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Course name: Vascular Ultrasound: Clinical Applications

Topic 1: Ultrasound-Guided Vascular Access during Cardiopulmonary Resuscitation

1. The use of ultrasound imaging support for internal jugular veins (IJV) location was first described in _____.
(A): 1955
(B): 1978
(C): 1990
(D): 2001

2. Which of the following is used for ultrasonic visualization of vascular structures, surrounding tissues, and anatomical formations?
(A): Two-dimensional (2D) gray-scale imaging
(B): Color Doppler ultrasonography
(C): Spectral Doppler ultrasonography
(D): all of the above

3. Which of the following is the basic differences between a vein and an artery in an ultrasound 2D image?
(A): artery is round
(B): arterial walls are thicker
(C): vein compressibility under a slight external surface pressure
(D): all of the above

4. During circulatory arrest, the blood pressure on the walls of arteries decreases and lose elasticity and are compressed together with veins when external surface pressure is applied by the ultrasonic probe.
(A): True (B): False

5. During CPR rhythmic change in diameter is typical for both veins and arteries due to compression and decompression of the chest with a frequency of _____ per minute.
(A): 10-30
(B): 40-60
(C): 100-120
(D): 150-200

6. The internal jugular veins (IJV) emerges from the outer jugular opening at the _____ posterior to the internal carotid artery (CA), then proceeds caudally, and shifts, taking anterolateral position in regards to CA.
(A): frontal lobe
(B): base of the skull
(C): mandibular arch
(D): orbits

7. Preliminary ultrasound evaluation of the vein patency, size, location, and possible anomalies is mandatory, it ensures avoiding futile attempts as in patients whose IJV is absent or thrombosed or who have congenital anomalies.
(A): True (B): False

8. The long axis view of the IJV can be obtained by positioning the ultrasound probe in longitudinal orientation on the patient's _____.
(A): arm
(B): wrist
(C): neck
(D): chest

9. The short axis view of the internal jugular vein can be obtained by positioning the ultrasound probe in a transverse orientation on the patient's neck that allows the visualization of which of the following?
(A): carotid artery
(B): lymph nodes
(C): thyroid

(D): all of the above

10. The lateral oblique short axis view of the internal jugular vein can be obtained by positioning the ultrasound probe rotated in _____ from the short axis.
(A): 10-50°
(B): 60-70
(C): 80-85
(D): 90-100

11. The common femoral vein and common femoral artery (FA) lie within the femoral triangle formed by which of the following?
(A): inguinal ligament
(B): long adductor muscle
(C): sartorius muscle
(D): all of the above

12. Real-time US guidance for vascular access puncture allows healthcare provider to confirm patency of the vessel, as well as needle, wire, and catheter position in the vessel.
(A): True (B): False

Topic 2: Ultrasound Guided Vascular Access
13. Which of the following can make placements of vascular catheters in central and peripheral veins challenging and time-consuming?
(A): chronic medical conditions
(B): intravenous drug use
(C): obesity
(D): all of the above

14. The low-frequency linear array transducer provides higher resolution of the superficial areas of soft tissue including artery and veins.
(A): True (B): False

15. _____ are the main ultrasound modes used for the purpose of venous access.
(A): A-Mode scans
(B): Endoscopic scans
(C): B-Mode and color Doppler
(D): none of the above

16. Color Doppler is an application to characterize _____.
(A): blood flow
(B): tumor composition
(C): ligament stiffness
(D): none of the above

17. If the blood flow in a vessel is moving towards the transducer, the color displayed in the vessel is _____.
(A): blue
(B): red
(C): green
(D): purple

18. The brightness of the image on the screen is controlled by the _____ setting of the ultrasound machine.
(A): depth
(B): focus
(C): gain
(D): frequency

19. Proper transducer orientation is an important step to accomplish a successful ultrasound procedure.
(A): True (B): False

20. Which of the following views are main planes used for the purpose of vascular access?
(A): Oblique and decubitus
(B): Transverse and longitudinal

(C): AP and lateral
(D): none of the above

21. _____ is the simplest way to distinguish artery from vein.
(A): Patient's size
(B): Compressibility of veins
(C): Type of procedure
(D): Size of transducer

22. In dynamic guidance, the provider uses the ultrasound in "_____," with continuous visualization of the needle insertion throughout the procedure.
(A): fluoroscopy mode
(B): static mode
(C): real time
(D): none of the above

23. In the one-provider method, the provider holds the ultrasound transducer with the non-dominant hand and the needle with the dominant hand.
(A): True (B): False

24. During the in-plane insertion, the needle is placed _____ to the transducer and the full length of the needle shaft and tip are visualized.
(A): vertical
(B): at an angle
(C): parallel
(D): none of the above

25. The subclavian vein (SC) continues in main length behind the medial third of _____ which makes it less available for ultrasound scanning.
(A): sternum
(B): heart
(C): thyroid gland
(D): clavicle

26. The femoral vein should be distinguished from the artery by which of the following characteristic?
(A): vein is more medial and deeper than artery
(B): its compressibility
(C): lack of pulsatile doppler
(D): all of the above

27. The depth of vein is measured by its distance from the _____.
(A): heart
(B): skin
(C): muscles
(D): organs

28. The left and right brachiocephalic veins join to become the _____, which empties into the right atrium.
(A): aorta
(B): femoral artery
(C): right pulmonary vein
(D): superior vena cava

29. The ability to obtain ultrasound guided IV access is a skill that combines knowledge of peripheral IV access and ultrasound.
(A): True
(B): False

Topic 3: Non-Coronary Vessel Exploration Under Intravascular Ultrasound: Principles and Applicability
30. The catheters used during intravascular ultrasound (IVUS) have frequencies from _____ MHz, planar resolutions from 50 to 150 μm, and a typical sampling rate of 30 images per second.
(A): 5 to 10

(B): 10 to 15
(C): 15 to 20
(D): 30 to 40

31. The current methods used to quantify a volumetric IVUS analysis are usually achieved by a simple summation of a targeted subsample of the _____ into a volumetric dataset.
(A): analog images
(B): fluoroscopic images
(C): 2-D images
(D): half-life of radioisotope

32. Since images are recorded at 30 frames per second, with a pullback speed of 0.5 mm/s, ____ frames are recorded for each 1-mm vessel segment.
(A): 60
(B): 88
(C): 97
(D): 105

33. The whole raw IVUS data, composed of the reflected acoustic signals, are displayed on IVUS consoles that could also be saved or stored on which of the following device?
(A): S-VHS videotape
(B): CD-ROM
(C): magnetooptical disks
(D): all of the above

34. Typical mechanical IVUS transducers produce cross-sectional images by rotating at the tip of the catheter using a flexible, high-torque cable.
(A): True
(B): False

35. The best image quality is obtained when the IVUS catheter is _____ to the vessel wall and when the ultrasound beam is perpendicular to the luminal surface.
(A): vertical
(B): at an angle
(C): parallel
(D): none of the above

36. During the procedure, real-time images of the investigated vessel are displayed on a monitor and are usually recorded digitally.
(A): True
(B): False

37. Which of the following is the first and most critical step in data processing and analysis?
(A): 2D sections from the investigated vessels
(B): Precisely identifying and tracing anatomical structures of studied vessel
(C): 3-D reconstruction
(D): none of the above

38. Color flow IVUS is produced by computer software that detects a difference between the movements of _____ particles from two sequential adjacent frames.
(A): nerve
(B): echogenic blood
(C): bone
(D): ligament

39. Which of the following are common indications for an intravascular stent placement after percutaneous trans-luminal angioplasty?
(A): Dissections, elastic recoil, or residual stenosis
(B): Significant residual pressure gradient across the lesion
(C): Plaque ulceration with local thrombus accumulation
(D): All of the above

Topic 4: Integrated Backscatter Intravascular Ultrasound

40. Ultrasound backscatter power is NOT proportional to the difference of acoustic characteristic impedance that is determined by the density of tissue multiplied by the speed of sound.
(A): True
(B): False

41. An _____ digitized the signals at 400 MHz with 8-bit resolution, and the digitized data were stored on the hard drive of the PC for later analysis.
(A): step-up transformer
(B): intensifying tube
(C): analog-to-digital converter
(D): none of the above

Topic 5: Clinical Applications of Intravascular Ultrasound

42. Intravascular Ultrasound (IVUS) is a non-invasive grey scale tomographic imaging modality providing cross-sectional images of the vessel wall.
(A): True
(B): False

43. IVUS imaging is complementary to _____ and allows the simultaneous assessment of lumen and components of the vessel wall.
(A): coronary angiography
(B): radionuclide therapy
(C): computed tomography
(D): chest x-ray

44. Standard coronary angiography is intrinsically limited to evaluate three-dimensional anatomical coronary cross sectional area due to _____.
(A): planar silhoutte imaging
(B): lack of fluoroscopy
(C): contrast administration
(D): none of the above

45. In addition to accurate stent sizing, IVUS can be used to evaluate lesion lumen area to predict which of the following?
(A): presence or absence of myocardial ischemia
(B): significant coronary stenosis
(C): high blood pressure
(D): both A and B

46. Following coronary intervention, the formation of _____ is mainly responsible for in-stent restenosis (ISR).
(A): cholesterol build-up
(B): red blood cells
(C): neointimal hyperplasia
(D): iron particles

47. One of the main factors for in-stent restenosis (ISR) is stent underexpansion.
(A): True
(B): False

48. IVUS studies have demonstrated that incomplete stent and vessel wall apposition, residual stenosis and irregular eccentric lumen in the
stented segment was present in almost _____% of the patients despite achieving an optimal angiographic result.
(A): 26
(B): 56
(C): 69
(D): 88

49. Coronary interventions of unprotected left main coronary artery (UPLM) with bare metal stents in the 1990s were associated with high rates of _____ due to restenosis.

(A): death
(B): revascularization
(C): myocardium infarction
(D): stroke

50. Chronic total occlusion (CTO)s are the most complex lesions that are considered for percutaneous coronary revascularization.
(A): True
(B): False

51. The number of Chronic total occlusion interventions has risen gradually due to which of the following factor?
(A): better operator experience
(B): technical improvements
(C): newer procedural techniques
(D): all of the above

52. The composition of atherosclerotic plaque is heterogeneous by nature and contains which of the following components?
(A): extracellular matrix and smooth muscle cells
(B): crystalline cholesterol and cholesterol esters mixed with macrophages
(C): platelets, fibrin, and calcium
(D): all of the above

53. Echodense plaques have an intermediate echogenicity between echolucent and highly echogenic calcified plaques.
(A): True
(B): False

54. The conventional IVUS image undergoes which of the following considerable processing to create real time imaging?
(A): envelope detection
(B): time-gain compensation
(C): logarithmic compression
(D): all of the above

Topic 6: Diagnostic Use of Sonography in the Evaluation of Hypertension
55. Hypertension leads to _____ increasing morbidity and mortality and is related with high costs to society, making this disease an important public health challenge.
(A): digestive issues
(B): hormonal imbalance
(C): cardiovascular end-organ damage
(D): none of the above

56. Ultrasound of the _____ is frequently used to detect and evaluate in the case of hypertension-induced vascular end organ damage.
(A): femoral veins
(B): carotid arteries
(C): inferior vena cava
(D): none of the above

57. The abdominal ultrasound supplies information about the etiology of hypertension as well as possible end organ damages.
(A): True
(B): False

58. Renal ultrasound has now almost completely replaced _____ in the anatomical exploration of the kidney.
(A): intravenous urography
(B): computed tomography
(C): MRI
(D): nuclear medicine

59. The left adrenal gland, lacking the acoustic window of the _____ and being obscured by air in the stomach, is inherently more difficult to scan than the right adrenal gland.
(A): pancreas
(B): spleen
(C): liver
(D): uterus

60. In the elderly (> 65 years) approximately ____% of the patients with hypertension have an isolated systolic hypertension.
(A): 10
(B): 35
(C): 48
(D): 60

61. The Doppler ultrasound of renal arteries allows an analysis of the renal _____.
(A): stones
(B): tumors
(C): necrosis
(D): perfusion

62. According to numerous studies the sensitivity and specificity of Doppler ultrasound in the diagnosis of renal artery stenosis lies at ____%
(A): 47
(B): 60
(C): 90
(D): 100

63. With today's ultrasound technology it is possible to visualize approximately 100% of all main and accessory renal arteries.
(A): True (B): False

64. Which of the following are positively associated with increased carotid intima-media thickness (IMT) in observational and epidemiological studies?
(A): aging and obesity
(B): elevated blood pressure
(C): diabetes and smoking
(D): all of the above

65. Doppler sonography is the most common imaging study performed for the diagnosis of carotid disease.
(A): True (B): False

66. Endothelial dysfunction is regarded as the initial step of _____ and therefore as the earliest detectable manifestation of vascular end-organ damage.
(A): diabetes
(B): hyperthyroidism
(C): atherosclerosis
(D): pancreatitis

Topic 7: Application of Orbital Sonography in Neurology
67. Color-coded duplex sonography is a well-established non-invasive method for vascular and parenchymal examination in a wide range of neurological disorders including which of the following?
(A): stroke
(B): cerebral venous thrombosis
(C): degenerative diseases
(D): all of the above

68. Orbital sonography can be easily performed using most color duplex ultrasound systems equipped with high frequency linear array transducers.
(A): True (B): False

69. The acoustic output of the ultrasound systems needs to be adjusted to the requirements of orbital

sonography according to the _____ in order to avoid damage to the lens and retina.
(A): air-gap technique
(B): ALARA principle
(C): inverse square law
(D): hounsfield chart

70. In order to prevent cavitation effects, the transmit frequency setting for orbital sonography in B-mode is _____ MHz.
(A): 14
(B): 36
(C): 47
(D): 50

71. To optimize the display of _____, the transducer is positioned a little on the temporal side and the patient is asked to try to look straight even with the eyes closed.
(A): ethmoid bones
(B): frontal sinuses
(C): optic nerve
(D): mandible joints

72. _____ supplies the blood to retina.
(A): jugular vein
(B): central retinal artery
(C): cerebral artery
(D): femoral artery

73. Conventional A- and B-mode ultrasound systems for visualization of the globe and orbit used in ophthalmology have transmit frequencies between _____MHz.
(A): 10 to 20
(B): 30 to 40
(C): 50 to 60
(D): 70 to 80

74. Elevation of intracranial pressure (ICP) is a common phenomenon caused by a variety of neurological disorders as brain tumors, intracranial bleedings, or head trauma.
(A): True (B): False

75. The optic nerve as part of the central nervous system (CNS) is surrounded by _____, and thus communicates with the inner and outer subarachnoid space.
(A): synovial liquid
(B): dura mater
(C): coronary arteries
(D): cerebrospinal fluid (CSF)

Topic 8: Assessment of Endothelial Function Using Ultrasound
76. Which of the following is the pathological complication of atherosclerosis?
(A): heart attacks
(B): strokes
(C): prostate cancer
(D): both A and B

77. From the lumen to the outer wall all arteries are composed of an intima, media, and adventitia.
(A): True (B): False

78. The _____ is the inner most lining of the vessel, and consists of the endothelium and underlying connective tissue.
(A): media
(B): adventitia
(C): intima
(D): none of the above

79. Endothelial dysfunction leads to which of the following?

(A): increased permeability to lipoproteins
(B): foam cell formation and T-cell activation
(C): smooth muscle migration into the arterial wall
(D): all of the above

80. Shear stress acts perpendicular to the vessel wall, whereas circumferential stress acts at a tangent to the wall to create a frictional force at the surface of the endothelium.
(A): True (B): False

81. _____ is considered to be the primary stimulus regulating endothelial cell function.
(A): Shear stress
(B): Circumferential stress
(C): Diabetes
(D): Liver function

82. Shear stress is primarily related to movement of red blood cells close to the endothelial layer.
(A): True (B): False

83. _____ can simultaneously image and measure blood velocity in conduit arteries in real-time and offers immense potential for tracking vascular mechanical and functional changes.
(A): MRI with contrast
(B): Digital Radiography
(C): Duplex Doppler functionality
(D): none of the above

84. Conventionally, _____ is used to visualize, in real-time, the ultrasound echo amplitude distribution in a tomographic plane.
(A): A-mode
(B): Endoscopic scan
(C): two-dimensional brightness mode (B-mode)
(D): fluoroscopy mode

85. When imaging a vessel care should be taken to ensure that the vessel clearly extends across the entire [un-zoomed] plane to minimize likelihood of skewing the vessel walls and ultrasound transducer should then be adjusted until the vessel walls appear thickest.
(A): True (B): False

86. To ensure image focus is maintained and that diameter waveforms are stable; the ultrasound probe needs to be fixed in place using a
_____.
(A): collimator
(B): probe holding device
(C): lead apron
(D): aluminum filter

87. For superficial arteries like brachial, radial, and posterior tibialis, a ____MHz probe will allow adequate penetration and will provide optimal axial resolution.
(A): 2.6
(B): 4.8
(C): 7.5
(D): 12

88. With ultrasound, blood velocity is calculated by measuring the _____, which results from a change in the frequency of a wave due to the motion of the wave source or receiver, or in the case of a reflected wave, motion of the reflector.
(A): patient's blood pressure
(B): quantum noise
(C): Doppler shift
(D): image histogram

89. Per cardiac cycle, Doppler ultrasound systems measure minimum, maximum, and mean blood velocities.
(A): True (B): False

Topic 9: Ultrasonography and Tonometry for the Assessment of Human Arterial Stiffness

90. The _____ function as both a reservoir to dampen oscillations from the pumping heart, as well as a conduit to transport blood to the periphery.
(A): muscles
(B): arteries
(C): neurons
(D): ligaments

91. The large elastic arteries such as the _____ provide the predominant cushioning reservoir for blood flow.
(A): cerebral artery
(B): hepatic artery
(C): aorta
(D): none of the above

92. Approximately 90% of the energy produced by the heart is used to distend the arteries during systole.
(A): True (B): False

93. _____ is emerging as one of the most important determinants of increased systolic blood pressure and pulse pressure in ageing and disease.
(A): Arterial stiffness
(B): Diabetes
(C): Alzheimer's disease
(D): Hepatitis

94. _____ is a common tool used in the non-invasive assessment of the elastic properties of the arterial wall.
(A): Angiography
(B): Nuclear Medicine test
(C): Digital x-ray
(D): Ultrasound

95. Regional arterial stiffness can be assessed using _____, which is commonly defined as the speed of the arterial pulse wave throughout the vasculature.
(A): radiation therapy
(B): stress test
(C): pulse wave velocity (PWV)
(D): none of the above

96. Arterial stiffness increases naturally with age, and the rate of arterial stiffening is often associated with lifestyle factors and disease.
(A): True (B): False

Topic 10: The Role of Ultrasonography in the Assessment of Arterial Baroreflex Function

97. The arterial baroreflex is critical to both short- and long-term regulation of blood pressure.
(A): True (B): False

98. The assessment begins with the identification of _____, which appear as parallel echogenic lines separated by a hypoechoic space in longitudinal B-mode image.
(A): mitral valve
(B): wall boundaries
(C): right ventricle
(D): myocardium

99. The Valsalva maneuver was first described by Antonia Maria Valsalva in the 17th century as a method for testing the patency of the _____.
(A): blood brain barrier
(B): left ventricle
(C): bicuspid valve
(D): eustachian tube

100. Baroreflex function testing is generally conducted in the upright position.
(A): True (B): False