

process. Opportunities for standardization and enhancement of the informed consent process should be pursued by consensus groups.

**Impact of Early and Delayed Postoperative Myocardial Infarction on Late Survival in Patients Undergoing Vascular Surgery**

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**Objectives:** Perioperative myocardial infarction (MI) has been shown to increase early and late mortality after vascular surgical (VS) procedures. We evaluated the frequency and timing of MI after VS and its impact on survival across a heterogeneous cohort of VS patients.

**Methods:** All patients undergoing a spectrum of VS (open aortic resection, endovascular aneurysm repair/thoracic endovascular aortic repair, carotid endarterectomy/carotid angioplasty and stenting, or lower extremity bypass) from July 2007 to May 2012 were included. MI was diagnosed by electrocardiogram changes, elevated troponin, or diagnosis by a cardiologist. Patients were identified by Current Procedural Terminology code using an institutional patient data research registry consisting of administrative/clinical data and stratified according to the temporal relationship of the MI to the indexed procedure (early:  $\leq 30$  days; intermediate: 1 month to 1 year; late:  $> 1$  year). Univariate and multivariate methods were used to identify predictors of MI and its impact on survival.

**Results:** We identified 2984 patients who underwent VS during the study interval. Early MI was observed in 110 (3.7%), intermediate MI in 66 (2.2%), and late MI in 136 (4.5%). Patient age per year (odds ratio [OR], 1.02; 95% confidence interval [CI], 1.0002-1.05;  $P = .03$ ) and history of coronary artery disease (CAD; OR, 4.6; 95% CI, 2.8-7.5;  $P < .01$ ) independently predicted risk of early MI. Intermediate MI was predicted by history of CAD (OR, 3.2; 95% CI, 1.9-5.3;  $P < .01$ ) and diabetes (OR, 1.7; 95% CI, 1.1-2.7;  $P = .02$ ). Procedure type was not predictive of perioperative or delayed MI. Patients who had an MI within the first year had a lower (log-rank  $P < .001$ ) survival at 1 year ( $77\% \pm 3\%$  vs  $92\% \pm 1\%$ ) and 5 years ( $61\% \pm 5\%$  vs  $71\% \pm 2\%$ ; Fig). Risk-adjusted (age, gender, CAD, race, hypertension) Cox regression modeling showed that early MI (HR, 1.5; 95% CI, 1.01-2.2;  $P = .04$ ) and, more importantly, intermediate MI (HR, 2.2; 95% CI, 1.5-3.2;  $P < .01$ ) independently predicted increase in late mortality, whereas late MI had no impact (HR, 1.03; 95% CI, 0.7-1.6;  $P = .9$ ).

**Conclusions:** The incidence of MI within the first year after major vascular procedures remains low yet is predicted by a history of CAD and diabetes. Readily identifiable high-risk patients should have focused intensive medical therapy before and after VS.

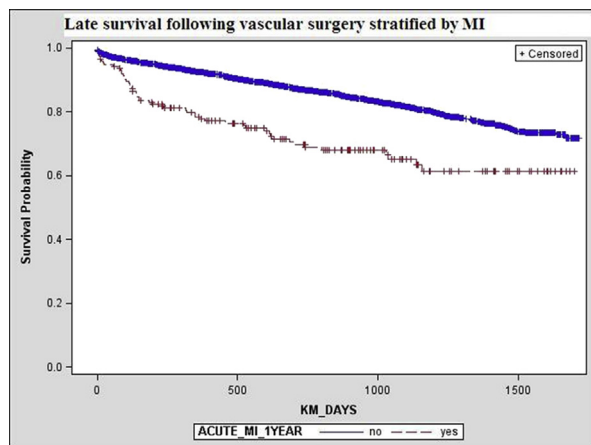


Fig. Late survival in vascular surgery patients stratified by MI.

**Outcomes of Reoperative Open or Endovascular Interventions to Treat Patients With Failing Open Mesenteric Reconstructions for Mesenteric Ischemia**

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**Objectives:** Outcomes of reinterventions for failing open mesenteric reconstructions (ORs) have not been described. Reoperative ORs (R-ORs) can be challenging because of excessive scar and more advanced mesenteric disease. The purpose of this study was to evaluate outcomes of R-ORs and endovascular revascularizations (ERs) in patients with stenosis or occlusion of ORs.

**Methods:** We reviewed a cohort of 593 patients treated for chronic mesenteric ischemia (CMI) in two academic centers from 1991 to 2013. Clinical data and outcomes of patients treated for failing ORs with R-ORs or ERs were included in the analysis. Case-control propensity score matching was used to analyze outcomes of R-ORs compared with patients who underwent their first-time ORs for CMI. End points were early and late mortality, morbidity, patency rates, and freedom from symptom recurrence and reintervention.

**Results:** There were 47 patients (5 male, 42 female; mean age,  $58 \pm 13$  years) treated by reinterventions for failing ORs. Clinical presentation was CMI in 38 patients (81%) or acute mesenteric ischemia (AMI) in nine (19%). Reinterventions included R-ORs in 28 patients (19 CMI and 9 AMI) and ERs in 19, all for CMI. Early mortality was 22% in patients treated by R-ORs for AMI. There were no early deaths among patients treated for CMI with R-OR or ER. Early morbidity was 78% for R-ORs in patients treated for AMI. Morbidity was significantly higher for R-ORs than for ERs in patients with CMI (68% vs 16%;  $P < .001$ ). Mean follow-up was  $50 \pm 60$  months. Patient survival at 5 years was  $60\% \pm 8\%$  for the entire cohort. Primary and secondary patency at 1 year was  $61\% \pm 10\%$  and  $92\% \pm 8\%$  for R-ORs and  $77\% \pm 10\%$  and 100% for ERs, respectively, ( $P =$  not significant). Freedom from symptom recurrence and reinterventions at 1 year was  $88\% \pm 6\%$  and  $87\% \pm 7\%$  for R-ORs and  $83\% \pm 8\%$  and  $71\% \pm 10\%$  for ERs. Using propensity score matched comparison, R-ORs were associated with similar mortality, morbidity, patency, recurrence, and reintervention rates compared with first-time ORs.

**Conclusions:** Reinterventions for failing open mesenteric reconstructions using R-OR or ER interventions carry similar mortality, patency, recurrence, and reintervention rates. Early morbidity is significantly lower with endovascular compared with R-ORs performed for CMI. Outcomes of R-ORs are similar to those obtained with the first time ORs in patients with CMI.

**Multicenter Experience With Retrograde Open Mesenteric Artery Stenting via Laparotomy for Treatment of Acute and Chronic Mesenteric Ischemia**

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**Objectives:** Retrograde open mesenteric stenting (ROMS) via laparotomy was introduced as an alternative to surgical bypass in patients with acute mesenteric ischemia (AMI). The purpose of this study was to evaluate the indications and outcomes of ROMS for treatment of acute and chronic mesenteric ischemia (CMI).

**Methods:** We reviewed the clinical data and outcomes of all consecutive patients treated by ROMS in seven academic centers from 2001 to 2013. ROMS was performed via laparotomy with retrograde access into the target mesenteric artery and stent placement using a retrograde or antegrade approach, or both. End points were early and late ( $> 30$  days) mortality, morbidity, patient survival, patency rates, and freedom from symptom recurrence and reintervention.

**Results:** There were 54 patients, 13 male and 41 female, with mean age of  $71 \pm 11$  years. Indications for ROMS were AMI in 44 patients (81%) and CMI with flush mesenteric occlusions in 10 (19%). Four celiac axis lesions and 53 superior mesenteric artery lesions were treated by stenting. The mean stent length was  $42 \pm 25$  mm. Retrograde mesenteric access was used in all patients, but 16 required a simultaneous antegrade approach. The retrograde puncture was closed primarily in 35 patients or with patch angioplasty in 17 and manual compression in one. Bowel resection was needed in 29 patients (54%) with AMI because of perforation or gangrene. Technical success was 98%. One patient was treated by bypass because an attempted ROMS failed. Early mortality was 41% (18 of 44) for AMI and 10% (1 of 10) for CMI ( $P < .01$ ). Early morbidity was 73% for AMI and 50% for CMI ( $P < .01$ ). Mean follow-up was  $11 \pm 19$  months. Patient survival at 1 year was  $36\% \pm 11\%$  for AMI and  $68\% \pm 12\%$  for CMI ( $P = .29$ ). For the entire cohort, primary and secondary patency was  $65\% \pm 11\%$  and

73% ± 13% at 3 years. Freedom from symptom recurrence and reinterventions was 75% ± 10% and 71% ± 10% at the same interval.

**Conclusions:** ROMS offers an alternative to bypass and percutaneous stenting in patients with AMI who require abdominal exploration for suspected bowel gangrene and for those with flush mesenteric occlusions who are not ideal candidates for percutaneous stenting. The technique can be performed with high technical success. Mortality remains high in patients with AMI. Morbidity is high for patients with AMI and CMI. Patency rates and freedom from symptom recurrence and reinterventions are comparable to results of stenting using percutaneous technique.

#### Standardization of a Multidisciplinary Clinical Pathway Improves Outcomes in Ruptured Abdominal Aortic Aneurysms

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**Objectives:** Although standardized protocols have been shown to improve safety in aviation and multidisciplinary care improves outcomes in oncologic surgery, a standardized multidisciplinary pathway for the treatment of ruptured abdominal aortic aneurysms (rAAAs) has not yet been described. We aim to describe and evaluate a standardized clinical pathway for the care of rAAAs.

**Methods:** Since 2002, our institution has managed an average of 30 rAAAs per year. In 2007, we developed and initiated a multidisciplinary clinical pathway to aid in expediting the care of patients with a rAAA from initial presentation at the referring facility to definitive care. This pathway includes electronic publication of prehospital care protocols for referring providers as well as a streamlined system for electronic transfer of imaging and records from other institutions. We have initiated protocols for prehospital and transfer providers, including guidelines for permissive hypotension as well as emergent patient registration and emergency department bypass and transfer directly to the operating room once the patient arrives at our institution. Circulating and scrub nurse protocols for education and operating room preparation are in place as well as anesthetic guidelines, including delay of induction until proximal aortic control is achieved. Finally, the endovascular rAAA repair (EVAR) procedure and postoperative transfer of care is outlined in detail to achieve optimal patient outcomes.

**Results:** Before initiation of the multidisciplinary pathway, 131 patients with a rAAA presented between 2002 and 2007, and 128 of these patients were treated with open surgical repair, with 30-day mortality rate of 57.8%. After initiation of our multidisciplinary clinical pathway, 118 patients presented with a rAAA between July 2007 and February 2012. One hundred were treated surgically, and 72 survived to discharge, with an overall 30-day mortality of 28%. Subset analysis revealed 21 of 39 patients treated with open surgery survived, with 30-day mortality of 46%, and 51 of 61 patients treated with EVAR survived, with 30-day mortality of 16%.

**Conclusions:** rAAA remains a clinical challenge despite advances in preoperative, intraoperative, and postoperative care. Although adherence to protocols across multiple sites and specialties can be difficult, standardization of a multidisciplinary clinical pathway from prehospital transfer through postoperative intensive care unit care is associated with improved patient outcomes after open repair and EVAR of rAAAs, suggesting there is benefit beyond the "EVAR-first protocol" to a standardized multidisciplinary pathway.

#### Midterm Outcomes After Prearteriotomy Guidewire Access (PAGA) With Antegrade Recanalization in Patients With Extensive Aortoiliac Occlusive Disease Without the Use of a Re-entry Device

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**Objectives:** A prearteriotomy guidewire access (PAGA) was described to treat bulky iliofemoral occlusive disease. A wire is passed first from the groin into the aorta, before the arteriotomy, to increase technical success. Achieving retrograde intraluminal access in extensive aortoiliac occlusive disease (AIFOD) can be a challenge. We modified the PAGA technique to successfully recanalize extensive aortoiliac occlusion performed with adjunctive femoral artery reconstruction as an alternative to extra-anatomic bypass in high-risk patients for aortobifemoral bypass.

**Methods:** We approach these cases via a left brachial approach and groin cutdown. Once brachial access is obtained, the patient is systematically heparinized. Then, a 90-cm destination sheath is placed in the distal aorta. A stiff glidewire and a guide catheter are used to recanalize the chronic AIFOD. The wire is passed in an antegrade fashion across the AIFOD all the way toward the femoral head. A femoral arteriotomy is done to capture the wire, thus establishing access from the groin into the patent aorta.

External iliac artery and femoral artery endarterectomy is performed around the wire. The wire is passed through the patch before the patch angioplasty is completed. Once femoral revascularization is done, a sheath is placed over the wire, and retrograde iliac stenting is performed to the level above the patch to avoid crossing the inguinal ligament.

**Results:** This procedure has been performed in 18 patients (13 with critical limb ischemia, 5 with claudication) with 94.4% technical success, without the use of a re-entry device. Four patients required an interposition graft, and 14 (77.8%) required femoral endarterectomy with patch angioplasty. The procedures in 10 patients (55.5%) were done under spinal anesthesia. All patients had significant cardiopulmonary comorbidities, and five had had multiple abdominal surgeries. One patient (5.5%) required oral antibiotics to treat a superficial wound infection. One patient (5.5%) died ≤30 days (massive myocardial infarction), and one patient required an axillobifemoral bypass at 6 months for acute stent occlusion. The remaining 17 patients were symptom free, with patent stents, at a mean of 16.5 months (range, 12-22 months).

**Conclusions:** Modified PAGA can be used to safely revascularize high-risk patients with extensive AIFOD, with acceptable complication rate and patency. This procedure is currently offered to patients with aortoiliac disease, not candidates for aortobifemoral bypass, instead of an extra-anatomic bypass.

#### Robotic Vascular Surgery

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**Objectives:** The feasibility of laparoscopic aortic surgery has been adequately demonstrated. Our clinical experience with robot-assisted aortoiliac reconstruction for occlusive diseases, aneurysms, endoleak type II treatment, and hybrid procedures performed using the da Vinci system is described.

**Methods:** Between November 2005 and August 2013, we performed 290 robot-assisted vascular procedures. A total of 212 patients were prospectively evaluated for occlusive diseases, 57 patients for abdominal aortic aneurysm, 4 for a common iliac artery aneurysm, 3 for a splenic artery aneurysm, 1 for an internal mammary artery aneurysm, 5 for hybrid procedures, and 8 for endoleak type II treatment after endovascular aneurysm repair. The robotic system was applied to construct the vascular anastomosis, for the thromboendarterectomy, for the aortoiliac reconstruction with a closure patch, for dissection of the splenic artery, and for the posterior peritoneal suture. A combination of conventional laparoscopic and robotic surgeries were initially included. A modified, fully robotic approach, without laparoscopic surgery, was used in the last 120 cases in our series.

**Results:** A total of 279 cases (96%) were successfully completed robotically. One patient's surgery was discontinued during laparoscopy due to heavy aortic calcification. In 10 patients (3.4%), conversion was necessary. The 30-day mortality rate was 0.3%, and early nonlethal postoperative complications were observed in six patients (2%).

**Conclusions:** Our experience with robot-assisted laparoscopic surgery has demonstrated the feasibility of this technique for occlusive diseases, aneurysms, endoleak type II treatment after endovascular aneurysm repair, and hybrid procedures. The da Vinci robotic system facilitated the creation of the aortic anastomosis, and shortened the aortic clamping time compared with purely laparoscopic techniques.

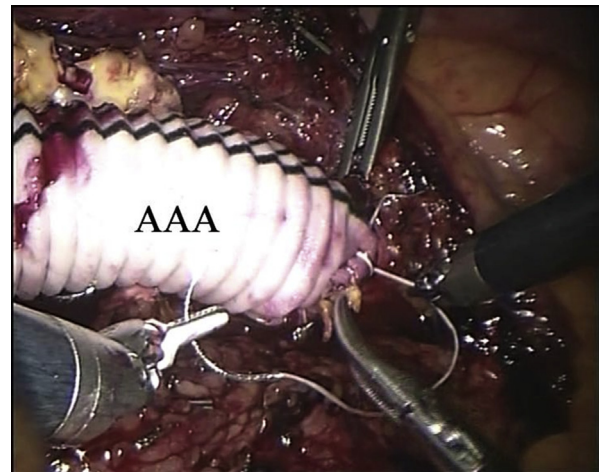


Fig. The central anastomosis of AAA.