

Review Article

Best Practices for Evaluation and Optimization of Patients Undergoing Abdominal Wall Reconstruction and Large Hernia Repairs in a Community Hospital Setting: A Review of Literature

JD Parmely^{1*}, JE Susoreny-Velgos¹, LN Oliver², CR Lumley², RT Hajjar²

¹Department of General Surgery, Beaumont Hospital-Farmington Hills, Farmington Hills, USA

²Department of Plastic and Reconstructive Surgery, Beaumont Hospital-Farmington Hills, Farmington Hills, USA

***Corresponding author:** JD Parmely, Department of General Surgery, Beaumont Hospital-Farmington Hills, Farmington Hills, MI 48336, USA. Tel: +12484718865; E-Mail: john.parmely@beaumont.org

Citation: Susoreny-Velgos JE, Oliver LN, Lumley CR, Hajjar RT, Parmely JD (2017) Best Practices for Evaluation and Optimization of Patients Undergoing Abdominal Wall Reconstruction and Large Hernia Repairs in a Community Hospital Setting: A Review of Literature. J Surg 2017; JSUR-135. DOI: 10.29011/JSUR-135.000035

Received Date: 16 April 2017; **Accepted Date:** 19 June, 2017; **Published Date:** 26 June, 2017

Abstract

Background: The purpose of this literature review is to identify best practices for patients undergoing abdominal wall reconstruction and large hernia repairs in a community hospital setting and to create a comprehensive preoperative protocol for ventral hernia repairs greater than 10 cm \pm loss of domain to optimize outcomes. These patients have unique physiological changes during abdominal wall reconstruction. With these changes, patients with comorbidities may fair worse when their disease processes are not optimized. The primary goals are reduction of postoperative morbidities and mortalities including wound complications, respiratory compromise, renal dysfunction, neurological sequela, and cardiac morbidity, sepsis, deep venous thrombosis, and post-op transfusion requirements. In a community hospital setting, optimal care must be ensured for each patient; otherwise they need evaluation at a tertiary center. There is currently little data published on pre-operative management of large hernia patients in a community setting though this is a common surgery performed by general surgeons at large.

Methods: A review of literature identified evidence-based practices to develop a conservative preoperative protocol for large hernia and abdominal wall reconstruction patients. The following topics were reviewed: hernia size in relation to increased morbidity, preoperative weight loss, BMI, functional status and frailty, glycemic control, nutritional evaluation, immunosuppressant management, nicotine use, and preoperative evaluation by cardiology, pulmonology and anesthesiology. Journal articles were reviewed from 1990 to 2016 using Ovid Medline and Pubmed. Articles in English and pertaining to adult humans were reviewed. Articles were retrieved using the following search terms: ventral hernia, postoperative complications, patient selection, risk reduction behavior, risk factors, risk assessment, preoperative care, health status, treatment outcomes, clinical protocols, preoperative weight loss, exercise, preoperative testing, cardiac workup, respiratory function tests, frailty, functional health status, preoperative hemoglobin A1C, glycosylated hemoglobin and surgical procedures, and hyperglycemia.

Results: Computerized Axial Tomography (CT) scan is the best tool for assessing the size and extent of contents of the hernia. Preoperative weight loss in obese patients decreases morbidity. Preoperative evaluation by cardiology, pulmonology and anesthesiology and appropriate prehabilitation for patients with poor pulmonary function and/or cardiac function improves their preoperative comorbidities. Evaluation of functional status and frailty identifies patients who will not tolerate surgery and recovery. Perioperative glycemic control, nutritional evaluation and optimization in addition to appropriate management of immunosuppressant medications and smoking cessation decrease wound complications.

Conclusion: Utilizing these recommendations should decrease morbidities and mortalities in the patients undergoing abdominal wall reconstruction. Abdominal wall reconstruction is a great endeavor for both the patient and the treatment team. The preoperative workup and preparation has the potential to last for months to achieve optimization of the patient's comorbidities and thus decrease risk. If these measures cannot be met in the community hospital setting, the patients should be referred to a tertiary care facility for evaluation.

Introduction

The biology of hernia formation is extremely complex and the exact pathophysiology of hernia formation is not completely understood. Abnormal collagen metabolism may lead to the development of primary and incisional hernias. There can be genetic basis for these collagen defects and acquired collagen defects related to poor nutrition and smoking [1]. The cost of ventral hernia repairs in 2006 totaled \$3.2 billion dollars [2]. This is a large part of the surgical portion of the health care industry and it is necessary as surgeons to optimize our patients for surgery and choose to our patients wisely to provide the best outcomes for our patients. In abdominal hernias over 10 cm in size, these are repaired with mesh, with or without release of components to achieve mesh coverage with fascia. The specifics of repairs are beyond the scope of this study though any repair has the potential to affect the patient's physiology from a mechanical standpoint. Postoperative morbidities and mortalities including wound complications, respiratory compromise, renal dysfunction, neurological sequela, and cardiac morbidity, sepsis, deep venous thrombosis, and post-op transfusion requirements can occur in the patients and these outcomes are influenced and sometimes prevented by perioperative care. In a community hospital setting, we must be stringent in our selection of ventral hernia patients to ensure that we are delivering quality care and excellent outcomes. There is little data published on overall outcomes in community hospitals versus tertiary care centers regarding hernia repairs over 10 cm in size, however, there is ample literature regarding pre-operative care for patients undergoing hernia repair. Our goal is to identify best practices to make hernia repair and abdominal wall procedures safe in the setting of a community hospital and aid in identification of high risk patients who warrant evaluation by a tertiary care center.

Methods

A review of literature was performed to identify evidence-based practices to develop a conservative preoperative protocol for large hernia and abdominal wall reconstruction patients. The following topics were searched via the Ovid Medline and PubMed databases from 1990 to 2016 for associations with major surgery and hernia repair: hernia size in relation to increased morbidity, preoperative weight loss, BMI, functional status, frailty, glycemic control, nutritional evaluation, immunosuppressant management, nicotine use, and cardiology, pulmonology and anesthesiology preoperative evaluation. The following subjects were excluded: hernia < 10 cm, patients < 18 years of age and articles not written in English. All articles were reviewed by two authors and the results were evaluated for best relevance to patient optimization for those undergoing hernia repairs or other major surgeries if no publications pertaining to hernia surgery were found.

Results

The following recommendations were found after reviewing existing papers on the above areas of interest:

Weight loss

Twenty-four articles pertaining to our criteria were reviewed. Obesity increases the risk of surgical complications and poses operative challenges for the surgeon. Age adjusted estimates indicate that more than two-thirds of adults were either overweight or obese, 34.9% were obese, and 6.4% were extremely obese in 2011-2012 [3]. This is extremely challenging for surgeons who want to provide the best care for their patients, but are concerned about complications. Obesity is a modifiable risk factor that influences postoperative surgical site infection [4,5]. Obesity is also a risk factor for hernia recurrence. A prospective study by Sauerland et al. in 2003 found that even when controlling for the influence of age, gender, hernia size, and surgical technique, obesity remained a significant predictor with a rate ratio of 1.10 per unit BMI (95%-CI: 1.02–1.18; P=0.01) [6]. Preoperative weight loss reduces complications and hernia recurrence, in addition to making the operation less challenging. A study from 2015 by Rosen et al. included 25 patients who were referred to a medical weight loss specialist and successfully lost weight using a modified protein sparing fast prior to complex abdominal wall reconstruction [7]. The mean preoperative weight loss was 24±21 kg (range 2-80 kg). Two patients lost enough weight to be considered non-obese and 22 patients kept the weight off for the study time of 18 months, which decreased overall complications. Morbidly obese patients (BMI greater than 35) benefit from weight loss prior to surgical repair of a hernia. The surgeon and patient must work together to create a tangible goal in a realistic time-frame. Though a BMI less than 35 is preferable, some patients may have difficulty achieving this goal without weight loss surgery.

Functional Status

Six articles on functional status were reviewed. The National Surgical Quality Improvement Program (NSQIP) tracks preoperative functional status, which is an area of increasing interest. A study from 2011 by Albright, et al. examined the preoperative functional health status, using NSQIP definitions, and how it impacts outcomes after ventral hernia repair [8]. The authors reviewed 76,397 patients who underwent ventral hernia repair. Of note, they were not matched in terms of age, BMI, comorbidities, wound classification, presence of incarcerated or strangulated hernia or laparoscopic repair. The authors found that totally dependent patients, who need total assistance for all activities of daily living, had an increased risk for all short-term outcomes including wound occurrence, pneumonia, pulmonary embolism, urinary tract

infection, myocardial infarction, deep venous thrombosis, sepsis and return to the operating room and death ($P < 0.001$). Even partially dependent patients were found to be at increased risk in postoperative complications. A study from 2013 identified 75,865 patients who underwent elective ventral hernia repair [9]. In this study, 1,144 patients were functionally dependent and overall major morbidity in 211 patients was 18.4%. The authors found that increasing age, ascites, preoperative renal failure, and preoperative pulmonary compromise are independent predictors of 30-day mortality. Non-operative management should be considered for any patient who is totally dependent and unable to participate in rehabilitation. Functional status should be seriously considered when choosing who should undergo ventral hernia repair. Those patients identified as frail will potentially benefit from prehabilitation prior to surgery.

Frailty

Four articles on frailty were reviewed. A study by Saxton and Velanovich from 2011 evaluated preoperative frailty and quality of life as predictors of postoperative complications [10]. Preoperative frailty was assessed retrospectively to determine a score using the Canadian Study of Health and Aging 70 Item Frailty Index (FI). The scoring system includes 70 items that can be obtained preoperatively during the initial consultation. Patients who had one or more postoperative complications had higher than median preoperative FI than those who did not. Recently another study used the Hopkins Frailty Score to evaluate patients and intermediately frail or frail patients were predictive of a patient experiencing a postoperative complication [11]. A less complicated way to assess frailty is the Simple “FRAIL” Questionnaire screening tool [12]. This is one of a few validated screening tools suggested by a consensus group from US and international societies on frailty. Of five questions if three or more indicate frailty according to the answer guide the patient is considered frail. While a response of one or two questions indicating frailty classifies the patient as pre-frail. Using the FRAIL scale is very simple and can easily be performed in the office setting when first evaluating a patient. All patients determined to be frail should be seriously considered for non-operative management. Patients who are considered prefrail could potentially benefit from preoperative prehabilitation to optimize their outcome.

Preoperative Imaging

Five articles on preoperative imaging were reviewed. Ventral hernias are often palpable on clinical exam, though patients may have multiple hernias or a body habitus that does not allow for easy assessment of a ventral hernia. A study from by Saber from 2008 found that occult ventral hernia defects are a common finding during laparoscopic hernia repair [13]. In a retrospective review of 146 consecutive LVHRs, 48% of patients had occult defects not detected on preoperative physical exam. With our increasingly obese population, it is difficult to fully appreciate the extent of

hernia formation. Computerized Tomography (CT) scans clearly demonstrate the anatomic site of a hernia sac, the shape and the content of the sac [14,15]. This information is helpful preoperatively to ensure that any visible hernias are repaired during the procedure. CT can also be used to evaluate patients with prior ventral hernia repairs who present with pain [16]. This was a prospective study including 50 patients who presented with symptoms postoperatively after an intraperitoneal Expanded Polytetrafluoroethylene (ePTFE) mesh hernia repair. Patients were evaluated by CT and the diagnosis was confirmed by laparoscopy in all patients. Hernia relapse was correctly diagnosed in 98% of cases by CT and 88% of cases by physical exam. The sensitivity with CT was 100% and exam was 75%. Per the Society of Gastrointestinal and Endoscopic Surgeons guidelines for laparoscopic ventral hernia repair, a pre-operative abdominal CT scan may be ordered or ultrasound may be considered for select patients with suspected ventral hernias to confirm the diagnosis or to aid the surgeon with preoperative planning [17]. There is only low-quality evidence to support this recommendation since there is a lack of research. For our protocol, we will recommend performing a CT abdomen and pelvis preoperatively for planning purposes. Valsalva maneuver is recommended during the CT scan to further delineate the hernia.

Glycemic Control

Ten articles on glycemic control were reviewed. There is little research related to perioperative blood sugar recommendations specifically related to ventral hernia repair patients though research applied generally to the perioperative time course is plentiful. The original research on blood glucose management was related to cardiac surgery. The Society of Thoracic Surgeons practice guidelines report that numerous studies have shown that increased fasting glucose levels preoperatively, during surgery, and after surgery are predictive of increased perioperative morbidity and mortality [18]. Their guidelines recommend blood glucose levels be kept below 180 g/dL and for diabetic patients it is recommended to use an insulin infusion. Additionally, if non-diabetic patients are difficult to control a perioperative infusion is recommended. It is also recommended that preoperative blood glucose be maintained less than 180 and it may be useful to obtain a hemoglobin A1C in diabetic patients and patients at risk for hyperglycemia upon initial consultation. A retrospective study by King, et al. in 2011 found that mean serum glucose concentrations of 150 mg/dL or more during the first 24 hours after non-cardiac surgery were associated with increased rates of postoperative infectious complications (8% of patients) [19]. The most common procedures were herniorrhaphy, carotid endarterectomy and open colectomy. Infections included pneumonia 2.3%, urinary tract infection 2.3%, superficial SSI 2.5%, deep SSI 1.2% and sepsis 1.2%. Won, et al. evaluated postoperative hyperglycemia after open ventral hernia repair and found that postoperative hyperglycemia was a predictor of length of stay, surgical site complications and time to first solid meal [20]. Patients with preoperative blood glucose greater than 140 were

considered to have poor glucose control. Half of patients in this group were not known to have DM preoperatively. This issue was also a concern in another observational cohort study by Koumpan, et al. in 2014 in which patients whose preoperative testing included blood glucose and hemoglobin A1C. 23.2% of the patients were found to be at risk for diabetes, 3.9% had a provisional diagnosis of diabetes ($A1C \geq 6.5$) and 56% patients with diabetes had suboptimal control[21]. Recommendations based on these findings are to check hemoglobin A1C two months prior to surgery and optimize glucose control. The patient's fasting blood sugar should also be checked preoperatively the day of surgery. All patients with elevated blood sugar should be managed with sliding scale insulin preoperatively and postoperatively to maintain blood sugar less than 180 g/dL. If patients are not controlled to less than 180 g/dL after two doses of IV insulin, an insulin drip should be initiated and an endocrinology consultation should be obtained.

Preoperative Nutrition

Three articles on pre-operative nutrition were reviewed. Nutrition is well documented in literature as having a pivotal role in a patient's perioperative course and their ultimate outcome. We sought to find the most impactful parameters to measure preoperatively to ensure that our patients are nutritionally optimized prior to surgery. Van Stijn et al. found in their systematic literature review that in the elderly population, below normal serum albumin levels (<2.5 g/dL) and $>10\%$ weight loss in the prior 6 months were the only nutritional parameters that predicted a negative post-operative outcome [22]. McClave, et al. support this as well as encouraging preoperative intervention with 7-10 days of enteral feedings in a controlled setting for the week preceding the surgery [23]. Nourhashemi, et al. advocate for the use of the Mini Nutritional Assessment tool which is proven in large population studies to aid in identifying which patients are at risk and potentially who could be optimized with proper dietary intervention [24]. In our interpretation of literature, the most straightforward parameters to evaluate are the serum albumin, examining any weight change in the preceding 6 months and utilization of the Mini Nutritional Assessment tool to find potential at risk patients who would benefit from a preoperative nutritionist consultation and subsequent dietary adjustment.

Immunosuppression

Three articles on immunosuppression were reviewed. Immunosuppression is increasingly common in the population, whether it be from steroid use, chemotherapy or immunomodulators treating an array of disease processes. This should be addressed individually with each patient. Often, patients neglect to mention immunosuppressive medications that they receive monthly via infusion or otherwise. Attention must be given to this because it will negatively affect healing if used on a chronic basis. Wang, et al. showed us that < 10 days of corticosteroid use for an acute treatment had no effect on wound healing [25]. However, chronic ste-

roid users of > 30 days prior to surgery have wound complications 2 to 5 times greater than a patient without steroid use. Fortunately, the effect of steroids can be reversed with administration of Vitamin A. Every patient undergoing abdominal wall reconstruction should be specifically asked about corticosteroid use and chronic users benefit from Vitamin A perioperatively. There are multiple classes of drugs used for immunosuppression in transplant patients. The effect of these can be long lasting after cessation of the medication. Again, vigilance on the surgeon's part is necessary to identify those patients who have been on these medications to aid in understanding their risks of undergoing surgery. Because of the numerous immunosuppressants and their respective combinations, it is difficult to quantify a calculated individual risk for these patients [26]. We advocate that in many circumstances, the risk of surgery would far outweigh the benefit, which is problematic in that transplant patients are at increased risk of incisional hernia formation. Patients with autoimmune diseases present a difficulty in that they can have a brief period off their medications, however, it may cause a relapse that was worse than their baseline, resulting in the need for higher medication dosages. The Härle, et al. review gives a synopsis of what medications are safe to continue and which should be stopped prior to surgery, as well as the timing[27]. They also make the important point that the goal is to provide as little immunosuppression as possible while providing as much as is necessary. These patients should be approached with a concerted effort alongside their rheumatologists.

Nicotine Use

One articles on nicotine use was reviewed. The effects of smoking and nicotine on wound healing are well described in literature. It is imperative to establish nicotine use habits with our patients. Patients are often only asked if they smoke which does not address use of other forms of tobacco, nicotine products and second-hand exposure. Sorensen, et al. showed that smoking directly decreases tissue oxygenation and cellular metabolism [28]. The inflammatory response is diminished and the release of proteolytic enzymes and inhibitors is disproportionate. Proliferation, migration, collagen synthesis and deposition are all negatively affected. After smoking cessation, metabolism and tissue oxygenation improve rapidly, however, inflammatory cell response takes 4 weeks to return to normal and the proliferative response will remain impaired. Nicotine alone does not affect the cellular environment but will decrease inflammatory response. From this, we conclude that while any nicotine containing product is ill-advised for our patients, nicotine alone is preferable to smoking. Based on these findings, recommendations are that patients must cease using all nicotine containing products and submit a urine sample the week prior to surgery and the morning of to test for nicotine.

Pulmonary

Two articles on pulmonary preoperative risk stratification were reviewed. Preoperative risk stratification performed by a pul-

monologist is a key component for completeness in evaluating the abdominal wall reconstruction candidate. In the majority of cases, the intra-abdominal compartment will be functionally smaller postoperatively and compress the diaphragm, restricting its movement. Thus, it is imperative to evaluate preoperative Pulmonary Function Tests (PFT's) to assess if the patient can tolerate surgery. Although the amount of change in intra-abdominal volume differs between cases, the patients who have severely dysfunctional PFT's may not tolerate surgery. They may, however, improve their PFT's through exercise as shown by Christopher et al., through medication management or weight loss [29]. Prevention of critical pulmonary events is particularly key in regard to our geriatric population as shown by Ramley, et al. and can be achieved through individualized treatment plans [30]. Appropriate recommendations should be made and complied with prior to return visit for preoperative planning, at which point, their improved PFT's can mark them as ready for surgery from a pulmonary standpoint.

Cardiovascular

Three articles regarding cardiovascular risk stratification were reviewed. We are heavily reliant on our cardiology counterparts to aid us in preoperative risk assessment of our patients. This often includes electrocardiograms, stress tests and echocardiograms. Reddy et al. describe an additional marker, timed stair climbs [31]. In their study, they evaluated multiple parameters through the NSQIP risk calculator to find the strongest predictor of perioperative complications in abdominal surgery and found that a timed stair climb provided the most useful correlation and highest value. We recommend that patients who have poor heart health who want surgery should be evaluated based on the 2014 ACC/AHA Guidelines on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery and be referred to a cardiologist for further testing as appropriate in addition to cardiac rehabilitation pre-operatively.

Anesthesia

Three articles were reviewed on anesthesia and ventral hernia repairs. Our anesthesia colleagues can greatly increase our chances of a successful through mindfulness of anesthetic agents given. Opiates depress respiratory drive, cause sleepiness and potentially make postoperative ambulation and other activities difficult for the patient. Uncontrolled pain can do the same; therefore, emphasis should be placed on non-opiate pain management for our patients. This immediately decreases each of the risks and side effects associated with narcotic use. A prior concern was the increased risk of bleeding from Non-Steroidal Anti-Inflammatory Drugs (NSAIDs) however, there are other alternatives now available. Redan, et al. advocate for usage of liposomal bupivacaine, which can be applied as a nerve block or used diluted throughout the operative field [32]. Ofirmev is another non-narcotic medication that can be used beginning in the preoperative suite to mitigate

pain. Use of epidurals or spinals is not advocated due to some cases of difficulty in ambulation postoperatively, which can slow the recovery process. Intraoperatively, a concern is fluid management, as the patients often experience significant insensible loss in addition to any blood loss. Fluids must be managed carefully so as not to cause fluid overload and negatively affect respiratory function postoperatively. Legrand, et al.'s study showed the cost-effectiveness of utilizing esophageal Doppler or arterial waveform analysis to guide fluid management [33]. It is a simple tool that has the potential to greatly benefit our patients with minimal cost and risk. Many patients are debilitated prior to surgery yet have the ability to improve their functional status. The Perioperative Surgical Home initiative created by and for anesthesiologist's advocates for "Prehabilitation" programs for selected patients. This should be coordinated with patients with poor frailty indices to improve their recovery capability post-surgery.

Discussion

There are numerous modalities that we can employ as surgeons to optimize our patient's outcomes before ventral hernia repair in a community hospital setting. A summarization of recommendations is listed in (Table 1). A drawback in this study is that it is not a comprehensive systematic review. There are other areas that need further research for better recommendations such as management of anticoagulation, type of hernia repair and management of other comorbidities.

Topic:	Recommendations:
Weight Loss	Attempt to achieve a BMI <35
Functional Status	Non-operative management for totally dependent patients, offer rehabilitation to partially dependent patients prior to surgery
Frailty	Non-operative management for frail patients, prehabilitation for pre-frail patients
Pre-operative Imaging	Pre-operative CT Abdomen/pelvis with Valsalva maneuver
Glycemic Control	check hgb A1C 2 months prior to surgery, maintain glucose <180g/dL, if uncontrolled after two doses of IV insulin, initiate an insulin drip and consult endocrinology
Preoperative Nutrition	If serum albumin <2.5 g/dL, >10% weight loss in the preceding 6 months or at risk when evaluated with Mini Nutritional Assessment tool, initiate preoperative nutritionist consultation and subsequent dietary adjustment to normalize albumin prior to surgery
Immunosuppression	Perioperative Vitamin A for patients who have used steroids for >30 days, avoid operating on immunosuppressed patients though it can be concerted with the aid of their oncologist or rheumatologist

Smoking	Nicotine cessation 4 weeks prior to surgery, check urine for nicotine 1 week prior to surgery and the morning of surgery
Pulmonary	Pre-operative evaluation with PFTs and plan for pre-surgical improvement
Cardiovascular	Pre-operative evaluation with EKG/echocardiogram, timed stair climb and plan for pre-surgical improvement
Anesthesia	Pre-operative evaluation with plan for non-opioid pain management, fluid management and pre-habilitation if needed

Table 1: Topics with Corresponding Recommendations.

Conclusion

In summation, abdominal wall reconstruction is a significant undertaking for both the patient and the treatment team. The preoperative workup and preparation has the potential to last for months to achieve optimization of the patient's co-morbidities and thus decrease risk. As the majority of large ventral hernias do not pose risk of strangulation, we do have the luxury of time to ensure that our patients have the best possible outcome. It is our responsibility to walk with them through the necessary steps to achieve this. If this is not achievable for any number of reasons, it is also our responsibility to refer them to an appropriate tertiary care center for evaluation.

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