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Concomitant open ventral hernia repair: what is the financial impact of performing open ventral hernia with other abdominal procedures concomitantly?

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Abstract

Background Open ventral hernia repair (VHR) is often performed in conjunction with other abdominal procedures. Clinical outcomes and financial implications of VHR are becoming better understood; however, financial implications of concomitant VHR during other abdominal procedures are unknown. This study aimed to evaluate the financial implications of adding VHR to open abdominal procedures.

Methods This IRB-approved study retrospectively reviewed hospital costs to 180-day post-discharge of standalone VHRs, isolated open abdominal surgeries (bowel resection or stoma closure, removal of infected mesh, hysterectomy or oophorectomy, panniculectomy or abdominoplasty, open appendectomy or cholecystectomy), performed at our institution from October 1, 2011 to September 30, 2014. The perioperative risk data were obtained from the local National Surgery Quality Improvement Program (NSQIP) database, and resource utilization data were obtained from the hospital cost accounting system.

Results 345 VHRs, 1389 open abdominal procedures as described, and 104 concomitant open abdominal and VHR cases were analyzed. The VHR-only group had lower ASA Class, shorter operative duration, and a higher percentage of hernias repaired via separation of components than the concomitant group ($p < 0.001$). The median hospital cost for VHR-alone was \$12,900 (IQR: \$9500–\$20,700). There were significant increases to in-hospital costs when VHR was combined with removing an infected mesh (63%) or with bowel resections or stoma closures (0.7%). The addition of VHR did not cause a significant change in 180-day post-discharge costs for any of the procedures.

Conclusions This study noted decreased costs when combining VHR with panniculectomy or abdominoplasty and hysterectomy or oophorectomy. For removal of infected mesh and bowel resection or stoma closure, waiting, when feasible, is recommended. Given the impending changes in financial reimbursements in healthcare in the United States, it is prudent that future studies evaluate further the clinical and fiscal benefit of concomitant procedures.

Keywords Concomitant ventral hernia repair · Cost-effectiveness · Financial impact · Hospital costs · Ventral hernia repair · Incisional hernia repair

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More than two million laparotomies are performed in the United States each year [1], and ventral hernia complicates as many as one in five of these procedures [2–5]. Many of these patients will require hernia repair subsequently. It has been estimated that more than 300,000 ventral hernia repairs were performed in the U.S. in 2006 [6]. Even though the techniques used and the prosthetic meshes implanted are consistently improved, open ventral hernia repair (VHR) is plagued with recurrence, and the risk of recurrence increases

after each repair [7]. Even with no hernia recurrence, patient quality of life can be adversely impacted, with 17.2–27.8% of patients reported to suffer from chronic pain after hernia repair [8, 9]. Furthermore, VHR places a significant financial burden on the health care system, with US $3.2 billion being spent in 2006 on VHR. In general, the costs related [6] to VHR are associated with overall financial losses [10].

Open VHR can be performed concurrently with other open abdominal procedures. A recent National Surgical Quality Improvement Program (NSQIP) review of colorectal procedures performed simultaneously with VHR with mesh or without mesh reported similar incidence in postoperative morbidity whether or not mesh was placed [11]. Superficial surgical site infection (SSI) was noted in 7.3% of patients with mesh implant and 10.5% of patients with no mesh placed [11], comparable to SSI for either procedure alone, and providing some evidence that VHR with mesh implantation can be safely performed in conjunction with colorectal procedures.

Previous work from our institution aided in the understanding of the socioeconomic implications of VHR [10, 12]; however, little is known about the financial implications of adding VHR to an open abdominal procedure. By evaluating the economic burden of adding VHR to unrelated open abdominal procedures, the purpose of this study was to ascertain whether or not there is a significant financial benefit to combining open procedures and VHR.

Methods

A single-institution retrospective review study design was used, reviewing procedures performed at the University of Kentucky from October 1, 2011, through September 30, 2014. Surgical databases were searched for procedures broadly separated into three categories: standalone open VHR, specific categories of isolated open abdominal procedures, and the same isolated open abdominal procedures done concomitantly with VHR. The open abdominal procedures included in the search were categorized as bowel resection or stoma closure, removal of infected mesh, hysterectomy or oophorectomy, panniculectomy or abdominoplasty, appendectomy or cholecystectomy. Cases in which more than one concomitant procedure were performed or in which a concomitant procedure that did not fall under the defined categories, such as an abdominal washout or nephrectomy, were excluded.

The patient perioperative risk data were obtained from the local NSQIP database. Resource utilization data were obtained from the hospital cost accounting system (Allscripts EPSi Version 7.5 FP2, Chicago, IL). Hospital costs included direct costs, such as supplies, operating room time, and ICU stay, and indirect costs, such as administration and facility costs. Demographic, clinical risk and cost data were compared between isolated and concomitant procedure groups using Fisher's exact or Mann–Whitney *U* tests as appropriate. Significance was set at $p < 0.05$. Significant *p* value implies that the cost difference of combining a VHR with an open abdominal procedure vs. performing them separately is statistically different. Statistical analyses were conducted using SPSS™ Version 22 (IBM™ Corp, Armonk, NY). All costs are reported as median US dollars with the interquartile range (IQR).

Results

A total of 1838 procedures were included in the analyses, 1389 of which were isolated open abdominal cases. A total of 549 VHRs were performed, isolated and concomitant, at our institution during the time period. Of the 549 VHRs, 345 cases were isolated VHRs. Of the remaining 204 VHR cases, 100 were excluded per the previously defined exclusion criteria. The remaining 104 VHRs were performed concomitantly with other open abdominal procedures and were included in the data analyses. The breakdown of numbers of the various open abdominal procedures included in the analyses is presented in Fig. 1. Figure 2 depicts the breakdown of all VHRs, and Fig. 3 describes the breakdown of VHRs done concomitantly with open abdominal procedures.

The mean age of the patients was 53 years in isolated VHR and VHRs performed concomitantly (Table 1). The isolated VHRs had a lesser percentage of female patients than the concomitant VHRs, a lower percentage of cases

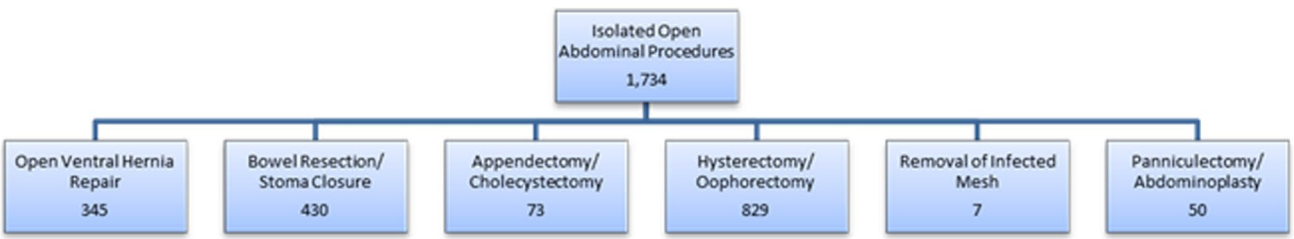

Fig. 1 Isolated open abdominal procedures breakdown

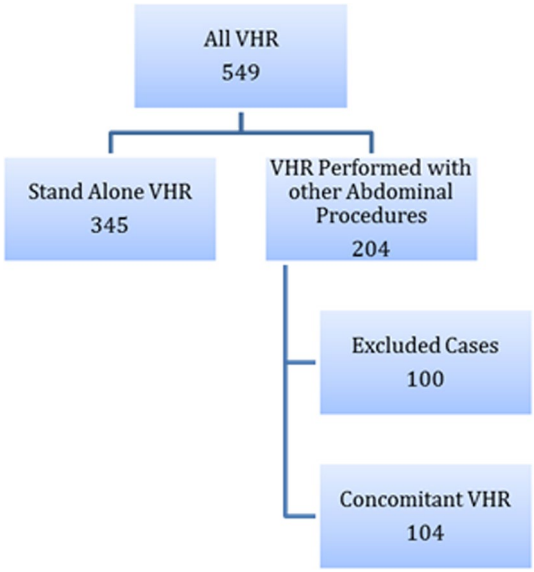

Fig. 2 Ventral hernia repair breakdown

that were ASA class 3 or greater, and more emergent cases. As expected, the procedures in which VHR was the only procedure performed were shorter in duration on average than procedures with VHR performed concomitantly (162 ± 71 min vs. 219 ± 87 min). The risk factor and demographic information for the patients included in the analyses are presented in Table 1.

Median costs for isolated abdominal procedures ranged from $4900 for removal of infected mesh to $16,000 for bowel resection or stoma closure and was $12,900 for isolated VHR. VHR performed concomitantly with the abdominal procedures added significant costs for all procedures (p's < 0.004) except appendectomy or cholecystectomy (Table 2). For removal of infected mesh and bowel resection or stoma closure procedures, the increased costs of concomitant VHR exceeded the costs of a later isolated VHR on average ($24,200 and $13,100 respectively vs. $12,900, Table 2; Fig. 4).

At 180-day post-discharge (180 d) from the index procedure, 31.6% of patients with an isolated VHR had costs greater than $1000; 19% had floor costs indicating an admission (≥ $500), 21% had operating room costs indicating an operation (≥ $500), 23% had emergency department costs ≥ $100, and 42% had imaging/laboratory costs ≥ $100 (Table 3). The percentage of patients with 180-day emergency department costs ≥ $100 increased significantly when a VHR was performed concomitantly with panniculectomy or abdominoplasty or hysterectomy or oophorectomy (p's < 0.05, Table 3). Overall, the percentage of patients with 180-day total same-site hospital costs ≥ $1000; floor costs ≥ $500, operating room costs ≥ $500 were similar in isolated abdominal procedures as compared to those procedures performed with concomitant VHR.

Discussion

In this study, we evaluated the hospital costs associated with VHR when performed as a standalone procedure compared to costs for VHR performed jointly with commonly performed open abdominal procedures. The abdominal procedures evaluated were chosen due to the frequency with which they are performed singularly and in combination with VHR at our institution, as they represented high volume procedures. The study showed that when adding a VHR to a panniculectomy or abdominoplasty, or hysterectomy or oophorectomy the costs were not greater than that of a standalone VHR performed at a later time.

In this study's panniculectomy or abdominoplasty concomitant group, the only procedures performed were the panniculectomy and the VHR; however, emergency room costs in the post-discharge time period were increased for combined cases compared to standalone cases, which could have been associated with increased incidence of wound or other complications. The data did not identify increased number of patients whose floor, operating room or lab/imaging costs were increased for combined procedures. When considering performing a VHR concomitantly with

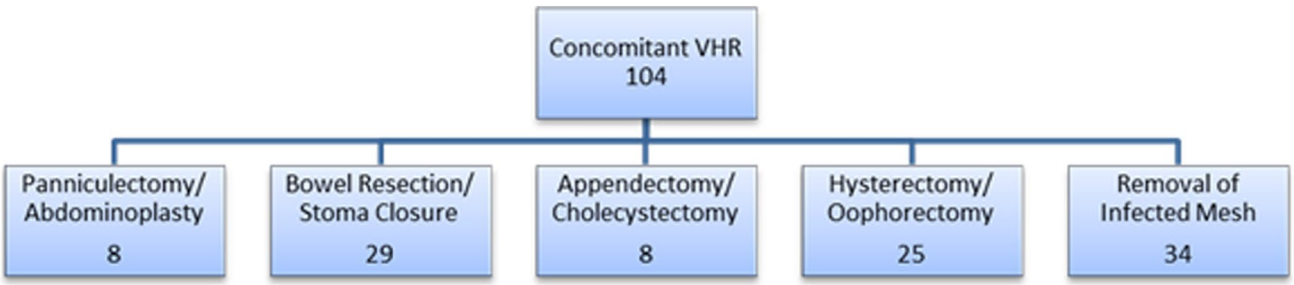

Fig. 3 Concomitant ventral hernia repair group breakdown

Table 1 Risk factor and demographic data

Procedure	No. of cases	% Female	Mean age, y ± SD	% ASA 3+	% Emergent	% Discharged same day	% w/Separation of Components	Mean duration of operation, min. ± SD
Isolated open ventral hernia repair (VHR)	345	57	53 ± 13	61	14	6	40	162 ± 71
VHR w/any of the following concomitant procedures	104	66	53 ± 14	72	6	1	32	219 ± 87
Isolated open procedures (without VHR or any other major procedure)								
Panniculectomy or abdominoplasty	50	92	46 ± 9	44	0	18	0	179 ± 84
Bowel resection or stoma closure	430	49	55 ± 16	64	34	1	0	130 ± 78
Open appendectomy or cholecystectomy	73	43	49 ± 18	58	41	0	0	110 ± 51
Hysterectomy or oophorectomy	829	100	50 ± 14	44	4	1	0	145 ± 54
Removal of Infected Mesh	7	43	45 ± 16	57	14	14	0	73 ± 60

All of the factors varied significantly by procedure type, chi-square or ANOVA, $p < 0.001$

Table 2 Median hospital costs for index procedure (in thousands of U.S. dollars)

Procedure	Median index procedure costs (IQR)			
	Isolated	With VHR	Difference in median costs	Difference *p* value
Open ventral hernia repair (VHR)	12.9 (9.5–20.7) n = 345			
Panniculectomy or abdominoplasty	8.2 (6.4–11.3) n = 50	15.8 (10.6–31.2) n = 8	7.6	0.002
Bowel Resection or stoma closure	16.0 (10.0–27.4) n = 430	29.1 (14.5–47.2) n = 29	13.1	0.004
Appendectomy or cholecystectomy	12.4 (8.2–21.3) n = 73	16.4 (8.2–31.5) n = 8	4.0	0.590
Hysterectomy or oophorectomy	8.5 (7.3–10.5) n = 829	11.9 (9.0–15.1) n = 25	3.4	< 0.001
Removal of infected mesh	4.9 (4.2–9.2) n = 7	29.1 (19.3–34.2) n = 34	24.2	0.003

IQR interquartile range

a panniculectomy, there are some clinical data available that can play a part in the decision-making process. In a study by Fischer et al., there was found to be an increased incidence of venous thromboembolism, increased risk of re-operation, increased risk of SSI, and increased overall morbidity when procedures are performed concomitantly [13]. However, in that study unlike the current study, there was an increased number of concurrent intra-abdominal procedures ($p < 0.001$) and increased number of bowel procedures ($p = 0.004$) [13]. The addition of intra-abdominal procedures may have contributed to the increased risk of complications. Furthermore, when a sub-group analysis was performed evaluating the SSI, it only showed an increase in superficial infections (5.2 vs. 7.6%). In a study by Zemlyak et al., concomitant panniculectomy and ventral hernia repair had an increased risk of cellulitis, but did not have an increased risk of other wound complications or need for operative interventions [14]. A study by Warren et al. had similar findings [15]. There was increased risk of SSI, but there were higher rates of skin necrosis and cellulitis [15]. Interestingly, they

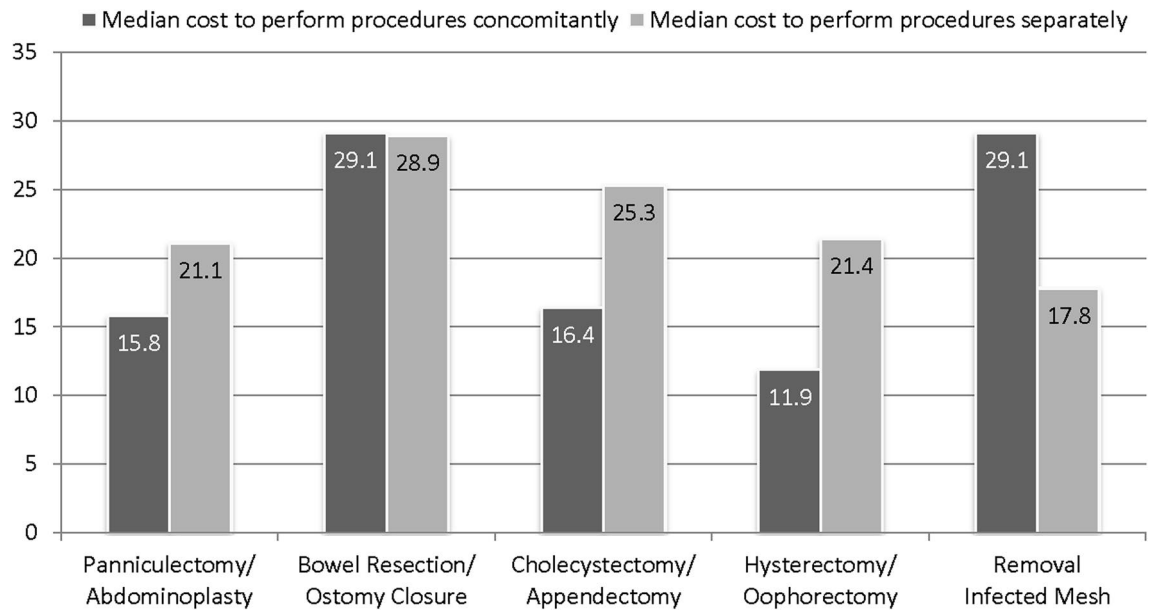

Fig. 4 Combined median hospital costs for concomitant VHR vs. isolated VHRs and isolated abdominal procedures (thousands of U.S. dollars)

also found no difference in the rate of recurrence at a mean follow-up of 11.4 months. When considering performing concomitant VHR and panniculectomy in morbidly obese patients, it is important to consider the results of the study by Shubinets et al. who found that the concomitant group had increases in length of stay (6.8 vs. 5.2 days), 30-day readmissions (13.6 vs. 8.1%), and rate of in-hospital adverse events (29.3 vs. 20.7%) [16]. Interestingly, however, they found a decreased rate of hernia recurrence in the concomitant group (7.9 vs. 11.3%) [16].

While the cost of adding a VHR to open appendectomy or open cholecystectomy is less than performing them as standalone procedures, the difference is not statistically significant, reflecting the uncertainty about the financial implications of combining these procedures. A previous NSQIP review comparing short-term clinical outcomes of combined laparoscopic cholecystectomy with laparoscopic ventral hernia repair reported increased postoperative morbidity with combined procedures rather than performed singly [17]. Similar clinical comparison for open cholecystectomy and open VHR in terms of postoperative morbidity is not available. At this point, given the data available, we recommend that the decision on whether to add the VHR concomitantly or to perform it at a later date should be a clinical decision, pending further studies.

Combining bowel resection and stoma closure with VHR was found to have a median cost only slightly greater than the cost of performing the procedures separately. In our review of the literature available on clinical outcomes, concomitant stoma closure with VHR was the only group that had some, albeit sparse, clinical data available. In the study by Wind et al., morbidity was shown to be increased when stoma closure and VHR were performed concomitantly [18]. An important point to note is that our cost data showed that the difference in costs between the two was $200. This difference, while statistically significant, may not be financially significant to overcome the clinical risks. With the financial difference being so small and the increased risk of morbidity, it is extremely important that the results of this study be a part of the clinical decision-making tree and not the sole guiding factor.

Removing an infected mesh and performing a concomitant VHR increased the inpatient cost nearly six times as opposed to removing the mesh alone. When the combined inpatient costs of a standalone VHR and a standalone removal of infected mesh are compared with performing them concomitantly, there is nearly a twofold increase in the inpatient costs. This cost increase seems expected when examining the situation clinically. Removing an infected mesh and performing a VHR, often with another mesh, without allowing for the infected area to fully heal is a likely etiology of complications, which undoubtedly led to increased inpatient costs. Based upon this cost analysis, removal of infected mesh with concomitant hernia repair is clearly not cost-effective. However, clinical circumstances may necessitate concomitant ventral hernia repair to contain abdominal viscera. Accordingly, based on cost data, removal of an infected mesh should be performed separately from ventral hernia repair when feasible clinically.

Aside from the obvious financial benefits in combining some of the aforementioned cases, there are also other benefits to be gained. The reason to combine procedures

Table 3 Costs incurred within 180-day post-discharge (PD) from the index procedure

Procedure	% Pts. w/180 days PD costs ≥ $1000			% Pts. w/floor costs ≥ $500			% Pts. w/OR costs ≥ $500			% Pts. w/ED costs ≥ $100			% Pts. w/imaging or lab costs ≥ $100		
	Isolated (%)	w/VHR (%)	*p* Value	Isolated (%)	w/VHR (%)	*p* Value	Isolated (%)	w/VHR (%)	*p* Value	Isolated (%)	w/VHR (%)	*p* Value	Isolated (%)	w/VHR (%)	*p* Value
Open ventral hernia repair (VHR)	32			19			21			23			42		
Panniculectomy or abdominoplasty	24	25	1.000	10	25	0.245	24	25	1.00	8	38	0.048	26	38	0.672
Bowel resection or stoma closure	53	55	0.850	31	28	0.837	36	35	1.00	29	45	0.093	62	62	1.000
Appendectomy or cholecystectomy	36	38	1.000	16	0	0.597	21	25	0.672	34	13	0.426	43	50	0.721
Hysterectomy or oophorectomy	20	28	0.312	6	16	0.060	11	20	0.191	9	24	0.019	30	32	0.825
Removal of infected mesh	43	47	1.000	29	41	0.685	29	32	1.00	29	41	0.685	71	53	0.438

may be pragmatic as by combing the procedures, patients have only one hospital admission and one trip to the operating room. This leads to a reduced anesthetic risk and decreased overall operative time. Furthermore, patients can have a net decrease in length of stay and also have only one recovery period. This reduces the amount of time they are away from work, which can help ease the personal and societal financial burden.

Ventral hernia repair hospital readmission rates are reported to be between 5 and 13%. Predictors of readmission following VHR have been studied extensively and are multifactorial [19–21]. The overall most common reason for unplanned hospital readmission is SSI across a number of surgical procedures, including VHR, colectomy or proctectomy, and hysterectomy [22]. Previous work at our institution has shown that hospital costs increase dramatically when any postoperative complication is incurred and with SSI the costs during the 90-day post-discharge time period result in significant cost increases [12]. As ventral hernia repair is fraught with complications for some patients, it is imperative that predictors of risk for all procedures be considered for each patient weighing risk vs. benefit prior to proceeding with combined procedures.

One of the inherent limitations of this study lies in the fact that it was a single-institution study, which limits the diversity of patients. Only patients who were able to obtain medical care at our institution were studied, yielding a selection bias. Multicenter studies are required to further evaluate the financial implications of combining these procedures. At the same time, however, several surgeons spanning across multiple specialties and experience levels performed the procedures with and without mesh. This provides our study a certain amount of generalizability. We can expect the results to be similar if these procedures are performed by surgeons outside our institution. An additional limitation of the study is its retrospective nature. The authors cannot present with certainty whether or not the procedures were related and cannot be certain of the equivalency of hernias across repairs.

One possible reason that our data showed that hysterectomy or oophorectomy was financially beneficial to combine with VHR could be due to the increased likelihood of primary repair/minor hernia repair rather than complex repair with or without mesh use in these procedures. Our data are limited by the lack of specifics of the hernia repairs. Each of the repairs was done via an open approach, but the size of the defect is not available. Repair of a small ventral hernia is drastically different than the repair of a large ventral hernia. Furthermore, mesh utilization, mesh type, and mesh size all contribute to operative costs. However, those details were not available to study. Future studies are needed to further evaluate these aspects.

Because the focus was on evaluating the financial implications of combining the procedures, it is challenging to draw conclusions about clinical parameters, such as postoperative complications of the concomitant procedures. However, as the results showed, there were no significant differences in the overall financial burden at 180-day post-discharge for any of the procedures. This is, however, limited by two factors that we cannot ascertain. The first is that we cannot say with confidence that the costs incurred in the 180-day post-discharge period were completely related to the index procedure(s). It is very much plausible that the costs incurred are secondary to an unrelated medical condition. The second factor is that patients may have received care for complications at a facility outside our healthcare network. Using $1000 as a cut off for 180-day post-discharge costs serves as a way to take into account significant post-discharge events that likely required interventions.

It is important to note that this study does not evaluate the long-term impact of performing the procedures concomitantly. Furthermore, it also does not evaluate the clinical impact of combining these procedures. Additional studies are warranted to evaluate the impact of combining procedures on hernia recurrence, chronic pain, postoperative infections, seroma formation, etc. While it can be implied that the 180-day post-discharge complication rate was not significantly different, the same claim cannot be made for the 1- and 5-year timeframes.

Conclusion

Our data suggest that there are decreased costs involved in combining VHR with panniculectomy or abdominoplasty and hysterectomy or oophorectomy rather than waiting for a later standalone VHR. As for the removal of infected mesh, bowel resection, or stoma closure, staged procedures appear to involve decreased costs. Surgical decision making must involve short-term and long-term risk stratification as well as the feasibility of performing procedures alone or together. While concomitant VHR may not be in the best interest of patients that have greater than minimal risk of adverse outcomes, there likely is a subset of patients for whom combined procedures would decrease the overall cost burden and allow return to productive lifestyle more quickly. Given the impending changes in financial reimbursements in healthcare in the United States, it is prudent that future studies evaluate further the fiscal benefit of concomitant procedures. Furthermore, given the risk of long- term complications such as chronic pain or recurrence with VHR, long-term studies evaluating for the complication rates of combined vs. standalone procedures is warranted.

Compliance with ethical standards

Disclosures Dr. Roth is a speaker for Bard, has grants with Bard, Life Cell, Gore, and MTF, and is a consultant for Life Cell. Dr. Madabhushi, Dr. Davenport, Dr. Plymale, Dr. Johnson, and Mr. Wade have no financial interests to disclose.

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