

A Prospective Study to Assess Open Retrorectus Hernia Meshplasty in Ventral Hernias

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Abstract:

Background:

Open retrorectus meshplasty is an established technique for ventral hernia repair, thought to confer advantages including reduced recurrence, infection rates, and improved anatomical restoration compared to onlay meshplasty. Ventral hernias—encompassing epigastric, umbilical, and incisional types—present significant surgical challenges, particularly with respect to postoperative wound complications such as seroma, infection, and recurrence. This prospective study was undertaken at Sri Narayani Hospital Research Centre, Vellore, to assess the clinical outcomes and complications associated with open retrorectus meshplasty in ventral hernias, emphasizing comparisons with historical and published data.

Materials and Methods: A prospective analytical and observational design was employed. Seventy-five patients aged 18–80 years undergoing open hernia meshplasty for ventral hernias (including defects of any size and number) between December 2022 and January 2024 were enrolled following strict inclusion and exclusion criteria. Clinical histories, operative, and follow-up data were systematically collected, with the principal outcomes being the incidence of seroma formation, recurrence, wound infection, hospital stay, and drain tube utilization. Data were coded and analyzed using SPSS v22, with appropriate statistical tests applied for quantitative and categorical variables.

Results: Patients included 51 women and 24 men, mean age 47.69 years. The most common hernia types were umbilical (n=29) and infraumbilical (n=21). The mean hospital stay was 3 days, mean surgery duration 53.46 minutes. No cases of wound infection were reported, and hernia recurrence was limited to one case. Seroma occurred in 35 patients (average volume 145 mL, range 5–465 mL); however, its management did not vary significantly with placement of a drain tube, as the retrorectus plane facilitated absorption. Drain tubes were used in 35 patients, with an average duration of 4 days. Pain resolved in most patients within a median of 14 days. The retrorectus technique demonstrated a low rate of postoperative complications, minimal recurrence, and can be performed efficiently even in complex cases.

Conclusion: Retrorectus meshplasty for ventral hernia repair is associated with a lower incidence of seroma and hematoma formation compared to onlay meshplasty and other repairs due to minimal skin flap dissection. Drain placement in Rives Stoppa repairs confers no additional benefit for seroma prevention, and early drain removal is feasible. The technique is safe, patient-friendly, offers durable anatomical results, and shows a notably low recurrence and infection rate even in a single-center setting. Further multi-center studies with larger cohorts are warranted to confirm generalizability of these findings.

Key Word: Retrorectus; Meshplasty; Onlay; Sublay; Seroma; Ventral Hernia; Rives Stoppa

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I. Introduction

A hernia is defined as a protrusion of a viscus or a part of a viscus through an abnormal opening in the walls of its containing cavity. The word hernia is derived from the Greek word „hernios“ meaning „a bud“

Ventral hernia, for the purposes of this thesis, is the term used to describe umbilical, epigastric and incisional hernias. Umbilical and paraumbilical hernia will be collectively referred to as umbilical hernia

RETROMUSCULAR PREPERITONEAL MESH REPAIR

It is an excellent method (Rives-Stoppa technique) by placing the sheet of prosthetic mesh in the plane between the posterior rectus sheath and the rectus muscles. This has distinct advantages over the intraperitoneal, inlay or overlay methods.

Though it is technically difficult with the higher rate of blood loss it has the distinct advantage of reducing the rate of infection and recurrence.

On the basis of our experience and reports in the literature, the advantages and disadvantages of onlay and prefascial mesh repair has been discussed.

Incisional hernia is a diffuse extrusion of abdominal contents through a weak surgical scar. A postoperative ventral, or incisional hernia is the result of failure of line of closure of abdominal wall following laparotomy.

Incisional hernia are variously reported as occurring in 6-12 percent of abdominal surgeries.

Laparoscopic repair of ventral abdominal hernias has become a standard of care. The surgery involves placement of a composite mesh with 3–5 cm overlap at the edges of the defect. The disadvantage of this repair is one, the composite mesh used for intraperitoneal placement is quite costly and two, it leaves a foreign body inside the peritoneal cavity, with the potential to cause problems in the future. To circumvent both these issues, we have developed a new approach, called the retrorectus sublay Mesh (RRSM) repair, which allows placement of a plain polypropylene mesh in an extraperitoneal plane.

Ventral Hernias for the purpose of the study includes epigastric, umbilical and incisional hernias. More emphasis was laid on incisional hernias. Incisional hernia is due to loss of continuity of fascial closure. It is one of the major complications of laparotomy with an incidence of about 3- 11%. There are so many etiological factors for incisional hernia and they should be repaired as soon as they are diagnosed to reduce the complications and reduce the recurrence rate. Defects less than 2.5 cm are closed by anatomical repair and those greater than 2.5 cm are closed with mesh repair.

After the advent of mesh repair the other procedures have become obsolete. Though it is associated with increased incidence of local complications, it reduces the recurrence rate.

The rationale behind using mesh repair invariably for all cases independent of size of defect, age, sex and weight of patient was to reduce the incidence of recurrence.

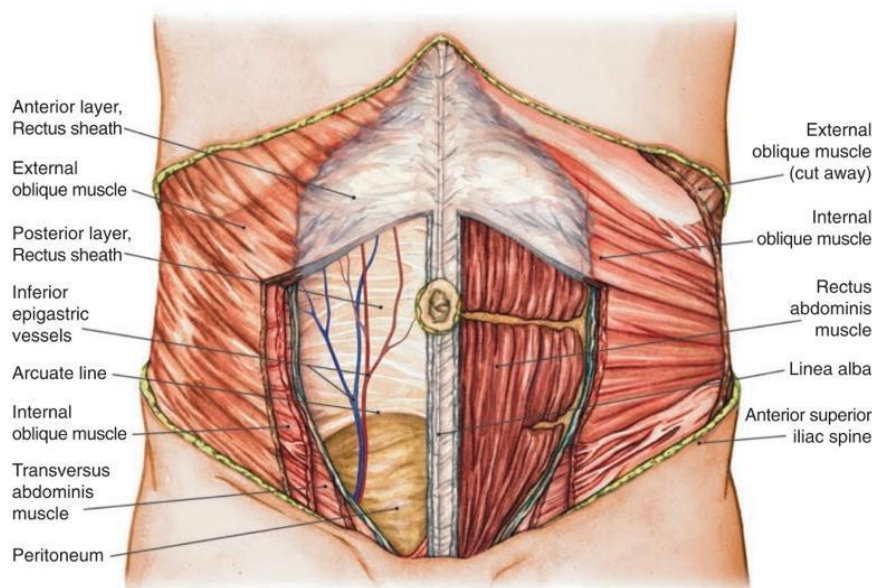


FIGURE 52.1 Muscles of the anterior abdominal wall.

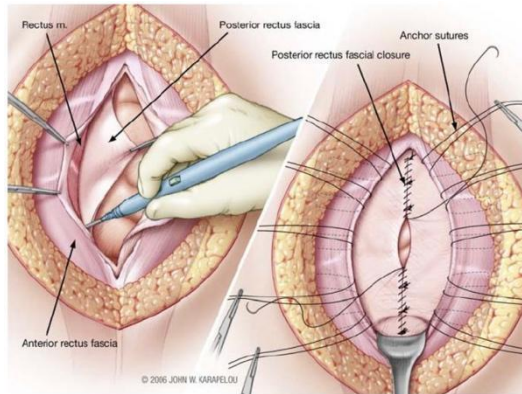
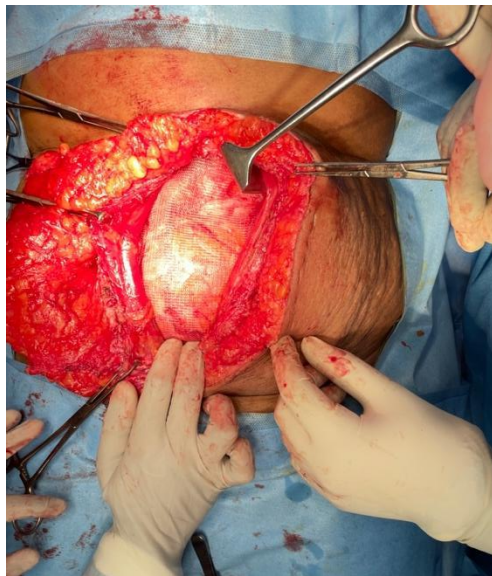


Figure 1. The posterior rectus sheath is dissected away from the overlying rectus abdominus muscle on both sides of the defect using electrocautery. The peritoneum is mobilized below the level of the arcuate line. Care must be taken to ligate and divide perforating blood vessels, as unidentified injury to these structures could result in the formation of rectus hematomas postoperatively. The posterior layer is approximated with running suture and reinforced intermittently with additional suture in order to avoid excess tension and tearing during manipulation.



II. Material And Methods

• AIM AND OBJECTIVES

PRIMARY OBJECTIVES:

- To evaluate the outcome of surgery like amount of seroma formation, recurrence and infection

SECONDARY OBJECTIVES :

- 1. To assess the number of patients who had Drain Tube
- 2. To assess the duration of surgery and duration of Drain Tube in situ

MATERIALS AND METHODS :

Study Design: A prospective analytical and observational study

Study Setting: Sri Narayani Hospital & Research Centre, Vellore

Sample Size: 75

This study will be conducted as a prospective observational study in the Department of General Surgery at Sri. Narayani Hospital, Vellore from 1st Dec 2022 to 1st Jan 2024 (12 months).Patients to be enrolled would have to meet the inclusion and exclusion criteria as mentioned below

Study Design: Prospective open label observational study

Study Location: This was a tertiary care teaching hospital based study done in Department of General Surgery, at Sri Narayani Hospital & Research Centre, Vellore, Tamil Nadu-632509.

Study Duration: November 2021 to November 2022, One Year

Sample size calculation:

The following formula has been used for sample size calculation.

The Sample size: $n = Z^2_{1-\alpha/2} p(1-p) / d^2$

Where p=expected proportion

d= absolute precision

α =significance level

Subjects & selection method: The study population was drawn from patients who presented to Sri Narayani Hospital & Research Centre, Vellore with ventral hernia and underwent open retrorectus hernia meshplasty November 2021 to November 2022. Patients were divided into three groups (each group had 100 patients) according to site of ventral hernia.

Inclusion criteria:

All symptomatic and asymptomatic ventral hernia patients undergoing open hernia meshplasty in patients aged between 18 and 80 years, and patients of both genders.

Defects of any size and any number

Exclusion criteria:

1. Patients below age 18 and above 80.
2. Patient with more than 3 abdominal surgeries.
3. Patients with psychiatric illness
4. Patient not willing to take part in the study
5. Morbidly obese
6. Patient with Compromised lung parameters.
7. All patients undergoing retro rectus meshplasty with open hernia meshplasty approach fulfilling inclusion and exclusion criteria will be included in the study after getting informed consent from the patients.
8. The informed consent would be in a language the patient would comprehend/read and write, either in English, Tamil or Bengali.

ETHICAL CLEARANCE:

Prior to commencement of study, the study will be approved from the Institutional Ethical Committee, Sri Narayani Hospital & Res. Centre, Sripuram

Procedure methodology

Study was done after explaining the study details in the language understandable to the patient. The patient was provided with an information sheet and consent form. Consent was taken from all patients included in the study. All adult patients (age > 18 years) and below 80 of both genders undergoing Retrorectus Hernia Meshplasty for ventral hernias at Sri Narayani Hospital & Research Centre during this study period fulfilling the inclusion criteria were included in the study. A detailed history was taken. Patients coming to the Emergency Room and those admitted to surgical wards will also be recruited for the study.

Detailed clinical history will be taken. Emphasis will be laid on age, sex, occupation and duration of illness. Details regarding systemic diseases (DM, HTN, DLP, CAD and CVA) will be taken. History of heavy weight lifting, chronic constipation, previous abdominal surgical history will be taken.

Examination part includes assessing the general condition of the patient on arrival, vitals, the site of swelling, pain associated with swelling, reducibility of swelling.

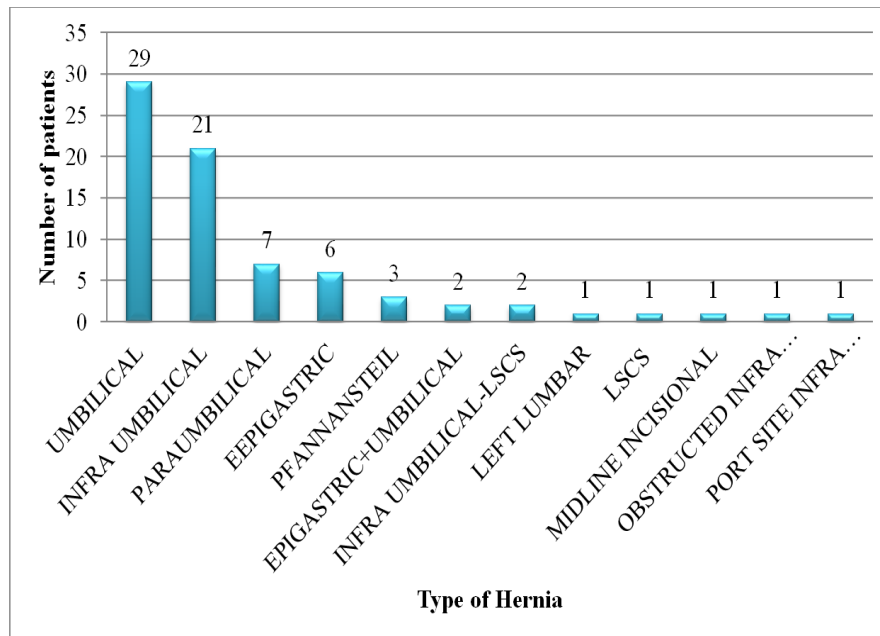
Reports of the imaging investigations will be noted which includes the location and size of defect, any other incidentally detected coexisting pathology. The postoperative course of each case is recorded which includes the duration of Surgical ICU stay, Nil Per Oral duration, oral tolerance, pain score, initiation of dependent as well as independent ambulation of patient after surgery, discharge date post surgery. Presentation will have only positive findings and relevant negative points to make the study brief and avoid unnecessary repetitions. The duration of the study will be from December 2022 to January 2024 with follow up for 6 months

STATISTICAL ANALYSIS:

The data collected was entered in the word excel and coded. The quantitative data was analyzed and represented as mean and standard deviation. The frequency and percentages were analyzed for all the variables in the study. Categorical variables were compared with Pearson's Chi-square and continuous variables were compared using analysis of variance and the Student's t-test wherever applicable. The SPSS licensed version 22 was used for the analysis.

III. Results

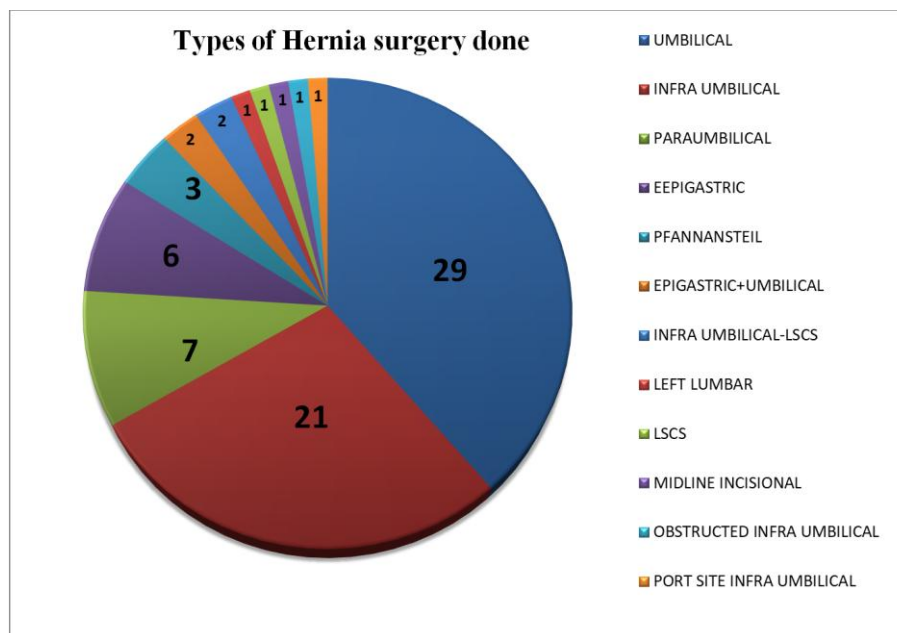
Patient distribution by type of Hernia surgery: The chart shows the number of patients for different types of hernia surgery



Patient distribution by type of Hernia surgery

Distribution of Patients by Type of Hernia Surgery

This pie chart illustrates the distribution of patients based on the type of hernia surgery performed

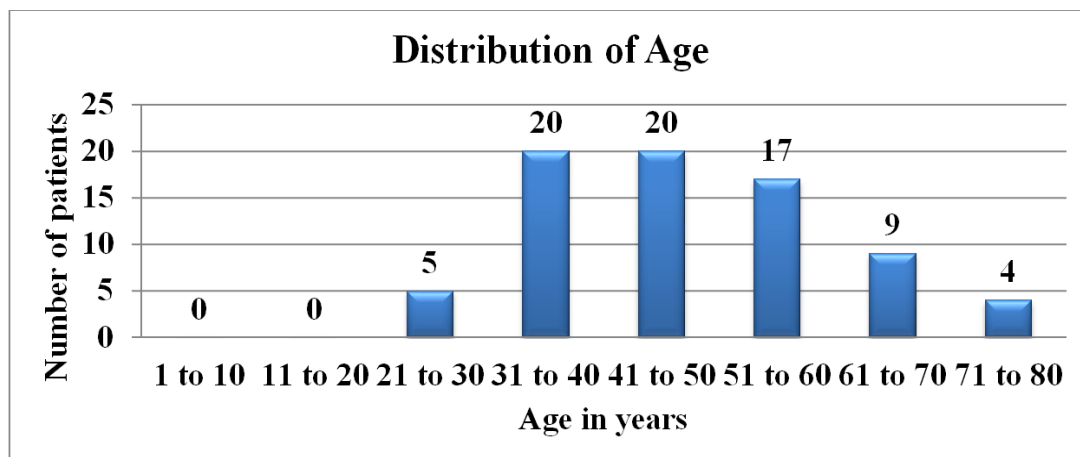


Type of Hernia		
UMBILICAL	29	
INFRA UMBILICAL	21	
PARAUMBILICAL	7	
EPIGASTRIC	6	
PFANNANSTEIL	3	
EPIGASTRIC+UMBILICAL	2	
INFRA UMBILICAL-LSCS	2	
LEFT LUMBAR	1	
LSCS	1	
MIDLINE INCISIONAL	1	
OBSTRUCTED INFRA UMBILICAL	1	
PORT SITE INFRA UMBILICAL	1	
Total Surgery	75	
Missing	0	
Average	6.25	EPIGASTRIC and PARAUMBILICAL
Std. Deviation	9.15	
Minumum	1	(LEFT LUMBAR,LSCS, MIDLINE INCISIONAL, OBSTRUCTED INFRA UMBILICAL, PORT SITE INFRA UMBILICAL
Maximum	29	UMBILICAL

DEMOGRAPHIC DATA

A. AGE DISTRIBUTION:

During this study 75 patients found to be eligible were enrolled. The age of the people ranged from a maximum of 77 to a minimum of 26. The mean age of patients was 47.69.

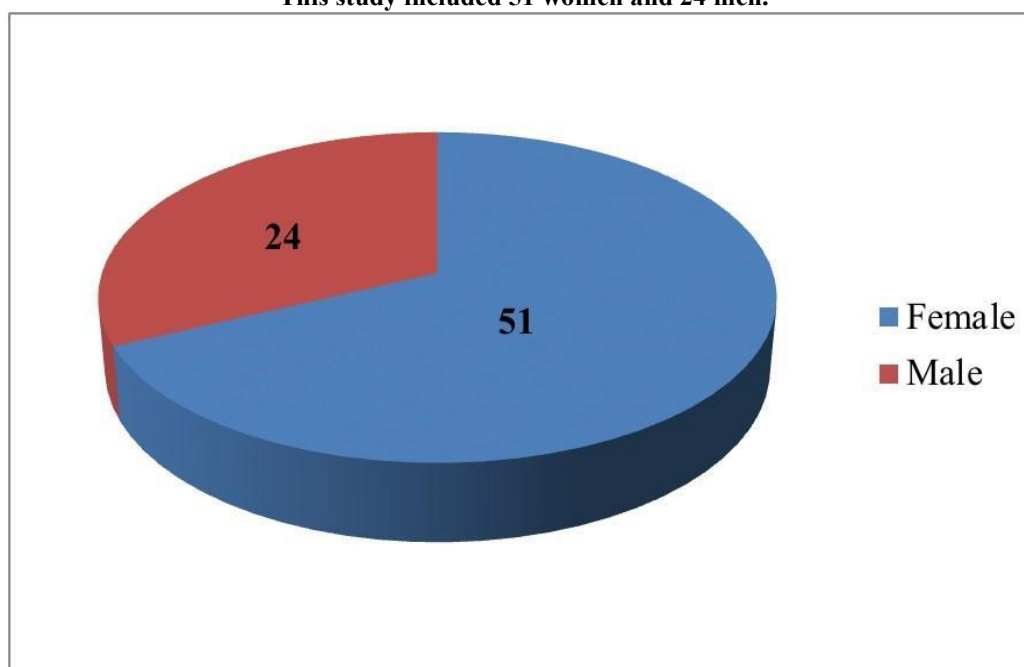


Descriptive Statistics

Age distribution	Number of patients
1 to 10 Years	0
11 to 20 Years	0
21 to 30 Years	5
31 to 40 Years	20
41 to 50 Years	20
51 to 60 Years	17
61 to 70 Years	9
71 to 80 Years	4
Valid/Number of patients	75
Missing	0
Mean Age (in years)	47.69
Std.Deviation	12.69
Minimum age (in years)	26
Maximum age (in years)	77

B.SEX DISTRIBUTION:

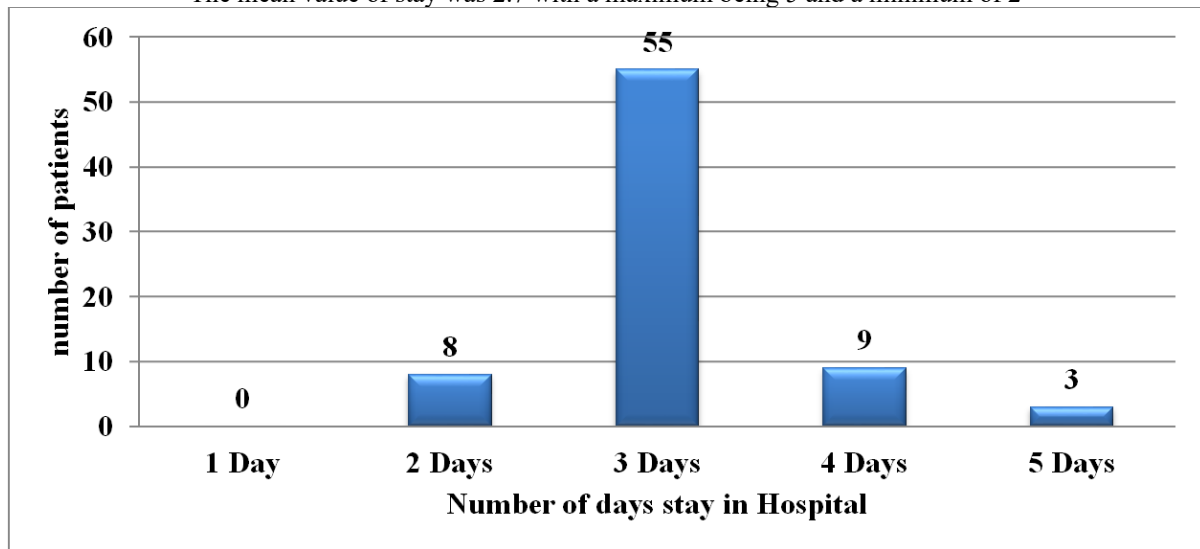
This study included 51 women and 24 men.



A. DISTRIBUTION OF THE VARIABLES:

1.DISTRIBUTION OF HOSPITAL STAY:

The mean value of stay was 2.7 with a maximum being 5 and a minimum of 2

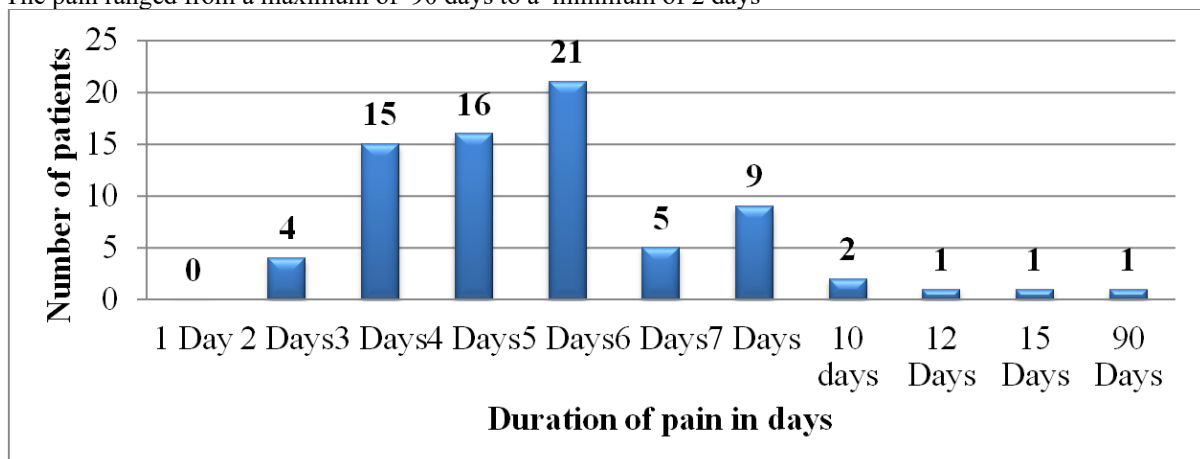


Number of days stay in Hospital

1 Day	0
2 Days	8
3 Days	55
4 Days	9
5 Days	3
Minimum days	1
Maximum days	5
Average days	3
Std. Deviation	1.58

2.DISTRIBUTION OF PAIN DAYS:

The pain ranged from a maximum of 90 days to a minimum of 2 days



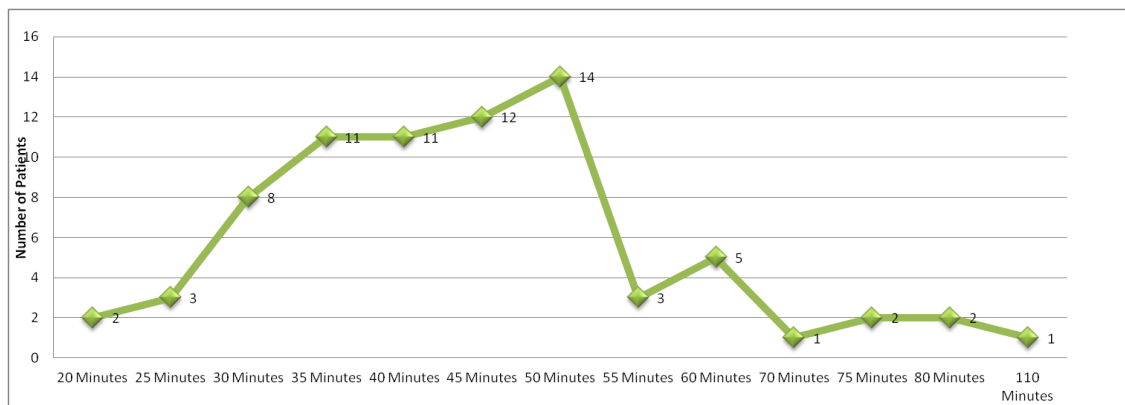
DURATION OF PAIN IN DAYS

1 Day	0
2 Days	4
3 Days	15
4 Days	16
5 Days	21
6 Days	5
7 Days	9
10 days	2
12 Days	1
15 Days	1
90 Days	1

Total Surgery patients	75
Minimum days of pain	1
Maximum days of pain	90
Average days of pain	14
Std. Deviation	25.54

Distribution of hernia surgery duration among patients

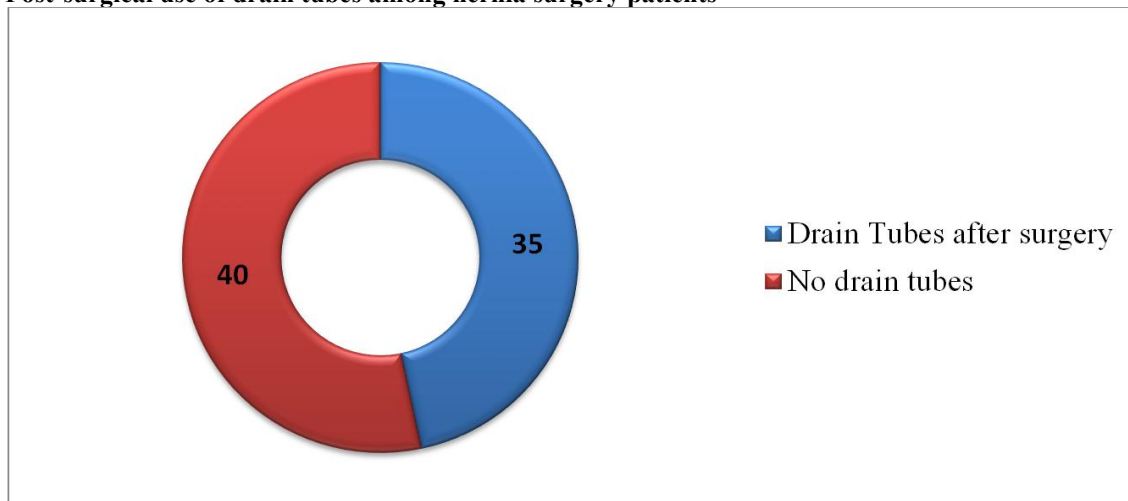
This line graph represents the number of patients corresponding to various durations of hernia surgeries. Each point on the graph indicates the number of patients who underwent surgery within a specific time frame ranging maximum of 100 minutes to minimum of 20 mins.



Duration of surgery (in Minutes)	Number of patients
20 Minutes	2
25 Minutes	3
30 Minutes	8
35 Minutes	11
40 Minutes	11
45 Minutes	12
50 Minutes	14
55 Minutes	3
60 Minutes	5

70 Minutes	1
75 Minutes	2
80 Minutes	2
110 Minutes	1
Total number of surgery	75
Average Duration	53.46 Minutes
Minimum Duration	20Minutes
Maximum Duration	110Minutes
Standard Deviation	25.44

Post-surgical use of drain tubes among hernia surgery patients

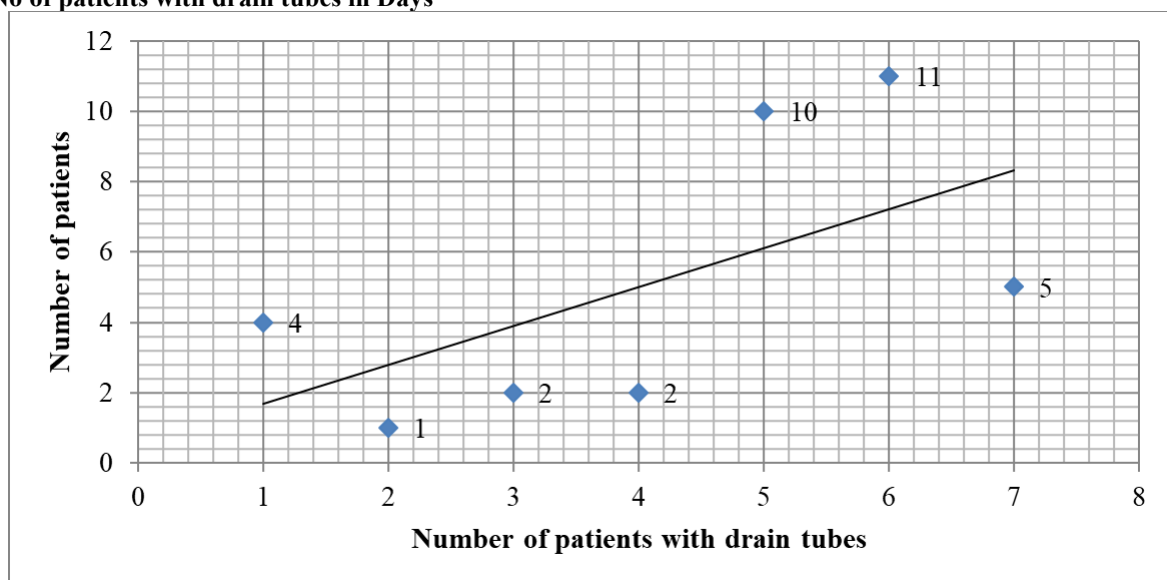


Amongst 75 patients, 40 patients had no DT and 35 had DT

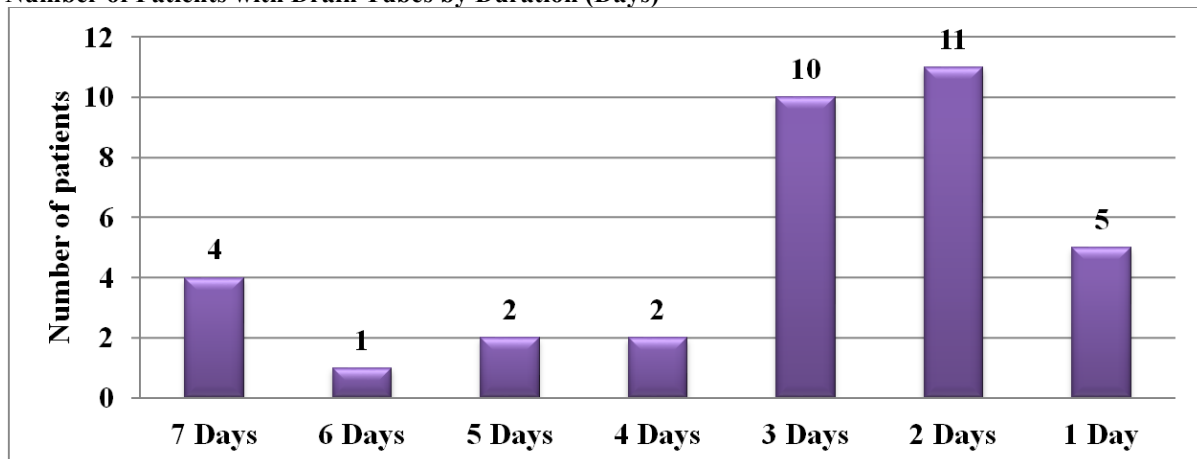
DISTRIBUTION OF DRAIN TUBE IN DAYS

DT ranges from a maximum of 7 days to a minimum of 1 day

No of patients with drain tubes in Days

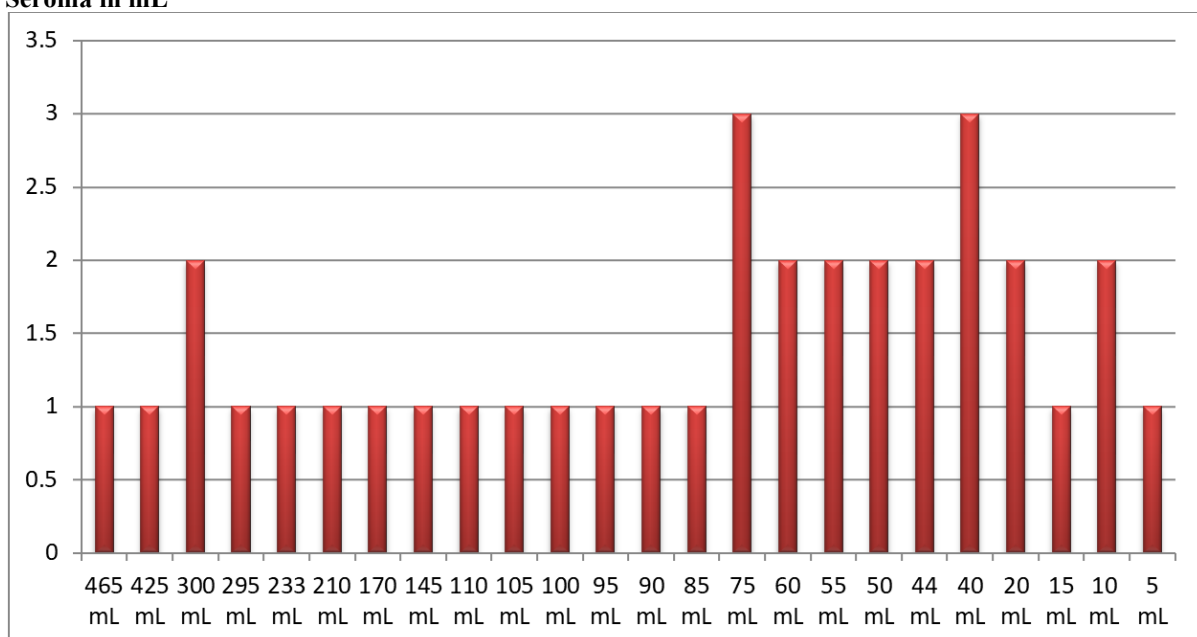


Number of Patients with Drain Tubes by Duration (Days)



7 Days	4
6 Days	1
5 Days	2
4 Days	2
3 Days	10
2 Days	11
1 Day	5
Minimum day with DT	1
Maximum days with DT	7
Average Days with DT	4
Std. Deviation	2.16

Seroma in mL



Seroma in mL	Number of patients
465 mL	1
425 mL	1
300 mL	2
295 mL	1
233 mL	1
210 mL	1
170 mL	1
145 mL	1
110 mL	1
105 mL	1
100 mL	1
95 mL	1
90 mL	1
85 mL	1
75 mL	3
60 mL	2
55 mL	2
50 mL	2
44 mL	2
40 mL	3
20 mL	2
15 mL	1
10 mL	2
5 mL	1
Number of surgeries done	75 patients
Incidence of Seroma in Patients	35 patients
Minimum Seroma Volume in Patients	5 mL
Maximum Seroma volume in patients	465 mL
Average Seroma volume in patients	145 mL
Std. Deviation	127.09

No of patients with Hernia		No of patients
		75
Types of Hernia	UMBILICAL	29
	INFRA UMBILICAL	21
	PARAUMBILICAL	7
	EPIGASTRIC	6
	PFANNANSTEIL	3
	EPIGASTRIC+UMBILICAL	2

	INFRA UMBILICAL-LSCS	2
	LEFT LUMBAR	1
	LSCS	1
	MIDLINE INCISIONAL	1
	OBSTRUCTED INFRA UMBILICAL	1
	PORT SITE INFRA UMBILICAL	1
	Easy	69
	Difficult	6
Duration of surgery (in Minutes)		
	20 Minutes	2
	25 Minutes	3
	30 Minutes	8
	35 Minutes	11
	40 Minutes	11
	45 Minutes	12
	50 Minutes	14
	55 Minutes	3
	60 Minutes	5
	70 Minutes	1
	75 Minutes	2
	80 Minutes	2
	110 Minutes	1
Drain Tubes		
	Drain tubes fixed after surgery	35
	No Drain tubes	40
DT days		
	7 Days	4
	6 Days	1
	5 Days	2
	4 Days	2
	3 Days	10
	2 Days	11
	1 Day	5
Wound Infection	NIL	
Recurrence	1	

IV. Discussion

Ventral hernia, for the purposes of this thesis, is the term used to describe umbilical, epigastric and incisional hernias. Umbilical and paraumbilical hernia will be collectively referred to as umbilical hernia. Incisional hernia, otherwise called postoperative hernia is a diffuse extrusion of peritoneum and abdominal contents through a weak scar of a previous surgery. Various surgical techniques have been developed for this challenging disease. The use of sheets of non-absorbable synthetic mesh prosthesis placed across the defect and stitched to the abdominal wall has revolutionized the repair of abdominal wall defects and has rendered the older type of surgeries obsolete. Ventral Hernias for the purpose of the study includes epigastric, umbilical and incisional hernias.

The Retrorectus Technique:

Rhemtulla et al²¹ described about Rives and Stoppa, the sublay technique of hernia repair more than half a century ago, but it took almost three decades to become truly appreciated and even longer for its full clinical potential and benefits to be realized. However in our study it was easy to perform and is successful and less technically challenging method of repair which is supported by Heartsill et al³³

The Study Population:

In this prospective observational study which is similar to Juvany et al¹³, we included 75 patients who underwent retromuscular mesh plasty amongst which 51 were women, 24 were men, the mean age was 47.69 which is similar to study by Heartsill et al³³. The mean age was 47.69 years in study population, minimum age was 26 and maximum age was 77. This study population is same as that of done by Vaghlokar et al⁴⁴. The hernia distribution gender wise with female predominance and type of hernia where supraumbilical and umbilical accounts for more in number than infra umbilical by Nau, P et al⁶⁰ is similar to our study population.

The Pros & Cons:

The major concern in post operative period for midline incisional hernias after meshplasty is the seroma formation, infection and recurrence rate which is low in our study and is similar to study by Daniel et al³¹. Warwick AM et al⁵ & Albino FP⁴² showed location of reinforcement of mesh in retrorectus placement is associated with low recurrence rate which is the same as our study.

The Outcome:

Sosin M et al⁴³ in the study says mesh reinforcement of a ventral hernia repair continues to be safe and efficacious, and the anatomic location of mesh implantation appears to influence outcomes. Retromuscular or underlay mesh repair is associated with a lower recurrence rate because retromuscular plane is a closed space, whatever seroma formed will easily be absorbed into the muscular plane anteriorly, thereby the placement of DT is not necessary and even though we place DT, the quantity of seroma is not the criteria for the removal of DT unlike seromas that are being collected in onlay placement where the DT has to come down less than 20 ml for removal. Thus making retrorectus mesh plasty a DT free procedure which is supported by Meyer AM et al¹⁵.

Nonetheless the most common procedure for both PH & IH in India is onlay as seen by Baig et al⁵⁸. We didn't place DT in 40 patients and placed DT in 35 patients, there was no statistically difference between two groups which is supported by Meyer AM et al¹⁵.

However studies from Lucas Timmermans et al⁶ observed no difference regarding seroma and hematoma.

Our study had low seroma similar to study by Beckers Pelletier L et al²⁵ because (Rives-Stoppa technique) by placing the sheet of prosthetic mesh in the plane between the posterior rectus sheath and the rectus muscles. This has distinct advantages over the intraperitoneal, inlay or overlay methods. Though it is technically difficult with the higher rate of blood loss it has the distinct advantage of reducing the rate of infection and recurrence.

The average duration of surgery in our study was 53.46 minutes with maximum duration of 110 minutes and minimum duration of 20 minutes, it was rather done easily despite its technical difficulty. Length of stay was also significantly increased by the presence of a drain which is similar to study by Louis et al¹⁶.

Follow up:

Hartog²¹ assessed prevalence of hernia recurrence, surgical site infection (SSI), seroma, serious complications, and mortality after retro-rectus repair. Retro-rectus repair was associated with lower recurrence rates which is similar to our study.

Primary outcomes included seroma, hernia recurrence. Secondary outcome measures were duration of hospital stay, long-term abdominal wall pain, and self-reported patient satisfaction which is similar to study by Iqbal CW et al¹⁰.

Bauer JJ et al¹⁹ observed no hernia recurrences (except in one patient), gastrointestinal complications, fistulas, or deaths who were followed up for 12 months similar to our study.

Thereby from the above we infer Rives-Stoppa technique allows for a more anatomical layered reconstruction, which helps restore the anatomical and physiological properties of the abdominal wall which was similarly demonstrated by Molina Vabarello et al²⁷.

The uniqueness of our study is demonstration of predominantly DT less meshplasty for retrorectus plane unlike other studies where they place DT to combat seroma and moreover if at all DT is placed, it is removed regardless of the quantity of seroma pertaining to the fact that seroma gets absorbed in the retromuscular plane which is detailly analysed with extensive coverage on number of days with DT and its early removal under single research. Hoping that our study will throw some light in this area.

Benefit:

Benefits of this technique include the ability to explore the entire fascial defect and to identify any potentially weak points in the fascia. Fenestrations in the peritoneum can be recognized, and if necessary, selection of a larger mesh implant to cover these areas of potential weakness can be made

Placement of the mesh between the posterior rectus sheath

and the rectus muscle takes advantage of the intra-abdominal pressure to secure the mesh, while minimizing the risk of adhesion and fistula formation

In contrast to McLanahan et al⁵⁹ which reported that 11% of patients had moderate to severe pain at 12 months after incisional hernia repair unlike our study where patients did not complain of pain for such longer duration.

Limitation:

1. Our study is a single center study involving a small group of patients
2. The study is based on a small sample size and in single center. Generalization of results requires results from large multicentric studies from the same region.

V. Conclusion

Summary:

- This cross sectional observational study was undertaken in the Department of General Surgery in Sri Narayani Hospital & Research Centre, Vellore.
- A total of 75 patients who underwent open retrorectus hernia meshplasty for ventral hernias were included.
- The variables duration of surgery & hospital stay, seroma collection, post op pain, recurrence, infection were observed.
- The age of the people ranged from 26 to 77. The mean age of patients was 47.9
- The study included 51 women and 24 men.
- On assessing the variables it was found that retrorectus hernia meshplasty has low seroma formation, low post op pain, easily done and patient friendly in terms of no dt placement.

Conclusion:

- The maximum incidence of seroma formation in incisional hernia repair is observed in Onlay Meshplasty due to excessive dissection of the flaps.
- The incidence of seroma & hematoma formation in sublay mesh plasty is significantly lowered as compared to other repairs, due to minimal dissection of the skin flaps.
- Placement of a drain in Rives Stoppa repair has no benefits in terms of seroma formation.
- The placement of a negative suction drain in Rives Stoppa repair for incisional hernia confers no added advantage to patients.
- The raising of skin flaps in Rives Stoppa repair is minimal as compared to other repairs since the mesh is placed in a retromuscular plane.

References

- [1]. Pearson DG, Madura JA 2nd. Modified retrorectus ventral hernia repair. *Am J Surg.* 2016 Mar;211(3):615-8.
- [2]. Wheeler AA, Matz ST, Bachman SL, Thaler K, Miedema BW. Retrorectus polyester mesh repair for midline ventral hernias. *Hernia.* 2009 Dec;13(6):597-603.
- [3]. McLanahan D, King LT, Weems C, Novotney M, Gibson K. Retrorectus prosthetic mesh repair of midline abdominal hernia. *Am J Surg.* 1997 May;173(5):445-9.
- [4]. Khansa I, Janis JE. Abdominal Wall Reconstruction Using Retrorectus Self-adhering Mesh: A Novel Approach. *Plast Reconstr Surg Glob Open.* 2016 Nov 23;4(11):e1145.
- [5]. Warwick AM, Smart NJ, Daniels IR. Retro-rectus repair of complex incisional hernia leads to low recurrence rate. *ANZ J Surg.* 2017 Jul;87(7-8):591-594.

- [6]. Timmermans L, de Goede B, van Dijk SM, Kleinrensink GJ, Jeekel J, Lange JF. Meta-analysis of sublay versus onlay mesh repair in incisional hernia surgery. *Am J Surg*. 2014 Jun;207(6):980-8.
- [7]. Rosen MJ, Reynolds HL, Champagne B, Delaney CP. A novel approach for the simultaneous repair of large midline incisional and parastomal hernias with biological mesh and retrorectus reconstruction. *Am J Surg*. 2010 Mar;199(3):416-20; discussion 420-1.
- [8]. Holihan JL, Bondre I, Askenasy EP, Greenberg JA, Keith JN, Martindale RG, Roth JS, Liang MK; Ventral Hernia Outcomes Collaborative (VHOC) Writing Group. Sublay versus underlay in open ventral hernia repair. *J Surg Res*. 2016 May 1;202(1):26-32.
- [9]. Langer C, Liersch T, Kley C, Flosman M, Süß M, Siemer A, Becker H. 25 Jahre Erfahrung in der Narbenhernienchirurgie. Eine vergleichende, retrospektive Studie an 432 Narbenbruchoperationen [Twenty-five years of experience in incisional hernia surgery. A comparative retrospective study of 432 incisional hernia repairs]. *Chirurg*. 2003 Jul;74(7):638-45. German.
- [10]. Iqbal CW, Pham TH, Joseph A, Mai J, Thompson GB, Sarr MG. Long-term outcome of 254 complex incisional hernia repairs using the modified Rives-Stoppa technique. *World J Surg*. 2007 Dec;31(12):2398-404.
- [11]. Hartog FPJD, Sneyders D, Darwish EF, Yurtkap Y, Menon AG, Muysoms FE, Kleinrensink GJ, Bouvy ND, Jeekel J, Lange JF. Favorable Outcomes After Retro-Rectus (Rives-Stoppa) Mesh Repair as Treatment for Noncomplex Ventral Abdominal Wall Hernia, a Systematic Review and Meta-analysis. *Ann Surg*. 2022 Jul 1;276(1):55-65.
- [12]. Molina Caballero AY, Pérez Martínez A, GoñiOrayen C. Abdominal hernia repair using the Rives-Stoppa technique: an abdominal reconstruction. *Cir Pediatr*. 2021 Jul 1;34(3):164-167.
- [13]. Juvany M, Guillaumes S, Hoyuela C, Bachero I, Trias M, Ardid J, Martrat A. Results of a Prospective Cohort Study on Open Rives Technique of the Midline Incisional Hernia: Midline Closure and Mesh Overlap. *Surg Innov*. 2022 Jun;29(3):321-328.
- [14]. Juul N, Henriksen NA, Jensen KK. Increased risk of postoperative complications with retromuscular mesh placement in emergency incisional hernia repair: A nationwide register-based cohort study. *Scand J Surg*. 2021 Jun;110(2):193-198.
- [15]. Meyer AM, Hu A, Liu AT, Jang DH, Perez Holguin RA, Delong CG, Pauli EM, Horne CM. Retromuscular drain output at removal does not influence adverse outcome rate in open ventral hernia repairs. *Surg Endosc*. 2024 Jan;38(1):356-362.
- [16]. Louis V, Diab S, Villemin A, Brigand C, Manfredelli S, Delhorme JB, Rohr S, Romain B. Do surgical drains reduce surgical site occurrence and infection after incisional hernia repair with sublay mesh? A non-randomised pilot study. *Hernia*. 2023 Aug;27(4):873-881.
- [17]. Krpata DM, Prabhu AS, Carbonell AM, Haskins IN, Phillips S, Poulose BK, Rosen MJ. Drain Placement Does Not Increase Infectious Complications After Retromuscular Ventral Hernia Repair with Synthetic Mesh: an AHSQC Analysis. *J Gastrointest Surg*. 2017 Dec;21(12):2083-2089.
- [18]. Kroese LF, van Eeghem LHA, Verhelst J, Jeekel J, Kleinrensink GJ, Lange JF. Long term results of open complex abdominal wall hernia repair with self-gripping mesh: A retrospective cohort study. *Int J Surg*. 2017 Aug;44:255-259.
- [19]. Bauer JJ, Harris MT, Gorfine SR, Kreel I. Rives-Stoppa procedure for repair of large incisional hernias: experience with 57 patients. *Hernia*. 2002 Sep;6(3):120-3.
- [20]. Ferranti F, Triveri P, Mancini P, Di Paola M. The treatment of large midline incisional hernias using a retromuscular prosthetic mesh (Stoppa-Rives technique). *Chir Ital*. 2003 Jan-Feb;55(1):129-36.
- [21]. Hartog, Floris P. J. den MD*; Sneyders, Dimitri MD, PhD*; Darwish, Es F. MD*; Yurtkap, Yağmur MD, PhD*; Menon, Anand G. MD, PhD†; Muysoms, Filip E. MD, PhD‡; Kleinrensink, Gert-Jan PhD§; Bouvy, Nicole D. MD, PhD¶; Jeekel, Johannes MD, PhD§; Lange, Johan F. MD, PhD*. Favorable Outcomes After Retro-Rectus (Rives-Stoppa) Mesh Repair as Treatment for Noncomplex Ventral Abdominal Wall Hernia, a Systematic Review and Meta-analysis. *Annals of Surgery* 276(1):p 55-65, July 2022.
- [22]. Masati, Bledi&Haxhiu, Asfloral&Dhima, Marsel&Punmira, Tomi &Zikaj, Gentian & Ibrahim, Alfred &Dogjani, Agron. (2024). The Benefit of Open Rives-Stoppa Procedure in Complex Incisional Hernia.. *Albanian Journal of Trauma and Emergency Surgery*. 8. 1371-1376.
- [23]. Marcolin P, de Figueiredo SMP, Constante MM, de Melo VMF, de Araújo SW, Mao RD, Lu R. Drain placement in retromuscular ventral hernia repair: a systematic review and meta-analysis. *Hernia*. 2023 Jun;27(3):519-526.
- [24]. Sevinç B, Okuş A, Ay S, Aksoy N, Karahan Ö. Randomized prospective comparison of long-term results of onlay and sublay mesh repair techniques for incisional hernia. *Turk J Surg*. 2018 Jan 4;34(1):17-20. doi: 10.5152/turksurg.2017.3712
- [25]. Beckers Perletti L, Spoelders F, Berrevoet F. Association between surgical hernia repair techniques and the incidence of seroma: a systematic review and meta-analysis of randomized controlled trials. *Hernia*. 2022 Feb;26(1):3-15.
- [26]. Liedberg F, Kollberg P, Allerbo M, Baseckas G, Brändstedt J, Gudjonsson S, Hagberg O, Håkansson U, Jerlström T, Löfgren A, Patschan O, Sörenby A, Bläckberg M. Preventing Parastomal Hernia After Ileal Conduit by the Use of a Prophylactic Mesh: A Randomised Study. *Eur Urol*. 2020 Nov;78(5):757-763.
- [27]. Bessa SS, El-Gendi AM, Ghazal AH, Al-Fayoumi TA. Comparison between the short-term results of onlay and sublay mesh placement in the management of uncomplicated para-umbilical hernia: a prospective randomized study. *Hernia*. 2015 Feb;19(1):141-6.
- [28]. Demetrasvili Z, Pipia I, Loladze D, Metreveli T, Ekaladze E, Kenchadze G, Khutsishvili K. Open retromuscular mesh repair versus onlay technique of incisional hernia: A randomized controlled trial. *Int J Surg*. 2017 Jan;37:65-70.
- [29]. Rhemtulla, Irfan A. MD, MS; Tecce, Michael G. DO; Broach, Robyn B. PhD; Messa, Charles A. IV BS; Mauch, Jaclyn T. BA; Fischer, John P. MD, MPH. Retromuscular Mesh Repair Using Fibrin Glue: Early Outcomes and Cost-effectiveness of an Evolving Technique. *Plastic and Reconstructive Surgery - Global Open* 7(4):p e2184, April 2019.
- [30]. Rhemtulla IA, Fischer JP. RetromuscularSublay Technique for Ventral Hernia Repair. *Semin Plast Surg*. 2018 Aug;32(3):120-126.
- [31]. Maman D, Greenwald D, Kreniske J, Royston A, Powers S, Bauer J. Modified Rives-Stoppa technique for repair of complex incisional hernias in 59 patients. *Ann Plast Surg*. 2012 Feb;68(2):190-3.
- [32]. Martinez M, Dove J, Blansfield J, et al. Outcomes of Open Retro-Rectus Hernia Repair With Mesh in Obesity Class III. *The American Surgeon*TM. 2020;86(9):1163-1168.
- [33]. Heartsill L, Richards ML, Arfai N, Lee A, Bingener-Casey J, Schwesinger WH, Sirinek KR. Open Rives-Stoppa ventral hernia repair made simple and successful but not for everyone. *Hernia*. 2005 May;9(2):162-6.
- [34]. Mehraabi M, Jangjoo A, Tavoosi H, Kahrom M, Kahrom H. Long-term outcome of Rives-Stoppa technique in complex ventral incisional hernia repair. *World J Surg*. 2010 Jul;34(7):1696-701.
- [35]. Yaghoobi Notash A, Yaghoobi Notash A Jr, SeiedFarshi J, Ahmadi Amoli H, Salimi J, Mamarabadi M. Outcomes of the Rives-Stoppa technique in incisional hernia repair: ten years of experience. *Hernia*. 2007 Feb;11(1):25-9.
- [36]. Schumpelick V, Junge K, Rosch R, Klinge U, Stumpf M. Retromuskuläre Netzplastik in Deutschland [Retromuscular mesh repair for ventral incision hernia in Germany]. *Chirurg*. 2002 Sep;73(9):888-94. German.
- [37]. Berry MF, Paisley S, Low DW, Rosato EF. Repair of large complex recurrent incisional hernias with retromuscular mesh and panniculectomy. *Am J Surg*. 2007 Aug;194(2):199-204.

- [38]. Gleysteen JJ. Mesh-Reinforced Ventral Hernia Repair: Preference for 2 Techniques. *Arch Surg*. 2009;144(8):740–745.
- [39]. Novitsky YW, Porter JR, Rucho ZC, Getz SB, Pratt BL, Kercher KW, Heniford BT. Open preperitoneal retrofascial mesh repair for multiply recurrent ventral incisional hernias. *J Am Coll Surg*. 2006 Sep;203(3):283-9.
- [40]. Temudom T, Siadati M, Sarr MG. Repair of complex giant or recurrent ventral hernias by using tension-free intraparietal prosthetic mesh (Stoppa technique): lessons learned from our initial experience (fifty patients). *Surgery*. 1996 Oct;120(4):738–43; discussion 743–4.
- [41]. Sakorafas GH, Sarr MG. Intraparietal retrorectus tension-free prosthetic mesh: a simple and effective method of repair of complex ventral hernias via a modified Stoppa technique. *Surgical technique. Acta Chir Belg*. 1999 May-Jun;99(3):109-12.
- [42]. Albino FP, Patel KM, Nahabedian MY, Sosin M, Attinger CE, Bhanot P. Does mesh location matter in abdominal wall reconstruction? A systematic review of the literature and a summary of recommendations. *Plast Reconstr Surg*. 2013 Nov;132(5):1295-1304.
- [43]. Sosin M, Nahabedian MY, Bhanot P. The Perfect Plane: A Systematic Review of Mesh Location and Outcomes, Update 2018. *Plast Reconstr Surg*. 2018 Sep;142(3 Suppl):107S-116S.
- [44]. Vagholkar K. Retro rectus mesh repair for umbilical hernia in adults: a study of 50 cases. *Int Surg J* 2020;7:49-53.
- [45]. Lasheen AE. Mesh expansion and fixation at the retro-rectus plane through multiple stabs by using two tip hole needles in midline hernias repair. A prospective study. *Int J Surg*. 2008; 6(5): 367-70.
- [46]. Etemad SA, Huang LC, Phillips S, Stewart TG, Pierce RA, Schneeberger SJ, Poulouse BK. Advantages of a Fixation-Free Technique for Open Retromuscular Ventral Hernia Repair. *Plast Reconstr Surg*. 2020 Oct;146(4):883-890.
- [47]. Dumanian GA. Discussion: Advantages of a Fixation-Free Technique for Open Retromuscular Ventral Hernia Repair. *Plast Reconstr Surg*. 2020 Oct;146(4):891-892.
- [48]. Alkhayat MM, Saleh HA, Nassar MN, El-Balshy MA. Evaluation of retro muscular mesh repair technique for treatment of ventral hernia. *International Surgery Journal*. 2018 Jan 25;5(2):364-7.
- [49]. Rogmark, P., Smedberg, S. & Montgomery, A. Long-Term Follow-Up of Retromuscular Incisional Hernia Repairs: Recurrence and Quality of Life. *World J Surg* 42, 974–980 (2018).
- [50]. Martín-Duce A, Noguerales F, Vileta R, Hernández P, Lozano O, Keller J, Granell J. Modifications to Rives technique for midline incisional hernia repair. *Hernia*. 2001 Jun;5(2):70-2.
- [51]. Masati, Bledi&Haxhiu, Asfloral&Dhima, Marsel&Punmira, Tomi &Zikaj, Gentian & Ibrahim, Alfred &Dogjani, Agron. (2024). The Benefit of Open Rives-Stoppa Procedure in Complex Incisional Hernia.. *Albanian Journal of Trauma and Emergency Surgery*. 8. 1371-1376.
- [52]. Ali, Ayman M.A. MD; Khalil, Magdy. Ventral hernias meshplasty: does mesh-implantation site affect the outcome?. *The Egyptian Journal of Surgery* 36(1):p 69-75, Jan–Mar 2017.
- [53]. Weltz AS, Sibia US, Zahiri HR, Schoeneborn A, Park A, Belyansky I. Operative Outcomes after Open Abdominal Wall Reconstruction with Retromuscular Mesh Fixation Using Fibrin Glue versus Transfascial Sutures. *The American Surgeon* TM. 2017;83(9):937-942.
- [54]. Bashian, Elizabeth MD1; Daoud, Georges MD1; Khansa, Ibrahim MD1,2,3; Janis, Jeffrey E. MD1,2. Abdominal Wall Reconstruction with Retrorectus Self-Adhering Mesh: A Single-Center Long-Term Follow-Up. *Plastic and Reconstructive Surgery* 151(3):p 646-650, March 2023.
- [55]. Albino, Frank P. M.D.; Patel, Ketan M. M.D.; Nahabedian, Maurice Y. M.D.; Sosin, Michael M.D.; Attinger, Christopher E. M.D.; Bhanot, Parag M.D.. Does Mesh Location Matter in Abdominal Wall Reconstruction? A Systematic Review of the Literature and a Summary of Recommendations. *Plastic and Reconstructive Surgery* 132(5):p 1295-1304, November 2013.
- [56]. Morris, Martin P. M.B.E.; Patel, Viren B.S.; Christopher, Adrienne N. M.D.; Broach, Robyn Ph.D.; Harbison, Sean P. M.D.; Fischer, John P. M.D., M.P.H.. Three-Year Clinical Outcomes and Quality of Life after Retromuscular Resorbable Mesh Repair Using Fibrin Glue. *Plastic and Reconstructive Surgery* 149(6):p 1440-1447, June 2022.
- [57]. Hartog, Floris P. J. den MD*; Sneyders, Dimitri MD, PhD*; Darwish, Es F. MD*; Yurtkap, Yağmur MD, PhD*; Menon, Anand G. MD, PhD†; Muysoms, Filip E. MD, PhD†; Kleinrensink, Gert-Jan PhD§; Bouvy, Nicole D. MD, PhD¶; Jeekel, Johannes MD, PhD§; Lange, Johan F. MD, PhD*. Favorable Outcomes After Retro-Rectus (Rives-Stoppa) Mesh Repair as Treatment for Noncomplex Ventral Abdominal Wall Hernia, a Systematic Review and Meta-analysis. *Annals of Surgery* 276(1):p 55-65, July 2022.
- [58]. Baig, S.J., Afaq, M.Y., Priya, P. *et al*. Practice and short-term outcomes in ventral hernia repair: a prospective multicenter data audit of Indian Association of Gastrointestinal Endo Surgeons Research Collaborative. *Hernia* 26, 1573–1581 (2022).
- [59]. McLanahan, D., King, L.T., Weems, C., Novotney, M. and Gibson, K. (1997) Retrorectus prosthetic mesh repair of midline abdominal hernia. *Am J Surg*, 173, 445–449.
- [60]. Nau, P. , J. Clark, C. , Fisher, M. , Walker, G. , Needleman, B. , Ellison, E. and Muscarella, P. (2010) Modified rives-stoppa repair for abdominal incisional hernias. *Health*, 2, 162-169.