Impact of early and delayed post-op myocardial infarction on late survival in patients undergoing vascular surgery

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OBJECTIVE: Perioperative MI has been shown to increase early and late mortality following 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, EVAR/TEVAR, CEA/CAS, or lower extremity bypass) from 7/2007 – 5/2012 were included and MI was diagnosed by EKG changes, elevated troponin, or diagnosis by a cardiologist. Patients were identified by CPT code using an institutional patient data research registry comprised of administrative/clinical data and stratified according to the temporal relationship of the MI to the indexed procedure (early = within 30 days, intermediate = 1month to 1year and 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 yr.) (OR1.02 [95%CI:1.0002 – 1.05]; P=0.03) and history of CAD (OR4.6 [95%CI:2.8–7.5]; P<0.01) independently predicted risk of early MI. Intermediate MI was predicted by history of CAD (OR3.2 [95%CI:1.9–5.3]; P<0.01) and diabetes (OR1.7 [95%CI:1.1–2.7]; P=0.02). Procedure type was not predictive of peri-op or delayed MI. Patients having an MI within the first year had a lower (Log rank P<0.001) survival at one (77±3% 1yr. vs. 92±1%) and five years (61±5% vs. 71±2%) (Figure1). Risk adjusted (age, gender, CAD, race, HTN) Cox regression modeling showed that early MI (HR1.5 [95%CI:1.01–2.2]; P=0.04) and more importantly intermediate MI (HR2.2 [95%CI:1.5–3.2]; P<0.01) independently predicted increase in late mortality, while late MI had no impact (HR1.03 [95%CI:0.7–1.6]; P=0.9).

CONCLUSIONS: Incidence of MI within the first year after major vascular procedures remains low, yet is predicted by a history of CAD and diabetes. Readily indentifiable high risk should have focused intensive medical therapy before and after VS.
OBJECTIVES: Outcomes of re-interventions for failing open mesenteric reconstructions (ORs) have not been described. Reoperative open mesenteric reconstructions (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 as compared to 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 re-intervention.

RESULTS: There were 47 patients (5 male, 42 female; mean age, 58±13 years) treated by re-interventions for failing ORs. Clinical presentation was CMI in 38 patients (81%) or acute mesenteric ischemia (AMI) in 9 (19%). Re-interventions 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 either R-OR or ER. Early morbidity was 78% for R-ORs in patients treated for AMI. Morbidity was significantly higher for R-ORs as compared to ERs in patients with CMI (68% vs 16%; P<0.001). Mean follow up was 50±60 months. Patient survival at 5-years was 60±8% for entire cohort. Primary and secondary patency at 1-year was 61±10% and 92±8% for R-ORs, and 72±10% and 100% for ERs (P=NS). Freedom from symptom recurrence and re-interventions at 1-year was 88±6% and 87±7% for R-ORs, and 83±8% and 71±10% for ERs. Using propensity-score matched comparison R-ORs were associated with similar mortality, morbidity, patency, recurrence and reintervention rates as compared to first time ORs.

CONCLUSIONS: Re-interventions for failing open mesenteric reconstructions using reoperative open or endovascular interventions carry similar mortality, patency, recurrence and re-intervention rates. Early morbidity is significantly lower with endovascular as compared to reoperative open reconstructions performed for CMI. Outcomes of reoperative open reconstructions are similar to those obtained with the first time open reconstructions in patients with CMI.
OBJECTIVE: 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 retrograde and/or antegrade approach. End-points were early and late (>30 days) mortality, morbidity, patient survival, patency rates and freedom from symptom recurrence and re-intervention.

RESULTS: There were 54 patients, 13 male and 41 female, with mean age of 71±11 years. Indications for ROMS were AMI in 44 patients (81%) and CMI with flush mesenteric occlusions in 10 (19%). Fifty-three superior mesenteric artery and 4 celiac axis lesions were treated by stenting; mean stent length was 42±25mm. Retrograde mesenteric access was used in all patients, but 16 required 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 failed attempted ROMS and was treated by bypass. Early mortality was 41% (18/44) for AMI and 10% (1/10) for CMI (P<0.01). Early morbidity was 73% for AMI and 50% for CMI (P<0.01). Mean follow up was 11±19 months. Patient survival at 1-year was 36±11% for AMI and 68±12% for CMI (P=0.29). For the entire cohort, primary and secondary patency were 65±11% and 73±13% at 3-years. Freedom from symptom recurrence and re-interventions were 75±10% and 71±10% at same interval.

CONCLUSION: 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 re-interventions are comparable to results of stenting using percutaneous technique.
OBJECTIVES: While 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 rAAA has not yet been described. We aim to describe and evaluate a standardized clinical pathway for the care of rAAA.

METHODS: Since 2002 our institution has managed an average of 30 rAAA per year. In 2007 we developed and initiated a multidisciplinary clinical pathway to aid in expediting care of patients with 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 streamlined system for electronic transfer of outside imaging and records. We have initiated protocols for prehospital and transfer providers including guidelines for permissive hypotension as well as emergent patient registration, 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 OR preparation are in place, as well as anesthetic guidelines including delay of induction until proximal aortic control is achieved. Finally, the rEVAR procedure and post-operative transfer of care is outlined in detail to achieve optimal patient outcomes.

RESULTS: Before initiation of the multidisciplinary pathway, 131 patients with rAAA presented between 2002 and 2007. 128 of these patients were treated with open surgical repair (OSR) with 30-day mortality rate of 57.8%. After initiation of our multidisciplinary clinical pathway, 118 patients presented with rAAA between July 2007 and February 2012. 100 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 OSR 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 pre, intra and postoperative care. While adherence to protocols across multiple sites and specialties can be difficult, standardization of a multidisciplinary clinical pathway from prehospital transfer through postoperative ICU care is associated with improved patient outcomes following open and endovascular repair of rAAA suggesting there is benefit beyond the “EVAR first protocol” to a standardized multidisciplinary pathway.
Objective: Quantify the effect of multi-disciplinary care upon amputation-free survival (AFS), and wound healing among chronic critical limb ischemia (CLI) patients.

Methods: We retrospectively reviewed a single-center, prospectively maintained database of consecutive, CLI patients presenting to the Vascular Surgery service. Subjects who received initial and follow-up wound care from the multi-disciplinary team (MWC; Vascular Surgery, Plastic Surgery and Podiatric Surgery), were compared to patients who received standard wound care (SWC; heterogeneous mixture of nurses, General Surgeons, internists and/or the patients themselves). Allocation of patients to either arm was determined by the referring physician or attending vascular surgeon at the time of consultation.

Results: Between August, 2010 and June, 2012, 145 patients (91 male, 63%) with CLI were evaluated by the Vascular Surgery Service with a median follow-up of 539 (IQR 314, 679) days. 85 subjects presented with ischemic tissue loss (N=39; Rutherford category 5; N=46, Rutherford category 6). Within this cohort 60% (N=51) had MWC, and 40% (N=34) had SWC. 59 (69%) subjects underwent revascularization (34=endovascular, N=18=open, 7=hybrid), 11 (13%) were managed with primary major amputation. AFS (mean, +/- se) was superior for the MWC arm (593 +/- 53.5 versus 281 +/- 38.2 days; HR=2.14, 95% CI, 1.14, 4.04; p=0.02, X²). Wound-healing (mean +/- se) favored the MWC arm (426.1 +/- 31.1 versus 610 +/- 91 days), which was not statistically significant (HR=1.33; 95% CI 0.54, 3.28; p=0.53, X²).

Multivariate analysis revealed the following independently predicted AFS: revascularization (HR=2.94; 95% CI 1.48, 5.84; p<0.01, X²); treatment by the MWC (HR=1.99; 95% CI 1.23, 3.21; p<0.01); and baseline independent ambulation (HR=2.40, 95% CI 1.60, 3.60; p<0.01).

Conclusions: Multi-disciplinary care for CLI patients durably improves AFS by a factor of two, and should be the standard of care for the CLI population. Wound healing remains prolonged regardless of pre-operative or post-operative wound care. Future study is required to evaluate the costs and functional outcomes for MWC for CLI patients.
Use of Antiplatelet Agents in Patients Receiving Lower Extremity Endovascular Interventions: A Regional Review of Compliance and Outcomes

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OBJECTIVES: The American College of Chest Physicians has recommended that all patients with peripheral arterial disease (PAD) be on a single agent antiplatelet regimen for secondary prevention unless contraindicated, and that patients undergoing percutaneous transluminal angioplasty (PTA) be maintained on long-term single agent antiplatelet therapy. The purpose of this study was to evaluate regional compliance with these guidelines, and to further characterize patterns of noncompliance with respect to outcomes.

METHODS: De-identified data were provided by the Virginia Vascular Study Group, which maintains a clinical vascular surgery database including patients in Virginia and West Virginia. Inclusion criteria were angioplasty and/or stent of a proximal lower extremity vessel (iliac through femoral). Patients requiring emergent intervention were excluded. We examined the records for patient characteristics pre-procedure as well as follow-up data post-procedure. Data were analysed using IBM SPSS Statistics, version 19. Hazard functions were plotted where appropriate; these were tested with a log-rank test.

RESULTS: Of 1,060 records available, 814 met inclusion criteria. Over 25% of patients were not on aspirin at the time of their intervention, and just under 20% were on no antiplatelet therapy of any kind. Medical contraindication to antiplatelet therapy accounted only for approximately 1% of patients. The majority of patients were discharged on appropriate medical therapy: only 2.6% of patients were discharged without either aspirin or a P2Y12 inhibitor. Hazard functions for time to percutaneous and surgical re-intervention, respectively were plotted for patients based on their antiplatelet regimen at the time of their initial intervention. Patients on antiplatelet therapy have fewer overall re-interventions and those interventions happen later than patients who were not on antiplatelet therapy at the time of their procedure.

CONCLUSIONS: A single antiplatelet strategy for optimizing PAD patients preoperatively has not been agreed upon, but our data indicate suboptimal compliance with existing guidelines regarding medical management of PAD. These data also suggest that improving compliance with antiplatelet therapy could delay and possibly prevent the need for re-intervention in this population.
OBJECTIVES: An increasing number of patients undergoing non-cardiac surgery have coronary stents. Although guidelines regarding perioperative management of antiplatelet therapies in this patient population exist, practice patterns remain incompletely understood. This study evaluated these practice patterns, with particular attention to differences in management between vascular and non-vascular surgeons.

METHODS: A link to a 23-question survey was displayed in the American College of Surgeons (ACS) electronic newsletter NewsScope, which is posted on the ACS website and emailed to 45,000 members. Questions were focused on perioperative management of antiplatelets (aspirin, clopidogrel) for bare-metal (BMS; placed within 2 months) and drug-eluting stents (DES; placed within the past year) during low and high-risk bleeding procedures, assuming a patient with no other confounding medical issues. Primary stratification was by surgeon specialty.

RESULTS: A total of 244 surgical providers responded to the survey, of which 40 (17%) were vascular surgeons. The majority of respondents were attending surgeons in practice for at least ten years (n=190; 79%). A significantly higher percentage of vascular versus non-vascular surgeons would not stop aspirin preoperatively in low bleeding risk procedures (BMS: 90% versus 54%, \( p=0.001 \); DES: 88% versus 58%, \( p=0.009 \)). A higher percentage of vascular surgeons would not stop aspirin preoperatively in high bleeding risk procedures as well (BMS: 70% versus 28%, \( p<0.001 \); DES: 78% versus 32%, \( p<0.001 \)). Most vascular surgeons would not stop clopidogrel in a low risk BMS patient (53% versus 21% of non-vascular surgeons, \( p=0.001 \)). Similar findings with clopidogrel were observed in low (would not stop: 65% vascular versus 30% non-vascular, \( p<0.001 \)) and high-risk DES patients (would not stop: 30% vascular versus 8% non-vascular, \( p=0.001 \)). The same trends were observed in resuming antiplatelets in the postoperative period (Figure). The majority of respondents were not familiar with professional guidelines regarding perioperative antiplatelet management (n=128; 52%), with no differences between vascular and non-vascular surgeons (45% versus 54%, \( p=0.30 \)).

CONCLUSIONS: This national survey demonstrates significant variation in perioperative antiplatelet management in patients with coronary stents, with marked differences between vascular and non-vascular surgeons. More effective communication of existing guidelines, or the development of new specialty-specific professional guidelines appears prudent.
The prevalence of lower extremity peripheral arterial disease varies significantly by race.

African Americans are reported to have an increased prevalence of diabetes, and lower extremity amputations when compared to other races. The possible effect of concomitant peripheral arterial disease (PAD) on the rate of amputation in African Americans is unknown. This study evaluated the prevalence of PAD in a large racially diverse population.

METHODS: 3,696,778 patients underwent voluntary vascular screening. Ankle-brachial index (ABI) data and information on race was available for 3,474,645 subjects over age 40 years. PAD was defined as an ABI ≤ 0.9. Race was self-reported, as was medical history. Univariate and multivariate statistical analysis were performed.

RESULTS: PAD was identified in 123,523 subjects (3.6%): 106,887 Caucasian (3.4%), 6,995 African American (6.5%), 1,924 Hispanic (2.3%), 1,521 Asian (2.2%), and 6,196 Native American (6.2%) individuals. African Americans had the highest prevalence of PAD, while Asians had the lowest. Patients with PAD were significantly more likely than those without to be older, and have diabetes, hypertension, hypercholesterolemia, and a smoking history. The prevalence of PAD dramatically increased with age in all races, except Hispanic individuals, reaching a peak at 90 years (Figure 1). Multivariate analysis controlling for age, sex and atherosclerotic risk factors identified age, smoking history, hypertension, dyslipidemia and diabetes mellitus to be independently associated with PAD. Additionally, multivariate analysis confirmed African American and Native American races to be independently associated with a significantly higher risk of PAD in both males and females when compared to their Caucasian counterparts: African American males (Odds ratio [OR], 2.13) and Native American males (OR, 1.45), and African American females (OR, 2.00) and Native American females (OR, 1.37).

CONCLUSIONS: In a large racially diverse population, PAD was associated with traditionally known risk factors. However, even after adjusting for these factors, African American men and women were twice as likely to have PAD as compared to Caucasians. This increased prevalence of PAD in African Americans is likely partially responsible for the increased risk of major lower extremity amputation in this group, and underscores the need to appropriately evaluate and treat African American patients for underlying PAD when they present with relevant lower extremity symptoms.
OBJECTIVE: We have previously described the clinical characteristics and outcomes of patients undergoing lower extremity amputation. In the present survey, we sought to evaluate the current functional, ambulatory, and living status of patients who have undergone amputations and investigate associations between these functional outcomes and patient clinical and demographic characteristics.

METHODS: Operating room records were reviewed for lower extremity amputations between August 2007 and August 2011. Medical records, including operative notes and clinic visits, were reviewed for clinical data including operative details, wound healing, and mortality. The social security death master file was also reviewed for mortality. Telephone surveys were conducted in July 2013 to assess patient ambulatory, living, and functional status.

RESULTS: Two hundred sixty three individual patients were identified. Of those, 108 (41%) were deceased at the time of survey. Of the 155 patients identified as living, 68 completed the survey (44%, summarized in figure). Dialysis dependence was associated with transfer-only ambulatory status and being homebound. Male gender was associated with independent functional status. All survey responders were able to complete their activities of daily living with no or minimal assistance. For survey responders, an increased number of prior amputations was associated with declining ambulatory status and a trend towards more dependent living and functional status.

DISCUSSION: Mortality remains distressingly high in this population and, concerningly, quantification of true mortality may be significantly underestimated by use of medical record alone. Among surviving patients, many remain ambulatory and independent, regardless of level of amputation. The ability to provide outcome data with regard to independent living and functional status following amputation can help create realistic expectations and guide patient and physician decision making when discussing treatment options. An additional challenge in managing this complex and at-risk population is the difficulty of maintaining follow up, as evidenced by the large group of patients (56%) assumed to be living but who could not be contacted based on information available through the medical record.
OBJECTIVES: While the incidence of casualties from the Global War on Terror is decreasing, there remains a focus on the long-term sequelae from injuries sustained in combat. Patients with prior significant limb injuries remain at risk for future complications. This study examines our institution’s experience with a multidisciplinary team approach toward this challenging patient population.

METHODS: All patients seen in a single institution Limb Preservation Clinic over a two year period were reviewed. Those patients who sustained a combat injury in theater were examined. Patient demographics, mechanism of injury, amputation rates, time to amputation, and reasons for failure were examined.

RESULTS: 94 patients were seen in our multidisciplinary Limb Preservation Clinic over a two year period. 20 patients (21%) were seen for combat-related injuries. 16 patients were evaluated and treated for chronic complications at a mean of 14 months from their injury. All 16 patients were male and the average age was 24 years. 10 patients (63%) sustained injuries secondary to a dismounted improvised explosive device (IED). All 16 patients had extensive soft tissue injuries and associated bone fractures. Only 3 patients (18%) had sustained a vascular injury. The average number of prior surgeries to the affected limb was 6. The limb salvage rate of 37% was lower than our non-combat cohort (47%). The most common reasons for amputation included chronic pain, osteomyelitis, and soft tissue infections.

CONCLUSIONS: The high amputation rates seen in this cohort underscores the need for long-term follow-up. Despite successful initial outcomes, many patients eventually progress to limb loss. Patients who sustain a dismounted IED are at greatest risk for a delayed amputation. Identifying and addressing those factors which lead to delayed amputation should be a priority for returning war veterans and focus of future studies.
OBJECTIVE: Thoracic endovascular aortic repair (TEVAR) frequently involves a proximal landing zone in the inner curvature of the distal aortic arch, potentially causing a bird-beak configuration. Bird-beak has been associated with endoleaks after TEVAR. This study quantitatively evaluates impact of TEVAR on aortic hemodynamics, with special focus on bird-beak.

METHODS: Pre- and postoperative computed tomography angiography from a patient treated with TEVAR for post-dissecting thoracic aneurysm was used to evaluate the anatomical changes induced by TEVAR and to generate the computational network essential for computational fluid dynamics (CFD) analysis. This analysis was focused on bird-beak configuration, flow distribution in supra aortic branches with (partial) coverage of the origin of the left subclavian artery (LSA) and stenosis in the distal descending thoracic aorta due to compression of the true lumen by the false lumen. Three different CFD analyses, cases A-C, (A=preoperative lumen; B=postoperative lumen; C=postoperative lumen, computed without stenosis) were performed and compared with each other at three time points T1-T3 (T1=maximum acceleration of blood flow; T2=systolic peak; T3=maximum deceleration of blood flow).

RESULTS: Postoperatively, disturbance of flow is reduced at the bird-beak location due to change of geometry after TEVAR when comparing A and B. The stent graft protrusion with partial coverage of the origin of the LSA produces disturbance of flow in the LSA. Strong velocity increase and flow disturbance at the location of aortic stenosis compared to no stenosis are found when comparing B and C; however stenosis in the distal descending aorta has no effect on the aortic arch hemodynamics. (Figures 1, 2)

CONCLUSIONS: CFD can help physicians in understanding change in aortic hemodynamics after TEVAR, giving useful information about effects of bird-beak, coverage of the LSA and a narrowed true lumen.

Figure 1. Velocity streamlines for investigated cases (A-C) at three time points (T1-T3). The corresponding velocity (cm/s) is used to color each streamline.

Figure 2. Contour plot of pressure (mmHg) distribution along a cross-section in the bird-beak region for case B.
OBJECTIVES: Technological innovation has led to the development of inferior vena cava filters (IVCFs) that can be removed. After placement in individuals at high risk for venous thromboembolic disease, these filters may be removed after the period of increased risk has passed. This strategy may reduce the long-term incidence of adverse, filter-related sequelae. However, reported rates of filter retrieval are low. To better realize the potential benefits of IVCF retrieval, we recently initiated a standardized protocol for patients after placement of these devices. This report reviews our experience with this regimen.

METHODS: A standardized protocol, including an electronic database into which all patients undergoing IVCF insertion were entered, was instituted in October 2010. This database was reviewed at regular intervals to identify appropriate candidates for filter retrieval. The retrieval rate after institution of this regimen was compared to the rate in a historical control group. Additional data collected from the study group include: indication, device type, patient demographics, procedural details of placement and retrieval, and complications.

RESULTS: During the 34-month study period, retrievable IVCFs were placed in 124 patients. Our retrieval rate after initiation of a standardized protocol increased to 31% (38/124), compared to a rate of 13% (4/32) in the control group. In the study group, retrieval occurred at a mean of 125 days after insertion and was performed without complication. IVCF retrieval was deemed inappropriate in 34 patients and two patients refused retrieval. Nine patients remain in active follow-up at study completion.

CONCLUSIONS: The introduction of a standardized protocol has increased our rate of IVCF retrieval.