

# Peripheral Endovascular Interventions Training Curriculum

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## Description

In the era of duty hour restrictions and increasing medico-legal pressures, surgical simulation offers a viable alternative to bridge the gap in experience and knowledge of residents<sup>2</sup>.

Training within a proficiency-based, virtual-reality training program can increase competency and reduce errors and complications during real surgical procedures<sup>10</sup>.

The skills acquired in the simulated environment should be transferable to the real clinical environment<sup>4</sup>.

The Symbionix ANGIO Mentor is a virtual reality simulator that provides a safe work environment for a variety of endovascular procedures.

The following curriculum is intended to promote the acquisition of endovascular skills and procedural performance for peripheral endovascular interventions.



## Objectives

- ◆ Practicing and acquiring competence in endovascular technical skills:
  - Guidewire and catheter handling
  - Performing diagnostic arteriography and selective catheterization
  - Safely crossing a lesion
  - Using a variety of interventional devices and materials
- Imaging Techniques – using fluoroscopy, DSA and roadmapping.
- Contrast - using power injection and hand injection
- ◆ Mastering and achieving confidence in the following interventional procedures, in a simulated environment:
  - Renal Angioplasty and Stenting
  - Iliac Angioplasty and Stenting
  - SFA Angioplasty and Stenting
  - Carotid Angioplasty and Stenting
  - Below the Knee Revascularization
  - Peripheral Embolization
- ◆ Practicing and acquiring competence in the following:
  - Managing intra-procedural complications
  - Hemodynamic patient management
  - Using medications

## Specialties

Vascular Surgery, interventional Cardiology, Interventional Radiology, Neuro Radiology, Neuro Surgery.

## Target Audience

Individuals or groups interested in following a structured curriculum to promote acquisition of endovascular skills and procedural performance for peripheral endovascular interventions.

## Assumptions

Previous anatomical and procedural steps knowledge is assumed.

## Suggested Time Length

The suggested program can be implemented during 1st year of residency, consisting of weekly faculty-mentored simulation-based sessions. Completing one case successfully in each module should take between 20 minutes to one hour.

## **Authors**

This curriculum is designed by Simbionix to serve as a template for program directors at institutions, who can tailor the curriculum to the individual training needs. Please review references for a detailed review of published studies.

## **Introduction to Curriculum**

Before each module is performed, provide a full demonstration of one case by an experienced operator, with an opportunity for the trainee to ask questions.

Suggested time length for the familiarization period is approximately 30 minutes.

## 1.1 Renal Intervention Module

The Renal Intervention module allows physicians to practice the diagnosis, angioplasty and stenting of renal artery stenosis using either a femoral approach or a retrograde brachial approach.

The module includes 8 virtual patient cases of increasing difficulty, presenting various stenosis locations and orientations of the renal arteries and various pathologies including an FMD patient.

### Objectives:

- ◆ Perform aortogram and visualize the stenosis
- ◆ Perform selective catheterization of the target renal artery
- ◆ Cross the stenosis and anchor the wire in a distal position
- ◆ Measure trans-stenotic pressure gradient using a diagnostic catheter
- ◆ Place an embolic protection device distal to the stenosis
- ◆ Appropriately size an angioplasty balloon and balloon-expandable stent
- ◆ Inflate a pre-dilatation balloon to allow stent passage or to resolve the stenosis
- ◆ Position and deploy a balloon-expandable stent
- ◆ Perform post-procedure angiography and verify that the stenosis was resolved
- ◆ Measure post-procedure trans-stenotic pressure gradient

### Instructions:

The module enables free-style training using different techniques, alternative approaches, and acquisition of the skill and knowledge necessary to safely cope with possible complications.

Practice selective catheterization of the target renal artery, angioplasty or stenting of the target renal artery lesion. Following performance of the patient case, the trainee is required to analyze his/her performance report and set personal standards for improvement.



#### Case 1 - Renal Intervention

Left Ostial Lesion



#### Case 2 – Renal Intervention

Left Ostial Lesion



### Case 3 – Renal Intervention

Right Non-Ostial Lesion



### Case 4 – Renal Intervention

Bilateral Ostial Lesions



### Case 5 – Renal Intervention

Right Non-Ostial Lesion, FMD Patient, Brachial Approach



### Case 6 - Renal Intervention

Left Bifurcation Lesion



### Case 7 – Renal Intervention

Left Ostial Lesion, Brachial Approach



## Case 8 – Renal Intervention

Right Ostial Lesion

## 1.2 Iliac Intervention Module

This module allows physicians to practice the diagnosis and treatment of iliac artery stenosis using either an ipsilateral common femoral approach or crossing the aortic bifurcation using the contralateral approach. The module includes 6 virtual patient cases, presenting different aortic bifurcation types and various stenosis locations (common iliac artery and external iliac artery), degree and types.

### Objectives:

- ◆ Perform diagnostic angiography
- ◆ Practice retrograde/crossover techniques
- ◆ Appropriately size an angioplasty balloon and a stent
- ◆ Inflate a pre-dilatation balloon to allow stent passage or to resolve the stenosis
- ◆ Position and deploy a stent
- ◆ Perform post-procedure angiography and verify that the stenosis was resolved

### Instructions:

The module enables free-style training using different techniques, alternative approaches, and acquisition of the skill and knowledge necessary to safely cope with possible complications.

Select the desired approach and perform diagnostic angiography of the iliac arteries. Inflate a balloon and deploy a stent to resolve the stenosis.

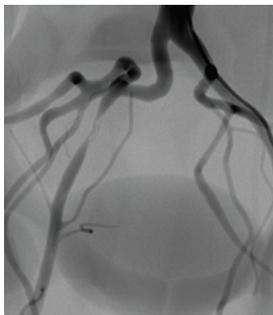
Following performance of the patient case, the trainee is required to analyze his/her performance report and set personal standards for improvement.



#### Case 1 - Iliac Intervention

Right Common Iliac Lesion

Recommended access: Right

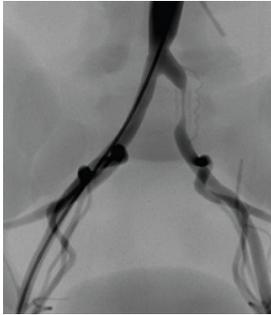


#### Case 2 - Iliac Intervention

Right External Iliac Lesion.

Narrow aortic bifurcation.

Recommended access: Right



### Case 3 - Iliac Intervention

Left Common Iliac Lesion.

Narrow aortic bifurcation.

Recommended access: Left

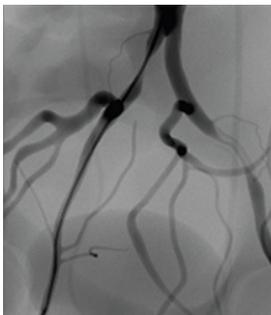


### Case 4 - Iliac Intervention

Left External Internal and Internal Iliac Lesions.

Narrow aortic bifurcation.

Recommended access: Left

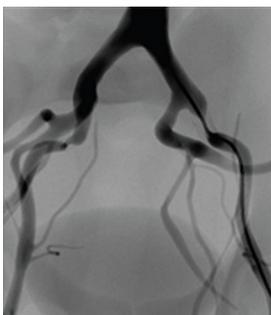


### Case 5 - Iliac Intervention

Right Common Iliac and Left External Iliac Lesions.

Narrow aortic bifurcation.

Recommended access: right and then left



### Case 6 - Iliac Intervention

Right and Left External Iliac Lesions

Recommended access: right and then left

Crossover approach is used to treat the left stenosis.

## 1.3 SFA Intervention Module

This module allows physicians to practice the diagnosis and treatment of common femoral artery and superficial femoral artery stenosis using either an ipsilateral approach or contralateral approach.

The module includes 6 virtual patient cases, presenting different aortic bifurcation types and various stenosis, degree and length.

### Objectives:

- ◆ Perform diagnostic angiography using oblique views to avoid overlapping of the SFA and profunda
- ◆ Practice retrograde/crossover techniques
- ◆ Appropriately size an angioplasty balloon and a stent
- ◆ Inflate a pre-dilatation balloon to allow stent passage or to resolve the stenosis
- ◆ Position and deploy a self-expanding stent / multiple overlapping stents
- ◆ Perform post-procedure angiography and verify that the stenosis was resolved

### Instructions:

The module enables free-style training using different techniques, alternative approaches, and acquisition of the skill and knowledge necessary to safely cope with possible complications.

Select the desired approach and perform diagnostic angiography.

Use crossover / ipsilateral approach to position a sheath proximal to the lesion.

Inflate a balloon and deploy a stent to resolve the stenosis.

Following performance of the patient case, the trainee is required to analyze his/her performance report and set personal standards for improvement.



#### Case 1 - SFA Intervention

Right SFA Lesion

Recommended access: Left (crossover)

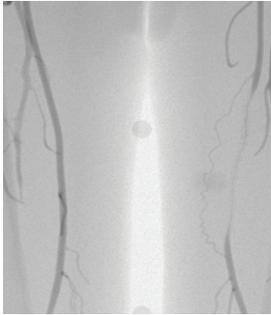


#### Case 2 - SFA Intervention

Right SFA Lesion

Narrow aortic bifurcation.

Recommended access: Left (crossover)



### Case 3 - SFA Intervention

Left SFA Lesion.

Narrow aortic bifurcation.

Recommended access: Right (crossover)

Deploy two overlapping stents.

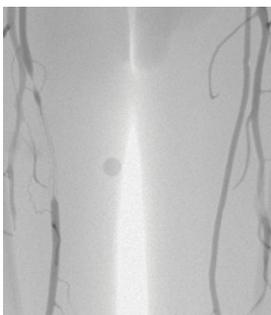


### Case 4 - SFA Intervention

Left SFA multiple focal lesions.

Narrow aortic bifurcation.

Recommended access: Right (crossover)

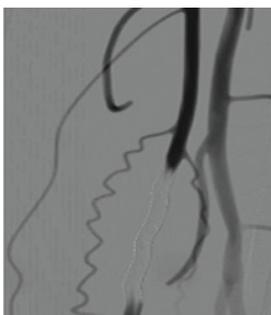


### Case 5 - SFA Intervention

Right SFA Lesions

Narrow aortic bifurcation.

Recommended access: left (crossover)



### Case 6 - SFA Intervention

Left external iliac (non significant lesion) and SFA Lesions

Narrow aortic bifurcation.

Recommended access: Left

Treat the SFA stenosis using antegrade approach (the external iliac stenosis is not significant).



## 1.4 Carotid Intervention Module

The Carotid module provides physicians practice of all aspects of the carotid stenting procedure, including diagnosis, protection device deployment, PTA and stenting.

The module includes 12 virtual patient cases presenting a variety of stenosis locations and anatomies, including aortic arch type I, II, III and a bovine arch.

Intra-procedural spasms and hemodynamic changes as a result of baroreceptor reaction must be attended to.

### Objectives:

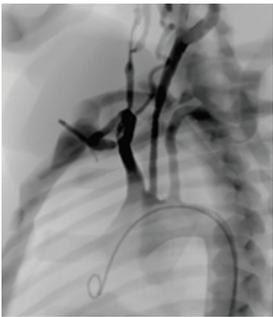
- ◆ Perform diagnostic aortogram and visualize the carotid origins
- ◆ Cannulate the target common carotid and perform selective angiography
- ◆ Learn how to use roadmapping
- ◆ Appropriately size an embolic protection device, angioplasty balloon and self-expanding stent
- ◆ Position a distal/proximal embolic protection device
- ◆ Perform pre-dilatation, stenting and post-dilatation while avoiding protection device movement and spasm
- ◆ Manage hemodynamic changes as a result of baroreceptor reaction using the drug panel
- ◆ Treat spasms using nitroglycerine

### Instructions:

The module enables free-style training using different techniques, alternative approaches, and acquisition of the skill and knowledge necessary to safely cope with possible complications.

Practice positioning a guiding catheter or sheath in the target common carotid, protection device positioning, angioplasty or stenting of the target lesion.

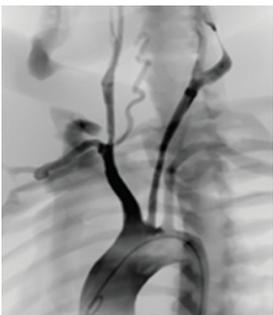
Following performance of the patient case, the trainee is required to analyze his/her performance report and set personal standards for improvement.



#### Case 1 - Carotid Intervention

Type 1 Arch

Right Bifurcation Lesion



#### Case 2 - Carotid Intervention

Type 1 Arch

Left Internal Carotid Lesion



### **Case 3 - Carotid Intervention**

Type 1 Arch

Right Internal Carotid Lesion



### **Case 4 - Carotid Intervention**

Type 1 Arch

Left Internal Carotid Lesion



### **Case 5 - Carotid Intervention**

Type 2 Arch

Left Internal Carotid Lesion



### **Case 6 - Carotid Intervention**

Type 2 Arch

Left Common Carotid Lesion



### **Case 7 - Carotid Intervention**

Type 2 Arch

Left Internal Carotid Lesion



### Case 8 - Carotid Intervention

Type 2 Arch

Right Internal Carotid Lesion



### Case 9 - Carotid Intervention

Type 3 Arch

Left Internal Carotid Lesion



### Case 10 - Carotid Intervention

Type 3 Arch

Right Bifurcation lesion



### Case 11 - Carotid Intervention

Bovine Arch

Right Internal Carotid Lesion



### Case 12 - Carotid Intervention

Bovine Arch

Left Internal Carotid Lesion

## 1.5 Below The Knee Intervention Module

The ANGIO Mentor BTK (Below The Knee) module focuses on chronic total occlusions (CTOs) in vessels below the knee. The module includes virtual patient cases, presenting different occlusion locations, stiffness degree, and length, and presents procedural complications such as perforation.

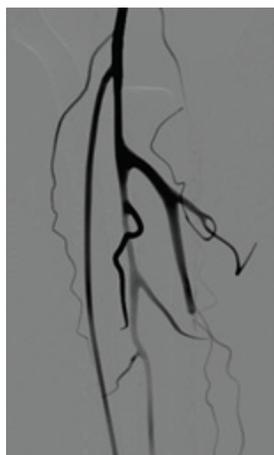
### Objectives:

- ◆ Perform diagnostic arteriogram of the lower limbs to visualize the occlusion
- ◆ Work with a variety of specialized wires (CTO wires with various tip loads) and catheters (diagnostic and support catheters), in a stepwise approach to gradually cross the occlusion
- ◆ Learn to use roadmap to visualize the target healthy vessel when crossing the occlusion
- ◆ Learn to identify whether the wire is inside and outside the occluded vessel
- ◆ Learn various techniques to cross a total occlusion, including antegrade and pedal access, snaring of retrograde wire
- ◆ Learn how to deal with intra-procedural complications, such as perforations and dissections

### Instructions:

The module enables free-style training using different techniques, alternative approaches, and acquisition of the skill and knowledge necessary to safely cope with possible complications.

Practice diagnostic angiography of the lower limbs, crossing the occlusion using various techniques and balloon angioplasty to resolve the occlusion.



### Case 1 - BTK Intervention

Right Posterior Tibial Artery Occlusion

#### Instructions:

Recommended approach: antegrade (right common femoral)

Start with positioning a long sheath in the distal right popliteal artery artery.

Cannulate the posterior tibial artery with a wire and diagnostic catheter. Position a catheter proximal to the occlusion and try to penetrate the occlusion using different wires, starting with 0.035" and going down to 0.014 wire. Use a support catheter/ balloon to support the wire.

After crossing the lesion with the wire, introduce and inflate a balloon.



## Case 2 – BTK Intervention

Left Anterior Tibial Artery Occlusion

### Instructions:

Start with antegrade approach (left common femoral artery), introduce a wire and a diagnostic catheter. Try to cross the occlusion.

If not successful, use pedal retrograde approach to cross the stenosis with a heavy-weight wire.

When reaching the antegrade catheter with the retrograde wire, switch back to antegrade approach and externalize the wire.

Complete with introducing an antegrade long balloon and inflating it along the occlusion.



## 1.6 Peripheral Embolization Module

The Peripheral Embolization module provides a selection of unique anatomies that allow practicing common as well as rare scenarios of embolization.

### Objectives:

- ◆ Perform diagnostic aortogram
- ◆ Perform selective catheterization to diagnose the target embolization site
- ◆ Reach the target embolization site using a microcatheter or a diagnostic catheter
- ◆ Use different types and shapes of microcoils and macrocoils
- ◆ Appropriately size the coils according to the target embolization site
- ◆ Avoid complications during coil delivery: spasm, coil migration, perforation

### Instructions:

The module enables free-style training using different techniques, alternative approaches, and acquisition of the skill and knowledge necessary to safely cope with possible complications.

Perform diagnostic aortography and selectively catheterize the target vessel leading to the embolization site. Perform coil embolization of the target site .

Following performance of the patient case, the trainee is required to analyze his/her performance report and set personal standards for improvement.



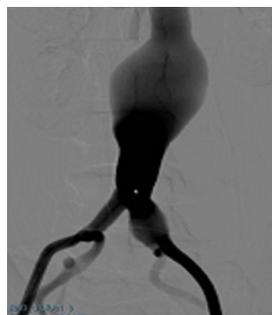
#### Case 1 – Peripheral Embolization

Left Renal Aneurysm

##### Instructions:

Selectively catheterize the left renal artery.

Using a diagnostic catheter, a microcatheter and microcoils, embolize the aneurysm



#### Case 2 – Peripheral Embolization

Internal Iliac Artery Embolization Prior to Endovascular AAA Repair.

##### Instructions:

Select the desired approach (crossover/ipsilateral), using a diagnostic catheter, access the left internal iliac. Place 0.035" coils through the diagnostic catheter to block the internal iliac artery.



### Case 3 – Peripheral Embolization

Right Renal Arterio-Venous Fistula

**Instructions:**

Perform selective renal artery catheterization using an appropriate diagnostic catheter. Diagnose the location of the fistula and deliver microcoils through a microcatheter to block the fistula.

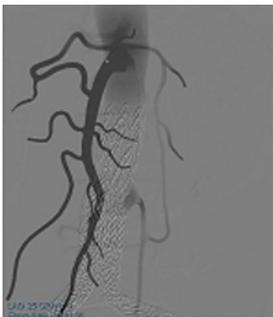


### Case 4 – Peripheral Embolization

Left Renal Wide-neck Aneurysm

**Instructions:**

Perform selective catheterization of the left renal artery using a guiding catheter. Position a balloon-expandable stent across the aneurysm. Position a microcatheter through the stent struts into the aneurysm and deliver microcoils to embolize the aneurysm.



### Case 5 – Peripheral Embolization

Post-EVAR Type II endoleak

**Instructions:**

Selectively catheterize the SMA. Perform an angiogram to find the endoleak location in the IMA. Deliver microcoils through a microcatheter to the IMA leak.

Catheterize the right internal iliac artery. Introduce a microcatheter into the iliolumbar artery and deliver microcoils to the lumbar artery to block the 2nd part of the endoleak.



### Case 6 – Peripheral Embolization

GI Bleeding

**Instructions:**

Selectively catheterize the SMA or the splenic artery to visualize a false aneurysm that causes a GI bleeding. Use a microcatheter to get to the aneurysm and deliver coils to the aneurysm itself or the branches leading to it.

## ANGIO Mentor Studies

1. **Training with simulation versus operative room attendance.** Desender LM, Van Herzeele I, Aggarwal R, Vermassen FE, Cheshire NJ. Department of Thoracic and Vascular Surgery, University Hospital Ghent, Ghent, Belgium. *J Cardiovasc Surg (Torino)*. 2011 Feb;52(1):17-37.
2. **Simulation in Neurosurgical Residency Training: A New Paradigm** Alejandro M. Spiotta, MD Richard P. Schlenk, MD The Cleveland Clinic Foundation, Cleveland, Ohio, USA The Congress of Neurological Surgeons(CNS) Quarterly 2010 page 18-20
3. **The Utility of Endovascular Simulation to Improve Technical Performance and Stimulate Continued Interest of Preclinical Medical Students in Vascular Surgery** Jason T. Lee , Mary Qiu , Mediget Teshome, Shyam S. Raghavan, Maureen M. Tedesco, and Ronald L. Dalman Division of Vascular Surgery, Stanford University School of Medicine, Stanford, California *Journal of Surgical Education* Volume 66, Issue 6, November-December 2009, Pages 367-373 Available online 30 January 2010.
4. **Results from endovascular skills training for surgical residence.** Jason T. Lee, Division of Vascular [Surgery, Stanford University School of Medicine, Stanford, California.](#)
5. **Virtual Reality Simulation in the Endovascular Field** Aggarwal Rajesh , Herzeele Isabelle Van European Virtual Reality Endovascular Research Team (EVEREST) *US Cardiology*, 2008;5(1):41-5
6. **Experienced endovascular interventionalists objectively improve their skills by attending carotid artery stent training courses.** S. Neequaye, I. Van Herzeele, R. Aggarwal, M. Hamady, A. Darzi, T. Cleveland, P. Gaines, N. Cheshire Department of Biosurgery and Surgical Technology, Imperial College London, U.K. *presented in the prize session of the European Society for Vascular Surgery (ESVS) Annual Meeting September 20 - 23, 2007 in Madrid, Spain*
7. **Analysis of simulated angiographic procedures. Part 2: extracting efficiency data from audio and video recordings.** Duncan JR, Kline B, Glaiberman CB. Mallinckrodt Institute of Radiology, Washington University School of Medicine, 510 S. Kingshighway Blvd., St. Louis, MO 63110, USA. *J Vasc Interv Radiol*. 2007 Apr;18(4):535-44
8. **The use of interventional cardiovascular simulation to evaluate operator performance: The carotid Assessment of operator performance by the Symbionix carotid Stenting Simulator Study (ASSESS)** Giora Weisz, Jacque Devaud, Stephen Ramee, Mark Reisman, William Gray Cardiovascular Research Foundation, and Center for Interventional Vascular Simulation, New-York Presbyterian Hospital, Columbia University, New York, NY *Journal of the Society for Simulation in Healthcare* 2007, Volume2, Issue 1
9. **Preliminary Results of Construct Validity of an Endo Vascular Simulator** Giora Weiss, Columbia University, New York The abstract was *accepted and presented at the 2006 TCT meeting October 22- 26, 2006 in Washington DC J Vasc Surg. 2012 Jun 26. [Epub ahead of print]*
10. **Development of a Virtual Reality Training Curriculum for Laparoscopic Cholecystectomy** Aggarwal, P. Crochet, A. Dias, A. Misra, P. Ziprin and A. Darzi *British Journal of Surgery* 2009; 96: 1086–1093.