ANGIO Mentor Based Neurovascular Interventions Training Curriculum

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.

Training within a proficiency-based, virtual-reality training program can increase competency and reduce errors and complications during real surgical procedures[11].

Nowadays simulators provide high-quality graphics and realistic haptics that can give trainees a unique skill set, required by neurointerventions, which cannot be taught in open neurosurgical training programs [3].

The Surgical simulation provides a zero-risk setting in which technical skills can be obtained through repetition. Incorporating the simulators for training purposes in a neurosurgical residency program facilitate the acquisition of technical angiography skills[1].

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

The following curriculum is intended to promote the acquisition of endovascular skill set and procedural performance for neurovascular interventions.

Objectives

- Practicing and acquiring competence in the following basic endovascular technical skills:
  - Guidewire and catheter selection and manipulation
  - Performing diagnostic aortography
  - Selective cannulation of common carotid artery and vertebral artery
  - Imaging techniques – using fluoroscopy, DSA and roadmapping, using a biplane C-arm system
  - Contrast - using power Injection and hand injection
- Mastering and achieving confidence in the following interventional procedures in a simulated environment:
  - Carotid Intevrvention – carotid stenting procedure, including diagnostic angiography, protection device deployment, PTA and stenting.
  - Cerebral Intervention – aneurysm embolization using detachable coils, including stent-assisted coiling, and stenting intracranial stenosis using self-expanding stent.
  - Acute Ischemic Stroke – emergency endovascular stroke treatment using a mechanical thrombectomy device, balloon guide catheter and aspiration.
- Practicing and acquiring competence in the following:
  - Managing Intra-procedural complications
  - Hemodynamic Patient Management
  - Using medications

Specialties

Interventional Neuro Radiology, Endovascular Neuro Surgery, Endovascular Neurology.

Target Audience

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

Assumptions

Previous anatomical and procedural steps knowledge is assumed.

Suggested Time Length

Completing one case successfully in each module should take between 20 minutes to one hour.
The suggested program can be implemented during residency, consisting of weekly faculty-mentored simulation-based sessions.
The modules can also be a part of training during fellowship or even CME training courses.

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- Instructors

The trainee is required to follow a structured step-by-step curriculum set in a hierarchical order, incorporating three consecutive segments:

a. Didactic
   Prior to hands-on experience with the simulator, trainees shall be given a short presentation by experienced instructor that will include basic anatomy, properties and geometries of diagnostic catheters and guidewires, and procedure-specific device sizing and instructions for use.
b. Demonstration
   Full demonstration of one case shall be provided by an experienced operator, with an opportunity for the trainee to ask questions. Suggested time length for the familiarization period is approximately 1 hour.
c. Hands On Training
   Trainees shall perform a specific case in accordance with the preliminary steps of the curriculum.

1.1 ANGIO Basic Skills Module

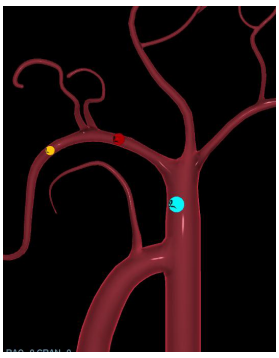
The module enables the trainee to acquire basic-level wire-catheter and imaging skills essential to building confidence and ease with endovascular techniques.
Tasks in a non-anatomic setting as well as on an anatomical vascular model provide a relaxed environment outside the cath lab / OR.

Objectives:

- Performing diagnostic aortogram
- Performing selective catheterization of different branches
- Navigating wire and catheter to reach target
- Acquiring stability of guide wire-catheter-sheath system
- Keeping catheter and wire stability during exchange
- Becoming familiar with different catheter head shape
- Learning to shape catheters
- Becoming familiar with different wire diameters/curves
- Practicing common carotid cannulation in different arch types

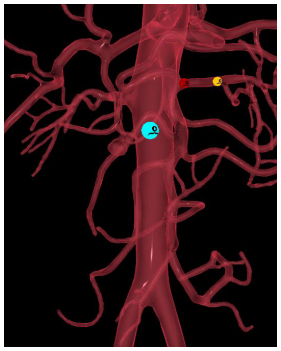
Instructions:

- Each case includes a few tasks, each task with a new group of targets.
- Perform diagnostic aortography (in fluoroscopic environment)
- A group of targets (2 or 3 balls) appear inside one of the model branches.
- Each ball should be touched by a different tool [red – guiding catheter/sheath (8F tool), blue – diagnostic catheter (5F tool), and yellow – guide wire (0.035 or 0.018/0.014 tool)].
- From the tool menu, select a guide wire, an appropriate shape of diagnostic catheter, and a sheath/guiding catheter to selectively catheterize the first target branch.
- Introduce a 0.035”/0.018”/0.014”” wire, a 5F catheter, and 8F catheter coaxially into the simulator.
- Navigate each tool to its target goal.
- Once you touch all the balls simultaneously with all tool tips, the targets disappear and new targets appear. You earn points with each group of targets you collect.



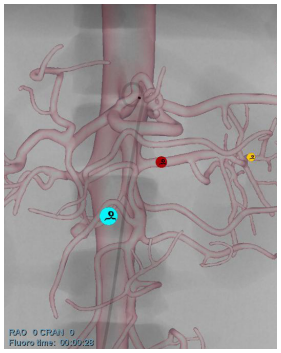
Case 1 - Imaginary 3D Maze

Cannulate different branches of 3D imaginary anatomy



Case 2 - Real Aortic Anatomy - 3D

Cannulate branches off the aorta – real 3D anatomy.



Case 3 - Real Aortic Anatomy - Fluoro

Perform diagnostic aortography and cannulate branches under fluoroscopy.

Case 5- Carotid Cannulation - Fluoro

Present 3 different types of aortic arches.

Perform aortography and cannulate the target common carotid artery.

1.2 Carotid Intervention Module

The Carotid module provides physicians practice of all aspects of the carotid stenting procedure, including diagnostic angiography, protection device deployment, PTA and stenting.
The practice includes cases with 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.

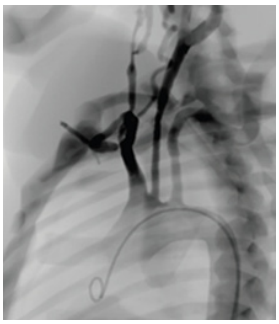
Objectives:

- Perform diagnostic aortography 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

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.

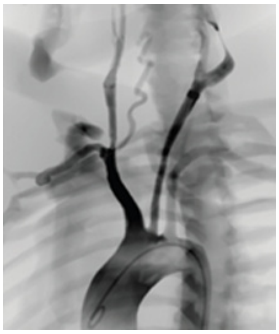
Following performance of the patient case, the trainee is required to analyze his/her performance report and set personal standards for improvement.



Case 1 - Carotid Intervention

Type I Arch

Right Bifurcation Lesion



Case 2 - Carotid Intervention

Type I Arch

Left Internal Carotid Lesion

Case 3 - Carotid Intervention

Type I Arch

Right Internal Carotid Lesion

Case 4 - Carotid Intervention

Type I Arch

Left Internal Carotid Lesion

Case 5 - Carotid Intervention

Type II Arch

Left Internal Carotid Lesion

Case 6 - Carotid Intervention

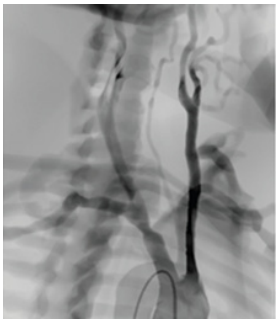
Type III Arch

Left Common Carotid Lesion

Case 7 - Carotid Intervention

Type II Arch

Left Internal Carotid Lesion



Case 8 - Carotid Intervention

Type II Arch

Right Internal Carotid Lesion

Case 9 - Carotid Intervention

Type III Arch

Left Internal Carotid Lesion

Case 10 - Carotid Intervention

Type III Arch

Right Bifurcation lesion

Case 11 - Carotid Intervention

Bovine Arch

Right Internal Carotid Lesion

Case 12 - Carotid Intervention

Bovine Arch

Left Internal Carotid Lesion

1.3 Cerebral Intervention Module

This module provides clinicians with an opportunity to practice performing intracranial aneurysm coiling, intracranial stenosis stenting and intracranial thrombus retrieval, as well as reacting to relevant complications such as aneurysm perforation. The module enables the use of a wide range of devices, such as guiding catheters, microcatheters, coils, as well as performing stent/balloon assisted coiling. It also features a simulation of a biplane x-ray system.
The module includes 9 virtual patient cases – 6 cerebral aneurysm cases and 3 intracranial stenosis cases. The cases present a range of cerebral vasculature, including a variety of aortic arch types, aneurysm with variation in sizes of stenosis and neck types.

Objectives:

- Perform diagnostic angiogram of the intracranial arteries
- Position a guiding catheter in the target internal carotid/vertebral artery
- Manipulate guidewires, detachable coils and microcatheters to access target aneurysm
- Correctly size coils
- Deploy 3D and helical detachable coils
- Perform stent-assisted coiling
- Stent intracranial lesions
- Manage complications (i.e., aneurysm perforation)

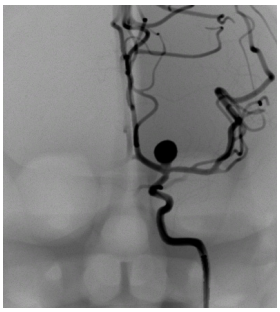
Instructions:

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.

To treat cerebral aneurysm, perform selective angiogram of the target common carotid or vertebral artery, position a guiding catheter in the internal carotid/vertebral. Access the aneurysm using a microwire, microcatheter, measure and embolize the aneurysm using coils.

To treat a stenosis, perform diagnostic intracranial arteriogram, position a guiding catheter, access the target artery with a microwire and deploy a stent.

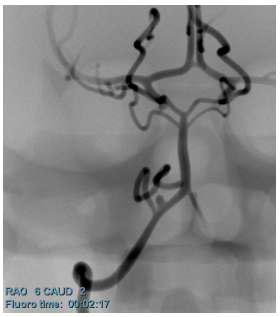
Following performance of the patient case, the trainee is required to analyze his/her performance report and set personal standards for improvement.



Case 1 – Cerebral Intervention

Left ICA bifurcation narrow-neck aneurysm

Type I Arch



Case 2 – Cerebral Intervention

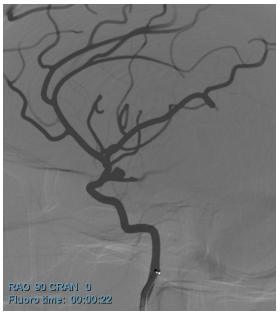
Right PICA wide-neck aneurysm

Type I Arch

Case 3 – Cerebral Intervention

Basilar artery tip wide-neck aneurysm

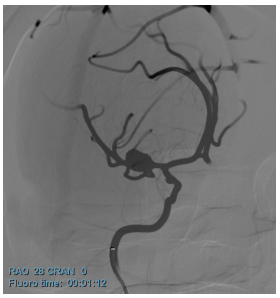
Type II Arch



Case 4 – Cerebral Intervention

Left PCOM wide-neck aneurysm

Type III Arch



Case 5 – Cerebral Intervention

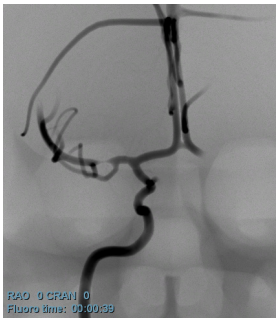
Right MCA (M1-M2 bifurcation) narrow-neck aneurysm

Type III Arch

Case 6 – Cerebral Intervention

Right ICA bifurcation narrow-neck aneurysm and ACOM wide-neck aneurysm

Type II Arch



Case 7 – Cerebral Intervention

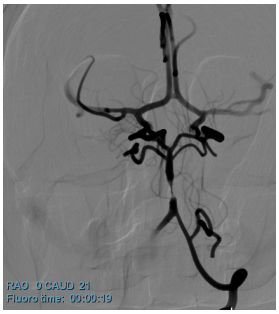
Right MCA stenosis

Type I Arch

Case 8 – Cerebral Intervention

Right ICA stenosis

Type III Arch



Case 9 – Cerebral Intervention

Basiliar artery stenosis

Type III Arch

1.4 Acute Ischemic Stroke Module

This module allows clinicians to practice an endovascular intervention for emergency treatment of acute ischemic stroke. It includes a variety of scenarios with common clot locations.

The module includes 4 virtual patient cases. The cases present a range of cerebral vasculature with variation in sizes and location of the occlusions.

Objectives:

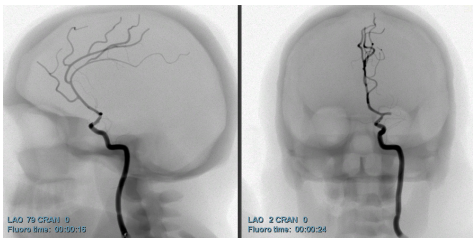
- Perform diagnostic intracranial angiogram
- Position a balloon guide catheter / guiding catheter the target internal carotid or vertebral artery
- Identify the clot proximal and distal ends
- Position a stent retriever beyond the clot
- Retrieve thrombus using a stent retriever, balloon guide catheter and aspiration

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.

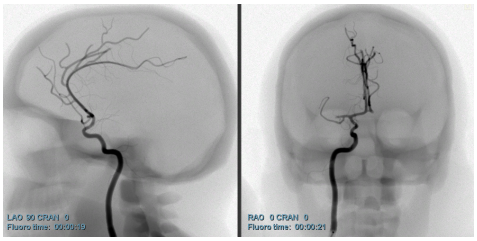
To treat stroke, perform diagnostic intracranial arteriogram, position a balloon guide catheter or a guide catheter in the cervical ICA / vertebral artery proximal to the occlusion, cross the thrombus using wire and microcatheter, assess the distal end of the thrombus, position and deploy a stent retriever distal to the clot and retrieve the clot while inflating a balloon guide catheter and/or performing aspiration.

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



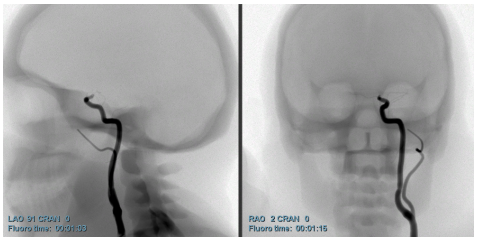
Case 1 – Acute Ischemic Stroke

Left MCA Occlusion



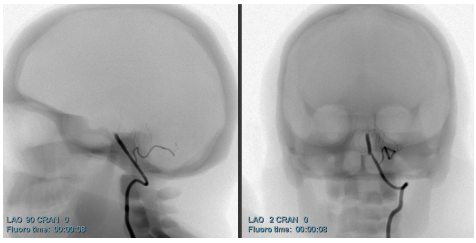
Case 2 – Acute Ischemic Stroke

Right M1-M2 Occlusion



Case 3 – Acute Ischemic Stroke

Left ICA-T Occlusion



Case 4 – Acute Ischemic Stroke

Basilar Tip Occlusion

ANGIO Mentor Studies

1. **Simulated diagnostic cerebral angiography in neurosurgical training: a pilot program**
Alejandro M Spiotta, Peter A Rasmussen, Thomas J Masaryk, Edward C Benzel, Richard Schlenk
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. **Results from endovascular skills training for surgical residence.** J. Jason T. Lee, Division of Vascular Surgery, Stanford University School of Medicine, Stanford, California.
4. **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.
5. **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.
6. **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
7. **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*
8. **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):535-4*
9. **The use of interventional cardiovascular simulation to evaluate operator performance: The carotid Assessment of operator performance by the Simbionix 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*
10. **Preliminary Results of Construct Validity of an Endo Vascular Simulator** Giora Weiss, Colombia 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]*
11. **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.*