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Effect of Stitch Length on the Rate of Postoperative Wound Complications in Midline Incisions

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Abstract:

Aim: *To study the effect of stitch length on the rate of Postoperative wound complications in midline incisions.*

Study design: *Randomized control trial.*

Place and duration of study: *General Surgery Department, NRI Medical College & General Hospital, Chinakakani from October 2013 to September 2015.*

Methodology: *60 patients with chronic wounds, of varying etiology, admitted in NRI Medical College & General Hospital, Chinakakani from January 2014 to July 2015. The patients having their midline incisions closed with an SL to WL ratio over 4 were selected. The rate of SSI and incisional hernia was analysed in relation stitch length (SL/number of stitches).*

Results: *Rate of granulation tissue was more rapid in vacuum assisted closure group as compared to conventional moist dressing group i.e. mean 78.68%for VAC group and mean51.92% forconventional moist dressing. Hospital stay was reduced in vacuum assisted closure group compared to conventional moist dressing group i.e mean 32.48 days for VAC group and mean 59.43 days for conventional moist dressing group. Percentage of graft uptake is more in vacuum assisted closure group compared to conventional moist dressing group i.e. mean 80.78% for VAC group and mean 59.58% for conventional moist dressing group*

Conclusion: *To conclude, vacuum assisted closure helps in faster healing of chronic wounds and better graft take-up and reduce hospital stay of these patients.*

Keywords: *Vacuum assisted closure, conventional moist dressings, chronic wounds.*

I. Introduction

Midline incisions allow rapid and wide access to the abdominal cavity with minimal damage to muscles, nerves and the vascular supply of the abdominal wall and are frequently used.

Postoperative wound complications, such as Surgical Site infection (SSI), seroma, wound dehiscence and incisional hernia cause patient suffering and morbidity. SSI which occurs in approximately 16% of patients after a major surgery, is a risk factor for the development of incisional hernia. Herniation often demands repair and occurs in up to 26% of midline incisions.

The quality of the suture technique has a profound effect on the risk of postoperative wound complications. Midline Incisions should be closed with a running suture and with a suture length (SL) to wound length (WL) ratio of at least 4. When the SL to WL ratio is less than 4, the risk of herniation is 3 times higher. The ratio (the length of the suture used through the length of the wound) depends on the size of each stitch and the stitch interval. Thus, a ratio of at least 4 can be achieved with many small stitches placed at close intervals or by incorporating a larger amount of tissue into stitches placed at greater intervals. It has been recommended to place larger stitches at least 10mm from the wound edge to produce strong wound. This has been attributed to inflammatory changes in tissue close to the wound edge diminishing its suture-holding capacity. But recent studies, taking the SL to WL ratio into account, have shown that a stronger wound is produced with small stitches placed 5-8mm from the wound edge. Long stitches have been associated with a high rate of surgical site infection and incisional hernia as they increase the amount of necrotic tissue in the wound and also the stitch slackens causing separation of wound edges[1,2,3.]

Recent studies revealed the increasing rate of incisional hernias being recorded in our country. Incisional hernia is an important complication as it causes patient discomfort and may warrant urgent surgery due to ileus[4]. The incidence of post-operative incisional hernia has been reported to be 10%[5].

Wound dehiscence occurs in 1-3% of abdominal surgical procedures. Systemic and local factors contribute to the development of these complications. Inadequate closure and deficient wound healing are the two most important local factors predisposing to wound dehiscence[6].

Median laparotomies and incisional hernias have been subject of investigation for a long period of time already. Although a lot is known about patient related risk factors and suture materials, technical risk factors such as suture techniques have not been investigated thoroughly.

The alarming increase in the rate of postoperative wound complications and their dependence on stitch length provoked us to take up this study. As identifying the ideal stitch length for wound closure helps prevent complications and minimizes patient discomfort.

In past few centuries medicine is so much advanced, in spite of thatmanagement of chronic wounds remains a tough challenge. To solve thislot of modalities of dressings and local applicants have been developed and lot of studies are still going on. Wounds which are showingcharacters of delayed healing or non healing is a problem which gives rise to various complications. Regardless of etiology, wounds are difficult to treat if coexisting factors (e.g.- infection or diabetes mellitus) prevent regular wound healing. Wounds represent a significant risk factor for hospitalization, psychological burden,amputation, sepsis, and even death, and from the patient's perspective, wound therapy is often uncomfortable or painful. Chronic wounds result in significant functional impairment, reduction in quality of life, and large financial costs for patients and the health care system.

Chronic wounds affect at least 1% of the population[1].Chronic wounds generally take longer time to heal, and care is enormously variable, as is the time to heal. There are approximately 4.5 million pressure ulcers in the world that require treatment every year. Many chronic wounds around the world are treated sub-optimally with general wound care products designed to cover and absorb some exudates. The optimal treatment for these wounds is to receive advanced wound management products and appropriate care to address the underlying defect that has caused the chronic wound; in the case of pressure ulcers a number of advanced devices exist to reduce pressure for patients. There are approximately 9.7 million venous ulcers, and approximately 10.0 million diabetic ulcers in the world requiring treatment. Chronic wounds are growing in incidence due to the growing age of the population, and the growth is also due to increasing awareness and improved diagnosis. Growth rates for pressure and venous ulcers are 6%–7% in the developed world as a result of these factors.Diabetic ulcers are growing more rapidly due mainly to increased incidence of both Type I and maturity-onset diabetes in the developed (high-GDP) countries around the world. The prevalence of diabetic ulcers is rising at 9% annually. At present, this pool of patients is growing faster than the new technologies are reducing the incidence of wounds by healing them.

Although wound dressing have been used for at least two millennia, there exists no ideal dressing. Surgical dressing of both open and closed wounds is based mainly on tradition, training and the surgeons own philosophy. Modern wound-healing concepts include different types of moist dressings and topical agents, although only a few of these treatments have convincingly been shown to give higher wound closure rates compared with traditional wet gauze dressings.[2-4].During the last two decades a wide variety of innovative dressing have been introduced.Negative pressure wound dressing is a new technology that has been shown to accelerate granulation tissue growth and promote faster healing, thereby decreasing the period between debridement and definite surgical closure in large wounds. In developing countries like India where the cost of dressing is a major concern, the locally constructednegative pressure dressing was an option.Clinical knowledge about the management of difficult-to-treat wounds is still limited owing to the lack of high-quality evidence.[5-8]. During the past few years, many clinical trials have been initiated, and first results have been reported in leading journals.

Recent studies have shown that application of a sub atmospheric pressure in a controlled manner to the wound site has got an important role in assisting wound healing. The present study was conducted to assess the efficacy of vacuum assisted closure dressings as compared to conventional moist wound dressings in improving the healing process in chronic wounds and to prove that negative pressure dressings can be used as a much better treatment option in the management of chronic wounds.

II. Aims And Objectives

- To study the effect of stitch length on postoperative wound complications such as:

a. Surgical site infection
b. Seroma
c. Wound dehiscence
d. Incisional hernia

- To study the effect of Suture length to Wound length ratio in causing postoperative wound complications.
- To study the strength of the wound and healing of the wound in relation to small and large stitches.
- To identify the ideal stitch length for closing midline incisions.

III. Materials And Methods

This prospective randomized comparative study included 60 patients with chronic wounds, of varying etiology, admitted in NRI Medical College & General Hospital, Chinakakani from January 2014 to July 2015 satisfying all the inclusion criteria mentioned below, after the clearance from the ethical committee was obtained. All chronic wounds where conventional dressings are indicated were included in the study.

3.1 Inclusion Criteria

- Patients in the age group of 20 to 60 years, who underwent planned surgery through midline incision.

3.2 Exclusion Criteria

- Patients with a previous midline incision,
- A previous abdominal incision crossing the midline,
- A preexisting ventral hernia such as an umbilical or epigastric hernia
- Known hypertensives
- Known diabetics
- Immunocompromised individuals
- Patients with Intestinal perforations and carcinomas.

All the patients who underwent planned surgery through midline incision in the Department of General Surgery of NRI Medical College and General Hospital were asked to participate in the trail. Patients with DM, HTN, Immunocompromised status, a previous midline incision, a previous abdominal incision crossing the midline, or a preexisting ventral hernia such as an umbilical or epigastric hernia were not eligible. All patients who underwent emergency surgeries were also excluded from the study. A continuous, single-layer monofilament suture closed the incision, and self-locking anchor knots were used. Loop Ethilon was the material used for wound closure.

Patients were randomized to wound closure with either a short or long stitch length. Randomization was achieved by using one technique or the other on alternating weeks. In the group randomized to a long stitch length, the previous standard technique for wound closure at the department was used and stitches were placed at least 10mm from the wound edge. For the short stitch group, stitches were placed 5 to 8 mm from the wound edge.

Patient's age, sex, weight, and height were recorded. The body mass index was calculated as weight in kilograms divided by height in meters square. Whether patients had previously received a diagnosis of diabetes mellitus was noted. The degree of wound contamination, the operation time, and the incision closure time were recorded. The length of the suture used to close the incision and the length of the wound were measured, and the Suture Length to Wound Length ratio was calculated. The number of stitches placed in the wound was recorded for calculation of the mean stitch length (SL/number of stitches) and the mean stitch interval (WL/number of stitches). Surgical site infection, wound dehiscence and seroma formation were watched for before the discharge of the patient and development of incisional hernia was looked into during follow up.

1.3 Materials used

Loop Ethilon.

1.4 Size Of The Stitches:

For one group stitches were placed at least 10mm from the wound edge and for the other group stitches were placed around 5 to 8 mm from the wound edge.

3.5 Statistical Analysis:

- The data was collected, compiled & analysed using SPSS v16.0.
- Results were presented in the form of frequency distribution tables, graphs & charts.
- The statistical tools applied were mean, average, standard deviation, Fisher exact p value.

IV. Observation And Results

60 cases that underwent various elective surgical procedures with midline incision at NRI Medical College and General Hospital, Chinakakani, were evaluated for post operative complications and the stitch and wound lengths were recorded. Equal number of patients was divided into two groups for small and large stitches.

Table 1: Age distribution of patients who underwent surgeries

Stitch length	Age				Total
	20 -30y	31 – 40y	41 – 50y	51 – 60y	
Small stitch	7	10	8	5	30
	23%	33%	27%	17%	100%
Large stitch	7	6	11	6	30
	23%	20%	37%	20%	100%
Total	14	16	19	11	60
	23%	27%	32%	18%	100%

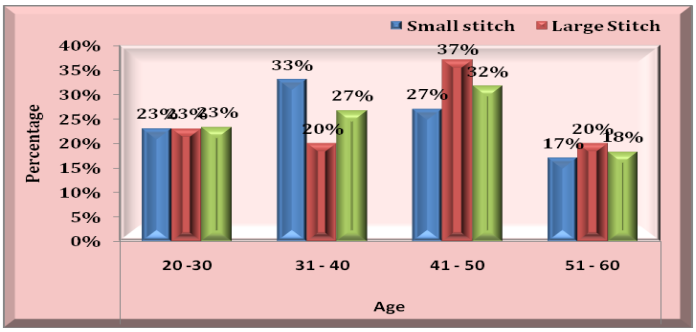


Table 2: Sex distribution in patients who underwent surgeries

Stitch length	Gender		Total
	Male	Female	
Small stitch	8	22	30
	27%	73%	100%
Large stitch	9	21	30
	30%	70%	100%
Total	17	43	60
	28%	72%	100

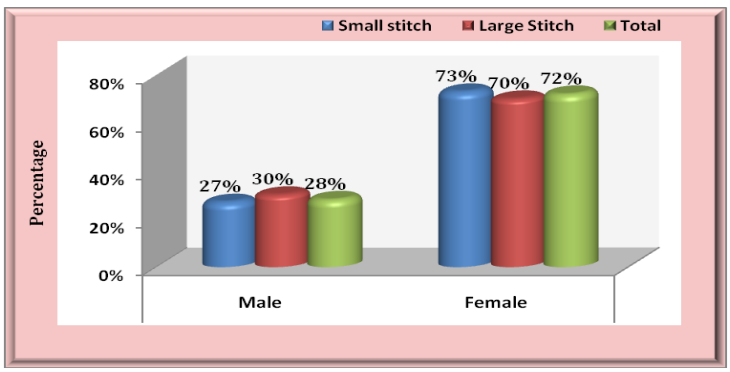


Table 3: Occurrence of SSI

Stitch length	Surgical Site Infection						Fisher exact p-value
	Present		Absent		Total		
	Frequency	%	Frequency	%	Frequency	%	
Small Stitch	6	20%	24	80%	30	100%	0.1
Large Stitch	13	43%	17	57%	30	100%	

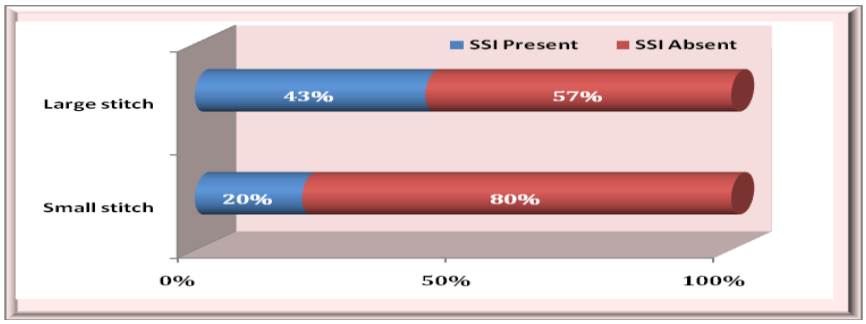


Table 4: Occurrence of Seroma

Stitch length	Seroma						Fisher exact p-value
	Present		Absent		Total		
	Frequency	%	Frequency	%	Frequency	%	
Small stitch	3	10%	27	90%	30	100%	0.3
Large stitch	7	23%	23	77%	30	100%	

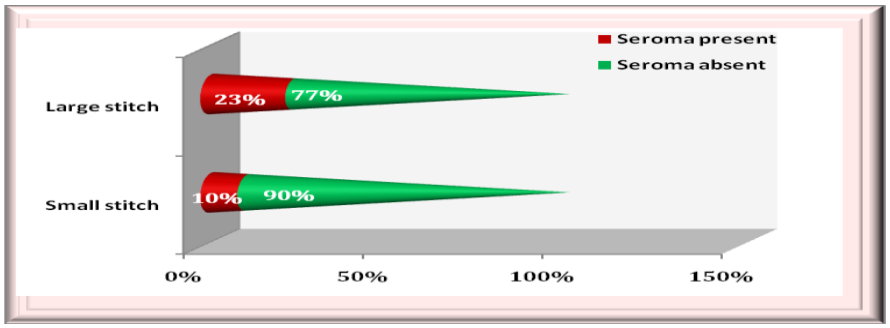


Table 5: Frequency of Wound dehiscence

Stitch length	Wound dehiscence						Fisher exact p-value
	Present		Absent		Total		
	Frequency	%	Frequency	%	Frequency	%	
Small stitch	4	13%	26	87%	30	100%	0.2
Large stitch	9	30%	21	70%	30	100%	

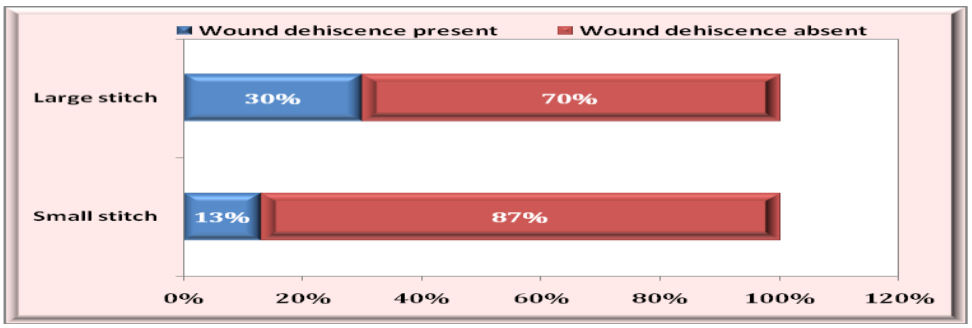


Table 6: Incidence of Incision hernia

Stitch length	Incisional Hernia						Fisher exact p-value
	Present		Absent		Total		
	Frequency	%	Frequency	%	Frequency	%	
Small stitch	1	3%	29	97%	30	100%	0.6
Large stitch	3	10%	27	90%	30	100%	

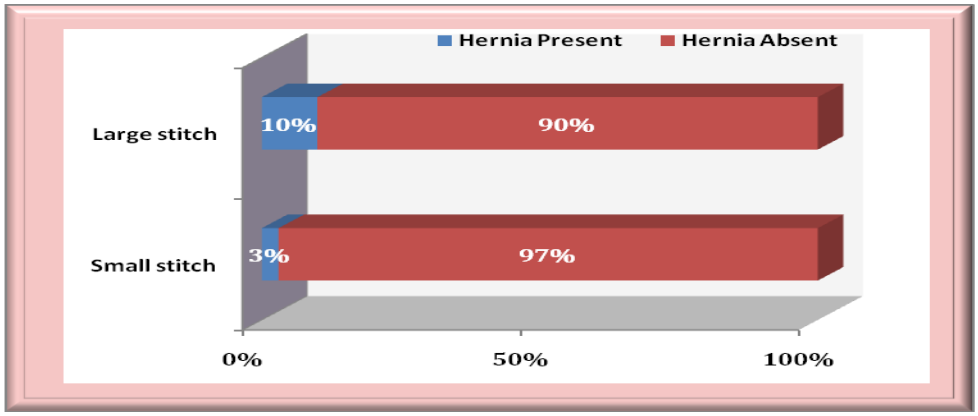


Table 7: Mean stitch length

Stitch Length				
Stitch length	**N**	**Mean**	**SD**	**p-value**
Small stitch	30	24.93 mm	1.36	<0.01
Large stitch	30	43.83 mm	1.84	

Table 8: Analysis of suturing time for small and large stitches

Suturing time				
Stitch length	**N**	**Mean**	**SD**	**p-value**
Small stitch	30	18.87 min	1.74	<0.01
Large stitch	30	16.20 min	1.86	

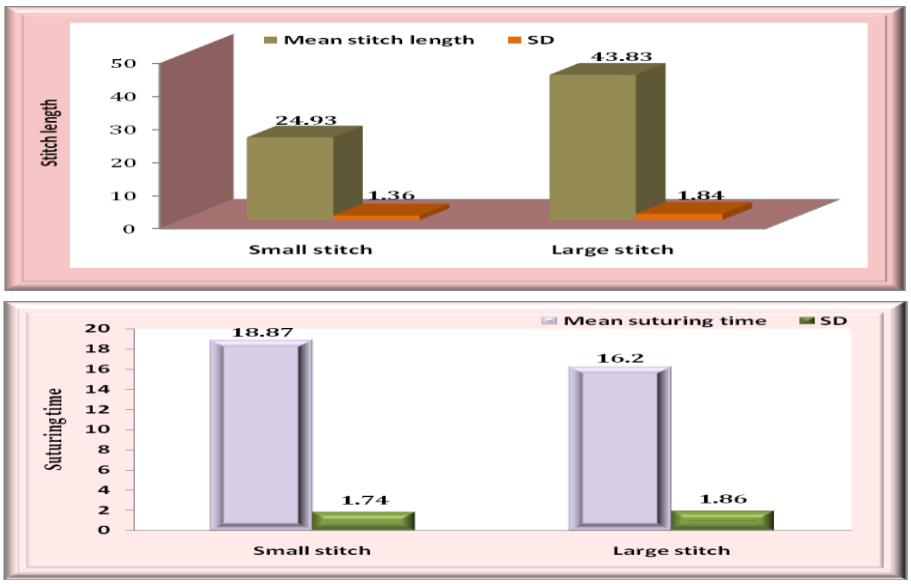


Table 9: Mean Wound Length

Wound Length				
Stitch length	**N**	**Mean**	**SD**	**p-value**
Small stitch	30	22.1 mm	0.60	0.07
Large stitch	30	25.3 mm	0.60	

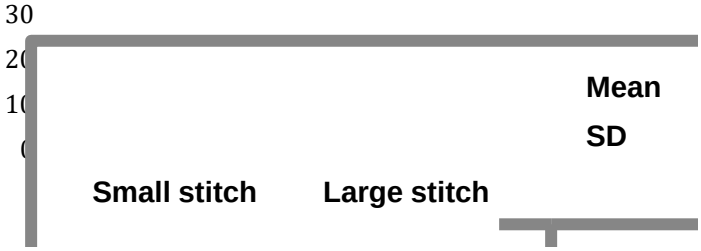


Table 10: Mean Stitch Interval

Stitch Interval				
Stitch length	**N**	**Mean**	**SD**	**p-value**
Small stitch	30	4.61 mm	0.18	<0.01
Large stitch	30	6.83 mm	0.30	

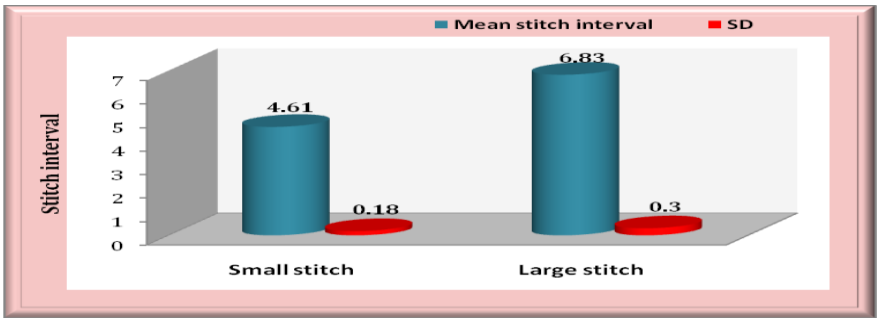
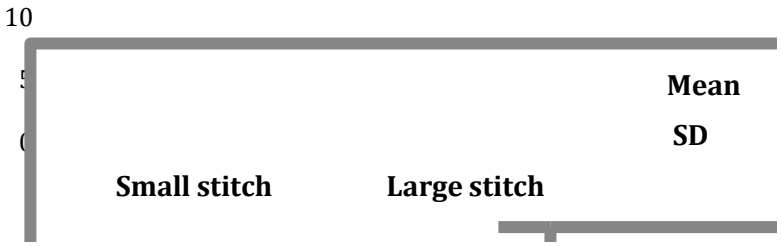


Table 11: Mean SL to WL ratio

Stitch length to Wound length ratio				
Stitch length	**N**	**Mean**	**SD**	**p-value**
Small stitch	30	5.2	0.20	<0.01
Large stitch	30	6.4	0.30	




Small Stitch


Large stitch


Surgical site infection


Surgical site infection


Incision hernia


Wound dehiscence


Healthy wound in large stitch


Healthy wound in small stitch

II. Discussion

The present study was done on the effect of stitch length on the rate of development of postoperative wound complications in midline incisions. These postoperative wound complications pose severe threat to the general health of patients undergoing surgery. An attempt was made to identify the ideal stitch length in closing midline incisions, so that there is minimal occurrence of postoperative wound complications.

The availability of specific references to compare the results obtained within our country were limited. In fact there were very few papers that were available regarding the effect of suture length on post-surgical complexities and healing time. Hence I was left with no choice other than taking the study conducted by the Department of Surgical and Perioperative Sciences at the UMEA University, Sweden as my prime reference to compare my study findings. I would hence take this opportunity to acknowledge the work done by Daniel Millbourn whose research findings enlightened me to carry forward this study.

A total of 60 patients volunteered for this study. Ethical clearance to perform the study on the volunteered patients was obtained from the Institutional Ethics Committee of NRI Academy of Sciences.

The age groups and sex of the patients that underwent the study were selected on random basis based on the available patient's and divided into two groups for small and large stitch. There had been no keen interest in grouping the cases with a specific sex ratio or an age group ratio as it does not have significant influence in our study. And also the availability of cases as per specific age and sex is difficult.

As detailed earlier in the methodology of the study all the 60 subjects selected for the study were perfect fit for the study. The subjects had

- No previous midline incision other than the one performed during the course of the study
- No previous abdominal incision crossing the midline
- No preexisting ventral hernia such as umbilical or epigastric hernia
- No known hypersensitivities
- Were non diabetic
- Were not immunocompromised individuals
- Had no intestinal perforations and carcinomas.

The study was conducted between the period of January 2014 to July 2015. The patient's age and sex were noted and strict care was taken to include only the patients within the age group of 20 to 60. It was ensured that they underwent planed surgery through midline incision were for the purpose of study.

The suturing technique and suture material used for the study and the definition of superficial and deep SSI with respect to this study were already mentioned in the methodology of the study.

Age:

Though cautious effort to select cases within the age group of 20 to 60 was made, it was highly impossible to select the predefined ratio of cases for detailed study depending on age factor. Keeping the limited availability of cases within the given age groups, the study managed to accommodate 23.3% of cases who were in the age group between 20 to 30 years, 26.7% of cases who were between 31 to 40 years, 31.7% of cases between age groups of 41 to 50 years and 18.3% of cases between 51 to 60 years.

The majority of the cases belonged to the age group 41 to 50 while least belonged to 51 to 60. The study performed by Daniel Millbourn had paatients who were only above 50 years of age, but the current study was performed with a mixed age group, which gains more significance in determination of the effect of age on the study.

Gender:

Again the study when performed within its given limitations had no luxury in choosing the number of cases in each gender that would participate in the study. The study was performed with a majority of female

cases which was 71% (43 out of the 60 selected cases) and only 28% were males. The effect of gender on the study does not have much significance but I believe that it would be an interesting aspect for further study.

Stitch length:

While the study carried out by Daniel Millbourn had 3 different stitch lengths to compare, the current study has limited its options to compare between two stitch lengths.

- The large stitches in this study are sutured 10mm from the wound edge and
- The smaller stitches were placed 5 to 8mm from the wound edge.

Care was taken that the cases were carefully divided into two groups of 30 each and one group was administered with a larger stitch length and the other with a smaller stitch length. Further among the 30 cases that were administered with a larger stitch 9 were males and 21 were females.

There were 8 males and 22 females in the group that was administered with a smaller stitch length. The limited availability of the male patients has left the study to perform a random distribution of male patients into the two groups. The detailed study on the effect of individual attributes on the study can be much more interesting and I believe it would be the further prospect of this study. While the study performed by Daniel Millbourn had the luxury to examine 368 cases, the results from his study show that they were in compliance with the results of the current study.

Table 12: Comparison of mean stitch length

	Daniel Millbourn, 2012	Present study, 2015
Small stitch	26 mm	24.93 mm
Large stitch	44 mm	43.83 mm

Suturing time:

The study also calculated the time taken to suture a small stitch and a large stitch. Though there was no significant importance given to this parameter in the study conducted by Daniel Millbourn, the current study intended to analyse the effect of the time taken to complete the stitch on the occurrence of SSI in the cases. While the smaller stitch took a mean time 18.87 minutes to complete, the larger stitch took an average of 16.20 minutes to complete.

Table 13: Comparison of mean suturing time

	Daniel Millbourn, 2012	Present study, 2015
Small stitch	18 min	18.87 min
Large stitch	14 min	16.20 min

Wound Length:

The wound length depends on the diagnosis and the type of surgery the patient is undergoing. It plays a role in determining the stitch interval. The mean wound length among our patients with small stitch was 22.1 mm and in patients with large stitch was 25.3 mm. These results have close resemblance with that of the study done by Daniel Millbourn.

Table 14: Comparison of mean wound length

	Daniel Millbourn, 2012	Present study, 2015
Small stitch	23.1 mm	22.1 mm
Large stitch	24.4 mm	25.3 mm

Stitch interval:

This is another important aspect that the study has focused on. The smaller stitches were placed at a mean interval of 4.61mm and the larger ones at a mean interval of 6.83mm. Interestingly the stitch interval remained same in the study conducted by Daniel Millbourn. The mean of the stitch interval in each of the cases was reported as 4.61 and 6.83 with a standard deviation of 0.18 and 0.30 for small and large stitches respectively.

Table 15: Comparison of mean stitch interval

	Daniel Millbourn, 2012	Present study, 2015
Small stitch	4.6 mm	4.61 mm
Large stitch	6.9 mm	6.83 mm

SL to WL ratio:

This important parameter plays a key role in determining the strength of the wound and thereby development of postoperative wound complications. The mean SL to WL ratio for small stitch was 5.2 with SD of 0.20 and large stitch was 6.4 with SD of 0.30. maintaining SL to WL ratio of 4 grossly decreases the

occurrence of postoperative wound complications. In small stitches where the mean ratio was 5.2 the incidence of incisional hernia is much less when compared to large stitches where the mean ratio was 6.4. This implies that in stitches where the ratio of atleast 4 is maintained the wound has more strength, like small stitch. Influence of ratio on SSI is more predominant than on incisional hernia. Development of SSI inturn leads to incisional hernia. The frequency of SSI is also grossly less in stitches with rayio of more than 4. In comparison of these findings with study by Daniel Millbourn, it coincides with the finding of SSI. In his study there was not much influence on incisional hernia. As small stitch with a ratio of more than 4 gives a strong wound and hence the incidence of wound dehiscence also decreases.

Table 16: Comparison of mean SL to WL ratio

	Daniel Millbourn, 2012	**Present study, 2015**
Small stitch	5.7	5.2
Large stitch	6.4	6.4

Seroma:

Out of the 30 cases administered with small stitch length, 3 subjects (10%) showed visible signs of seroma while 7 subjects (23%) of the 30 administered with large stitch length had seroma. This is again a clear sign that smaller stitch length is ideal to close a mid-line incision. This complication was not studied by Daniel Millbourn in his study.

Surgical Site Infection:

The presence of the SSI was observed during the post-operative recovery period. The cases from both the groups that were administered small and large stitches were closely observed for the presence of any possible SSI's.

The results were promising. The results depicted that there were minimal SSI's in cases that were administered with small stitch length. To be precise only 6 cases out of the 30 who got their mid line incision closed with a smaller stitch length showed possible signs of SSI's, while 13 cases out of the 30 who had large stitch length to close the mid-line incision showed SSI's. This clearly shows that smaller stitch length was the ideal to close the mid-line incision.

The results correlate with the findings of Daniel Millbourn. He found that only 17(5.2) cases out of the 326 who got their mid-line incision closed with a smaller stitch length showed signs of SSI's, while 35 (10.2)samples out of 343 had SSI's with large stitch length. This shows that the data observed on a larger and smaller sample groups reiterate that closing the mid-line incision with a smaller stitch results in a minimal rate of SSI occurrence. The possibility of other complications postoperatively were also observed to complete the study.

Table 17: Comparison of occurrence of SSI

	Daniel Millbourn, 2012	**Present study, 2015**
Small stitch	5.2 %	20%
Large stitch	10.2%	43%

Incisional Hernia:

While only 1 (3%) case out of the 30 administered with small stitch showed signs of hernia, 3 cases (10%) from the other group that were administered with a larger stitch had hernia. The study conducted by Daniel Millbourn also revealed that only 5.6% of his massive sample size administered with small stitch length had hernia while 18% of the cases administered with larger stitch showed visible signs of incisional hernia. This again reinforces the advantage of using small stitches to close mid-line incision for minimal occurrence of hernia.

Table 18: Comparison of incidence of incisional hernia

	Daniel Millbourn, 2012	**Present study, 2015**
Small stitch	5.6%	3%
Large stitch	18%	10%

Wound dehiscence:

4 cases (13%) out of the 30 subjects administered with small stitch length had wound dehiscence and 9 cases (30%) out of the 30 cases administered with large stitch length showed wound dehiscence. Interestingly the study carried out by Daniel Millbourn depicts that there was no case of wound dehiscence in the patients administered with small stitch length while there was a single case of wound dehiscence in the patients administered with large stitch length. Though it's an alarming rate of wound dehiscence in the current study when compared to that of Daniel it still depicts that small stitch length is the ideal to give a stronger wound.

Table 19: Comparison of frequency of wound dehiscence

	Daniel Millbourn, 2012	**Present study, 2015**
Small stitch	0%	13%
Large stitch	0.3%	30%

Though not much references were available regarding the similar study, the available studies performed reveal that the small stitch length is ideal to close a mid-line incision for a speedy recovery, low morbidity and minimal postoperative wound complications.

Studies performed by Mustafa Sahin et al (2001)[56,57], also reveal that smaller stitch length is ideal to close a mid-line incision.

V. Conclusion

It was quite a challenging task to take up research in an aspect that has limited literature and also less focus in our country. The importance of establishing an ideal suture length in order to minimize the post-operative complications is the need of the hour as the post-operative complications can sometimes turn fatal and cause morbidity and mortality.The research findings show that the small stitch length anywhere between 5 to 8mm depending on the wound site is the ideal stitch length to close a midline incision. The research findings of Daniel Millbourn from the Department of Surgical and Perioperative sciences, UMEA university Sweden has also depicted the same result. Apart from the result that I have established, it was really alarming to see that the size of the samples with post-operative wound complications were comparatively less in spite of his huge sample size when compared to the current study. This draws our attention towards the need of development of better techniques that can minimize the chances of these infections to the least possible level.

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