VOLUME - 10, ISSUE - 07, JULY- 2021 • PRINT ISSN No. 2277 - 8160 • DOI : 10.36106/gjra

Original Research Paper

General Surgery

A COMPARATIVE STUDY BETWEEN ONLAY AND RETRORECTUS MESH REPAIR IN THE TREATMENT OF INCISIONAL HERNIAS

Dr. S. Yashwanth Assistant Professor, General Surgery, NMC, Nellore.

Dr. S. Dayakar* Post Graduate, General Surgery, NMC, Nellore. *Corresponding Author

ABSTRACT

INTRODUCTION: Over the years, surgeons tried the placement of mesh at different locations like On-lay, Under-lay, Sub-lay and pre-peritoneal, retroperitoneal intraperitoneal, Inter-muscular, etc. with each procedure having its advantages and disadvantages. Commonly Onlay and sub lay mesh repairs are done. Though the literature says, sub lay procedures have fewer complications and a high success rate. However, in a few studies, the ideal position for mesh repair appears to be retro muscular, where the force of abdominal pressure holds the mesh against deep surfaces of muscles. In this study, a comparison of both Onlay and retro rectus procedures with regards to the duration of surgery, postoperative complications like seroma, wound infection, wound dehiscence, and also the period of postoperative stay in the hospital. The aim of the study is To compare 'Onlay' versus 'retro rectus' mesh repair in influencing the outcome in incisional hernia with regards to Duration of surgery, Postoperative complications like seroma formation, wound infection, Postoperative stay, Recurrences. **PATIENTS AND METHODOLOGY:** Type of Study: A Prospective comparative study Study Setting: Department of general surgery, Narayana Medical College & Hospital, Nellore.Study Period: November 2018 to September 2020 Study Sample: 50 cases, divided into two groups by random allocation technique. Groups A and B with 25 patients in each group. **RESULTS:** The mean age of cases in Group A is 40.48 years. The mean age of patients in Group B is 44.08 years. Youngest was 31 years and 36 years in group A and group B, respectively, and the eldest was 51 years and 53 years in group A and group B, respectively. In Group A, 11 were male, and 14 were female, and in Group B, 11 were male, and 14 were female. The male to female ratio in the study was 1:1.27. The mean Operative Time in Group A was 1.93 Hrs, and that in Group B was 2.98Hrs. Nine patients (36%) in group A and one patient (4%) in group B had seroma formation. Eight patients (32%) in group A and one patient (4%) in group B had a wound infection. The mean Hospital Stay in Group A was 5.44 Days, and Group B was 4.88 days. No short-term recurrences were noted in either of the two groups when followed for six months. **CONCLUSION :** Retrorectus mesh repair is an excellent alternative to Onlay mesh repair that may apply to incisional hernia. The mesh-related overall complication rate like seroma wound infections and hospital stay is less than Onlay mesh repair.

KEYWORDS : Incisional Hernia, Onlay Repair, Retrorectus repair

INTRODUCTION

As defined by Ruggiero Nigro, an incisional hernia indicates the protrusion of viscera from the abdominal cavity through a route formed after trauma-induced by cutting (surgical incision, laparoscopic trocar puncture wounds, and stab wounds). More than 80% of ventral hernias result from previous surgery in adults, hence incisional hernias[1].

Over the years, surgeons tried the placement of mesh at different locations like On-lay, Under-lay, Sub-lay and pre-peritoneal, retroperitoneal intraperitoneal, Inter-muscular, etc. with each procedure having its advantages and disadvantages. Commonly Onlay and sub lay mesh repairs are done. Though the literature says, sub lay procedures have fewer complications and a high success rate. However, in a few studies, the ideal position for mesh repair appears to be retro muscular, where the force of abdominal pressure holds the mesh against deep surfaces of muscles.

In this study, a comparison of both Onlay and retro rectus procedures with regards to the duration of surgery, postoperative complications like seroma, wound infection, wound dehiscence, and also the period of postoperative stay in the hospital.

AIMS AND OBJECTIVES OF THE STUDY

The aim of the study is

To compare 'Onlay' versus 'retro rectus' mesh repair in influencing the outcome in incisional hernia with regards to

- Duration of surgery
- Postoperative complications like seroma formation, wound infection
- Postoperative stay
- Recurrences

PATIENTS AND METHODOLOGY

Type of Study: A Prospective comparative study

Study Setting: Department of general surgery, Narayana Medical College & Hospital, Nellore.

Study Period: November 2018 to September 2020

Study Sample: 50 cases, divided into two groups by random allocation technique. Groups A and B with 25 patients in each group.

Inclusion criteria:

1. All patients of both sex
2. With age between 18 – 55 years
3. With a defect of 2 – 10 cm

Exclusion criteria:

1. Emergency surgery (incarcerated hernia)
2. Planned other gastrointestinal surgery
3. Recurrent incisional hernia
4. Age less than 18 years and greater than 55 years
5. Large incisional hernia with a defect of more than 10 cm
6. Any comorbidities like chronic cough, cardiac diseases, anemia, hypoproteinemia

Methodology:

Institute Ethical Committee clearance certificate obtained for the study. Patients admitted to the general surgery department with Incisional hernia formed the study subjects.

Demographic data of the patients recorded in the proforma. After preliminary investigations and confirmation of diagnosis and pre-anaesthetic check-up, the patients were subjected to the required surgery.

Patients were grouped into two by **Random Allocation Technique**.

Group A patients who underwent Onlay mesh repair. **Group B** patients who underwent retro rectus mesh repair. The patients

underwent the following procedure according to their groups.

At the end of the study, Observations in both the groups will be made regarding the duration of surgery, postoperative complications like seroma formation, wound infection, postoperative stay, and recurrences.

Statistics:
Microsoft Excel was used to construct a master chart using SPSS 22.0. Mean and percentages for descriptive analysis. t and p values are used to determine the significance of the difference noted between the two groups.

OBSERVATIONS AND RESULTS

Table No 1: Age Distribution In The Study Groups (N=50)

Age In Years	No of Cases		
	Group A	Group B	Total
31-35	4 (16%)	0	4
36-40	10 (40%)	9 (36%)	19
41-45	6 (24%)	6 (24%)	12
46-50	4 (16%)	7 (28%)	11
51-55	1 (4%)	3 (12%)	4
Total	25	25	50

Table No 2: Sex Distribution in The Study Groups (N=50)

Sex	Group A	Group B	Total
Male	11	11	22
Female	14	14	28
Total	25	25	50

Table No 3: Complications in The Study Groups (N=50)

Complication	Group A	Group B	Total
Seroma	9	1	10
Wound Infection	8	1	9
Recurrence	0	0	0
Total	17	2	19

Table No 4: Seroma Comparison in The Study Groups (N=50)

Seroma								
Valid	Group A				Group B			
	Frequency	Percent	Valid Percent	Cumulative Percent	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	9	36	36	36	1	4	4	4
No	16	64	64	100	24	96	96	100
Total	25	100	100		25	100	100	

Table No 5: Wound Infection Comparison in The Study Groups (N=50)

Wound Infection								
Valid	Group A				Group B			
	Frequency	Percent	Valid Percent	Cumulative Percent	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	8	32	32	32	1	4	4	4
No	17	68	68	100	24	96	96	100
Total	25	100	100		25	100	100	

Table No 6: Descriptive Statistics in The Study Groups (N=50)

Descriptive statistics										
	Group A					Group B				
	N	Min	Max	Mean	SD	N	Min	Max	Mean	SD
Age	25	31	51	40.48	5.40154	25	36	53	44.08	5.20352
Operative time	25	1.10	3.15	1.936	0.77802	25	2.45	3.35	2.98	0.28904
Hospital stay	25	2	10	5.44	2.16179	25	3	8	4.88	1.01325
Valid N	25					25				

Table No 7: Group Statistics in The Study Groups (N=50)

Group statistics						
Variable	Group	N	Mean	SD	t	P
Age	A	25	40.48	5.40154	-2.400	**0.020 S**
	B	25	44.08	5.20352		
Operative time	A	25	1.936	0.77802	-6.289	**0.000 S**
	B	25	2.980	0.28904		
Hospital stay	A	25	5.440	2.16179	1.173	0.247 NS
	B	25	4.880	1.01325		

The mean age of cases in Group A is 40.48 years. The mean age of patients in Group B is 44.08 years. Youngest was 31 years and 36 years in group A and group B, respectively, and the eldest was 51 years and 53 years in group A and group B, respectively. Between both, the groups' p-value was < 0.05, which was significant.

The mean Operative Time in Group A was 1.93 hours with a standard deviation of 0.77, and that in Group B was 2.98 hours with a standard deviation of 0.28. Between both, the p-value was < 0.05, which was significant. The mean Hospital Stay in Group A was 5.44 Days with a standard deviation of 2.16, and that in Group B was 4.88 days with a standard deviation of 1.013. Between both, the p-value was > 0.05, which was not significant.

Table No 8: Sex Cross Tabulation

Sex Cross Tabulation				
		Male	Female	Total
Group	A	11	14	25
	B	11	14	25
Total		22	28	50
		X^2=0.000	p = >0.05 NS	

In Group A, 11 were male, and 14 were female, and in Group B, 11 were male, and 14 were female. The male to female ratio in study was1:1.27. Between both, the p-value was > 0.05, which was not significant.

Table No 9: Cross Tabulation in The Study Groups (N=50)

Cross tab						
	Seroma			Wound infection		
Count	Yes	No	Total	Yes	No	Total
Group A	9	16	25	8	17	25
Group B	1	24	25	1	24	25
Total	10	40	50	9	41	50
	X^2=8.000	**p 0.005 S**		X^2=6.640	**p 0.010 S**	

In comparison with Onlay (group A) and retro rectus (group B), seroma was noted more in the Onlay group accounting for 36% with a significant p-value of < 0.05.

In comparison with Onlay (group A) and retro rectus (group B), wound infection was noted more in the Onlay group accounting for 32% with a significant p-value of< 0.05.

From the overall group statistics, there was a significant difference in the patients' age, operative time, complications like seroma, and wound infections. No significant difference

was noticed in the sex of the patients and hospital stay.

DISCUSSION

Age and sex: In the present study, the mean age of patients in Group A is 40.48 years. The mean age of patients in Group B is 44.08 years. Youngest was 31 years and 36 years in group A and group B, respectively, and the eldest was 51 years and 53 years in group A and group B, respectively. In the study In Group A, 11 were male, and 14 were female, and in Group B, 11 were male, and 14 were female.

A study done by Kundan Kharde in 2013 included 25 patients in group A who underwent traditional on-lay mesh repair (6 males and 19 females) in which the range of patient's age was between 31 and 55 years old, with a mean age of 53.84 ± 13.05 years. Group B included 25 patients of retro-rectus mesh repair (9 males and 16 females) in which the patient's age ranged from 28 to 57 years old, with a mean of 54.24 ± 10.86 years.

In a study done by Ali Hussein Al-Tai, a total of 120 patients' hernias was managed by both sub lay mesh, and Onlay meshes repair techniques. The youngest patient was 22 years old, and the oldest 77-year-old; the patients' mean age was 48 ±5 years. The majority of the patients were female; that is, 90 patients represented 75%, and 30 male patients represented 25% of the sample.

Operative time:

In the present study, the mean Operative Time in Group A (Onlay mesh repair) was 1.93 Hrs, and that in Group B (retro rectus mesh repair) was 2.98Hrs.

In a study done by **Aly Saber** and **Emad K Bayumi** comparing Onlay and sub lay mesh repair for ventral hernia, operative time in the Onlay group was 45 min to 1.30 hrs and in sub lay repair was 1 hr to 2.20 hrs.

A comparative study between Onlay and sub lay mesh repair in ventral hernias: a randomized controlled trial was done by **Tharun Ganapathy Chitrambalam et al.** in 2019. The mean duration of surgery in group A was 48.49±0.71 minutes, and group B was 72.84±0.72 minutes.

In the study done by **Kundan Kharde**, the operative time in Group A ranged from 50 to 110 min with a mean of 69.8±12.20 min, while in Group B it ranged from 55 to 110 min with a mean of 77.8 ± 10.71 min with no significant difference between two groups.

Elsesy, et al., in their study noticed that the operative time for pre-peritoneal mesh repair (74 min) was more than that for on-lay mesh repair (70 min).

Seroma

In this study, In comparison with Onlay (group A) and retro rectus (group B), seroma was noted more in the Onlay group accounting for 36% with a significant p-value of < 0.05.

A meta-analysis of randomized controlled trials Review done by **Mohamed Ali Chaouch et al.** comparing Onlay versus sub lay mesh repair of open ventral incisional hernia, out of seven Randomized controlled trials involving a total of 954 patients (487 Onlay and 466 sub lay mesh repairs), a total of 451 patients developed seroma formation in which 84 of 231 patients underwent Onlay repair, and 29 of 220 patients underwent sub lay mesh repair. A significantly lower seroma rate in sub lay repair patients (OR: 3.71, 95% CI: 2.26–6.09, $p < 0.00001$).

Evaluation of "Sub lay" and "Onlay" Mesh Hernioplasty Techniques of Ventral Hernial Repair done by **Ali Hussein Al-Tai**, a total of 120 patients hernias was managed by both sub lay mesh, and Onlay meshes repair techniques. Seroma formation was observed in 2 patients (3.33%) in the sub lay group, whereas in 12 patients (20%) of the Onlay group.

The study of Giuseppe Salamone et al[2] suggests that patients with the deep subtype of mesh-associated seromas may require closer clinical follow-up. The seroma causes discomfort or is infected then drainage is necessary eventually followed by a microbiological examination. Many studies were done on the use of adjuncts to reduce seroma in open incisional hernia repair: In a systematic review of 1093 studies identified by L. H. Massey, S. Pathak, A. Bhargava, N. J. Smart & I. R. Daniels,9 met the inclusion criteria, and they observed the following:[3]

Medical talc: one cohort study of 74 patients underwent talc application followed by pre-peritoneal mesh placement and found a significantly reduced seroma formation of 20.8 versus 2.7% ($p < 0.001$), but a retrospective study of 21 patients with Onlay mesh repair found an increased incidence of seroma formation of 76% from 9.5% ($p = 0.001$). Fibrin glue: one comparative study of 60 patients found a reduction in seroma formation from 53 to 10% ($p = 0.003$), but a retrospective study of 250 patients found no difference (11 vs. 4.9% $p = 0.07$) in seroma formation. Negative pressure wound therapy: 4 retrospective studies, including a total of 358 patients, found no significant difference in seroma formation. Others: one randomized study of 42 patients undergoing either suction drainage or "quilting" sutures found no difference in seroma formation.

Wound infection

Preoperative comorbidities such as active smoking, poorly controlled diabetes mellitus, skin or wound issues, and obesity have shown to increase the risk of mesh infections.[4] Operative and technical factors that have been previously identified as risk factors for mesh infection include surgical approach, prolonged operative time, emergency operations, wound classification, concomitant gastrointestinal (GI) surgery, and inadvertent enterotomies.[5,6,7]

The repair of an abdominal wall hernia is a generally clean procedure with a low risk of infectious complications. However, when wound infections occur following a hernia repair, they can be associated with hernia recurrence, mesh infections, and systemic complications.[8,9] Even in expert centres, postoperative wound-related infective complications in the huge incisional hernia (≥10 cm) are as high as 40–50%.[10]The most common reason for readmission is the high rate of wound complications, occurring in 29%–66% of patients.[11] One meta-analysis also identified patient factors of advanced age, American Society of Anesthesiologists score ≥3, and tobacco smoking as significant risk factors for the development of mesh infection.[12] Smoking causes decreased tissue oxygenation, which negatively affects wound healing.[13] Removal of mesh is the preferred management strategy for mesh infection following incisional hernia repair,[14], which causes secondary trauma to the abdominal wall tissue and increases the risk of recurrence and other morbidities. There are only a few reports at present on the mesh-preserving treatment of mesh infection after hernia repair.[15] In this study, In comparison with Onlay (group A) and retro rectus (group B), wound infection was noted more in the Onlay group accounting for 32%. A study done by **A. Ravi Kamal Kumar et al.** five patients (25%) developed wound infections, and among 17 patients who underwent sub lay repair, only one patient (5.8%) acquired wound infection.

A meta-analysis of randomized controlled trials Review done by Mohamed **Ali Chaouch et al.** comparing Onlay versus sub lay mesh repair of open ventral incisional hernia out of seven

Randomized controlled trials involving a total of 954 patients (487 Onlay and 466 sub lay mesh repairs), Wound infections were reported in six studies, which included a total of 515 patients. They were detected in 27 of 263 patients undergoing Onlay repair and 11 of 252 patients undergoing sub lay repair. There was a significantly reduced incidence of wound infection in sub lay repair patients (OR: 2.33, 95% CI: 1.09–4.94, p = 0.03].

In a comparative study of Onlay and retro rectus mesh placement in incisional hernia repair done by **Kundan Kharde** et al in 2013, out of a total of 50 patients with 25 patients each in the Onlay and retro rectus group, wound infection requiring extrusion of mesh was noted in only one (4%) patient in Group A and none in Group B. In the study done by **Ali Hussein Al-Tai**, Wound infection was seen in one patient (1.66%) of the sub lay technique group, whereas in 6 (10%) patients of the Onlay group. One patient (1.66%) of the second group suffered from mesh infection and needed its removal, whereas none was observed in the sub lay group.

Hospital stay:

In this study, The mean Hospital Stay in Group A was 5.44 Days with a standard deviation of 2.16, and that in Group B was 4.88 days with a standard deviation of 1.013. Between both, the p-value was > 0.05, which was not significant.

A comparative study between Onlay and sub lay mesh repair in ventral hernias: a randomized controlled trial was done by **Tharun Ganapathy Chitrambalam et al.**in 2019; the mean duration of postoperative hospital stay in Onlay mesh repair was 9.39±0.29 days when compared to 5.71±0.14 days in sub lay mesh repair with a significant p-value of 0.0001.

Recurrence:

Incisional hernia repair is one of the most common procedures performed in General Surgery[16]. Although it is a common operation, evidence shows high figures of IH recurrence (IHR).[17] The Danish hernia registry reported an incidence of 12.7% IHR in 3212 patients.[18] A Swedish registry reported an incidence of up to 23% IHR when the defect was greater than 3 cm and in Onlay mesh repair[19] and, a Spanish registry reported 20.7% IHR after one-year follow-up, especially in previously repaired hernias (18.1% primary vs 30.6% recurrence).[20]

Risk factors for IHR: Characteristics of the patient (e.g., older age, obesity, diabetes, smoking, immunosuppression),[21] Characteristics of hernia (e.g., transverse diameter, location, recurrence, mesh),[22] and Surgical performance (e.g., experience, previous training)[23,24] Low recurrence rates have been related to specific techniques for ventral hernia repair, such as preperitoneal ventral hernia repair,[25] even when using meshes recurrence rates of up to between 25 and 32% are observed after 5 and 10 years.[26,27,28] It is only after ten years' follow-up that the actual recurrence rate can be estimated.[29] In this study, No short-term recurrences were noted in either of the two groups when followed for six months.

In a study done by **A. Ravi Kamal Kumar et al.** comparing Onlay and sub lay mesh repair in incisional hernia, among 20 patients who underwent Onlay mesh repair, one patient (5%) developed recurrence, and among 17 patients who underwent sub lay repair, no patient (0%) developed recurrence on two years follow up.

A comparative study of Onlay and retro rectus mesh placement in incisional hernia repair was done by **Kundan Kharde** in 2013, out of a total of 50 patients with 25 patients each in the Onlay and retro rectus group, when patients were followed-up for six months. One recurrence (4%) was noted in Group A and none in group B.

Evaluation of "Sub lay" and "Onlay" Mesh Hernioplasty Techniques of Ventral Hernial Repair done by **Ali Hussein Al-Tai**, a total of 120 patients with ventral hernias was managed by both sub lay mesh and Onlay mesh repair techniques. The recurrence rate in 2 years follow-up in the sub lay group exhibited no recurrence (0%), whereas that in the Onlay group 4 patients had a recurrence (6.66%).

CONCLUSION

Retrorectus mesh repair is an excellent alternative to Onlay mesh repair that may apply to incisional hernia. The mesh-related overall complication rate like seroma wound infections and hospital stay is less than Onlay mesh repair. Although the time taken for surgery in retro rectus mesh repair is significantly higher than Onlay mesh repair, complications and morbidity associated with it are substantially lower than Onlay repair. Hence, retro rectus mesh repair can be used as the preferred method of treating incisional hernias.

REFERENCES

1. The Historical Evolution of the Treatment of Incisional Hernia Ruggiero Nigro, Feliciano Crovella F. Crovella, G. Bartone, L. Fei (eds.) Incisional Hernia. © Springer 2008
2. Giuseppe Salamone, Leo Licari, Antonino Agrusa, Giorgio Romano, Gianfranco Cocorullo, Ann Ital Chir. 2015 May 12;86(ePub)
3. Hernia volume 22, pages273–283(2018)Published: 25 October 2017
4. Arnold MR, Kao AM, Gbozah KK, Heniford BT, Augenstein VA. Optimal management of mesh infection: Evidence and treatment options. Int J Abdom Wall Hernia Surg 2018;1:42-9.
5. Sanchez VM, Abi-Haidar YE, Itani KM. Mesh infection in ventral incisional hernia repair: Incidence, contributing factors, and treatment. Surg Infect (Larchmt) 2011;12:205-10
6. Hawn MT, Gray SH, Snyder CW, Graham LA, Finan KR, Vick CC, et al. Predictors of mesh explantation after incisional hernia repair. Am J Surg 2011;202:28-33
7. Rosenberger LH, Politano AD, Sawyer RG. The surgical care improvement project and prevention of post-operative infection, including surgical site infection. Surg Infect (Larchmt) 2011;12:163-8.
8. Finan KR, Vick CC, Kiefe CI, et al. Predictors of wound infection in ventral hernia repair. Am J Surg 2005; 190:676.
9. Luijendijk RW, Hop WC, van den Tol MP, et al. A comparison of suture repair with mesh repair for incisional hernia. N Engl J Med 2000; 343:392.
10. Bikhchandani J, Fitzgibbons RJ., Jr Repair of giant ventral hernias. Adv Surg 2013;47:1-27.
11. Kaafarani HM, Kaufman D, Reda D, Itani KM. Predictors of surgical site infection in laparoscopic and open ventral incisional herniorrhaphy. J Surg Res 2010;163:229-34.
12. Mavros MN, Athanasiou S, Alexiou VG, Mitsikostas PK, Peppas G, Falagas ME, et al. Risk factors for mesh-related infections after hernia repair surgery: A meta-analysis of cohort studies. World J Surg 2011;35:2389-98
13. Cobb WS, Warren JA, Ewing JA, Burnikel A, Merchant M, Carbonell AM, et al. Open retromuscular mesh repair of complex incisional hernia: Predictors of wound events and recurrence. J Am Coll Surg 2015;220:606-13.
14. Bueno-Lledó J, Torregrosa-Gallud A, Carreño-Saénz O, et al. Partial versus complete removal of the infected mesh after abdominal wall hernia repair. Am J Surg 2017;214:47-52.
15. Meagher H, Clarke Moloney M, Grace PA. Conservative management of mesh-site infection in hernia repair surgery: a case series. Hernia 2015;19:231-7. 10
16. Poulose BK, Shelton J, Phillips S, et al. Epidemiology and cost of ventral hernia repair: making the case for hernia research. Hernia. 2012;16:179–83.
17. Helgstrand F, Rosenberg J, Kehlet H, Jorgensen LN, Bisgaard T. Nationwide prospective study of outcomes after elective incisional hernia repair. J Am Coll Surg. 2012;216:217–28.
18. Kokotovic D, Bisgaard T, Helgstrand F. Long-term recurrence and complications associated with elective incisional hernia repair. JAMA. 2016;316:1575–82.
19. Israelsson LA, Smedberg S, Montgomery A, Nordin P, Spangen L. Incisional hernia repair in Sweden 2002. Hernia. 2006;10:258–61.
20. Pereira JA, López-Cano M, Hérnandez Granados P, Feliu X, et al. Initial results of the national registry of incisional hernia. Cir Esp May. 2016;94:595–602.
21. Liang MK, Holihan JL, Itani K, Alawadi ZM, Gonzalez JR, Askenasy EP, Ballecer C, Chong HS, Goldblatt MI, Greenberg JA, Harvin JA, Keith JN, Martindale RG, Orenstein S, Richmond B, Roth JS, Szotek P, Towfigh S, Tsuda S, Vaziri K, Berger DH. Ventral hernia management: expert consensus guided by systematic review. Ann Surg. 2017;265:80–9.
22. Aquina CT, Fleming FJ, Becerra A, Xu Z, Hensley BJ, Noyes K, Monson JRT, Jusko TA. Explaining variation in ventral and inguinal hernia repair outcomes: a population-based analysis. Surgery. 2017;162:628–39.
23. Ross SW, Oommen B, Kim M, Walters AL, Green JM, Heniford BT, Augenstein VA. Little slower, but just as good: postgraduate year resident versus attending outcomes in laparoscopic ventral hernia repair. Surg Endosc. 2014;28:3092–100.
24. Luijendijk RW, Hop WCJ, van den Tol MP, de Lange DCD, Braaksama MMJ, IJzermans JNM, et al. . A comparison of suture repair with mesh repair for incisional hernia. N Engl J Med. (2000) 343:392–8.
25. Heniford BT, Ross SW, Wormer BA, Walters AL, Lincourt AE, Colavita PD, Kercher K, Augenstein VA. Preperitoneal ventral hernia repair: a decade long prospective observational study with analysis of 1023 patient outcomes: Ann

Surg August 3 Volume Publish Ahead of Print – Issue p; 2018
26. Luijendijk RW, Hop WCJ, van den Tol MP, de Lange DCD, Braaksama MMJ, IJzermans JNM, et al. . A comparison of suture repair with mesh repair for incisional hernia. N Engl J Med. (2000) 343:392–8.
27. Burger JWA, Luijendijk RW, Hop WCJ, Halm JA, Verdaasdonk EGG, Jeekel J. Long-term follow-up of a randomized controlled trial of suture vs. mesh repair on incisional hernia. Ann Surg. (2004) 240:578–85.
28. Flum DR, Horvath K, Koepsell T. Have outcomes on incisional hernia repair improved with time? A population-based analysis. Ann Surg. (2003) 237:129–35.
29. Köckerling F, Koch A, Lorenz R, Schug-Pass C, Stechemesser B, Reinpold W. How long do we need to follow-up our hernia patients to find the real recurrence rate? Front. Surg. (2015) 2:24. 10.3389/fsurg.2015.