

A Comparative Study of Surgical Outcomes Following Onlay and Underlay Repairs for Ventral Hernias

JOSEPH MATHEW¹, V SHASHIKALA², N ARUN KUMAR³

ABSTRACT

Introduction: Today, a variety of procedures are available for ventral hernia repair. Prosthetic reinforcement is necessary in all but the smallest of hernias to reduce recurrence rates. However, the ideal site of mesh placement for better outcomes in open repair has not been established in literature.

Aim: To compare onlay and underlay (either retrorectal or preperitoneal) techniques in adults, with respect to operative parameters and treatment outcomes, and to determine the associated prognostic factors.

Materials and Methods: This prospective, observational study was conducted from January 2012 to January 2015 at Bangalore Medical College and Research Institute; 199 patients with midline ventral hernias (primary or following first recurrence) with defect size less than 10cm and scheduled to undergo mesh repair were selected. Demographic data, relevant comorbidities, body mass indices and hernia characteristics were noted preoperatively. Type of repair was decided by the attending surgeon based on clinical judgement. Operating time, post-operative pain, wound-related complications and duration of hospitalization were recorded. Patients were followed-up for two years to detect recurrence. Statistical analysis was performed using one way-ANOVA to compare means and Chi-square test, to determine

association between categorical variables. p-value <0.05 was considered statistically significant.

Results: Mean age at presentation was 44.3±12.90years. Females comprised 77.9% of cases. Primary hernias constituted 66.3%. Mean follow-up period was 15.9±8.39months. Onlay repair was performed in 56.3% whereas retrorectal and preperitoneal in 22.6% and 21.1% cases, respectively. Significantly shorter operating time (in minutes) was noted with onlay (48.8±8.63) compared to retrorectal (59.0±15.47) and preperitoneal (64.5±16.00) repairs (p<0.001). Differences in pain scores were not statistically significant. Incidence of surgical site occurrences (SSO) and length of hospitalization were significantly higher with onlay repair (p-values 0.005 and <0.001, respectively). Statistical significance was not evident when comparing recurrence rates at 1year follow-up. Obesity, diabetes and previous surgery were associated with significantly higher SSO rates, pain scores and duration of hospital stay.

Conclusion: Compared to onlay, underlay repairs have significantly lower wound-related complications and may be considered the procedure of choice over other open techniques for small, uncomplicated ventral hernias. Obesity, diabetes and prior surgery are important risk factors adversely affecting surgical outcomes.

Keywords: Onlay repair, Risk factors, Wound complications

INTRODUCTION

Hernia repairs account for over 20 million operations performed annually and is considered one of the most frequently undertaken surgical procedures across the world today [1].

Hernias of the anterior abdominal wall or ventral hernias are abnormal protrusions of viscera or preperitoneal contents, through congenital or acquired defects in the fascia or musculature of the parietal abdominal wall [2]. They occur in 0.5-1% of the population [3]. Midline ventral hernias constitute approximately 20% of all abdominal wall hernias; they may be primary or secondary [4]. The former include umbilical, paraumbilical and epigastric hernias [2].

Generally, ventral hernias arise secondary to increased intra-abdominal pressure in the setting of obesity, multiparity or ascites [5]. In addition, defective primary wound healing, surgical site infection, malnutrition, multiple procedures and technical errors contribute in the development of incisional hernias [2,6].

Most, if not all, ventral hernias require surgery as they tend to enlarge over time and may develop complications such as incarceration, obstruction or strangulation resulting in considerable morbidity and mortality [5,7].

Experience with primary tissue repair revealed a lower incidence

of wound-related complications, however, recurrence rates (ranging from 15-40%), were unacceptably high [8]. Introduction of prosthetic repairs have substantially reduced recurrence rates when compared to primary tissue approximation and are indicated in all but the smallest of ventral hernias [9,10]. However, higher rates of wound-related complications and chronic pain have been observed in this group [8,11]. Laparoscopic ventral hernia repair combines the advantages of these two techniques.

Today, a number of options exist with regard to operative approach, type of prosthesis and anatomical plane of placement. Position of the mesh influences the tissue reaction and subsequent ingrowth affecting tensile strength in the long-term [12-14]. Implantation of the mesh on the anterior rectus sheath over the defect is termed onlay repair whereas, inlay repair bridges the defect using a mesh sutured to the aponeurotic edges of the rectus sheath. Underlay repairs involve positioning the mesh below the defect, either deep to the rectus abdominis (retrorectal), in the preperitoneal space (preperitoneal) or in the peritoneal cavity (intraperitoneal) [3,15].

Presently, data regarding the superiority of one technique over the other is conflicting and inconclusive. There is no universal consensus regarding indications for surgery, optimal approach, most appropriate method of repair, need for a prosthesis, ideal

material and location of placement.

This study sought to identify the clinical patterns of presentation of ventral hernias in adults, compare the commonly performed open repairs with regard to operating time, pain, wound-related complications, duration of hospital stay and recurrence, and determine the factors influencing these outcomes.

MATERIALS AND METHODS

This prospective, observational study was undertaken at Bangalore Medical College and Research Institute from January 2012 to January 2015. A total of 199 cases were eligible for inclusion into the study.

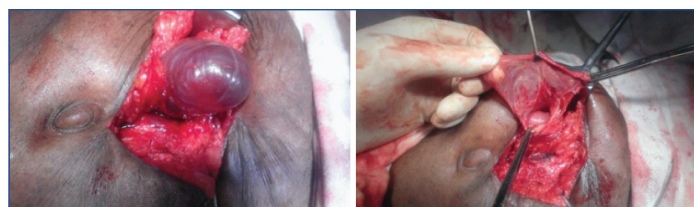
For subject selection, we utilized the ventral hernia staging system which stratifies ventral hernias into three stages, based on width of the defect and wound class [16]. Patients over the age of 18 years diagnosed with stage one midline ventral hernias (defect size <10cm and no contamination) and meriting prosthetic repair, were included. These hernias could either be primary or following first recurrence.

Small hernias meriting anatomical repair, large hernias with loss of abdominal domain requiring alternative methods of repair, complicated (obstructed or strangulated) hernias precluding mesh repair, and hernias recurring after mesh repair were excluded. Patients with signs of infection or who were seriously ill (ASA 4 and 5) and patients unwilling to give informed consent were also excluded.

Demographic data, presence of relevant comorbidities and treatment history were recorded. Body Mass Indices (BMI) were calculated and grouped according to the Revised Consensus Guidelines for India with obesity defined as a BMI $\geq 25\text{kg/m}^2$ [17]. Prior to surgery, patients underwent ultrasonogram to assess the number, size and location of defects and to rule out any concurrent abdominal pathology precluding the use of a mesh.

Antimicrobial prophylaxis was administered and surgery was performed under spinal or general anaesthesia. Epidural catheterisation was used when indicated for postoperative analgesia.

Procedures were performed by experienced general surgeons. Intraoperatively, hernia sac was identified, adhesions released, contents reduced and the peritoneum closed [Table/Fig-1]. The repair was completed by primarily approximating the defect without tension and reinforcing the same with an artificial prosthesis, placed either onlay, retrorectus or in the preperitoneal space, the latter two constituting underlay repairs [Table/Fig-2]. A lightweight macroporous polypropylene mesh permitting overlap of at least 4 cm from fascial margin in all directions was used. Care was taken to avoid contact with underlying viscera. Closed suction drains were placed when indicated and removed when the output was under 20 ml. Total time taken for surgery was documented.



[Table/Fig-1]: Intraoperative picture showing hernial sac, a) in a case of incarcerated incisional hernia, which had formed a hydrocele of the sac; b) After the sac was opened.



[Table/Fig-2]: Schematic diagram of the anterior abdominal wall and position of mesh placement in the respective repairs.

Pain was assessed on the fifth postoperative day using a visual analogue scale (VAS) ranging from 0 (no pain) to 10 (unbearable pain). Surgical Site Occurrences (SSO) in the early postoperative period was noted. Before discharge, all patients were counselled regarding follow up for a minimum period of two years.

STATISTICAL ANALYSIS

Data was entered in Excel software and analysed using R software version 3.2.2. Continuous variables were presented as mean and Standard Deviation (SD) and categorical variables as count and per cent. To compare means of more than two groups, One-way ANOVA was used. Chi-square test was used to determine the association between categorical variables, and when expected cell count was less than five, Fisher's-exact test was used. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 199 cases were studied. Age of the patients ranged from 18–85 years with a mean age of 44.3 years (SD \pm 12.90). Statistically significant difference ($p < 0.001$) was noted on comparing mean age at presentation of primary (41.7 years, SD \pm 11.33) and secondary (49.4 years, SD \pm 14.30) ventral hernias.

Overall, 22.1% (n=44) were male and 77.9% (n=155) were female. Primary and secondary hernias were equally distributed between both the genders.

Most patients were asymptomatic apart from the swelling (n=164, 82.4%). Only 17.6% complained of pain associated with swelling.

Mean BMI of the study population was 24.4kg/m² (range 20.2–30.6kg/m²; SD \pm 2.08kg/m²). Normal BMI (18.5–22.9kg/m²) was observed in 29.6%, 45.7% were overweight (23.0–24.9kg/m²) and 24.6% were obese ($\geq 25\text{kg/m}^2$).

The average diameter of the hernial defects was 3.8cm (range 2.2–6.0cm; SD \pm 0.76cm). Incisional hernias were noted to have significantly larger defects (4.6cm) when compared to primary ventral hernias ($p < 0.001$).

The majority of ventral hernias were primary (n=132, 66.3%); incisional hernias constituted the remaining 33.7%. Gynaecological procedures (n=45; 22.6%) were the most common preliminary operation that these patients had undergone. Others included laparotomies (6.5%) and ventral hernia repairs (4.5%).

The different surgical modalities of repair performed with respect to hernia type are shown in [Table/Fig-3]. Overall, onlay repair was the most commonly performed procedure (56.3%). Retrorectal and preperitoneal repairs constituted 22.6% and 21.1% of repairs, respectively. There was no significant difference in age, sex, presence of comorbidities, BMI, hernia type or defect size between the repair groups.

Mean operative time, pain scores, incidence of SSO and duration of hospital stay for the various operative groups are given in [Table/Fig-4]. A significant difference in time taken for surgery ($p < 0.001$) was noted when comparing retrorectal (59.0min; SD \pm 15.47min) and preperitoneal (64.5min; SD \pm 16.00min) repairs with onlay repair (48.8min; SD \pm 8.63min), whereas difference between retrorectal and preperitoneal repairs was not ($p = 0.091$). There was no significant difference in pain scores between the treatment groups ($p = 0.571$) even after excluding potentially confounding factors such as SSO ($p = 0.492$).

A significantly higher incidence of SSO was observed in the onlay repair group ($p = 0.005$). This was due to significant increase in incidence of seroma formation ($p = 0.048$) and surgical site infection ($p = 0.05$). Differences in haematoma formation were insignificant between the groups ($p = 0.872$). A significantly longer duration of hospital stay was noted in the onlay group ($p < 0.001$).

Females were significantly more likely to develop surgical site

		Type of Repair Performed			p-value
		Onlay	Retrorectal	Preperitoneal	
N		112	45	42	
Age of the Patient (in years)		45.2 (±13.12)	45.2 (±13.48)	41.0 (±11.35)	0.176
Age Distribution (in years)	<30	15 (13.4%)	6 (13.3%)	7 (16.7%)	0.725
	31-40	33 (29.5%)	15 (33.3%)	18 (42.9%)	
	41-50	28 (25.0%)	10 (22.2%)	9 (21.4%)	
	51-60	22 (19.6%)	9 (20.0%)	4 (9.5%)	
	>60	14 (12.5%)	5 (11.1%)	4 (9.5%)	
Sex of the Patients	M	28 (25.0%)	8 (17.8%)	8 (19.1%)	0.532
	F	84 (75.0%)	37 (82.2%)	34 (81.0%)	
Body Mass Index (kg/m ²)		24.5 (±2.38)	24.3 (±1.75)	24.4 (±1.53)	0.735
Type of Hernia	Epigastric	5 (4.7%)	3 (6.7%)	4 (9.5%)	0.771
	Paraumbilical	35 (31.3%)	14 (31.1%)	17 (40.5%)	
	Umbilical	32 (28.6%)	13 (28.9%)	9 (21.4%)	
	Incisional	40 (35.7%)	15 (33.3%)	12 (28.6%)	
Size of the Defect (in cm)		3.9 (±0.82)	3.8 (±0.68)	3.7 (±0.67)	0.388
Comorbidities	Diabetes	13 (11.6%)	3 (6.7%)	0	0.057
	Hypothyroidism	1 (0.9%)	1 (2.2%)	2 (4.8%)	0.311
	COPD	2 (1.8%)	2 (4.4%)	2 (4.8%)	0.514
	Hypertension	4 (3.6%)	3 (6.7%)	0	0.241

[Table/Fig-3]: Demographic features and types of hernia with respect to the different surgical modalities of repair performed.

*Independent Student t-test for continuous variables and Chi-square test for categorical variables were used to test statistical significance. $p < 0.05$ was considered statistically significant.

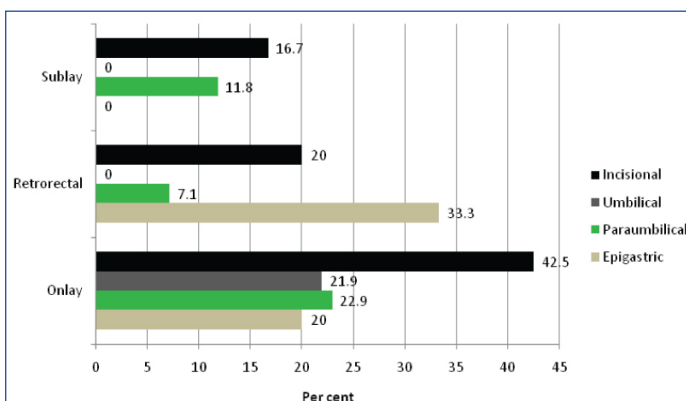
		Type of Repair Performed			p-value
		Onlay	Retrorectal	Preperitoneal	
N		112	45	42	
Operating Time (in minutes)		48.8 (±8.63)	59.0 (±15.47)	64.5 (±16.00)	<0.001
Drain insertion		95 (84.8%)	21 (46.7%)	16 (38.1%)	<0.001
Pain Score on Day 5		3.5 (±1.07)	3.1 (±0.83)	3.3 (±0.91)	0.571
Complications	SSO*	33 (29.5%)	5 (11.1%)	4 (9.5%)	0.005
	Seroma	15 (13.4%)	1 (2.2%)	2 (4.8%)	0.048
	Haematoma	4 (3.6%)	2 (4.4%)	1 (2.4%)	0.872
	SSI**	15 (13.4%)	2 (4.4%)	1 (2.4%)	0.050
Hospital Stay (in days)		6.0 (±1.81)	4.5 (±1.75)	4.4 (±1.58)	<0.001
Follow-up Period (in months)		16.2 (±8.30)	16.4 (±7.69)	14.7 (±9.39)	0.580
Recurrence (as % of N)		12 (10.7%)	1 (2.2%)	2 (4.8%)	0.142
Mean Time before Recurrence (in months)		13.0 (±3.69)	18.0 (-)	22.5 (±2.12)	0.012
Recurrence Range (in months)		6-18	-	21-24	

[Table/Fig-4]: The different modalities of repair performed and their surgical outcomes.

*SSO – Surgical Site Occurrences

**SSI – Surgical Site Infections

Independent Student t-test for continuous variables and Chi-square test for categorical variables were used to test statistical significance. $p < 0.05$ was considered statistically significant.



[Table/Fig-5]: Surgical Site Occurrences for the types of surgery and types of hernia.

infection ($p=0.009$) but, not seromas or haematomas. Obesity was associated with significantly longer operating times ($p=0.01$), higher

incidence of SSO excluding haematoma formation ($p<0.001$), postoperative pain ($p<0.001$) and duration of hospitalization ($p<0.001$). In diabetics, risk of seroma formation ($p=0.043$) and SSI ($p=0.008$), pain ($p=0.011$) and prolonged hospital stay ($p<0.001$) was significantly more.

Incisional hernia repair, irrespective of the type of surgical modality used, was associated with significantly longer operating time ($p<0.001$), greater pain scores ($p=0.005$), SSO rates ($p=0.035$) and duration of hospital stay ($p<0.001$) [Table/Fig-5].

Mean follow-up period was 15.9 months (range 3–36 months; $SD\pm 8.39$ months). During this period, 15 patients (7.5%) developed recurrence.

DISCUSSION

Ventral hernias represent a heterogeneous variety of entities, each with unique clinical and pathophysiological characteristics. The tendency to affect individuals irrespective of age, gender and ethnicity, frequently in the setting of multiple comorbidities, their negative impact on quality of life and the considerable morbidity and mortality associated with complications, necessitate a comprehensive understanding of these conditions.

In this study, most ventral hernias were noted to arise in the economically productive age group of 31-50 years which is comparable with existing literature [18,19]. This has far-reaching implications, especially in developing countries, wherein disease-related morbidity and negative surgical outcomes add to healthcare costs and overall economic burden, adversely affecting productivity and quality of life. Moreover, age over 80 years has been observed to be an independent predictor of overall morbidity and mortality following repair [20].

Although, a female predominance was observed, this distribution was not significant with regard to hernia type. These results are in agreement with present data [21,22]. Although, older literature suggests a significantly higher prevalence of umbilical and incisional hernias in females and epigastric hernias in males, analyses of current data on ventral hernias reveal a growing trend towards male predominance [5]. An increasing incidence of obesity in men, reduced parity in women and a longer life expectancy are possible explanations [4].

Lack of a unifying, comprehensive hernia classification system has hindered advances in our understanding of these diverse disorders. The European Hernia Society classification and, more recently, the ventral hernia staging system are attempts in this direction [16,23]. Stratifying these hernias based on factors affecting surgical outcomes permits comparison between treatment options. In this study, no significant difference in age, gender, presence of major comorbidities, ventral hernia type or defect size was noted between the repair groups, ensuring comparability.

Among the operative parameters considered, mean operative time was significantly lower in the onlay group. This is in agreement with current literature: creation of subcutaneous planes in onlay repair entails less time compared to the extensive dissection associated with underlay repairs [22,24]. There was no significant difference in time taken for retrorectal and preperitoneal repairs.

Pain scores calculated on the fifth postoperative day were not significant between the groups. Due to the frequent use of preemptive anaesthesia in the study population, pain severity was not assessed earlier. Currently, data regarding pain outcomes are conflicting [9,19]. Extent of dissection involved in underlay repairs has been cited as the cause of higher pain scores in this group. However, extensive tissue undermining and the resulting devitalization of tissues and wound-related complications can be a cause for pain in patients undergoing onlay repair [18].

The term SSO was coined by the Ventral Hernia Working Group, and encompasses all perioperative wound events including infection

(cellulitis and SSI), sterile fluid collections (seromas and haematomas), wound dehiscence, and enterocutaneous fistulae [25].

Seromas are common complications following ventral hernia repair. The incidence varies in literature with studies quoting figures of 14% for onlay and 2% for underlay [26,27]. Although the majority resolves spontaneously, 30-35% may be symptomatic, requiring percutaneous aspiration [28]. Compression dressings in the immediate postoperative period are known to reduce seroma incidence.

Skin necrosis is a complication almost unique to onlay repairs. Extensive tissue handling involved in flap dissection has been known to disrupt perforating vessels, compromising the vascularity of overlying skin. Excision of necrosed margins and serial debridement under antibiotic cover facilitates closure by secondary intention [29].

SSI rates range from 7-13% for onlay and 4-11% for underlay [19,26,27]. Incidence of mesh infection in ventral hernia repair has been reported to be under 1%, with older age, obesity and diabetes being recognized risk factors [28,30]. Macroporous prostheses are associated with lesser infection rates and increased mesh salvage rates in open repair [31].

In this study, a significantly higher SSO rate, specifically regarding seroma formation and SSI, were observed in the onlay group. These results are in accordance with other studies [15,22].

Most surgical site infections were superficial and resolved with antibiotics, percutaneous drainage and regular dressing. In the onlay group, one case of deep SSI was encountered which responded to conservative management and did not require mesh removal.

Skin necrosis was noted in five patients in the onlay group. There was no evidence of fistula formation in any of the patients in the postoperative period. Duration of hospital stay was reflective of the incidence of early postoperative complications and response to treatment.

Generally, recurrence rates tend to be lower with underlay (0-5%) compared to onlay repairs (12-15%) [19,27]. However, these figures are highly variable and depend on patient age, presence of risk factors, type of hernia, and history of prior repair. Surgery-related factors include choice of improperly sized prostheses, inadequate overlap of the fascial margins and failure to identify and correct occult hernias [28]. Longer periods of follow-up are advantageous in determining the true efficacy of a surgical repair. In a prospective study, 67% of recurrences following open repair occurred within one year of surgery and 77% within the second year [21].

Recurrence was observed in 15 patients of whom 12 had undergone onlay repair. Of these, six recurred within one year and the rest within two years. Incidence could not be calculated for this study as a significant proportion of patients were lost to follow-up. Loss of $\geq 20\%$ has been shown to reduce the validity of observed results in prospective studies [32].

Retrorectal and preperitoneal repairs were similar with respect to operative parameters and surgical outcomes. These findings suggest that the ideal position for prosthesis placement is underlay (either retrorectal or preperitoneal). Onlay involves extensive tissue undermining and superficial mesh placement (facilitating bacterial colonization), which results in higher SSO rates. Moreover, pressure required to dislodge the mesh from an onlay position is less when compared to underlay (Pascal's law), predisposing for higher recurrence rates [7]. Depth of the retrorectal space and greater vascularity accelerate tissue ingrowth, preventing infection [12,33].

Nevertheless, onlay repair may be one of the few options available in cases where multiple previous surgeries or a hostile abdomen preclude retrorectal or preperitoneal dissection. Moreover, the procedure is simple, operative time shorter and direct contact with the bowel is avoided, aspects which prove advantageous especially in elderly and seriously ill patients [7].

Prevention by controlling modifiable risk factors has assumed greater importance in recent times.

A number of co-morbid conditions can predispose to ventral hernia formation and influence surgical outcomes. Foremost among these are advanced age, obesity, chronic pulmonary disease, diabetes mellitus, ascites and multiparity [5,34]. These conditions coupled with a history of multiple procedures, wound infection and impaired healing give rise to incisional hernias [2,6].

Obesity has been implicated in a number of studies both as a risk factor for hernia occurrence as well as for recurrence after repair. Excessive fat deposition raises the intra-abdominal pressure, separates muscle bundles and weakens aponeurosis. Obese individuals are also at higher risk of developing cardiopulmonary, surgical site and mesh-related complications and chronic pain in the postoperative period [35]. Poor vascularity, impaired wound healing and altered biomechanics are likely explanations [36]. Weight reduction prior to surgery has been shown to minimize procedure-related morbidity in the short-term as well as decrease recurrence rates. All patients undergoing hernia repair should be counselled regarding the potential complications associated with obesity [37]. Laparoscopic hernia repair is an accepted alternative in this subset of patients [35,36,38].

In this study, obesity and diabetes were associated with significantly higher incidence of SSO, seroma formation and SSI possibly accounting for the higher postoperative pain scores, duration of hospital stay and recurrence rates observed in these patients. Obesity and diabetes as significant predictors of morbidity in patients undergoing elective repair have been observed in multiple studies [34,39].

Incisional hernia repairs had significantly longer operating time, more postoperative pain, wound-related complications and duration of hospitalization, irrespective of surgical technique. Eleven of the 15 patients who developed recurrence had been operated for incisional hernia. Significantly greater age and larger defect size compared to primary hernias could explain these findings. Thus, prior surgery can be considered a negative prognostic factor in terms of surgical outcomes. Sound surgical technique and the use of a 4:1 suture-to-wound length ratio have been shown to significantly reduce incidence of incisional hernias [40]. Its relevance, especially in other surgical specialties, is evident in this study wherein 67.2% of incisional hernias were secondary to gynaecological procedures [19].

Thus, a one-size-fits-all approach to patients with ventral hernias may not suffice in achieving desired results. Relevant procedure-related factors including optimal anatomical approach need for prosthesis, the ideal material and the location for placement need to be considered.

Patient-related factors which have a bearing on surgical outcomes include age, presence of comorbidities, and history of prior repairs, hernia characteristics and presence of complications.

Outcomes fall below expectations when all factors are not taken into consideration.

The reconstructive options for ventral hernias are diverse. The surgeon should be familiar with several techniques and tailor the procedure according to patient-specific requirements.

LIMITATION

A limitation of this study was the variable follow-up period. A significant proportion of our patients were lost to follow-up. Incidence of chronic pain and impact on quality of life were not assessed.

CONCLUSION

Today, prosthetic repairs have significantly reduced recurrence rates when compared to primary tissue repairs and are indicated in all but the smallest of ventral hernias. In this study, underlay repair was

associated with significantly lower wound-related complications compared to onlay repair. Obesity, diabetes and previous surgery were important risk factors adversely affecting surgical outcomes. Thus, in the setting of small, uncomplicated ventral hernias, the underlay repair, with acceptable SSO and recurrence rates, may be considered the procedure of choice compared to other open techniques. However, a one-size-fits-all approach cannot be applied to all patients with ventral hernias. An in-depth knowledge of the various surgical options, approaches and meshes available matched by a thorough understanding of patient comorbidities and hernia characteristics is crucial in selecting the right operation for the right patient and achieving satisfactory surgical outcomes.

REFERENCES

- [1] Kingsnorth A, LeBlanc K. Hernias: Inguinal and Incisional. *Lancet*. 2003;362(9395):1561-71.
- [2] Seymour NE, Bell RL. Abdominal Wall, Omentum, Mesentery and Retroperitoneum. In: Brunicaardi FC, et al (eds). *Schwartz's Principles Of Surgery*. 10th Ed. New York: McGraw-Hill Education; 2015.p 1454-1456.
- [3] Punjani R, Shaikh I, Soni V. Component Separation Technique: an Effective Way of Treating Large Ventral Hernia. *Indian J Surg*. 2015;77(3):1476-1479.
- [4] Dabbas N, Adams K, Pearson K, Royle G. Frequency of abdominal wall hernias: is classical teaching out of date? *JRSM Short Reports*. 2011;2(1):5.
- [5] Malangoni MA, Rosen MJ. Hernias. In: Townsend Jr CM, Beauchamp RD, Evers BM, Mattox KL (eds). *Sabiston Textbook of Surgery. The Biological Basis of Modern Surgical Practice*. 20th Ed. Philadelphia, PA: Saunders Elsevier; 2017.p 1109-10.
- [6] Hesselink VJ, Luijendijk RW, de Wilt JHW, Heide R. An evaluation of risk factors in incisional hernia recurrence. *Surg Gynaecol Obstet*. 1993;176(3):228-34.
- [7] Chien JS, Tsai PJ, Liu KY, Wang S, Shyr YM, Su CH, et al. Open Suture Repair and Open Onlay Technique for Incisional Hernia in Elderly Patients with Multiple Comorbidities. *IJAST*. 2011;1(3):34-40.
- [8] Mathes T, Walgenbach M, Siegel R. Suture Versus Mesh Repair in Primary and Incisional Ventral Hernias: A Systematic Review and Meta-Analysis. *World J Surg*. 2016;40(4):826-35.
- [9] Burger JW, Luijendijk RW, Hop WC, Halm JA, Verdaasdonk EG, Jeekel J. Long-term follow-up of a randomized controlled trial of suture versus mesh repair of incisional hernia. *Ann Surg*. 2004;240(4):578-585.
- [10] Aslani N, Brown CJ. Does mesh offer an advantage over tissue in the open repair of umbilical hernias? A systematic review and meta-analysis. *Hernia*. 2010;14(5):455-462.
- [11] Nguyen MT, Berger RL, Hicks SC, Davila JA, Li LT, Kao LS, et al. Comparison of outcomes of synthetic mesh vs suture repair of elective primary ventral herniorrhaphy: A systematic review and meta-analysis. *JAMA Surg*. 2014;149(5):415-21.
- [12] Conze J, Binnebosel M, Junge K, Schumpelick V. Incisional hernia – how do I do it? Standard surgical approach (in German). *Chirurg*. 2010;81(3):192-200.
- [13] Binnebosel M, Klink CD, Otto J, Conze J, Jansen PL, Anurov M, et al. Impact of mesh positioning on foreign body reaction and collagenous ingrowth in a rabbit model of open incisional hernia repair. *Hernia*. 2010;14(1):71-77.
- [14] Johansson M, Gunnarsson U, Strigard K. Different techniques for mesh application give the same abdominal muscle strength. *Hernia*. 2011;15(1):65-68.
- [15] deVries Reilingh TS, van Geldere D, Langenhorst B, de Jong D, van der Wilt GJ, van Goor H, et al. Repair of large midline incisional hernias with polypropylene mesh: comparison of three operative techniques. *Hernia*. 2004;8(1):56-59.
- [16] Petro CC, O'Rourke CP, Posielski NM, Criss CN, Raigani S, Prabhu AS, et al. Designing a ventral hernia staging system. *Hernia*. 2016;20(1):111-7.
- [17] Misra A, Chowbey P, Makkar BM, Vikram NK, Wasir JS, Chadha D, et al. Consensus statement for diagnosis of obesity, abdominal obesity and the metabolic syndrome for Asian Indians and recommendations for physical activity, medical and surgical management. *J Assoc Physicians India*. 2009;57:163-70
- [18] Saber A, Al-Masry AR. Pattern of Wound Complications and Postoperative Pain in Sublay versus Onlay Mesh Repair for Ventral Hernia. *Journal of Surgery. Special Issue: Abdominal Surgery: Toward the Best*. 2016;4(1-1):19-23.
- [19] Kumar V, Rodrigues G, Ravi C, Kumar S. A comparative analysis on various techniques of incisional hernia repair – experience from a tertiary care teaching hospital in South India. *Indian J Surg*. 2013;75(4):271-273.
- [20] Spaniolas K, Trus TL, Adrales GL. Ventral hernia repairs in the oldest-old: high-risk regardless of approach. *Surg Endosc*. 2014;28(4):1230-7.
- [21] Singhal V, Szeto P, VanderMeer TJ, Cagir B. Ventral Hernia Repair: Outcomes Change with Long-Term Follow-Up. *JLSL*. 2012;16:373-379
- [22] Demetrashvili Z, Pipia I, Loladze D, Metreveli T, Ekaladze E, Kenchadze G, et al. Open retromuscular mesh repair versus onlay technique of incisional hernia: A randomized controlled trial. *Int J Surg*. 2017;37:65-70.
- [23] Muysoms F, Miserez M, Berrevoet F, Campanelli G, Champault GG, Chelala E, et al. Classification of primary and incisional abdominal wall hernias. *Hernia*. 2009;13(4):407-414.
- [24] den Hartog D, Dur AH, Tuinerbreijer WE, Kreis RW. Open surgical procedures for incisional hernias. *Cochrane Database Syst. Rev*. 2008;16:CD 006438.
- [25] Ventral Hernia Working Group, Breuing K, Butler CE, Ferzoco S, Franz M, Hultman CS, et al. Incisional ventral hernias: Review of the literature and recommendations regarding the grading and technique of repair. *Surgery*. 2010;148(3):544-58.
- [26] Machairas A, Misiakos EP, Liakakos T, Karatzas G. Incisional hernioplasty with extraperitoneal onlay polyester mesh. *Am Surg*. 2004;70(8):726-729
- [27] Hameed F, Ahmed B, Ahmed A, Dab RH, Dilawaiz M. Incisional hernia repair by preperitoneal (sublay) mesh implantation. *APMC*. 2009;3:27-31
- [28] Misiakos EP, Patapis P, Zavras N, Tzanetis P, Machairas A. Current Trends in Laparoscopic Ventral Hernia Repair. *JLSL*. 2015;19(3).pii:e2015.00048.
- [29] Bougard H, Coolen D, deBeer R, Folscher D, Kloppers JC, Koto MZ et al. HIG (SA) Guidelines for the Management of Ventral Hernias. *S. Afr. J. Surg*. 2016;54(4):s1-s32.
- [30] Forbes S, Eskicioglu C, McLeod R, Okrainec A. Metaanalysis of randomized controlled trials comparing open and laparoscopic ventral and incisional hernia repair with mesh. *Br J Surg*. 2009;96(8):851-858.
- [31] Brown RH, Subramanian A, Hwang CS, Chang S, Awad SS. Comparison of infectious complications with synthetic mesh in ventral hernia repair. *Am J Surg*. 2013;205(2):182-187.
- [32] Sackett DL, Strauss SE, Richardson WS, Rosenberg WMC, Haynes RB (eds). *Evidence based medicine: How to practice and teach EBM*. 2nd Ed. Edinburgh: Churchill Livingstone; 2000.
- [33] Cobb WS, Warren JA, Ewing JA, Burmkel A, Merchant M, Carbonell AM. Open retromuscular mesh repair of complex incisional hernia: predictors of wound events and recurrence. *J. Am. Coll. Surg*. 2015;220:606-613.
- [34] Anthony T, Bergen PC, Kim LT, Henderson M, Fahey T, Rege RV, et al. Factors affecting recurrence following incisional herniorrhaphy. *World J Surg*. 2000;24:95-101
- [35] Regner JL, Mrdutt MM, Munoz-Maldonado Y. Tailoring surgical approach for elective ventral hernia repair based on obesity and national surgical quality improvement program outcomes. *Am J Surg*. 2015;210(6):1024-1030.
- [36] Birgisson G, Park A, Mastrangelo M, Witzke D, Chu U. Obesity and laparoscopic repair of ventral hernias. *Surg Endosc*. 2001;15(12):1419-1422.
- [37] Martindale RG, Deveney CW. Preoperative risk reduction: strategies to optimize outcomes. *Surg Clin North Am*. 2013;93(5):1041-55
- [38] Novitsky YW, Cobb WS, Kercher KW, Matthews BD, Sing RF, Heniford BT. Laparoscopic ventral hernia repair in obese patients: A new standard of care. *Arch Surg*. 2006;141(1):57-61.
- [39] Novitsky YW, Orenstein SB. Effect of patient and hospital characteristics on outcomes of elective ventral hernia repair in the United States. *Hernia*. 2013;17(5):639-45
- [40] Muysoms FE, Antoniou SA, Bury K, Campanelli G, Conze J, Cuccurullo D, et al. European Hernia Society guidelines on the closure of abdominal wall incisions. *Hernia*. 2015;19:1-24.

PARTICULARS OF CONTRIBUTORS:

1. Postgraduate Resident, Department of General Surgery, Bangalore Medical College and Research Institute, Bengaluru, Karnataka, India.
2. Professor, Department of General Surgery, Bangalore Medical College and Research Institute, Bengaluru, Karnataka, India.
3. Biostatistician, Manipal Hospital, Bengaluru, Karnataka, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Joseph Mathew,
House No. S2, Hutchins Corner Apartments No. 2, North Road Cooke Town, Bengaluru-560084, Karnataka, India.
E-mail: josef_matew@yahoo.co.in

FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **Apr 10, 2017**
Date of Peer Review: **Jul 10, 2017**
Date of Acceptance: **Sep 04, 2017**
Date of Publishing: **Nov 01, 2017**