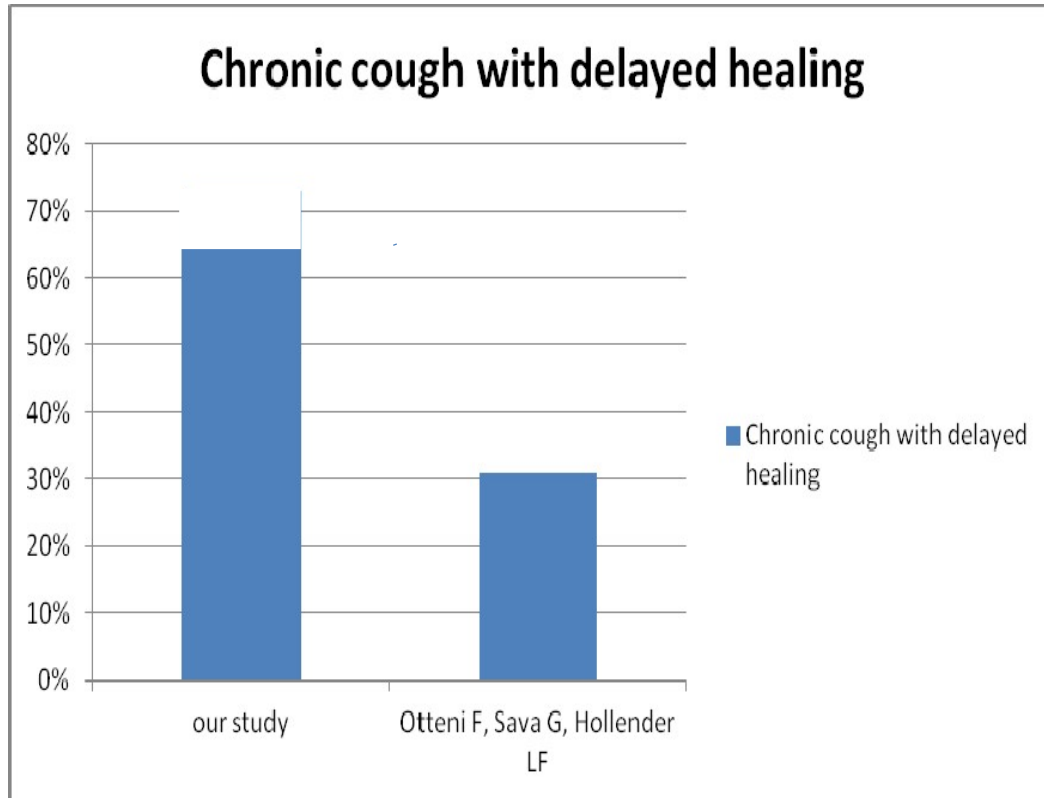
Graph 16: Glucocorticoids



Chronic Cough

In our study 66% of patients with chronic cough had delayed healing. Which is much higher than the results reported by Otteni F, Sava G, Hollender L F who reported 31% of patients with delayed healing possibly attributable to chronic cough [13].

Graph 17: Chronic Cough



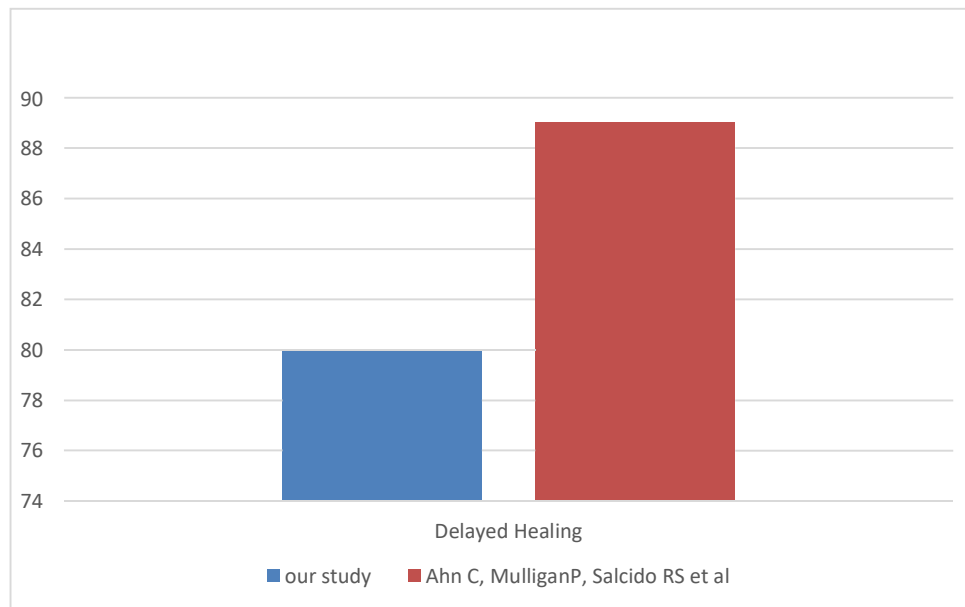
Smoking

In our study 80% of patients who were smokers, developed delayed wound healing. This is similar to the results published by Ahn C, Mulligan P, Salcido R S et al., University of Pennsylvania School of Medicine, Philadelphia, who found delayed wound healing in 89% of their patients who were smokers [14].

Table 19: Smoking

	Our study	Ahn C, Mulligan P, Salcido RS et al
Delayed Healing	80%	89%

Graph 18: Smoking



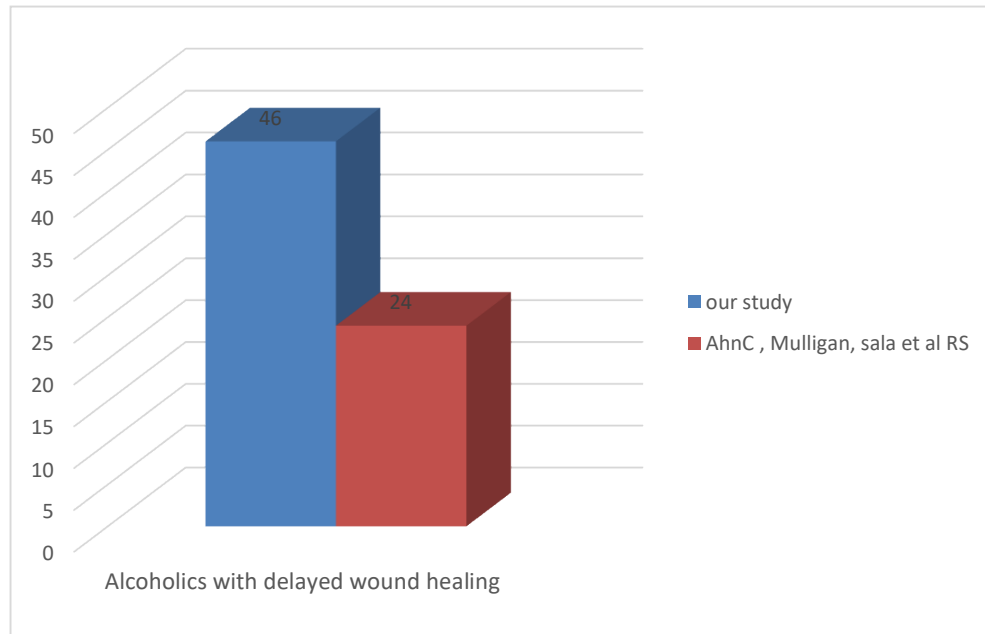
Alcohol

In our study 58.3% of alcoholics developed delayed wound healing. This is more than in comparison to 24% as per the results published by Radek K A, Matthies A M, Burns A L, Heinrich S A, Kovacs E J, Dipietro L A et alⁿ. Loyola University Medical Center, Maywood [15].

Table 20: Alcohol

	Our study	Radek KA, Matthies AM, Burns AL et al.
Alcoholics with delayed healing	58.3%	24%

Graph 19: Alcohol



Type of Laparotomy

In our study 50% of emergency laparotomies and 16 % of elective laparotomies developed delayed wound healing. This is a higher than the results published by Rodríguez-Hermosa JI, Codina-Cazador A, Ruiz B, Roig J et al who found delayed healing in 20% of emergency surgeries and less than 5% in elective surgeries [16].

Table 21: Type of Laparotomy

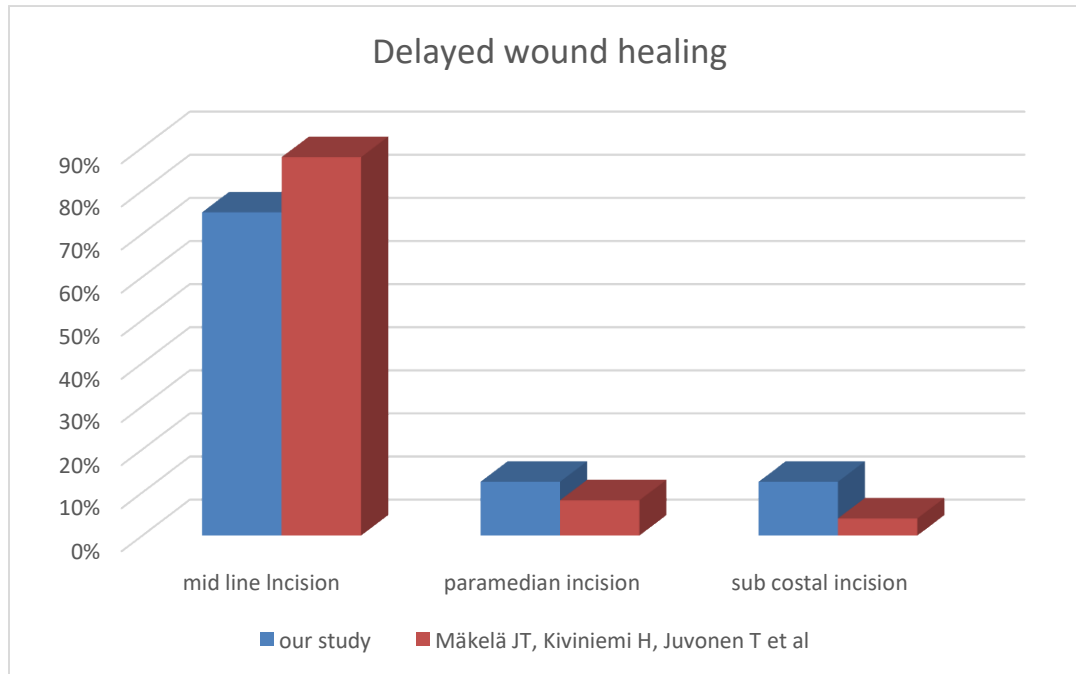
	Our study	Rodríguez-Hermosa JI, Codina-Cazador A, Ruiz B, Roig J et al
Emergency Laparotomy	50 %	20 %
Elective Laparotomy	16 %	5 %

TYPE OF INCISION

Out of the 100 patients included in the study,

- 75 underwent laparotomy through vertical midline incision, in which wound healing was delayed in 30. It came to be 75%. This is less than the study in Mäkelä JT, Kiviniemi H, Juvonen T et al which is 87.8%.
- 16 underwent laparotomy through right subcostal incision, in which wound healing was delayed in 5 . It came to be 12.5% . This is more than the study in Mäkelä JT, Kiviniemi H, Juvonen T et al being 4%.
- 9 underwent laparotomy through paramedian incisions in which wound healing was delayed in 5. This came to 12.5 %. This value is more than the study in Mäkelä JT, Kiviniemi H, Juvonen T et al being 8.2 %.

Graph 20 - Type of Incision



Multiple studies have concluded that vertical midline incision increases the risk of wound dehiscence. In the study of Rodríguez-Hermosa JI, Codina-Cazador A, Ruiz B, Roig J et al. out of 33 patients 87.87% patients underwent surgery with vertical midline incisions and 8.1% patients with right paramedian incisions had burst abdomen, that is more than 95% patients with vertical incisions had wound dehiscence [16]. Anatomical factors which might make a vertical upper abdominal wound more likely to burst are • Interference with blood supply • Rectus abdominis muscle has segmental blood supply and nerve innervations. If incision is lateral, the medial part of the rectus is denervated and later atrophies which becomes a weak spot in abdominal wall resulting in burst abdomen. • The fibers of rectus sheath run transversely so when midline vertical incision is given these fibers are disturbed and weakened and also the anterior sheath is detached from its insertion • With upper abdominal incision, the pain prevents chest movements thus increasing the likelihood of respiratory infections and cough, this increases the intrabdominal pressure leading to tension and strain on the fresh wound. • Elastic fibers of the skin also run transversely, so when they are cut by vertical incision, the strength of the wound is decreased.

Wound Infection

In present study 95% of the patients had having delayed healing had wound infection. This is higher than the results published by Rodríguez-Hermosa JI, Codina- Cazador A, Ruiz B, Roig J who attribute wound infection to be associated with 70% of patients with delayed healing [16].

Table 22: Wound infection

	Present study	Rodríguez-Hermosa JI, Codina- Cazador A, Ruiz B, Roig J et al.
Wound infection with delayed healing	95%	70%

CONCLUSION

- The principal associated factor of delayed wound healing was found to be wound infection. The other factors may directly delay healing or may indirectly increase chances of wound infection.
- Factors that could not be altered like age above 65 and male sex, might alert the surgeon, that the patient has an increased risk of having delayed wound healing.
- Alterable factors such as low haemoglobin, Serum Albumin require corrective measures as far as possible. Chronic cough though frequently associated with smoking, requires serious attention.
- Diabetics require strict glyceamic control in order to, not retard the wound healing process.
- Smoking and alcohol consumption are definite risk factors and may be important factors to take into consideration especially in elective cases.
- Emergency laparotomies are at a higher risk of delayed healing, probably due to increase in contamination and inadequate preparation for surgery
- Among the type of incisions, delayed healing was associated mostly with para-median incisions.
- Low pre-operative Heamoglobin and Albumin were also significantly associated with delayed healing, Poorly controlled Diabetes was an important risk factor for wound infection and delayed healing. Alcoholics were found to have a pre- disposition for poor wound healing.

CONFLICT OF INTEREST – None

FUNDING – Nil

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