ECHOCOLORDOPPLER LESSONS

ULTRASOUND EVALUATION
OF PSEUDOANEURYSMS AND ARTERIOVENOUS FISTULAS

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Ultrasound evaluation of pseudoaneurysms and arteriovenous fistulas

INTRODUCTION

The echocolor Doppler technique is useful for identifying the pseudoaneurysms and the arteriovenous fistulas. The ultrasound evaluation of the pseudoaneurysm allows to identify the size of the pseudoaneurysm and of the communicating channel: spectral waveforms in the communicating channel demonstrate “to-and fro” flow (forward flow in systole and complete reversal of flow in diastole). The arteriovenous fistula is an abnormal communication between an artery and a vein. The ultrasound evaluation is useful for identifying the level of the abnormal vascular communication and the flow disturbances produced by the communication: the spreading of color pixels into the extraluminal soft tissues, the high diastolic flow in the arterial waveform proximal to the fistula, the decreased flow in the artery caudal to the fistula and the arterialized waveform in the draining vein.

This lesson describes the echocolor Doppler characteristics of the pseudoaneurysms and the arteriovenous fistulas.
lower-extremity arteries

- PSEUDOANEURYSMS
- ARTERIO-VENOUS FISTULAS
Peripheral arterial pseudoaneurysms

US criteria

**PSEUDOANEURYSM**
- is a hematoma with a persistent communication to the artery (not contained by all layers of a vascular structure)
PSEUDOANEURYSM

- most frequently is a complication of percutaneous transfemoral catheterization (from 0.1% to 2.2%). This incidence has been increasing in recent years as more patients are on anticoagulants
- can result from rupture of a native vessel or leakage at the site of a surgical anastamosis (less commonly)
US IN PSEUDOANEURYSMS

- US are useful for identifying
  1. the size of the pseudoaneurysm
  2. the residual lumen
  3. the communicating channel
**Peripheral arterial pseudoaneurysms**

**US criteria**

**Pseudo-aneurysm / “to-and-fro” flow**

- During systole: **“to”**
  - Flow enters PA via the neck
  - Pseudo-aneurysm lumen enlarges

- During diastole: **“fro”**
  - Flow exits PA via the neck
  - Pseudo-aneurysm lumen contracts

**To-and-fro flow**

**Typical triphasic flow**


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**US IN PSEUDOANEURYSMS**

- Spectral waveforms should be obtained in the communicating channel to demonstrate “to-and-fro” flow (forward flow in systole and complete reversal of flow in diastole)
peripheral arterial pseudoaneurysms
US criteria

PSEUDOANEURYSM OF THE COMMON FEMORAL ARTERY

a) longitudinal scan: pseudoaneurysm ("false" aneurysm with a communicating hematoma that is not contained by all layers of a vascular structure)

b) spectral Doppler: waveform in the communicating channel (the specific sign "to-and fro" flow)
PSEUDOANEURYSM OF THE COMMON FEMORAL ARTERY

a) pseudoaneurysm and communicating channel
b) the “to and fro” sign (the most specific sign):
   - in systole the pressure is higher on the arterial end thus blood flows into the pseudoaneurysm
   - in diastole the pressure is higher in the pseudoaneurysm (due to wall forces in the aneurysm sac secondary to distension and decreased arterial pressure)
PSEUDOANEURYSM OF THE COMMON FEMORAL ARTERY

a) neck communicating with aneurysm
b) “to and fro” sign (diastolic flow reversal in aneurysm neck) and “yin-yang” sign (turbulent flow in the aneurysm sac, may resemble yin yang)
Peripheral arterial pseudoaneurysms

US criteria

PSEUDOANEURYSM FOLLOWING FEMORAL ARTERY CATHETERIZATION:

Two main US findings which suggest the diagnosis of pseudoaneurysm:

a) pseudoaneurysm and neck communicating with the common femoral artery (in contrast, a hematoma does not have a “neck”)

b) the Doppler cursor placed on the neck displays a to and fro flow
Peripheral arterial pseudoaneurysms

US criteria

PSEUDOANEURYSM FOLLOWING FEMORAL ARTERY CATHETERIZATION

a) transverse and longitudinal ultrasound image of the pseudoaneurysm
b) the typical bidirectional flow within the lesion from arterial blood flowing into the lesion
peripheral arterial pseudoaneurysms
US criteria

**PSEUDOANEURYSM OF THE COMMON FEMORAL ARTERY**

a) neck communicating with a pseudoaneurysm (≈ 2.4 x 1.09 cm.) of the common femoral artery

b) the "to and fro" sign (pathognomonic sign): reversal of flow in the neck during diastole due to changes in pressure gradients
PSEUDOANEURYSM FOLLOWING RADIAL ARTERY CATHETERIZATION

a) b-mode/color longitudinal ultrasound image of the pseudoaneurysm (18 x 26 mm.). The “yin-yang” sign (turbulent flow in the aneurysm sac) is present and the radial artery is visualized

b) typical bidirectional flow (“to and fro” sign) within the lesion from arterial blood flowing into the lesion
peripheral arterial pseudoaneurysms
US criteria

PSEUDOANEURYSM FOLLOWING OMERAL ARTERY CATHETERIZATION

a) color longitudinal ultrasound image of the omeral pseudoaneurysm (7 mm.).

b) bidirectional flow within the lesion: reversal of flow in the neck during diastole due to changes in pressure gradients
US IN PSEUDOANEURYSMS

in cases of therapeutic intervention US may be used:

1. as a guide to therapy
2. and as a means of documenting therapeutic success
**Peripheral arterial pseudoaneurysms**

**US criteria**

**Pseudo-aneurysm / US-guided compression**

3 steps

- **Preparation**
- **Compression**
- **Following repair**

**Duration of compression:** 10 – 15 minutes

**Success rate:** 75 – 85%

**Complications:** PA rupture, distal embolization, & venous thrombosis


**Pseudo-aneurysm / US-guided thrombin injection**

Replaced compression as technique of choice

- Needle advanced into superficial aspect of PA to avoid neck
- 100 – 300 units of human thrombin
- Avoid fast injection
- Success rate 97% according to several studies


**US IN PSEUDOANEURYSMS**

Therapeutic intervention: US may be used as a guide to therapy
peripheral arterial pseudoaneurysms
US criteria

**PSEUDOANEURYSM**

a) neck communicating with aneurysm of the common femoral artery
b) “to and fro” sign: diastolic flow reversal in aneurysm neck

c) control after US guided compression repair (longitudinal and transverse scan: is present hematoma but not pseudoaneurysm and communicating channel)
peripheral arterial pseudoaneurysms
US criteria

PSEUDOANEURYSM
a) neck communicating with aneurysm of the common femoral artery
b) “to and fro” sign: diastolic flow reversal in aneurysm neck

CONTROL AFTER US GUIDED COMPRESSION REPAIR
c) control after US guided compression repair (longitudinal and transverse scan, with hematoma but non pseudoaneurysm)
Peripheral arterial pseudoaneurysms
US criteria

**PSEUDOANEURYSM AND CONTROLS AFTER US GUIDED COMPRESSION REPAIR**

a) Tranverse scan: pseudoaneurysm of the common femoral artery
b) Tranverse scan: control three days later after US guided compression repair (hematoma and pseudoaneurysm)
c) Tranverse scan: control five days later after US guided compression repair (hematoma but non pseudoaneurysm)
CONTROLS AFTER US GUIDED COMPRESSION REPAIR

a) acute phase (pseudoaneurysm of the comm. fem. art.): “yin-yang” and “to and fro” signs

b) 4 days later control after US guided compression repair, longitudinal scan: appearance of thrombus in the pseudoaneurysm, the “to and fro” sign is unchanged

c) 6 days later: the residual lumen is further reduced and the “to and the fro” sign is unchanged, documenting therapeutic insuccess
lower-extremity arteries

- PSEUDOANEURYSMS
- ARTERIO-VENOUS FISTULAS
**ARTERIO-VENOUS FISTULA**

- an A-V fistula is an abnormal communication between an artery and vein
ABNORMAL COMMUNICATION BETWEEN A-V

- the A-V fistula is a rare complication of percutaneous transfemoral catheterization
- may be congenital (less commonly)
ULTRASOUND IN ABNORMAL COMMUNICATION BETWEEN A-V

- US are useful for identifying:
  - the level of such communications
  - the flow disturbances produced by the abnormal vascular communications (transmitted soft tissue vibrations)
arteriovenous fistulas

US criteria

US EVALUATION OF ARTERIOVENOUS FISTULA

- visible connection between the artery and vein
- spreading of color pixels into the extraluminal soft tissues
- high diastolic flow in the arterial waveform proximal to the fistula and decreased flow in the artery caudal to the fistula
- a high-velocity arterialized waveform in the draining vein
arteriovenous fistulas

US criteria

**US IN ARTERIOVENOUS FISTULA FOLLOWING FEMORAL ARTERY CATHETERIZATION**

a) visible connection between the artery and vein

b1) high diastolic flow in the common fem. art. waveform proximal to the fistula and (b2) decreased flow in the superficial fem. art. caudal to the fistula

a) a high-velocity arterialized waveform in the common femoral vein
arteriovenous fistulas

US criteria

**US IN IATROGENIC A-V FISTULA IN THE GROIN**

a) visible connection between the A-V with spreading of color pixels into the extraluminal soft tissues and turbulent flow in the fistula site

b) proximal to the fistula site: femoral artery with high diastolic flow and femoral vein flow with a pulsatile component
arteriovenous fistulas

**US criteria**

**US IN ACQUIRED A-V FISTULA**

a) longitudinal scan:
   - during systole: double visible connection between the A-V fistula and spreading of color pixels into the extraluminal soft tissues
   - during diastole: perivascular color artifact is not seen

b) turbulent flow and “to and fro” sign, at the fistula site

c) pulsatile component, in the vein near the fistula
arteriovenous fistulas

**US criteria**

**US IN ACQUIRED A-V FISTULA**

a) abnormal communication between common femoral art. and vein

b) turbulent, high-velocity flow spectrum at the junction of the artery and the vein
iatrogenic A-V fistula
*US criteria*

**US IN ACQUIRED A-V FISTULA**

a) aliasing and disturbed, turbulent flow at the artery-vein junction;
b) high diastolic flow in the arterial waveform proximal to the fistula site and
c) decreased diastolic flow in the artery caudal to the fistula;
d) high velocity turbulent flow, with a pulsatile component, in the vein near the fistula
arteriovenous fistulas

**US criteria**

**US IN IATROGENIC ARTERIOVENOUS FISTULA FOLLOWING FEMORAL ARTERY CATHETERIZATION**

a) visible connection between the artery and vein with a focal perivascular color artifact
b) turbulent flow at the fistula site
c) flow with a pulsatile component in the vein near the fistula
arteriovenous fistulas

**US criteria**

- **a)** visible connection between the A-V and turbulent flow at the fistula site with spreading of color pixels into the extraluminal soft tissues
- **b)** high diastolic flow in the arterial waveform proximal to the fistula site and decreased flow in the artery caudal to the fistula
- **c)** flow with a pulsatile component in the vein near the fistula
arteriovenous fistulas

US criteria

**US IN ACQUIRED A-V FISTULA**

a) longitudinal scan: double visible connection between the A-V and tissue vibrations secondary to the flow disturbances produced by abnormal vascular communications

b) transverse scan: visible connection between the A-V

c) turbulent flow at the fistula site

d) pulsatile component in the vein near the fistula
arteriovenous fistulas

**US criteria**

### US IN ACQUIRED A-V FISTULA

**a)** longitudinal scan:
- during peak systole: double visible connection between the A-V and spreading of color pixels into the extraluminal soft tissues
- during diastole: perivascular color artifact is not seen, and flow in common femoral artery has ceased

**b)** turbulent flow and “to and fro” sign, at the fistula site

**c)** arterial like pulsations in the vein near the fistula
arteriovenous fistulas

**US criteria**

**US IN CONGENITAL ARTERIOVENOUS FISTULA OF THE FOOT (1)**

a) A-V fistula of the foot; b) high diastolic flow in the ATA, PTA and dorsalis pedis artery (proximal to the fistula): the PSV and the rise time (time between the beginning of systole and syst. peak) are normal; c) high velocity turbulent flow, with a pulsatile component, in the vein near the fistula.
US IN CONGENITAL ARTERIOVENOUS FISTULA OF THE FOOT (2)

a) persistent high diastolic flow (the PSV and the rise time are normal) in the arterial waveform distant from the fistula (femoral artery) and
b) high velocity turbulent flow, with a pulsatile component, in the femoral vein
short videos and playlists on ultrasound examinations of pseudoaneurysms and arteriovenous fistulas are available on my youtube channel:
http://www.youtube.com/channel/UCij561sX0bQoEjXlWKuPnKg