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EVAR is associated with less malnutrition than open AAA repair

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Abstract

Background—Patients undergoing abdominal aortic aneurysm (**AAA**) repair have high rates of postoperative malnutrition. We examined whether endovascular aneurysm repair (**EVAR**) is associated with reduced postoperative malnutrition compared to open AAA repair.

Methods—The records of patients undergoing AAA repair in the Veterans Affairs (**VA**) Connecticut Healthcare system were reviewed. Primary outcomes were 30-day morbidity, lengths of hospitalization and intensive care unit (**ICU**) stay, duration of intubation, and nutritional risk index (**NRI**) scores.

Results—Sixty-two patients were included (open repair: 37; EVAR: 25). Nutritional parameters were comparable between groups before surgery. Patients treated with EVAR had improved postoperative nutritional profiles as determined by albumin (3.7±0.08 vs. 3.2±0.12; p=0.003), and NRI (97.9±1.3 vs. 88.9±1.8; p=0.0006), compared to patients treated with open repair.

Conclusion—Patients undergoing EVAR developed significantly less postoperative malnutrition compared to those having open repair. EVAR may be a strategy to avoid malnutrition and improve outcomes in patients at risk for malnutrition after undergoing AAA repair.

Short summary—Patients undergoing EVAR developed significantly less postoperative malnutrition compared to those having open repair. Superior nutritional profiles were associated with a lower incidence of postoperative infections and discharge to home. EVAR may be a strategy to avoid malnutrition and improve outcomes in patients at risk for malnutrition after undergoing AAA repair.

Keywords

aneurysm; malnutrition; endovascular

Introduction

Nutrition is essential for adequate wound healing and optimal immune function.(1,2) Multiple studies have shown that malnutrition predisposes surgical patients to worse outcomes. Poor nutrition increases the rates of mortality and morbidity and prolongs hospital stay. (3-7) Low albumin level (less than 3.7 g/dL) was associated with higher mortality and higher infection

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rate in elderly patients undergoing cardiac surgery. (8) In patients undergoing major abdominal surgery, mild malnutrition as determined by a nutritional risk index (**NRI**) between 97.5 and 100 increased the risk of complications by 1.9 times while severe malnutrition (NRI < 83.5) increased the risk to 9.8 times.(9) Veterans are particularly at high risk for malnutrition. Twenty-three percent presented to surgery with albumin level less than 3.5 g/dL in a large multicenter VA study. (10) Of note, veterans cared for at Veterans Affair (**VA**) hospitals are at particularly high risk for development of both preoperative and postoperative malnutrition. For example, in a large multicenter VA study 23% of patients presented to surgery with a serum albumin < 3.5 g/dL. (10)

Patients with vascular disease have high rates of malnutrition. (11) Moreover, as shown in a prior study from our institution, patients undergoing abdominal aortic aneurysm (**AAA**) repair tend to have worse nutritional profile than patients presenting for carotid or peripheral vascular procedures. (12) In a recent meta-analysis looking at 21,178 patients after AAA repair, Lovegrove et al. concluded that endovascular repair has superior perioperative results compared to open repair. Patients treated with the endovascular method had shorter hospital stay, ICU stay, and lower respiratory and cardiac complications. (13) This study is the first to assess the nutritional profile of patients undergoing endovascular AAA repair compared to open repair in a population of veterans.

Methods

The charts of patients who underwent AAA repair at the VA Connecticut healthcare system between 1998 and 2008 were retrospectively reviewed. Three different techniques were used to repair the AAA: open transabdominal, open retroperitoneal, and endovascular; patients that underwent open transabdominal and retroperitoneal repairs were grouped together as the open repair group. The indications for repair were aneurysm diameter more than 5.5 cm, rapid growth rate more than 1cm per year, and symptomatic aneurysm. Patients presenting with aneurysm rupture were not included in the study. Patients that did not have either serum albumin or weight measurement recorded in the postoperative period were excluded from the study. Patient demographics and comorbid conditions were recorded. Chronic renal insufficiency was defined by a baseline creatinine > 1.5 mg/dL. Patient nutritional profile was determined by body mass index (**BMI**), albumin and NRI. BMI was calculated as:

$$\mathrm{BMI}=\mathrm{W}/\mathrm{H}^2 \tag{1}$$

Where W is weight (kilograms) and H is height (meters). NRI was calculated as:

$$\mathrm{NRI}=1.519^{*}\mathrm{Alb}+41.7^{*}\mathrm{W_c}/\mathrm{W_u} \tag{2}$$

Where Alb is serum albumin (g/dL), W_c is current weight (kilograms) or postoperative weight and W_u is usual weight (kilograms) or preoperative weight. Malnutrition was defined by NRI less than 100. (14,15) Patients' weight, BMI, albumin and NRI were recorded before surgery. The same parameters were also recorded postoperatively two weeks after surgery and up to 2 months.

The primary outcomes of the study were 30-day morbidity, length of stay in the hospital, and length of stay in the intensive care unit (**ICU**) as well as duration of intubation. The 30-day morbidity included urinary tract infection (**UTI**), wound infection, pneumonia, acute renal failure, myocardial ischemia and stroke. Acute renal failure was defined by an increase in creatinine of more than 0.5 mg/dL compared to baseline. Myocardial ischemia was defined by a rise in troponin level above normal. Surgical intervention within 30 days of the AAA repair was considered reoperation. The number of patients discharged to home versus a nursing facility in each group was compared.

Results were reported as mean ± standard error (**SEM**). Analysis of variance (**ANOVA**) was used to compare groups. The effects of patient factors on outcome were analyzed by multivariable logistic regression, using backward selection with a threshold of 70% to remove insignificant variables. P values ≤ 0.05 were considered statistically significant. (Statview 5.0, SAS Institute, Cary, NC).

Results

The charts of 157 patients who underwent AAA repair were reviewed. Sixty-two patients had complete nutritional parameters recorded in both the preoperative and the postoperative periods and form the subjects of this study; there were 37 open repairs and 25 endovascular repairs. The age and comorbid conditions of the two groups were comparable (Table 1). The patients in the endovascular repair group had a trend toward higher incidence of diabetes (32% vs 19%, p=0.2) and cancer (44% vs 29%, p=0.3) compared to the patients in the open group. However, these differences were not statistically significant. The average aneurysm size was 60.5 mm in the open group and 56.3mm in the endovascular (p=0.2). Aneurysms were discovered by screening (55%) or incidentally (42%). In this study population, patients undergoing open repair were more likely to present with abdominal pain (13%) compared to patients undergoing endovascular repair (0%, p=0.05). Table 2 shows the nutritional parameters of the two groups before and after surgery. There were no differences in BMI (27.1 ± 0.8 vs. 28.9 ± 1.0, p= 0.2), albumin (4.2 ± 0.08 vs. 4.1 ± 0.1, p=0.5), and NRI (105.1 ± 1.3 vs. 103.6 ± 1.4, p=0.5) between the two groups before surgery. Postoperatively, patients treated with an endovascular procedure had consistently better nutritional profile than patients treated with an open procedure. The patients in the endovascular group had higher BMI (28.4 ± 0.9 vs. 25.8 ± 0.8, p=0.05), serum albumin (3.7 ± 0.08 vs. 3.2 ± 0.12, p=0.003), and NRI (97.9 ± 1.3 vs. 88.9 ± 1.8, p=0.0006).

The patients undergoing EVAR also had shorter hospital LOS (4.0 ± 0.6 vs. 14.1 ± 2.3, p=0.0008), spent fewer days on the ventilator (0.04 ± 0.04 vs. 3.8 ± 1.7, p=0.04), and in the ICU (2.20 ± 0.3 vs. 8.4 ± 1.8, p=0.009) compared to the patients undergoing open repair (Table 3). There were trends towards more wound infections (11% vs. 8%), pneumonias (11% vs. 0%), urinary tract infections (16% vs. 8%), and overall infections (32% vs. 16%) in the open repair group, although these trends did not reach statistical significance. The rates of stroke (3% vs. 0%, p=0.45) and myocardial ischemia (46% vs. 40%, p=0.74) were also comparable between the two groups. Three patients in the open repair group required reintervention (8%) within 30 days of the initial surgery. The first patient had a small bowel injury identified on postoperative day five. The second patient was taken back three days after open transabdominal repair for persistent bleeding. The third patient developed a radial artery pseudoaneurysm related to placement of an arterial line and required surgical repair. Ninety-two percent of patients undergoing endovascular repair were discharged home as compared to only 70% of the patients in the open repair group (p=0.04), with the remaining patients in each group discharged to rehabilitation facilities.

Multivariable logistic regression showed a statistically significant association between postoperative NRI, discharge home and incidence of pneumonia (Table 4). Patients with higher postoperative NRI were more likely to be discharged home (OR =1.1) and less likely to acquire pneumonia (OR = 0.8) after surgery. A history of cancer and smoking were the best predictors of postoperative malnutrition.

Discussion

Since the introduction of endovascular therapy for AAA in 1991(16), there has been increasing evidence supporting improved perioperative mortality and morbidity with EVAR compared to open repair.(17,18) The superiority of EVAR is attributed to multiple factors. The minimally invasive nature of endovascular therapy reduces operative trauma, operative time, and allows faster postoperative recovery. Hassen et al. showed that EVAR is associated with less incidence of systemic inflammatory response syndrome (**SIRS**) compared to open repair. (19). Our results demonstrate an additional advantage for EVAR, i.e. improved postoperative nutritional profile. The open and the endovascular groups were not different before surgery with respect to their nutrition as measured by BMI, albumin, and NRI. After surgery, both groups exhibited a drop in all three nutritional parameters. However, the endovascular group maintained a statistically significant better nutritional profile. This result is not surprising because patients undergoing endovascular surgery usually resume diet as early as the day of surgery. On the other hand, transabdominal AAA repair is performed with significant bowel manipulation and breech of the peritoneal cavity. The patients usually do not resume diet before the second day after surgery and even then they are at a significant risk of developing an ileus. Thus, perioperative starvation is significantly prolonged with open repair.

Endovascular therapy allowed patients to recover faster by decreasing the length of ICU stay, the number of days on the ventilator, and the total number of days spent in the hospital. In fact, patients treated with EVAR were shown consistently and in multiple randomized trials to require less intensive unit care and less hospitalization compared to patients treated with open repair.(18) Furthermore, 92% of the patients in the EVAR group were discharged home compared to only 70% in the open group. This finding was further supported by the multivariate analysis showing a statistically significant correlation between higher postoperative NRI and the likelihood to be discharged home.

The results of this study show a persistent trend towards higher infection rates in the open group. However, the differences in UTIs, pneumonias, wound infections, and all infections combined were not statistically significant. Several studies in the literature showed similar trends between infection and malnutrition without reaching statistical significance. Clugston et al. reported a significantly higher rate of malnutrition in jaundiced patients presenting for surgical intervention. Patients with jaundice had a trend towards higher morbidity and mortality but this trend did not reach statistical significance. (20) Similarly, Rich et al. studied the effects of malnutrition on elderly patients undergoing cardiac surgery. The authors demonstrated an increase in cardiac complications and prolonged hospitalization in malnourished patients. Their data showed trends toward higher infection rates and higher mortality in patients with albumin less than 3.5 g/dL. The trends did not reach statistical significance. (21) It is likely that, in both other papers as well as in this report, the relatively small number of patients does not provide enough statistical power, creating a type II error. On the other hand, the association of malnutrition and septic complications in vascular patients was demonstrated in the literature by Durkin et al. (11) Similarly, Gibbs et al. found in a population of more than 50,000 veterans from 44 VA centers that patients with albumin less than 3.5 g/dL have higher incidence of pneumonias, UTIs, and wound infections at 30 days after surgery. (10) In concordance with this evidence, the multivariate regression in this study demonstrated a negative correlation between higher postoperative NRI and incidence of pneumonia (Table 4). Thus, malnutrition is an established risk factor for infection in the literature and this is consistent with the trends encountered in this study.

The major limitation of this study is that it is retrospective and based on chart review. We restricted our inclusion criteria to patients who had a serum albumin as well as a weight recorded in the period of 2 weeks postoperatively and up to 2 months. This time frame is optimal to discern subtle changes in nutritional parameters. Measurements in the immediate postoperative period may be confounded by changes in fluid status and inflammatory mediators. On the other hand, waiting for more than 2 months could allow complete recovery of most patients and return to preoperative baseline. That reduced the sample size significantly from 157 to 62 patients.

Malnutrition is prevalent in vascular patients and may be related to the older age of these patients. The average age of our patient population is 73.4 years, similar to that reported in the EVAR1 study (17) and the DREAM trial. (18) Elderly patients are particularly vulnerable to malnutrition.(21,22) Awareness of the risks of malnutrition have pushed many surgeons to become more aggressive with resumption of diet postoperatively even after major gastrointestinal surgery.(23) On the other hand, there is a paucity of data relating prevention of complications to preoperative nutritional supplementation that reflect clinical practice outside of trials. Moreover, most of the studies published have examined the effect of preoperative nutritional supplementation in patients undergoing gastrointestinal surgery and oncologic procedures. Patients presenting for AAA repair may constitute a group that would particularly benefit from a preoperative intervention to optimize nutritional status.

In conclusion, EVAR has several proven short term advantages over open AAA repair. This study provides an additional advantage related to superior nutritional profile in the postoperative period. Despite this advantage, vascular patients undergoing AAA repair do develop malnutrition after endovascular surgery.

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Table I

Patient Demographics and Aneurysm

	All patients	Open Repair	EVAR	p value
N	62	37	25	
Age (yrs)	73.9 ± 1.0	73.9 ± 1.3	73.2 ± 1.5	0.9
CAD	36 (58%)	23 (62%)	13 (52%)	0.7
Arrythmia	9 (15%)	5(13%)	4 (16%)	0.8
Carotid disease	10 (16%)	5 (13%)	5 (20%)	0.5
PVD	23 (37%)	16 (43%)	7 (28%)	0.2
Hypertension	49 (79%)	25 (67%)	19 (76%)	0.6
Diabetes	15 (24%)	7 (19%)	8 (32%)	0.2
Hyperlipidemia	42 (67%)	25 (67%)	17 (68%)	0.9
CRI	11 (17%)	6 (16%)	5 (20%)	0.7
COPD	27 (44%)	18 (49%)	9 (36%)	0.3
Hypothyroidism	7 (11%)	3 (8%)	4 (16%)	0.3
Cancer	22 (35%)	11 (29%)	11 (44%)	0.3
Cardiac Stent	11 (18%)	8 (22%)	3 (12%)	0.3
CABG	14 (23%)	9 (24%)	5 (20%)	0.8
Abdominal surgery	39 (63%)	24 (65%)	15 (60%)	0.7
Aneurysm characteristics				
Size (mm)	58.8 ± 1.5	60.5 ± 1.5	56.3 ± 2.9	0.2
Screening	34 (55%)	19 (51%)	15 (60%)	0.5
Incidental	26 (42%)	17 (46%)	9 (36%)	0.4
Abdominal pain	5 (8%)	5 (13%)	0 (0%)	0.05*

CAD - Coronary Artery Disease, PVD - Peripheral Vascular Disease

CRI - Chronic Renal Insufficiency, COPD - Chronic Obstructive Pulmonary Disease

CABG - Coronary Artery Bypass Graft

*Significant Values

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Table II

Nutritional Parameters

	All patients	Open Repair	EVAR	p value
N	62	37	25	
Preoperative				
BMI (Kg/m^2)	27.8 ± 0.6	27.1 ± 0.8	28.9 ± 1.0	0.2
Albumin (g/dL)	4.1 ± 0.06	4.2 ± 0.08	4.1 ± 0.1	0.5
NRI	104.5 ± 1.0	105.1 ± 1.3	103.6 ± 1.4	0.5
Postoperative				
BMI (Kg/m^2)	26.8 ± 0.6	25.8 ± 0.8	28.4 ± 0.9	0.05 *
Albumin (g/dL)	3.4 ± 0.08	3.2 ± 0.12	3.7 ± 0.08	0.003 *
NRI	92.3 ± 1.3	88.9 ± 1.8	97.9 ± 1.3	0.0006 *

BMI - Body Mass Index, NRI - Nutritional Risk Index

* Significant Values

Table III

Outcomes of Repair

	All patients	Open Repair	EVAR	p value
N	62	37	25	
LOS (days)	11.3 ± 1.9	14.1 ± 2.3	4.0 ± 0.6	0.0008 *
Days on ventilator	3.0 ± 1.1	3.8 ± 1.7	0.04 ± 0.04	0.04 *
Days in ICU	6.6 ± 1.2	8.4 ± 1.8	2.20 ± 0.3	0.009 *
Wound infection	6 (10%)	4 (11%)	2 (8%)	0.8
Pneumonia	4 (6%)	4 (11%)	0 (0%)	0.09
UTI	8 (13%)	6 (16%)	2 (8%)	0.4
All infections	16 (26%)	12 (32%)	4 (16%)	0.17
Stroke	1 (2%)	1 (3%)	0 (0%)	0.45
ARF	4 (6%)	4 (11%)	0 (0%)	0.09
Troponin elevation	27 (44 %)	17 (46%)	10 (40%)	0.74
Reoperation	3 (5%)	3 (8%)	0 (0%)	0.16
Discharge home	49 (79%)	26 (70%)	23 (92%)	0.04 *

LOS - Length of Stay, UTI - Urinary Tract Infection, ARF - Acute Renal Failure

* Significant Values

Table IV

Multivariate Analysis of Outcomes

	P Value	Odds Ratio	95% CI
Discharge to Home			
Pre-op NRI	0.28	0.9	0.9 - 1.0
Post-op NRI	0.05 *	1.1	1.0 - 1.2
Age	0.02 *	0.8	0.8 - 0.9
Post Op Pneumonia			
Pre-op NRI	0.32	1.1	0.9 - 1.3
Post-op NRI	0.02 *	0.8	0.6 - 0.9
Age	0.89	0.9	0.8 - 1.2
Pre-op Creatinine	0.42	1.6	0.5 - 4.7
Post-Op Malnutrition			
CAD	0.5	0.6	0.2 - 2.4
CRI	0.13	6.0	0.6 - 59
COPD	0.19	2.7	0.6 - 12
Cancer History	0.02 *	0.1	0.02 - 0.7
Smoker	0.03 *	0.1	0.02 - 0.8

NRI - Nutritional Risk Index, LOS - Length of Stay, CAD - Coronary Artery Disease

CRI - Chronic Renal Insufficiency, COPD - Chronic Obstructive Pulmonary Disease

*Significant Values