VASCULAR SURGERY RESEARCH DAY

Friday June 3rd, 2016

University Club of Toronto
380 University Avenue
Toronto, ON
It is with great pleasure that I welcome you to the Annual University of Toronto Vascular Surgery Research Day. It’s been another productive year and as we come to the end of the academic year we gather to celebrate the successes and research productivity of our faculty, students, residents, fellows and research trainees. This year’s Research Day has several new features, including the announcement of the inaugural Blair Foundation Innovation Fund Grant recipients, Researcher’s Forum sessions and a Rapid Fire session.

The highlight of the day will be the 5th Annual K. Wayne Johnston Visiting Lecture in Vascular Surgery. We are privileged to have Dr. Melina Kibbe from Northwestern University as our guest. Melina has had an extremely successful career at Northwestern and has recently been appointed the new Chair of the Department of Surgery at the University of North Carolina. I’m sure her talks will be fascinating, informative and will inspire us to greater academic heights.

I’d like to extend specific thanks to the U of T Vascular Surgery Executive who made this day possible through their commitment to our academic mission. These surgeons include: Drs. Thomas Lindsay (Division Head, UHN), Mohammed Al-Omran (Division Head, St. Michael’s), Andrew Dueck (Division Head, Sunnybrook), Marc Pope (Division Head, Trillium), Aaron Beder (Division Head, Humber River), George Oreopoulos (Residency Program Director), Mark Wheatcroft (Fellowship Program Director), Elisa Greco (Director of Undergraduate Medical Education) and Giuseppe Papia (Quality & Best Practices).

Special thanks to Michelle Paiva, our Division’s Administrative Assistant, without who this day would not have been possible.

Also, we appreciate the generosity and commitment of W.L. Gore & Associates who are the premier sponsor of this event through an unrestricted education grant.

Welcome and I hope you enjoy the University of Toronto Vascular Surgery Research Day.

Sincerely,

Thomas L. Forbes, MD, FRCSC, FACS
Professor & Chair, Division of Vascular Surgery
University of Toronto

United in a Tradition of Leadership, Discovery & Excellence
K. Wayne Johnston Visiting Lecturer in Vascular Surgery

In recognition of Dr. Johnston’s unprecedented contributions to our specialty of Vascular Surgery and the University of Toronto an annual lecture began in his name. Dr. Johnston was a founding member and President of the Canadian Society for Vascular Surgery and later became President of the Society for Vascular Surgery. He is a pre-eminent academic surgeon who served as Editor-in-Chief of the Journal of Vascular Surgery and Co-Editor of two editions of Rutherford’s Textbook of Vascular Surgery. No other Canadian, and few internationally, have contributed more to academic vascular surgery than Dr. Johnston. In 2009 he was honored with the Lifetime Achievement Award by the Society for Vascular Surgery.

This lectureship was made possible through the generous donations of faculty, students and alumni.

Previous Recipients

<table>
<thead>
<tr>
<th>Year</th>
<th>Lecturer</th>
<th>Institution</th>
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<tbody>
<tr>
<td>2012</td>
<td>Joseph L. Mills</td>
<td>University of Arizona</td>
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<tr>
<td>2013</td>
<td>Lewis B. Schwartz</td>
<td>University of Chicago</td>
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<tr>
<td>2014</td>
<td>Philip P. Goodney</td>
<td>Dartmouth</td>
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<tr>
<td>2015</td>
<td>Ronald L. Dalman</td>
<td>Stanford</td>
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Melina R. Kibbe, MD, is Professor of Surgery with tenure, the Edward G. Elcock Professor of Surgical Research, and Vice Chair of Research in the Department of Surgery at Northwestern University; co-Chief of the Vascular Surgery service at the Jesse Brown VA Medical Center at JBVAMC. She also serves as Deputy Director for the Simpson Querrey Institute for BioNanotechnology at Northwestern University. She has significant experience with both open and endovascular surgery, including the treatment of carotid stenosis, peripheral vascular disease, and abdominal aortic aneurysms. She is board certified in general and vascular surgery and is RVT and RPVI certified by ARDMS. Dr. Kibbe completed a fellowship in The Hedwig van Ameringen Executive Leadership in Academic Medicine (ELAM) Program for Women at Drexel University College of Medicine in 2012. She will be leaving Northwestern this summer to become Chair of the Department of Surgery at the University of North Carolina.

Dr. Kibbe’s research interests focus on developing novel therapies for patients with vascular disease while simultaneously studying the mechanism of how these therapies impact the vascular wall. She is currently PI on 3 NIH R01 awards, 1 NIH T32 award, and 1 VA Merit award, in addition to serving as co-Investigator on several other awards. She holds 7 patents or provisional patents. Her research was recognized by President Obama with the Presidential Early Career Award for Scientists and Engineers in 2009.

Nationally, she is actively involved in several societies and has assumed leadership positions. She is past-president for the Association for Academic Surgery, president for the Midwestern Vascular Surgical Society, and president-elect for the Association of VA Surgeons. She is also an active member in the American College of Surgeons, the American Surgical Association, the Society for Vascular Surgery, and the American Heart Association, among others. She is the Editor-in-Chief for JAMA Surgery, and served as an Associate Editor of the Journal of Surgical Research. She is a member of the editorial boards for Surgery and Annals of Surgery.

More recently, Dr. Kibbe has been a strong advocate for sex inclusion in biomedical research. She was interviewed by Leslie Stahl for 60 Minutes in February 2014 on this topic, and later appeared on the Colbert Report. Her publication in the journal Surgery on the presence of sex bias in surgical research gained much media attention nationally and internationally, and resulted in discussions with the National Institutes of Health, the Government Accountability Organization (GAO), and the FDA about policy change.

Her bibliography includes over 190 peer-reviewed manuscripts, review articles, and book chapters, with an emphasis on nitric oxide vascular biology and nitric oxide-based therapies. She has authored or co-authored over 190 nationally and internationally presented abstracts. She has received numerous awards, including the Society of Vascular Surgery Lifeline Research Award, 2010 Women’s Leadership Award, the Society of Gene Therapy Young Investigator Award, the Association of Women Surgeons Outstanding Woman Surgeon 2002 Resident Award, and an AMWA Gender Equity Award. She was also inducted into Alpha Omega Alpha Medical Honor Society, in 1994. She has received 16 awards for teaching excellence from Northwestern University as a faculty member.

Dr. Kibbe graduated from the University of Chicago Pritzker School of Medicine in 1994. She completed her internship, residency, and research fellowship at the University of Pittsburgh Medical Center in 2002, and her vascular surgery fellowship at Northwestern University Feinberg School of Medicine in 2003.
Objectives:

1. To obtain new knowledge regarding advances in basic science and clinical research in the field of vascular surgery.
2. For vascular surgery trainees, to have an opportunity to present their research work and to obtain feedback and questions from their peers.
3. To obtain new knowledge regarding the pathophysiology of abdominal aortic aneurysms.
4. To understand the value of continuing quality assurance in surgical practice.
5. To have an opportunity to learn and collaborate with colleagues within and without the University of Toronto.

Accreditation:

The 2016 University of Toronto Division of Vascular Surgery Annual Research Day is a self-approved group learning activity (Section 1) as defined by the Maintenance of Certification Program of the Royal College of Physicians and Surgeons of Canada.

Certificates of Attendance and Evaluation Forms will be sent to attendees following the meeting.
Sponsorship:

W.L. Gore and Associates has agreed to a three year commitment as sole sponsor to support the U of T Vascular Surgery Research Day through an education grant. Special thanks to David Grieco, Senior Development Officer in the Office of Advancement at the U of T Faculty of Medicine for stewarding this donation.

Marty Sylvain, Global Sales Leader for Gore says, “W.L. Gore & Associates has provided creative therapeutic solutions to complex medical problems for more than forty years. During that time, more than 35 million innovative Gore Medical Devices have been implanted, saving and improving the quality of lives worldwide. W.L. Gore & Associates is committed to advancing vascular surgical and endovascular therapy and as a result is pleased to be able to provide educational grant support to the University of Toronto, Division of Vascular Surgery. It is our hope that through this educational grant we will be able to support the University of Toronto in some of our shared values including commitment to ongoing learning, dedication to sharing knowledge with peers and patients, creating consensus within the medical community and the analysis of clinical outcomes”.

0715 – 0745: Continental Breakfast

0745 – 0800: Welcoming Remarks

Dr. Thomas Forbes  
Professor & Chair, Division of Vascular Surgery, University of Toronto

0800 – 0915: Morning Session – I (10 minute presentations, 5 minutes questions)  
Moderator: Dr Thomas Lindsay (Division Head, University Health Network)

Zeyad Khoushhal, Mohamad A. Hussain, Elisa Greco, Mohammad Mamdani, Andrea Tricco, Ori Rotstein, Mohammed Al-Omran

0815 – 0830: Valproic Acid Induces Endothelial-to-Mesenchymal-Like Phenotypic Switching  
Husain Al-Mubarak, Yi Pan, Mohammed Al-Omran, Subodh Verma, Krishna K. Singh

0830 – 0845: Vascular Complications and Procedures Following Trans catheter Aortic Valve Implantation  
Sneha Raju, Naomi Eisenberg, J Montbriand, Maral Ouzounian, Eric Horlick, Mark Osten, W Tsang, Graham Roche-Nagle

0845 – 0900: Quantification of serum Oxidized LDL-specific immunoglobulins in murine models of atherosclerosis with a novel Enzyme-linked immunosorbent assay.  
Caleb CJ Zavitz, Angela Li, Norbert Degousee, Eric Shikatani, Mansour Husain, Barry B Rubin, Clinton S Robbins

0900 – 0915: Temporary inferior vena cava filters: indications, retrieval rates and follow-up management at a multicenter tertiary-care institution  
Mary J Tao, JM Montbriand, Naomi Eisenberg, Kenneth W. Sniderman, Graham Roche-Nagle
0915 – 0930: Winners of 2016 Blair Foundation Innovation Grants

Dr. Elisa Greco, Division of Vascular Surgery, St. Michael’s Hospital
Pulse Wave Velocity Imaging in the Assessment of Peripheral Arterial Disease

Dr. Mark Wheatcroft, Division of Vascular Surgery, St. Michael’s Hospital
Direct visualization of carotid artery plaque and stenting using a novel scanning fiber angioscope

0930 - 1015: 5th Annual K. Wayne Johnston Lecturer

Sex bias in biomedical and clinical research
Dr. Melina R. Kibbe
Edward G. Elcock Professor of Surgical Research
Vice-Chair Research, Department of Surgery, Northwestern University

1015 - 1045: Refreshment Break

1045 - 1100: Researcher’s Forum

Krishna Singh PhD, Staff Scientist, Keenan Research Centre for Biomedical Science and Li Ka Shing Knowledge Institute, St. Michael’s Hospital. Assistant Professor, Department of Surgery, University of Toronto

Endothelial Mechanosensors: Novel Watchdogs of Cardiac Fibrosis

1100 - 1145: Morning Session – II (10 minute presentations, 5 minutes questions)
Moderator: Dr George Oreopoulos (Residency Program Director)

1100 - 1115: Vascular Boot Camp: Implementation and 3 year experience
Luis Figueroa, Mark Wheatcroft, George Oreopoulos

Lauren Gordon, Oonagh Scallan, Thomas L Forbes

1130 - 1145: “Who are they and what do they want?”: A demographic and needs assessment survey amongst International Vascular Surgery Fellowship Applicants
Lukasz M. Boba, Mark D. Wheatcroft, George D. Oreopoulos
1145 - 1230: Surgeon Scientist Training Program Forum
(10 minute presentations, 5 minutes questions)
Moderator: Dr Mohammed Al-Omran (Division Head, St. Michael’s Hospital)

1145 - 1200: Trends and long-term outcomes of carotid endarterectomy versus stenting in a 12-year multicenter observational study
Mohamad A. Hussain, Muhammad Mamdani, Jack V. Tu, Gustavo Saposnik, Deepak L. Bhatt, Subodh Verma, Mohammed Al-Omran

1200 - 1215: Understanding and predicting endovascular device rotation
Sean A. Crawford, Ryan M. Sanford, Matthew G. Doyle, Cristina H. Amon, Thomas L. Forbes

1215 - 1230: Magnetic Resonance Imaging as a predictor of forces required to cross peripheral arterial lesions with a guidewire
Trisha Roy, Garry Liu, Noor Shaikh, Andrew D. Dueck, Graham A. Wright

1230 - 1315: Lunch

1315 - 1415: Afternoon Session (10 minute presentations, 5 minutes questions)
Moderator: Dr Andrew Dueck (Division Head, Sunnybrook)

1315 - 1330: Smart(phone) learning experience amongst vascular residents utilizing a response system application
Wissam Al-Jundi, Giuseppe Papia, Andrew Dueck

1330 - 1345: Ten Years of Endovascular Aortic Aneurysm Repair: A Population-based Evaluation of Post-operative Imaging and Mortality
Charles de Mestral, Ruth Croxford, Naomi Eisenberg, Graham Roche-Nagle

1345 - 1400: Visceral Stents In Twenty-Eight Advanced Endovascular Aortic Repairs: An Ontario Single Center Experience
Mutalib Al Masloom, Caleb Zavitz, Mark Wheatcroft, Tony Moloney, Al Lossing, Mohammed Al-Omran, Elisa Greco

1400 - 1415: Drug-eluting balloon angioplasty versus non-stenting balloon angioplasty for peripheral arterial disease of the lower limbs.
Ahmed Kayssi, Talal Al-Atassi, George Oreopoulos, Graham Roche-Nagle, Kong Teng Tan, Dheeraj Rajan
1415 - 1430: Researcher’s Forum

Matthew Doyle PhD, Research Associate, Department of Mechanical and Industrial Engineering, Division of Vascular Surgery, Department of Surgery, University of Toronto

The application of mechanical engineering techniques to surgical planning

1430 - 1515: 5th Annual K. Wayne Johnston Lecturer

The ups and downs of translational research – one surgeon’s journey
Dr. Melina R. Kibbe
Edward G. Elcock Professor of Surgical Research
Vice-Chair Research, Department of Surgery, Northwestern University

1515 - 1540: Refreshment Break

1540 - 1620: Rapid Fire Presentations (5 minute presentations, 3 minutes questions)
Moderator: Dr Mark Wheatcroft (Fellowship Director)

1540 – 1548: Public health campaigns and their effect on stroke knowledge in an Urban population: A five-year study
M Metias, N. Eisenberg, MD Clemente, EM Wooster, AD Dueck, DL Wooster, G Roche-Nagle

1548 – 1556: Predicting iliac artery deformation in response to guidewire insertion using computational simulations
Ryan M. Sanford, Sean A. Crawford, Matthew G. Doyle, Cristina H. Amon, Thomas L. Forbes

1556 – 1604: Predictors of Arteriovenous Hemodialysis Fistula Maturation: A Systematic Review of the Literature
Konrad Salata, Mohamad Hussain, Zeyad Khoushhal, Mohammed Al-Omran

1604 - 1612: Hybrid repair of a traumatic arteriovenous fistula and giant pseudoaneurysm: case report and review of current management
Miranda Witheford, Aaron Beder, Kerry Graybiel

1612 – 1620: A study of methods to stimulate self-practice of surgical techniques
Omar Selim, Andrew Dueck
1630: Awards Presentation

Best Presentation by a Junior Resident (PGY1 & 2)

Best Presentation by a Senior Resident or Fellow

Alumni Award for Best Presentation by a SSTP Resident

Adjournment
Introduction: Previous studies suggest wide discrepancies in the rates and causes of attrition among surgical residents.

Objectives: Our aim was to examine the prevalence and drivers of attrition in surgical residency programs.

Methods: We systematically searched Medline, EMBASE, Cochrane, PsycINFO and ERIC databases for studies reporting on rates and causes of attrition in surgical residents, and the characteristics and destinations of residents that left their training program. Two reviewers independently reviewed the studies and collected the data. We calculated pooled estimates using random effects meta-analyses where appropriate.

Results: Overall, we included 31 studies that reported on residents from general surgery (N=22), obstetrics/gynecology (N=4), neurosurgery (N=2), ophthalmology (N=1), otolaryngology (N=1) and orthopedic (N=1) programs. The pooled estimate for the overall attrition rate among general surgery residents was 16% (95% CI, 14-19%), with significant between-study variation (I²=96.3%; P<0.001). Attrition was higher among female general surgery residents (25% [95% CI, 16-34%]) compared to male (15% [95% CI, 11-20%]), and most residents left after their first post-graduate year (49% [95% CI, 40-58%]). Departing residents often relocated to another general surgery program (20% [95% CI, 15-24%]) or switched into anesthesia (13% [95% CI, 11-16%]). The most common reported causes of attrition were uncontrollable lifestyle and transferring to another specialty. No conclusions were drawn about other surgical specialties due to a paucity of data.

Conclusion: General surgery programs have relatively high attrition, with females more likely to leave their training programs than males. Residents most often relocate or switch to another specialty after the first post-graduate year due to lifestyle-related issues.
Figure 1: Prevalence of Attrition among General Surgery Residents
Valproic Acid Induces Endothelial-to-Mesenchymal-Like Phenotypic Switching

Husain Al-Mubarak1,3,5, Yi Pan2, Mohammed Al-Omran1,3,4,5, Subodh Verma2,3,4, Krishna K. Singh1,2,3,4
Division of 1Vascular and 2Cardiac Surgery, Keenan Research Centre for Biomedical Science at St. Michael’s Hospital, 3Department of Surgery and 4Institute of Medical Science, University of Toronto, 5Department of Surgery, King Saud University and the King Saud University-Li Ka Shing Collaborative Research Program, Riyadh, Kingdom of Saudi Arabia

Introduction: Valproic acid (VPA) is a widely used anticonvulsant drug that is currently undergoing clinical evaluation for anticancer therapy. VPA is a histone deacetylase (HDAC) inhibitor and was recently shown to inhibit angiogenesis in vitro and in vivo. The endothelium is a monolayer of endothelial cells (ECs) that line the lumen of blood vessels and facilitate vascular homeostasis. ECs, however, can transition into mesenchymal cells and this form of EC plasticity is called endothelial-to-mesenchymal transition (EndMT). EndMT is recognized as a crucial component of development and wound healing, and it has of late been also implicated in a wide variety of pathological conditions, namely cancer and organ fibrosis. Furthermore, HDACs are known to modulate EndMT, however, the effect of VPA on EC plasticity and EndMT remains completely unknown.

Methods: To elucidate the effect of VPA on EndMT, we treated human umbilical vein endothelial cells (HUVECs) with different dose (0, 1, 5, 10 and 20 mM) of VPA. Markers of EndMT and apoptosis were measured using qPCR after 24 hours, and immunoblotting and immunofluorescence after 48 hours of VPA (10 mM) treatment to HUVECs.

Results: VPA-treatment significantly inhibited tube formation, migration and nitric oxide (NO) production in HUVECs. A microscopic evaluation revealed marked morphological and ultra-structural changes, with a complete loss of the conventional cobblestone appearance and an increase in spindle-shaped morphology with cytoskeletal rearrangement typically observed in mesenchymal cells in VPA treated HUVECs (Figure). qPCR performed for the expression of endothelial markers, CD31, Tie-2 and VE-cadherin, demonstrated significantly reduced levels with increased levels of mesenchymal markers, α Smooth Muscle Actin (α-SMA), N-cadherin and Fibroblast-specific Protein 1 (FSP-1) indicating EndMT like phenotypic switching in VPA-treated HUVECs. The qPCR data was further confirmed by immunoblotting and immunofluorescence, which also demonstrated significantly reduced endothelial markers (CD31, Tie-2 and VE-cadherin) and increased mesenchymal markers (α-SMA, N-cadherin and FSP-1) in VPA-treated HUVECs. Our immunoblotting data on cleaved caspase-3, did not demonstrate significant apoptosis in HUVECs after VPA treatment. VPA is known to induce epigenetic modifications and accordingly to understand the mechanism behind VPA-induced EndMT, we are in the process to perform Epigenetic Chromatin Modification Enzymes PCR Array.
Conclusion: The main observation made in this study is that VPA-treatment associated epigenetic changes lead to aberrant EndMT. These data suggest that VPA-treatment associated EndMT contributes to the VPA-associated loss of endothelial function. Our data also suggest that VPA based therapeutics may lead to exacerbate the fibrosis related phenotype in the patients and warrants differential treatment strategy in those patients.

Figure. Microscopic picture (magnification 10X) demonstrating VPA-treatment induced EndMT-like phenotypic switching in endothelial cells.
Vascular Complications and Procedures Following Trans catheter Aortic Valve Implantation
Sneha Raju, Naomi Eisenberg, J Montbriand, Maral Ouzounian, Eric Horlick, Mark Osten, W.Tsang, Graham Roche-Nagle

**Objectives:** Transcatheter aortic valve implantation (TAVI) is a treatment option for high-risk patients with aortic valve stenosis. However, vascular complications (VC) remain a significant morbidity and have been associated with worse clinical outcomes. The present study analyzed the incidence, and impact of VC as well as necessary vascular procedures post-TAVI.

**Methods:** A retrospective chart review was conducted of 388 consecutive TAVI patients from January 2007-April 2015, of whom, 237 were transfemoral, 146 transapical and 5 direct-aortic. All VC were classified according to the Valve Academic Research Consortium 2 guidelines.

**Results:** Among the transfemoral patients, 42 were completed with surgical cut-down while the rest (n=195) were percutaneous (Table 1). While VC occurred in 66 (27.8%) cases, only 8 (3.38%) were classified as major complications. Of these, 26 (10.9%) were intra-operative, with 4 major (1.6%) and 22 minor (9.3%). Procedures to correct VC occurred in 10 (4.2%) cases, with the majority (80%) being surgical and the remainder treated by endovascular techniques. Post-operative VC occurred in 40 cases (16.9%), with four (1.6%) being major. Nine surgical procedures, predominantly embolectomies, were performed to correct post-op complications. Dissections and hematomas were the etiology of most peri-operative and postoperative complications, respectively. There was no linear or quadratic relationship found between time and cases with VC. Thirty-day all-cause mortality in this cohort was 2.5 % (n=6), with VC making no contribution. The 30-day readmission rate was 3.8% (n=9), with three (1.3%) due to VC including hematomas and groin infections.

**Conclusions:** VC are important contributors to operative morbidity in TAVI patients. We observed low major VC rates over an 8-year period. Although the majority of VC during the intra-operative period were due to dissections, hematomas and pseudoaneurysms were the primary causes in the post-operative period.
Table 1: Pre-operative characteristics

<table>
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<tr>
<th>Characteristic</th>
<th>Result (N=237)</th>
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<tr>
<td>Age, mean years</td>
<td>81.03</td>
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<tr>
<td>Male</td>
<td>147 (62.0%)</td>
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<tr>
<td>BMI, mean</td>
<td>27.85</td>
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<tr>
<td>Aortic Valve Area (AVA), mean</td>
<td>0.76</td>
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<tr>
<td>NYHA: Class III / Class IV</td>
<td>208 (87.8%)/ 11 (4.64%)</td>
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<tr>
<td>Logistic EuroScore : Mean (Median)</td>
<td>12.92 (9.92)</td>
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<tr>
<td>Percutaneous access</td>
<td>195 (82.2%)</td>
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<tr>
<td>Prosthesis Type</td>
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<tr>
<td>• Medtronic CoreValve (26mm, 29mm, 31mm)</td>
<td>144 (60.8%)</td>
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<tr>
<td>• Edwards Sapien (23mm, 26mm)</td>
<td>93 (39.2%)</td>
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<tr>
<td>Biggest Sheath Size</td>
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</tr>
<tr>
<td>• Surgical</td>
<td>26F</td>
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<tr>
<td>• Percutaneous</td>
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Quantification of serum Oxidized LDL-specific immunoglobulins in murine models of atherosclerosis with a novel Enzyme-linked immunosorbent assay.

Caleb CJ Zavitz, Angela Li, Norbert Degousee, Eric Shikatani, Mansour Husain, Barry B Rubin, Clinton S Robbins.

Introduction: Systemic atherosclerosis is the leading source of morbidity and mortality in the world. Much attention has rightly been focused on the role of the inflammatory (innate immune) response in driving this reactive yet ultimately maladaptive process. Macrophages in particular have emerged as the key cellular protagonists. Considerably less attention has been focused on the role of the adaptive immune system in atherogenesis. Yet numerous lines of evidence from our work and others' have established the importance of adaptive immunity, especially B-cell mediated humoral immunity, in this disease.

Objective: Our objective was to develop the tools necessary to quantify antigen-specific humoral immune responses in murine models of atherosclerosis.

Methods: We developed a novel enzyme-linked immunosorbent assay which allows quantification of antigen- and isotype-specific immunoglobulins from murine serum. We then applied this technique to quantify the oxidized-LDL-specific antibody titres in wild type and atherosclerosis-prone genetic model animals fed either usual diet, or a diet high in fat and cholesterol.

Results: Genetically atherosclerosis-prone (LDLR−/−) mice show elevated titres of ox-LDL specific IgG and IgG2a, but not IgG1, when fed a diet high in fat and cholesterol.

Conclusions: We developed and operationalized a novel ELISA technique. When used this technique to demonstrate that atherosclerosis-prone mice on a high fat and cholesterol diet do mount a robust humoral immune response against oxidized LDL. Additional studies are ongoing to determine the impact of this response on atherogenesis.
Temporary Inferior Vena Cava Filters Indications, Retrieval Rates and Follow-Up Management at a Multicenter Tertiary-Care Institution

Mary J Tao1,5, JM Montbriand2,4, Naomi Eisenberg1, Kenneth W. Sniderman3, Graham Roche-Nagle1

1Division of Vascular Surgery, Peter Munk Cardiac Centre, Toronto General Hospital, University Health Network, University of Toronto, 2Department of Anesthesia and Pain Management, Pain Research Unit, University Health Network, University of Toronto, 3Department of Medical Imaging, Division of Vascular and Interventional Radiology, University Health Network, University of Toronto, 4Department of Psychology, York University, 5Faculty of Medicine, University of Toronto

Objectives: To investigate the practice pattern of IVC filters and to determine factors predictive of filter retrievals at a multicenter, tertiary-care institution.

Methods: A retrospective review of all IVC filter procedures performed between January 2001 and July 2013 was conducted. Data collected included demographics, VTE risk factors, medical co-morbidities, insertional and retrieval characteristics, referring services, complications, discharge and follow-up management.

Results: During the study period, 1,123 IVC filter procedures were performed; 69% (n=810) insertions and 31% (n=313) retrievals. Of the patients receiving filters, the average age was 61.4 years and 53.3% were male. Overall, 408 filters (51.5%) were placed with absolute indications, 214 (27.0%) for relative indications, 138 (17.4%) prophylactically and 32 (4.0%) for reasons outside the established guidelines. Of the 663 retrievable filters, successful removal rate was 41.6% (n=276) while the mean time to first retrieval attempt was 76.4 days (SD=110.5). Documentation of the filter was present in 342 (43.1%) discharge summaries and outlined instructions for filter management was seen in 129 (16.3%) cases. Significant predictors of filter removal were thrombosis follow-up (OR 6.7; p<.01) and the ordering service as filters ordered by medical specialties were less likely to be retrieved than surgical specialties (OR 0.53; p=.04). Compared to discharge summaries without filter management instructions, those with plans had higher filter retrievals rates (OR 3.74, p<.00). Filter-related complications were observed in 57 patients.

Conclusion: Given the established complications relating to long indwelling times and recent FDA guidelines, a multidisciplinary and systematic follow-up protocol needs to be implemented to optimize filter retrieval rates and to ensure exemplary quality of care.
PULSE WAVE VELOCITY IMAGING: A novel optical technology for assessing tissue blood flow
M. Dervenis1, A. Douplik1, E. Greco2,3, G. Saiko1, K. M. Cross1,2,3
1Ryerson University, 2University of Toronto, 3St. Michael’s Hospital

Objective: Our purpose was to validate a novel Pulse Wave Velocity Imaging (PWVi) technology used to assess ischemia. PWVi generates the same information as Duplex ultrasonography and photoplethysmography (PPG). The advantage of PWVi is that it is quick and does not require a specialized vascular laboratory. PWVi is superior to our current practice of utilizing Doppler to assess blood flow in flaps and limbs. This is a pilot study testing the first generation of PWVi.

Method: PWVi is based on a 12-bit RGB camera (Basler acA-2000-165uc) capturing videos at 1000 fps. Videos of the hands and fingers of healthy individuals were taken under fluorescent, incandescent, LED, and ambient lighting, and processed to assess pulse wave velocity (PWV) photoplethysmographic (PPG). Videos were also acquired from an ‘ischaemic’ finger, clamped with a tourniquet, so as to determine the technology’s sensitivity to pulse presence and amplitude.

Results: PWV and PPG waveforms were readily collected under all lighting conditions. The PWVi device performed well in all conditions without an external source of illumination, which represents a major advance in optical imaging. PWVi was also able to differentiate between ‘ischaemic’ and non-ischaemic fingers by the amplitude of the PPG alone.

Conclusions: We captured PWV and PPG measurements using a simple RGB camera. Blood flow can be measured in real time and interventions monitored utilizing this device. This represents a significant advantage for plastic surgeons, as we rely on skin perfusion for our reconstructions of all areas of the human body. This device will eventually be miniaturized to attach to a smart phone to make it more accessible.
Intravascular endoscopic inspection of carotid artery atherosclerosis and stenting in a porcine model system

Patrick Z. McVeigh\textsuperscript{1,2}, Brian C Wilson\textsuperscript{1}, Mark Wheatcroft\textsuperscript{2,3}

\textsuperscript{1}Department of Medical Biophysics, University of Toronto, \textsuperscript{2}Division of Vascular Surgery, University of Toronto, \textsuperscript{3}Division of Vascular Surgery, St Michael’s Hospital

Background: We have previously demonstrated the feasibility of utilizing high-resolution scanning fiber endoscopy (SFE) to directly visualize intravascular structures in real time, and have shown the potential utility of angioscopy as an adjuvant to fluoroscopy in complicated endovascular interventions. These previous studies have, however, been carried out in non-diseased vessels and have made use of aggressive optical clearing solution flow rates that may prove unsuitable for direct clinical translation.

Objective: To develop a porcine model of carotid atherosclerosis and to investigate the potential utility of SFE angioscopy for branch vessel identification, plaque morphological characterization, and stent placement/post-deployment assessment.

Methods: Atherosclerosis will be induced in the carotid arteries of pigs using a surgically created flow limiting segment and maintained with a high-cholesterol diet for 3 months. Doppler ultrasound and fluoroscopic angiograms will be compared to the stenosis as judged with the SFE. Plaque features such as adherent thrombus, endothelial coverage, and apparent lipid content will be compared with ex-vivo pathology. Angioplasty and stenting will be performed and the apparent stent/balloon positioning differences between the two imaging modalities compared, as well as any plaque reaction (protruding lipid, plaque rupture) detected.

Results: In healthy medium-sized arteries, long segment imaging of the lumen is achievable with proximal occlusion and irrigation flow rates of 100mL/min, though the absolute rate is dependent on collateral vessel density and any induced vasospasm. Reducing the FOV to less than 1cm greatly reduces the necessary flow rates (10mL/min) and still allows for vessel orifice identification without the need for continuous irrigation. The comparison to the atherosclerotic model system is ongoing, but irrigation flow rates are expected to be minimal in the case of hemodynamically significant occlusions.

Conclusion: SFE angioscopy can provide intraluminal details far in excess of what is achievable with fluoroscopy and may serve as a useful adjunct for case selection in carotid stenting. The use of a limited field of view reduces the necessity for continuous irrigation to rates that are achievable in patients.
1045 - 1100: **Researcher’s Forum**

**Krishna Singh PhD**, Staff Scientist, Keenan Research Centre for Biomedical Science and Li Ka Shing Knowledge Institute, St. Michael’s Hospital. Assistant Professor, Department of Surgery, University of Toronto

**Endothelial Mechanosensors: Novel Watchdogs of Cardiac Fibrosis**

Dr. Krishna Singh is a staff scientist from the Department of Cardiac and Vascular Surgery at St. Michael’s Hospital, and Assistant Professor at the Department of Surgery, University of Toronto. He received PhD from Hannover Medical School, Germany and then joined St. Michael’s Hospital for his post-doctoral research under Dr. Subodh Verma. His research looking at the role of DNA damage & repair and autophagy in cardiovascular system was published in prestigious journals like Nature Communications, Journal of Biological Chemistry and Circulation. He has received several awards including Vivien Thomas Young Investigator Award and Expert Opinions Clinical Impact Award. His current research interests include cardiac fibrosis and epigenetics.
1100 - 1145: Morning Session – II

Vascular Boot Camp: Implementation and 3 year experience
Luis Figueroa, Mark Wheatcroft, George Oreopoulos

Objectives: Implementing a pre-clinical (vascular surgery specific) skills curriculum for ‘0+5’ residents on entry into residency. Secondary objective, assessment of specific surgical skills in the entry residents with longitudinal follow-up.

Methods: The vascular surgery boot camp curriculum (Table 1) was modeled after the University of Toronto’s orthopaedic surgery specialty-specific boot camp. Incoming vascular surgery PGY-1’s at U of T participated in objective skills assessment as part of the curriculum. This study is being conducted at Mt. Sinai Hospital’s Surgical Skills Centre, using commercially available vascular models and standardized skills checklists. Data collected included: Resident demographics, task-specific assessments (open AAA and CEA), resident self-evaluation, and global assessment after 2 weeks of training. New evaluations will be performed at least once during residency training and on completion of training.

Results: Five residents (2014/15) were enrolled aged 27.8 (24-35), 80% male, 80% right handed, prior surgical experience 0.2 years (0-1). Positive feedback from trainees and staff members has been given.

Conclusions: Ongoing study, objective analysis of skill acquisition is presently limited by the small number of residents who have completed the program. This model of pre-clinical training is now a mandatory part of the vascular surgery residency at the University of Toronto, and will be applied to the upcoming competency based training, starting in 2108.
### Table 1. Vascular boot camp curriculum (2015)

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<tr>
<th>Date</th>
<th>Time</th>
<th>Lecture/Skill</th>
<th>Staff</th>
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<tr>
<td>Monday, Jul 20</td>
<td>8-9</td>
<td>Welcome and consent</td>
<td>Figueroa</td>
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<td>9-12</td>
<td>Vascular Anastomosis</td>
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<td>13-16</td>
<td>Embolectomy</td>
<td>Figueroa</td>
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<td>Tuesday, Jul 21</td>
<td>9-12</td>
<td>Sapheno-Femoral Dissection</td>
<td>Byrne</td>
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<td>Lunch</td>
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<td></td>
<td>13-16</td>
<td>Arterial and Venous Physiology</td>
<td>Greco</td>
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<td>Wednesday, Jul 22</td>
<td>9-12</td>
<td>CEA</td>
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<td>Lunch</td>
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<td>13-16</td>
<td>Practice for Open AAA</td>
<td>Figueroa</td>
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<td>Thursday, Jul 23</td>
<td>9-12</td>
<td>Medtronic EVAR Simulator</td>
<td>Greg</td>
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<td>Open AAA</td>
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<td>Friday, Jul 24</td>
<td>9-12</td>
<td>Radiation Safety</td>
<td>Roche-Nagle</td>
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<td>Practice for Vascular Anastomosis and Embolectomy</td>
<td>Crawford</td>
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<td>Monday, Jul 27</td>
<td>8-9</td>
<td>Meeting with PD</td>
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<td>9-12</td>
<td>Vascular Lab</td>
<td>Werneck</td>
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<td>1230-13</td>
<td>Lunch - Provided by Gore</td>
<td>Lesley</td>
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<td>Lunch</td>
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<td>Endovascular Gear and Technics</td>
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<td>12-13</td>
<td>Lunch</td>
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<td>U/S and vascular Anastomosis practice</td>
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<td>CEA and AAA Practice</td>
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<td>Lunch</td>
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<td></td>
<td>13-16</td>
<td>Endovascular Cases</td>
<td>Wheatcroft</td>
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Learning Curves in Vascular Surgery: a review of current practice
Lauren Gordon, Oonagh Scallan, Thomas L Forbes

Introduction: Defining learning curves in vascular surgery both assists in adopting new techniques and educating new vascular trainees. Cumulative sum (CUSUM) analysis is often used for these learning curves: this technique graphs sequential procedures and can detect deviations in performance for the better or worse. A number of comparatively new CUSUM methods, including risk-adjusted (RA-CUSUM) analysis and learning curve (LC-CUSUM) methods provide opportunities to analyze learning with diverse case mixes and the length of learning curve, respectively. We sought to categorize how cumulative sum methods have been used in the vascular literature.

Methods: We searched the databases Medline, EMBASE, Web of Science, MathSciNet and Current Index to Statistics for articles using cumulative sum for learning curve estimation in vascular surgery. The abstracts and were screened by hand. Included articles used CUSUM to analyze learning curves for vascular surgical interventions and training in simulation. We excluded articles exclusively on vascular medicine, involving pediatric patients and animal studies.

Results: Fourteen articles were identified during our search of the literature, spanning from 2004 to 2015, by nine distinct first authors. Seven articles identified learning curves in abdominal aortic repair, three articles focused on thoracic aortic repair, two on carotid endarterectomy and one on combined arterial procedures and on skills in simulation. Twelve articles employed a classic cumulative sum technique while only two of these articles employed a risk-adjusted CUSUM method. Notably, no articles employed an LC-CUSUM technique. Setting, reporting and interpretation of CUSUM parameters varied considerably between articles.

Conclusions: CUSUM analysis has been slow to be adopted in the vascular surgery literature, perhaps due to lack of publicity or lack of knowledge as to how to construct CUSUM charts. Reporting standards for cumulative sum analysis are still needed in order to critically evaluate and compare these statistical techniques in the literature. Furthermore, we would encourage the use of RA-CUSUM to determine the effects of a diverse case mix on a learning curve, as well as LC-CUSUM to answer questions about the time to proficiency and durability of the learning when a surgeon takes on a new procedure.
“Who are they and what do they want?”: A demographic and needs assessment survey amongst International Vascular Surgery Fellowship Applicants
Lukasz M. Boba, Mark D. Wheatcroft, George D. Oreopoulos

Background: The University of Toronto accepts international candidates for Vascular Surgery Fellowship training annually (IVSF). A diverse, increasing applicant-pool, and an emphasis on Global health surgical education initiatives have stimulated interest in how this group’s needs may be better served.

Objectives: We wanted to determine the demographics and educational needs of IVSF applicants. This data will inform decisions about curriculum reform and allocation of educational resources within our program.

Methods: IVSF applicants who contacted the Division of Vascular Surgery for potential fellowship training were contacted via email. A survey was sent to applicants examining their personal and academic background, clinical experience, goals and training expectations. Survey information was anonymous and confidential, in keeping with REB standards. Over one year period, surveys were sent to 56 applicants with a response rate of 66%.

Results: Most applicants were males (81%), 30-40 years of age who originated from Asia. Most had a family whom they wished to bring to Canada for the duration of their training. 69% of IVSFs had additional postgraduate (MSc, PhD) degrees and 80% had at least 5 years of postgraduate training. 71% had vascular surgery training. 73% wished to advance their vascular skills with a hope to bring experience back to their home countries. 65% mentioned a shortage of vascular surgeons in their country. IVSFs were most skilled in: arterial-venous fistulas, open varicose vein stripping and vascular trauma. The most desired educational experiences were found to be: EVAR, advanced EVAR, Carotid artery stenting, TEVAR, open TAA repair and peripheral angioplasty. The least desired procedures were varicose vein stripping, access surgery, and peripheral bypass revascularizations. The majority of respondents would like to train for a year, in an academic hospital and be involved in research.

Conclusions: Most IVSFs are prepared to travel abroad with young families for training in advanced endovascular techniques that may improve their marketability for academic jobs. Ensuring adequate foundational vascular training, academic and family support, may improve their educational experience and help them best achieve their goals.
Trends and long-term outcomes of carotid endarterectomy versus stenting in a 12-year multicenter observational study
Mohamad A. Hussain¹,², Muhammad Mamdani³, Jack V. Tu⁴, Gustavo Saposnik⁵,⁶, Deepak L. Bhatt⁶, Subodh Verma¹,³,⁷, Mohammed Al-Omran¹,²,³
¹Department of Surgery, University of Toronto ²Division of Vascular Surgery, St. Michael’s Hospital, ³Li Ka Shing Knowledge Institute, St. Michael’s Hospital, ⁴Division of Cardiology, Sunnybrook Health Sciences Centre, ⁵Division of Neurology, St. Michael’s Hospital, ⁶Harvard Medical School, ⁷Division of Cardiac Surgery, St. Michael’s Hospital

Objective: We sought to compare the trends and long-term outcomes of carotid endarterectomy vs. stenting in the real-world setting.

Methods: We conducted a multicenter observational study using validated linked databases from Ontario (2002-2014). We used time-series analyses to examine utilization rates of carotid endarterectomy and stenting, and we compared 12-year and 30-day outcomes of each strategy using multivariable multilevel Cox proportional hazards models and propensity-score matching.

Results: A total of 16,772 patients were studied (14,394 endarterectomy; 2,378 stenting). The rate of carotid revascularization decreased from 6.0 procedures per 100,000 adults ≥40 years of age in April 2002 to 4.3 in the first quarter of 2014 (P<0.001). The rate of endarterectomy decreased from 5.6 to 3.6 procedures per 100,000, whereas the rate of stenting increased from 0.39 to 0.67 procedures per 100,000 (both P<0.001). We observed an increase (P<0.001) in the rate of stenting following publication of the SAPPHIRE trial in 2004, whereas the rate of stenting remained unchanged following publication of subsequent trials. Rate of the composite outcome of 12-year ischemic stroke or transient ischemic attack (TIA), myocardial infarction, or death was higher with stenting compared with endarterectomy (44.5% vs. 35.4%; adjusted HR, 1.28; 95% CI, 1.21-1.35; P<0.001; Figure). The primary outcome was driven by increased risks for ischemic stroke or TIA and death with stenting (both P<0.001); rates of long-term myocardial infarction were not different (P=0.12). Results were confirmed with 1:2 propensity-score matching.

Conclusion: Although the rates of carotid revascularization and endarterectomy have fallen since 2002, the rate of carotid stenting has risen since the publication of SAPPHIRE. As compared to carotid endarterectomy, stenting was associated with an early and sustained ~30% increased risk for ischemic stroke or TIA, myocardial infarction, or death over 12 years.
Figure. Primary outcome (long-term ischemic stroke or TIA, myocardial infarction, or death)

<table>
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<tr>
<th>Years Since Carotid Revascularization</th>
<th>Freedom from Primary Outcome (%)</th>
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<tr>
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<tr>
<td>1</td>
<td>99.5</td>
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<tr>
<td>2</td>
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<td>3</td>
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<td>4</td>
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<td>5</td>
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No. at risk

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<td>2</td>
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</table>
UNDERSTANDING AND PREDICTING ENDOVASCULAR DEVICE ROTATION
Sean A Crawford¹,², Ryan M Sanford³, Matthew G Doyle², Cristina H Amon¹,², Thomas L Forbes³
¹Institute of Biomaterials and Biomedical Engineering, University of Toronto, ²Department of Mechanical and Industrial Engineering, University of Toronto, ³Division of Vascular Surgery, University Health Network, University of Toronto

Objective: Stent grafts used in the repair of abdominal aortic aneurysms can rotate unexpectedly during deployment, potentially leading to serious complications. The purpose of the current study is to understand the geometric factors of the iliac arteries that contribute to stent graft rotation.

Methods: A prospective study evaluating all patients undergoing advanced endovascular aneurysm repair at Toronto General Hospital was initiated in November, 2015. In addition to a qualitative assessment of the stent graft deployment, fluoroscopic images were quantified to determine the degree of device rotation. The local iliac artery geometric variables (radius, curvature, and torsion) were then calculated from the preoperative CTA imaging. Results were analyzed with respect to two groups (control and rotation) based on the qualitative assessment.

Results: Twelve patients have been enrolled with a mean age of 75 [66-86] and a mean aneurysm diameter of 64 mm [58-74mm]. One patient was excluded following an aborted procedure. The incidence of stent graft rotation was 58.3% (N=7) with a mean rotation of 20.4° [7.5-51.0°]. There were no significant differences in iliac diameter between the two groups. The total net torsion in the iliac arteries was significantly higher in the rotation group, 4.2±0.63 mm⁻¹ vs 1.5±0.42 mm⁻¹ (P<0.01). There was also a trend towards increased mean curvature in the rotation group vs the control group (0.031±0.004mm⁻¹ vs 0.022±0.002 mm⁻¹).

Conclusions: This preliminary data from a prospectively followed cohort suggests that total net torsion of the iliac arteries may be the primary causative factor for unexpected stent graft rotation during deployment. Further studies will need to evaluate the local relationships between diameter, calcification, and torsion of the iliac arteries.
Magnetic Resonance Imaging as a predictor of forces required to cross peripheral arterial lesions with a guidewire

Trisha Roy, Garry Liu, Noor Shaikh, Andrew D. Dueck, Graham A. Wright
Sunnybrook Research Institute, University of Toronto

Objective: Percutaneous vascular interventions (PVI) are associated with immediate technical failure as well as medium- and long-term restenosis leading to re-intervention or failure. Limitations with current imaging make predicting which patients will have low rates of immediate technical failure and good long-term outcomes imprecise. Immediate risk of technical failure is typically judged only by length and degree of lesion calcification. In this study, we sought to delineate risk of immediate technical failure by utilizing MRI to characterize peripheral arterial lesions beyond simple degree of calcification. Following this we sought to measure crossing forces required by guidewires as a surrogate for risk of immediate technical failure.

Methods: 40 excised peripheral arterial plaques from 6 amputation patients were imaged at 7 Tesla using T2-weighted and Ultrashort Echo Time sequences at high resolution (75μm³ voxels). 15 samples were studied to validate MR imaging signatures with microCT and histology. 25 lesions were chronic total occlusions (CTOs). CTOs were classified as soft (those with fat, thrombus or microchannels), intermediate (those with loose fibrous tissue), hard (those with dense fibrous tissue/collagen), or calcified (those containing calcium). A 2kg load cell advanced the back-end of a 0.035” Lunderquist® Extra Stiff (Cook Medical) guidewire at a fixed displacement rate of 0.05mm/s through the CTOs, and the force required to cross the lesion was measured.

Results: Densely “calcified” CTOs (n=4) immediately failed mechanical testing. Non-calcified “hard” CTOs (n=6) required a puncture force of 1.74N ± 0.58 (Figure 1). Intermediate CTOs (n=11) required a puncture force of 0.45N ± 0.33. Soft CTOs (n=4) required a puncture force of 0.07N ± 0.02. The difference between groups were statistically significant (One-way ANOVA (F(2,18) = 29.490, P <.05).

Conclusion: These results demonstrate the potential of high-resolution MRI to predict guidewire crossing forces in peripheral CTOs. Future work will determine lesion crossability in-vivo with clinical MRI scanners, and the degree to which lesion characteristics predict mid- and long-term outcomes.
Figure 1: “Hard” dense collagen CTO and associated force displacement curve. The MRI signature of collagen is hypointense on T2 and isointense on UTE (using smooth muscle as the reference intensity).
Smart(phone) learning experience amongst vascular residents utilizing a response system application

Wissam Al-Jundi, Giuseppe Papia, Andrew Dueck

Objectives: Smartphones have become the most important personal technological device. M-learning is learning through mobile device educational technology. We aim to assess the acceptability of a smartphone learning experience amongst the vascular residents and determine if results could inform formal teaching efforts.

Methods: A survey of the vascular residents at a single centre was conducted following a trial of smartphone learning experience. A vascular fellow utilized a smartphone response system application (PolltoGo*, Inspirapps Inc) to send a daily multiple-choice question (figure 2) to the vascular residents for 20 consecutive working days. The application allows for only one attempt from each user and the answers are registered anonymously. However, each participant receives instant feedback on their response by viewing the correct answer after answering each question along with a distribution of answers amongst other users.

Results: 9 residents participated in the trial and all of them filled a post trial survey. All the residents possessed smartphones. The majority (78%) were not aware of the concept of m-learning. The mobile engagement score (number of answers received divided by total possible answers) was 145/180 (80.6%). All the residents were “satisfied” or “very satisfied” with the experience, and the same number stated that they were “likely” or “very likely” to use this technology in the future. The majority (89%) agreed that such an application could assist them in their board exam preparation. On 3 occasions, 75% or more of the participating residents answered the multiple choice question incorrectly which resulted in addressing the relevant topics in the unit’s weekly teaching conference.

Conclusion: Utilizing smartphones for education is acceptable amongst the vascular residents and the trial of a response system application with instant written feedback represents a novel method for using smartphones for collaborative learning. Such an application can also inform program directors and surgical trainers of their trainees’ learning needs.
Ten Years of Endovascular Aortic Aneurysm Repair: A Population-based Evaluation of Post-operative Imaging and Mortality
Charles de Mestral, Ruth Croxford, Naomi Eisenberg, Graham Roche-Nagle

Objectives: Compliance with regular imaging follow-up after endovascular aortic aneurysm repair (EVAR) is inconsistent. Furthermore, evidence in support of a defined imaging surveillance schedule is limited. We sought to characterize the frequency of post-operative imaging and explore its association with mortality.

Methods: Using administrative databases capturing all hospital admissions and radiologic imaging within the province of Ontario, Canada, we identified a cohort of patients who underwent EVAR between 2004 and 2014. Minimum appropriate imaging follow-up (MAIFU) was defined as a CT scan or ultrasound of the abdomen within 90 days of EVAR as well as every 15 months thereafter. Multivariable time-to-event analysis was performed to characterize the association between post-operative imaging frequency and all-cause mortality. Two definitions of the main exposure variable (post-operative imaging frequency) were considered: (1) whether the patient met MAIFU criteria - a time-varying binary variable, (2) the proportion of the follow-up period meeting MAIFU criteria - a time-varying continuous variable.

Results: 4,988 patients treated by EVAR were identified. Median follow-up was 3.4 years (interquartile range 2.0-5.3 years) and 90-day mortality was 1.7% (N=86). Among those who survived over 90 days, 87% (N=4,251 of 4,902) underwent at least one CT scan or ultrasound of the abdomen within 90 days and, 58% (N=2,859 of 4,902) met the definition for MAIFU. On multivariable analysis, meeting MAIFU criteria was associated with a lower risk of death when compared to missing first imaging follow-up within 90 days (HR= 0.81, 95%CI 0.69 - 0.96, p=0.012) as well as when compared to follow-up including first imaging within 90 days but not meeting MAIFU criteria (HR=0.78, 95%CI 0.68 - 0.90, p < 0.001). A larger proportion of the follow-up period meeting MAIFU criteria was associated with a lower risk of death. The strength of this latter association increased with greater time since EVAR.

Conclusions: Regular imaging after EVAR is associated with lower all-cause mortality and the reduced mortality risk appears most pronounced in the long term. Efforts to improve imperfect compliance with imaging follow-up after EVAR are warranted.
Visceral Stents In Twenty-Eight Advanced Endovascular Aortic Repairs: An Ontario Single Center Experience
Mutalib Al Masloom, Caleb Zavitz, Mark Wheatcroft, Tony Moloney, Al Lossing, Mohammed Al-Omran, Elisa Greco

Objective: To review our center experience with the advanced repairs. To identify factors that affect branch patency, lead to complication or graft failure.

Background: Visceral branch stenting is the most common endovascular approach during juxtarenal and thoracoabdominal aneurysm repairs. These procedures are time consuming with a major hemodynamic stress on the patient with significant contrast dose radiation exposure for both the patient and the surgery team. Visceral branch occlusions may be associated with major consequences that alter the outcome of the repair.

Methods: We set out to retrospectively review the advanced endovascular aorta repairs (A-EVAR), involving one or more visceral branch stenting, performed at a single center between 1 June 2010 to end of June 2015. A total of 28 cases were encountered. Demographic data, comorbidities, aneurysm repair indication with device description were collected. In addition to in hospital morbidity, mortality and long term follow up.

Results: 28 cases with A-EVAR, with mean age of 70.8 years old (range 49-86). Among the vascular comorbidities diabetics were 14%, preexisting renal insufficiency of 17%, 48% coronary artery disease, 58.6% dyslipidemia, smoking and COPD 65.5% and hypertension present in 69%. A total of 102 vessels interventions were performed on the 4 main visceral arteries. 41 fenestrations, 48 branches, 7 scallops, 3 vessels were Amplatzed and 3 open bypasses. Out of 99 arteries treated endovascularly, 89 were stented. Total of 122 stents were deployed. Majority of the vessels needed a single stent 59, double stents were used in for 28 arteries while 3 and 4 stents were used in a single artery each. Majority of the stents were Atrium 66 (mean of 16.5 per artery) followed by 19 arteries treated using Viabahn while Fluency was used in 4 only. The overall primary branch patency as determined by last date of postoperative CT angiography performed on 26 patients showed a total median of 375.5 days (range 3 - 1082 days). 3 branches were embolized intraoperatively while only 1 was thrombosed after the procedure. Reintervention was done for type III endoleaks in 2 cases and to stent a perfusion branch in 3 cases. The mean average of days in the hospital is 10.6 days (range 3-57).

Conclusion: Advanced endovascular repair of complex aortic anatomy is safe with good intermediate term branch vessels patency. Further follow up is recommended to determine the long-term outcomes.
Drug-eluting balloon angioplasty versus non-stenting balloon angioplasty for peripheral arterial disease of the lower limbs
Ahmed Kayssi, Talal Al-Atassi, George Oreopoulos, Graham Roche-Nagle, Kong Teng Tan, Dheeraj Rajan

Objective: To assess the efficacy of drug-eluting balloon (DEB) compared with uncoated, non-stenting balloon angioplasty in patients with symptomatic lower-extremity peripheral arterial disease (PAD).

Methods: A Cochrane systematic review and meta-analysis was carried out of all published randomized-controlled trials that compared DEBs with non-stenting balloon angioplasty for PAD.

Results: Eleven trials that randomized 1838 participants met the study inclusion criteria. DEBs were associated with better outcomes for up to two years in primary vessel patency (Odds ratio (OR) 3.84, 95% Confidence Interval (CI) 1.43 to 10.31 at six months; OR 1.92, 95% CI 1.45 to 2.56 at 12 months; OR 3.51, 95% CI 2.26 to 5.46 at two years) and late lumen loss (Mean difference (MD) -0.64 mm, 95% CI -1.00 to -0.28 at six months; MD -1.10 mm, 95% CI -1.41 to -0.79 at 12 months; MD -0.80 mm, 95% CI -1.44 to -0.16 at two years). DEB were also superior to uncoated balloon angioplasty for up to five years in target lesion revascularization (OR 0.28, 95% CI 0.17 to 0.47 at six months; OR 0.40, 95% CI 0.31 to 0.51 at 12 months; OR 0.28, 95% CI 0.18 to 0.44 at two years; OR 0.21, 95% CI 0.09 to 0.51 at five years) and binary restenosis rate (OR 0.44, 95% CI 0.29 to 0.67 at six months; OR 0.38, 95% CI 0.15 to 0.98 at 12 months; OR 0.26, 95% CI 0.10 to 0.66 at two years; OR 0.12, 95% CI 0.05 to 0.30 at five years). There was no significant difference between DEB and uncoated angioplasty in amputation, patient mortality, ankle-brachial index (ABI) measurements, change in Rutherford category and quality of life (QoL) scores, or treadmill walking distance, although none of the trials were powered to detect a significant difference in these clinical endpoints. Two subgroup analyses were carried out to examine outcomes in femoropopliteal and tibial interventions as well as in patients with critical limb ischemia (CLI) (≥4 Rutherford class), and showed no advantage for DEBs at six and 12 months compared with uncoated balloon angioplasty.

Conclusions: There is an advantage for DEBs compared with uncoated balloon angioplasty in several anatomic endpoints, but no significant advantage in clinical endpoints such as amputation or QoL. Well-designed studies with long-term follow-up are needed to adequately compare DEB with uncoated balloon angioplasty for both anatomic and clinical study endpoints before the widespread use of this expensive technology can be justified.
Matthew Doyle PhD, Research Associate, Department of Mechanical and Industrial Engineering, Division of Vascular Surgery, Department of Surgery, University of Toronto

The application of mechanical engineering techniques to surgical planning

Matthew Doyle, Ph.D. is a Research Associate in the Department of Mechanical and Industrial Engineering and the Division of Vascular Surgery at the University of Toronto. He received his Ph.D. in Mechanical Engineering from the University of Ottawa in 2011. His areas of expertise are cardiovascular mechanics, computational fluid dynamics, and finite element analysis. His research interests focus on the application of mechanical engineering techniques to clinical research problems in vascular and cardiac surgery, with current projects including understanding stent graft rotation, developing a medical device for failing Fontan circulation, and developing tools for improving tetralogy of Fallot repair.
Public health campaigns and their effect on stroke knowledge in an Urban population: A five-year study
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Background and Objective: The level of knowledge of stroke risk factors and stroke symptoms within a population may determine their ability to recognize and ultimately react to a stroke. The aim of this study was to determine the change in baseline knowledge of stroke risk factors, symptoms, and source of stroke knowledge in an urban population between 2010 and 2015.

Methods: Questionnaires were distributed to adults presenting to cardiovascular clinics at the University of Toronto in Toronto, Canada. In 2010 and 2015 a total of 207 and 818 individuals participated in the study, respectively. Participants were identified as stroke literate if they identified (1) at least one stroke risk factor and (2) at least one stroke symptom.

Results: A total of 198 (95.6%) and 791 (96.7%) participants completed the questionnaire in 2010 and 2015 respectively. The most frequently identified risk factors for stroke in 2010 and 2015 were smoking (58.1%) and hypertension (49.0%), respectively. The most common stroke symptom identified was trouble speaking (56.6%) in 2010 and weakness, numbness or paralysis (67.1%) in 2015. Approximately equal amounts of respondents were able to identify ≥1 risk factor (80.3% vs. 83.1%, p=0.339) and ≥1 symptom (90.9% vs. 88.7%, p=0.382). Overall, the proportion of respondents who were able to correctly list ≥1 stroke risk factors and stroke symptoms was similar (76.8% vs. 75.5%, p=0.704). The most commonly reported stroke information resource was television (61.1% vs. 67.6%, p=0.086).

Conclusion: Stroke literacy has remained unchanged despite large investments in public campaigns over recent years. However, the baseline remains high over the study period. Evaluation of previous campaigns and development of targeted advertisements using more commonly used media sources offer opportunities to enhance education.
PREDICTING ILLIAC ARTERY DEFORMATION IN RESPONSE TO GUIDEWIRE INSERTION USING COMPUTATIONAL SIMULATIONS

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Objective: The objective of this study was to use finite element analysis to predict the deformation of an iliac artery in response to the insertion of a stiff guidewire, as the first step towards simulating stent graft delivery and deployment.

Methods: The computational study was performed using the explicit finite element solver LS-DYNA (LSTC, Livermore, CA, USA). The 3-D centerline of an iliac artery was generated using The Vascular Modelling Tool Kit. An idealized iliac artery geometry was created by lofting a circle (11 mm diameter) along the centerline curve using SolidWorks (Dassault Systèmes, Waltham, MA, USA). A mesh consisting of 441,316 quadrilateral and triangular shell elements was generated using LS-PrePost (LSTC), and a constant vessel wall thickness of 1.5 mm was specified. At one end of the vessel, a boundary condition of nonlinear springs was implemented in order to simulate upstream and downstream arterial tissue, with a rigid support specified at the other end. The vessel was pre-stressed via the application of an 80 mm Hg outward pressure. A stiff guidewire was displaced to follow the path of the iliac artery centreline. This imposed displacement condition was then removed, which initiated contact between the wire and the vessel wall and caused the wire to attempt to deform back to straight. The vessel wall, with a Young’s Modulus representative of an iliac artery, then deformed in response to the deformation of the wire.

Results: The simulations showed that the insertion of the stiff guidewire causes the iliac artery to fold over, or “accordion”, on itself (Fig. 1). This is consistent with what has been reported in the literature and observed clinically.

Conclusions: Using LS-DYNA, we were able to accurately simulate the deformation of an iliac artery in response to the insertion of a stiff guidewire. These results will be used in later simulations of stent graft deployment.
Figure 1 - Deformed Iliac Artery Due to Guidewire Insertion
Predictors of Arteriovenous Hemodialysis Fistula Maturation: A Systematic Review of the Literature
Konrad Salata, Mohamed Hussain, Zayed Khoushhal, Mohammed Al-Omran

Objectives: The advantages of arteriovenous fistulae (AVF) over other forms of hemodialysis access are well-established. These include superior mortality, lower re-hospitalization and re-intervention rates, and lower overall cost. Unfortunately, AVFs are plagued by high non-maturation rates and prolonged maturation periods. The literature regarding the factors that affect AVF maturation is sparse and generally of poor quality. The objective of this study is to comprehensively consolidate the data available on the predictors of AVF maturation.

Methods: We conducted a systematic review of the literature in accordance with PRISMA guidelines. Our search protocol was developed in consultation with an experienced cardiovascular librarian. We searched MEDLINE, EMBASE, and The Cochrane Library for all studies investigating the impact of demographic, comorbid, anatomic and medication-related factors on AVF maturation. Studies were independently screened for inclusion by two authors. Discrepancies were resolved by a third author and a kappa statistic was calculated for inter-rater agreement. Study quality was assessed using the Ottawa Newcastle Scale. Data extraction was conducted by two authors using standardized data collection forms. Odds ratios with 95% confidence intervals were calculated where applicable. Pooled analyses were based on random-effects models, and heterogeneity was quantified using the $I^2$ statistic.

Results: The present study is currently in the screening phase. Our optimized search strategy yielded 4958 studies. Retention for full review is approximately 10% based on preliminary screening.

Conclusion: No conclusions can be made from preliminary screening data. Based on the preliminary retention rate, our inclusion criteria and the scope of our review may require focusing for feasibility.
HYBRID REPAIR OF A TRAUMATIC ARTERIOVENOUS FISTULA AND GIANT PSEUDOANEURYSM: CASE REPORT AND REVIEW OF CURRENT MANAGEMENT
Miranda Witheford, Aaron Beder, Kerry Graybiel

Objectives: The management of acquired arteriovenous fistulae (AVF) represents an evolving clinical challenge given their diverse presentations and etiologies. Commonly, acquired AVF with or without associated pseudoaneurysm are the result of cardiovascular intervention (iatrogenic AVF), although traumatic AVF are also prevalent, and may be the result of penetrating or, infrequently, blunt trauma. Here we present a case of traumatic arteriovenous fistula with giant pseudoaneurysm secondary to gunshot wound. Using a hybrid endovascular and open approach we address this patient’s complex injuries, resolving the patient’s limb ischemia. A review of physiologic and anatomic considerations in this case provides a broader scope for discussing evidence-based treatment of traumatic arteriovenous fistulae.

Methods: We have explored the patient’s presentation, and indications for intervention, as well as presenting the anatomic considerations of this case. The case reports and case series that are available in the literature are reviewed, and an argument constructed regarding our approach to management in this case.

Results: The management deliberations in this case reflect anatomic considerations, as well as the complexity of the involved lesion(s). In the literature, small case series and case reports document the use of endovascular and open strategies for repair. A discussion of considerations for management in this case, endovascular, open, and hybrid, and the evidence for strategies for repair of these lesions is reviewed.

Conclusions: Traumatic arteriovenous fistulae represent highly varied vascular lesions, and the current evidence for their management in the literature is undergoing some evolution. Treatment indications include systemic complications (high-output congestive heart failure), distal limb ischemia, as well as local effects resulting in injury/compromise to nearby structures. Both open and endovascular strategies for excluding arteriovenous fistulae with or without pseudoaneurysm have been documented. What may be gleaned from this review is that the anatomic location of the AVF, its association with pseudoaneurysm, and the clinical presentation of the patient suggest which treatment modality is most suitable, given the understanding that there is no evidence to suggest the overarching superiority of one repair stratagem over the other.
A study of methods to stimulate self-practice of surgical techniques.
Omar Selim, Andrew Dueck

Objective: It is widely accepted that a learner’s surgical skills improve with repetition. Furthermore, it has been comprehensively shown that distributed practice, as opposed to massed practice, stimulates improved skill retention. However, current surgical skill teaching consists primarily of large, massed simulation sessions, where opportunities for continued, distributed practice are limited by the availability of simulation spaces and the scheduling difficulties associated with clinical training programmes. Therefore, it is of interest to investigate ways with which continued distributed practice can be stimulated amongst trainees. Given this, and evidence supporting the effectiveness of self-directed practice using computer based video training methods, this study has been designed to compare traditional surgical skills curricula with computer based video training in terms of stimulating surgical skill practice amongst medical students.

Methods: A group of medical students were randomized to the two arms of the study – the first undergoing a surgical skills teaching day at the Mount Sinai clinical skills lab, the second given open-ended access to online instructional videos detailing surgical techniques. The techniques covered were equivalent between both groups. The first group were allowed to schedule follow-up practice sessions at the simulation lab, while the second group were provided with suturing materials to allow for self-directed practice. Both were followed over a 6 week period and the number of practice sessions undertaken was recorded. With the end of the initial trial period, both cohorts were crossed over to the alternative study arm and the study repeated. The difference in the number of practice sessions between study arms was assessed for significance.

This study is currently at the REB phase.
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