

# Ultrasound Evaluation of Dialysis Steal Syndromes

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Laboratory  
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# DISCLOSURE

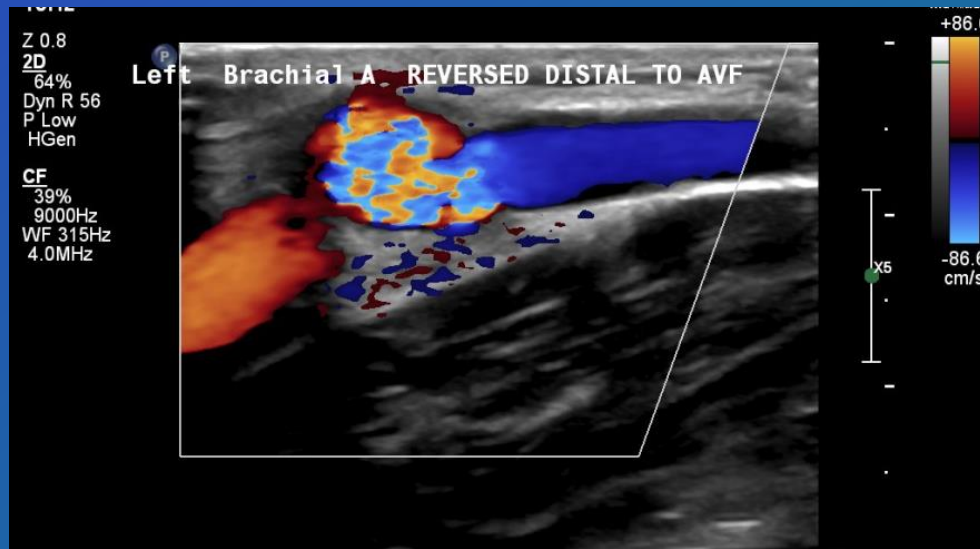
**Watson Smith, III, BS, RDMS, RVT**

**No Relevant Financial  
Relationship Reported**



# Introduction

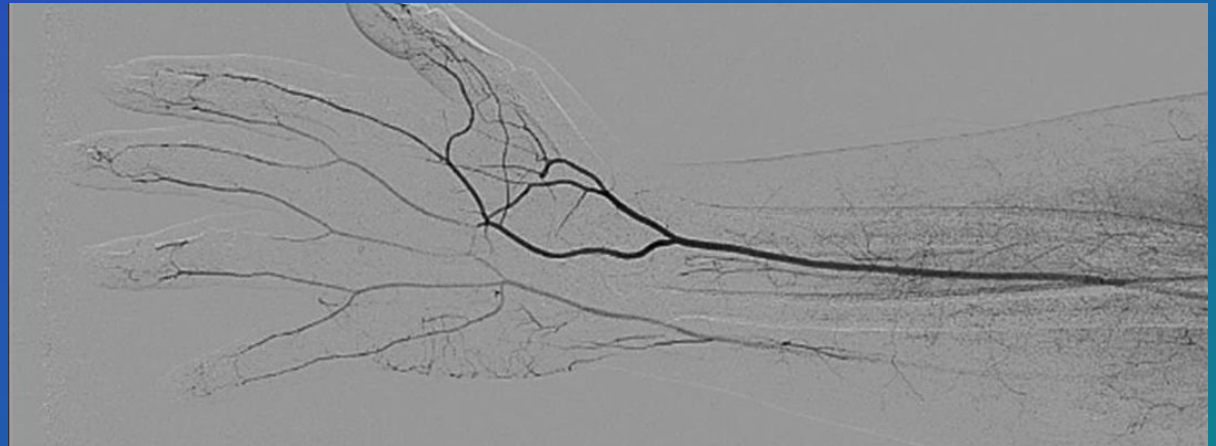
- A steal develops when the artery supplying the fistula or graft is unable to provide adequate flow into both the fistula and the distal arterial circulation.



- Flow preferentially follows the path of least resistance. From the high pressure arterial system, through the fistula, to the low pressure venous outflow, and away from the distal extremity.

# Introduction

- Steal phenomenon results in decreased Pressure and Flow in the distal extremity.
- Steal may result in hand and finger pain, weakness, numbness. It can lead to small vessel occlusions, ulceration, gangrene, and loss of digits



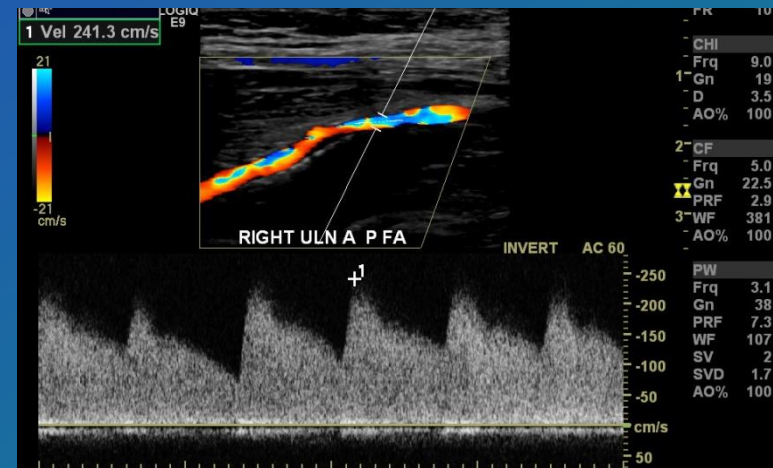
- Pressure and Flow can be readily assessed by utilizing the Physiologic capabilities of the Vascular Lab

# Incidence

- Flow diversion away from the distal arterial circulation is often present with dialysis access sites.
- In the majority of these instances patients remain asymptomatic.
- The incidence of symptomatic arterial steal by location:
  - Lowest with forearm access sites (0.25% to 1.8%)
  - Highest with access sites originating directly from the brachial artery (4% to 9%)

# Contributing Factors

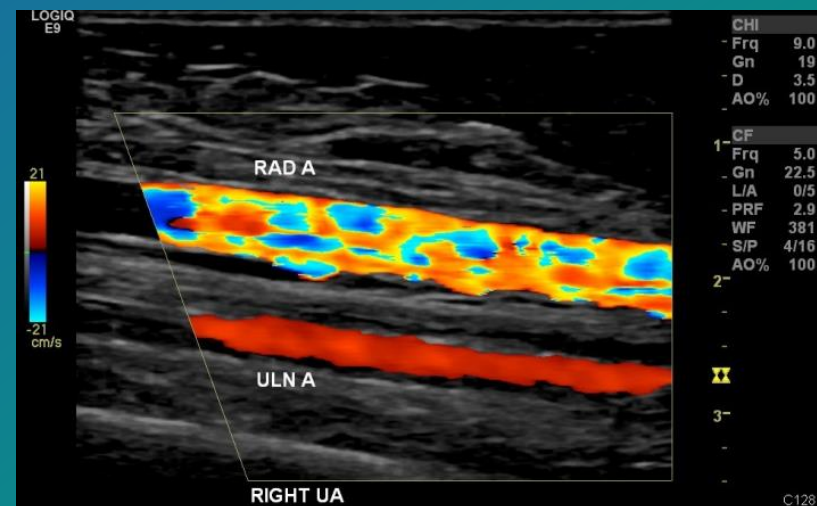
- Steal phenomenon rarely occurs without *arterial occlusive disease* present proximal or distal to the fistula site.



- Steal phenomenon is more common in *diabetic patients*.

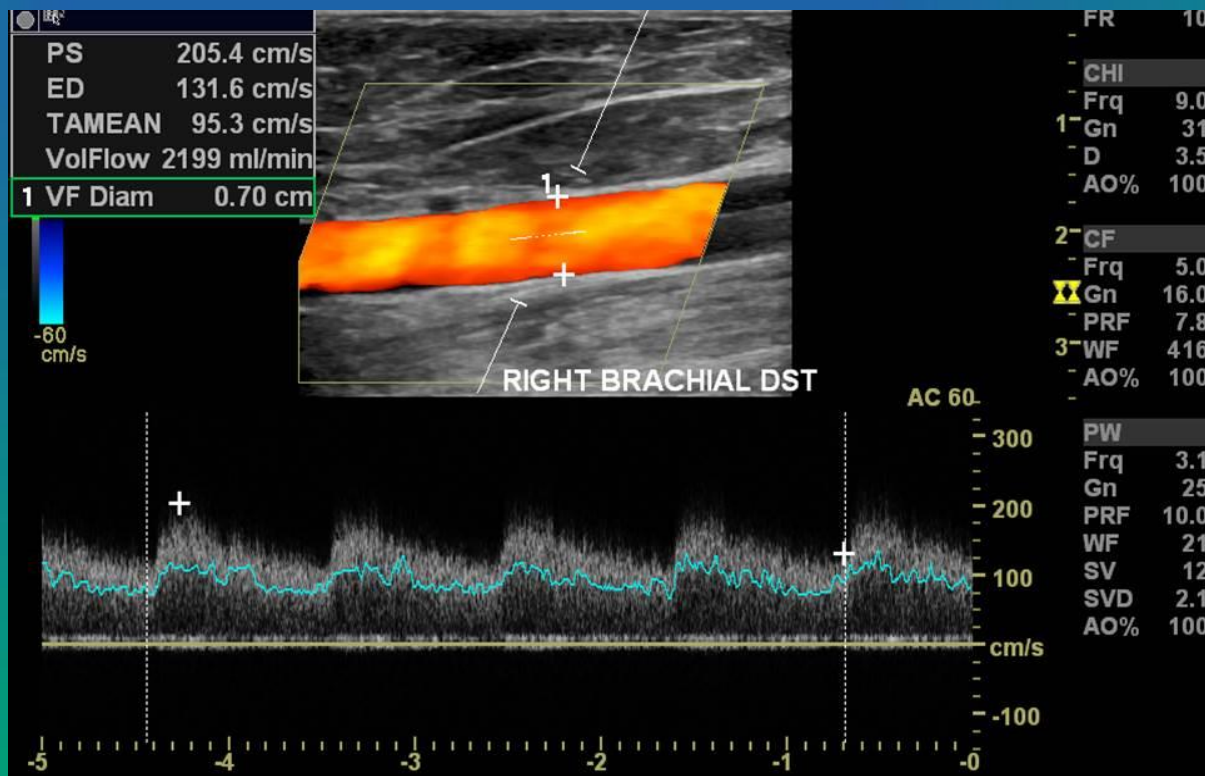
- Anatomic variants:*

- High radial and ulnar bifurcation
- Dominant radial or ulnar arteries
- Small arteries

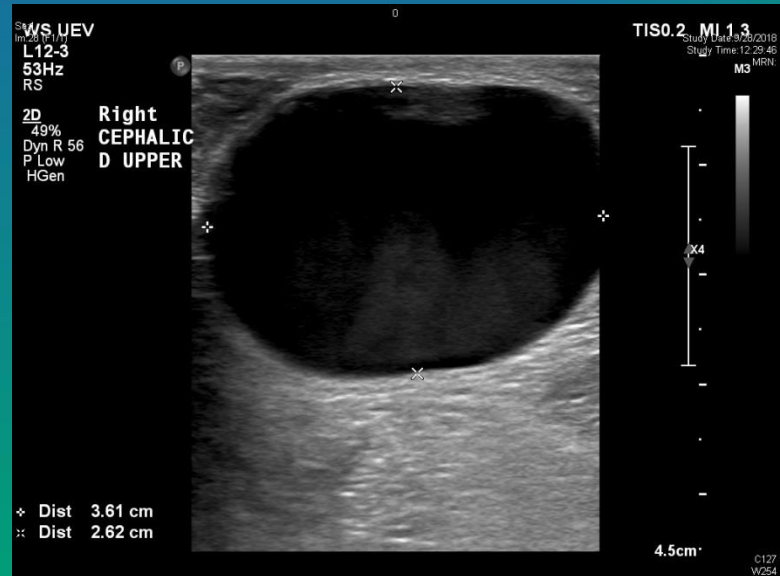
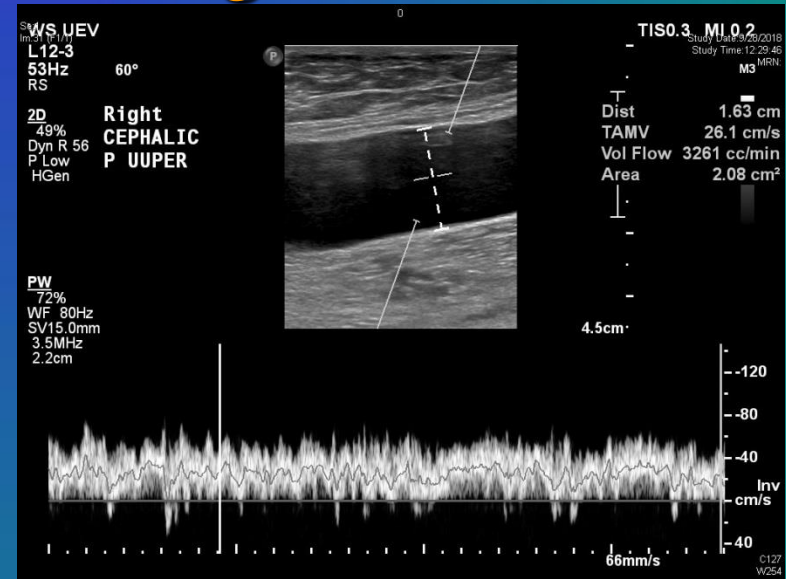
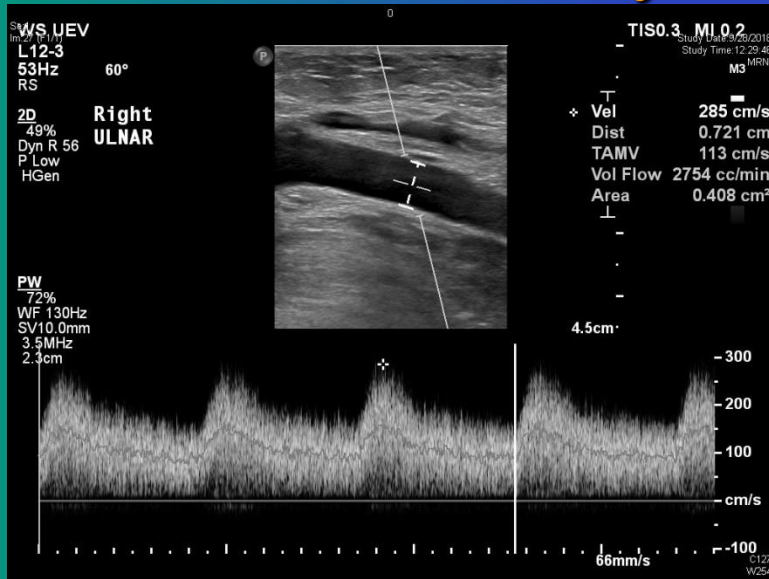


# Contributing Factors

- *Access sites with high flow rates* are also more likely to produce a symptomatic arterial steal
- Pain during dialysis can occur with high flow fistulas
- *> 900 cc/min*



# High Flow Fistulas- Aneurysmal Enlargement





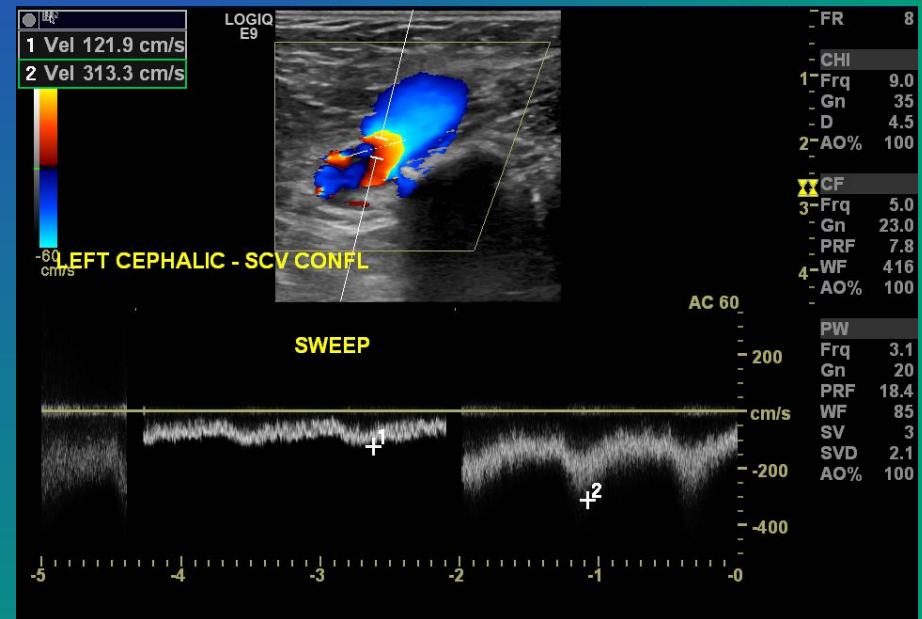
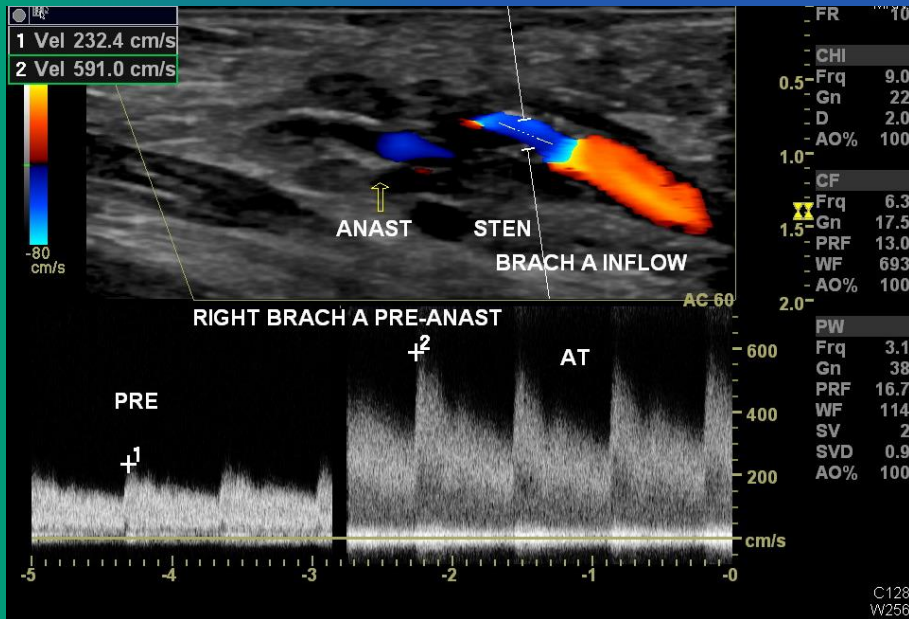
# Noninvasive Assessment in the Vascular Laboratory

- Useful for diagnosis of steal phenomenon.
- Helpful to predict the response to treatment.
- ***Flow*** - Duplex US with PW Doppler
  - Waveform analysis
  - Flow direction
- ***Pressure***
  - PPG and CW Doppler pressures

***At rest (fistula open) and with manual compression of the dialysis access fistula or graft.***

# Assessing *Flow* – Duplex US *Proximal* to the DAF

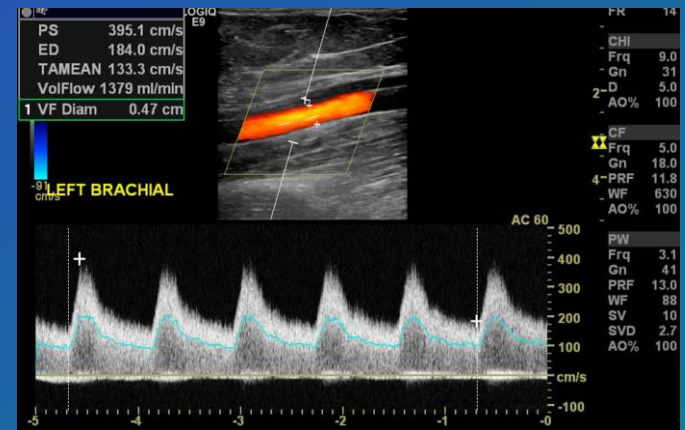
- Stenosis - *Focal* velocity increase in the high velocities which are normally present throughout the DAF.



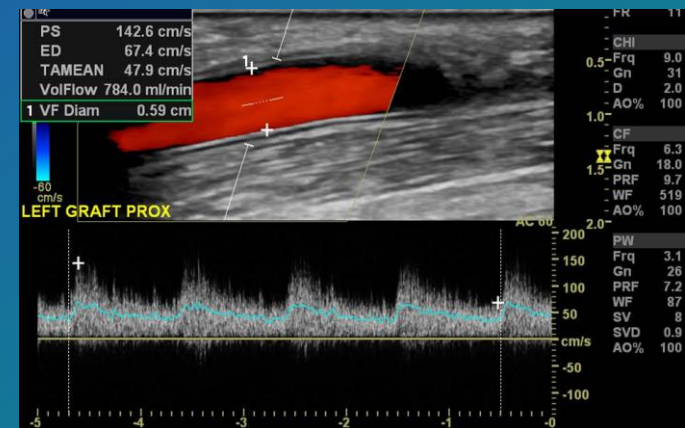
# Assessing *Flow* – Duplex US *Proximal* to the DAF

## Volume Flow Measurement

Brachial artery →



Outflow conduit (vein or graft) →

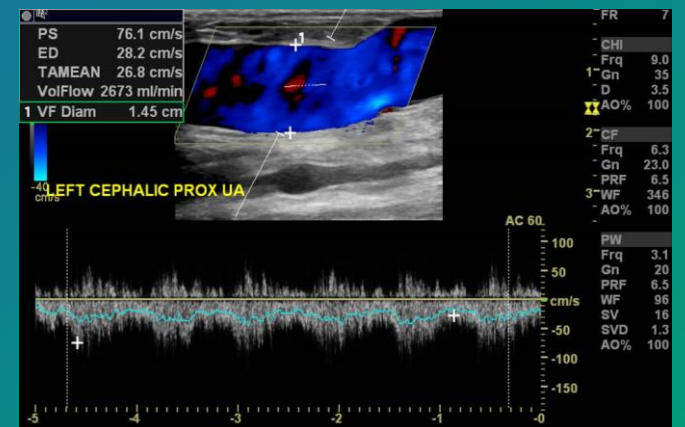


Outflow vein- *Volume Flow Ranges* →

Low (less than 600 ml/min)

Acceptable (600-800 ml/min)

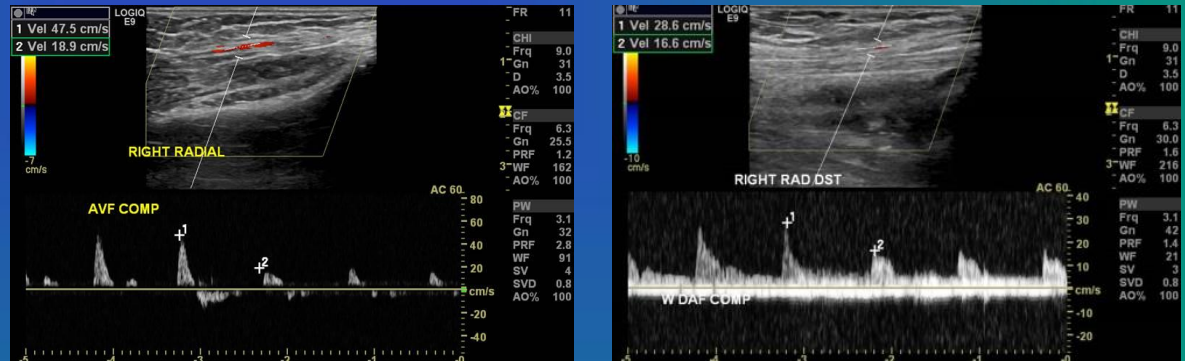
High (greater than 800 ml/min)



# Assessing *Flow* – Duplex US

## *Distal* to the DAF

- Performed at rest and with manual compression of the DAF or DAG

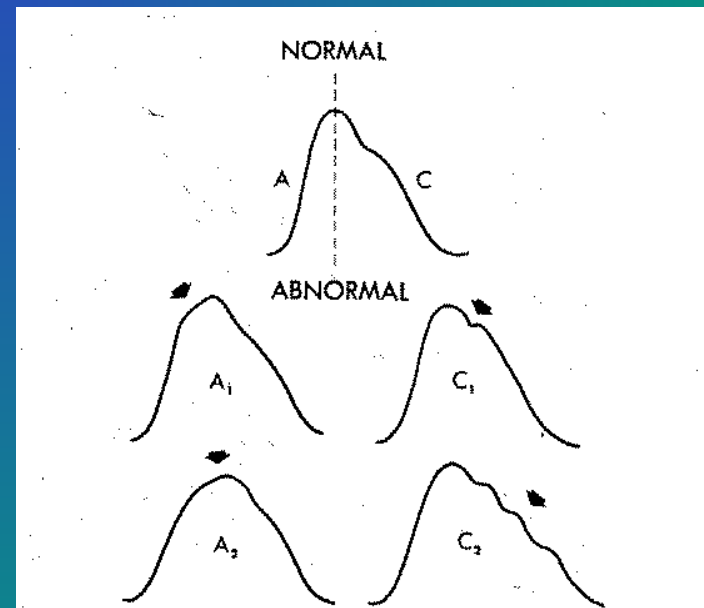
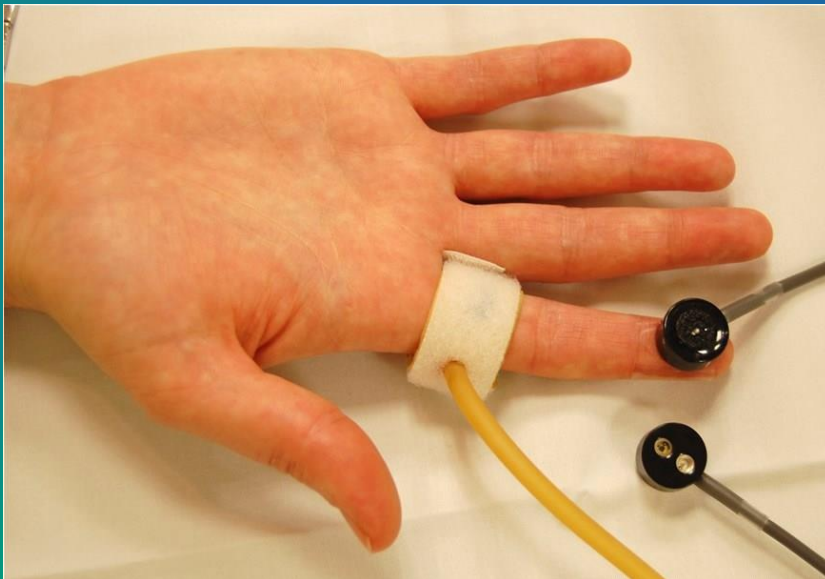


- Dampened flow- decreased velocity and pulsatility.
- Retrograde or alternating flow direction.



# Assessing Pressure-Digit PPG Pressures and Waveforms

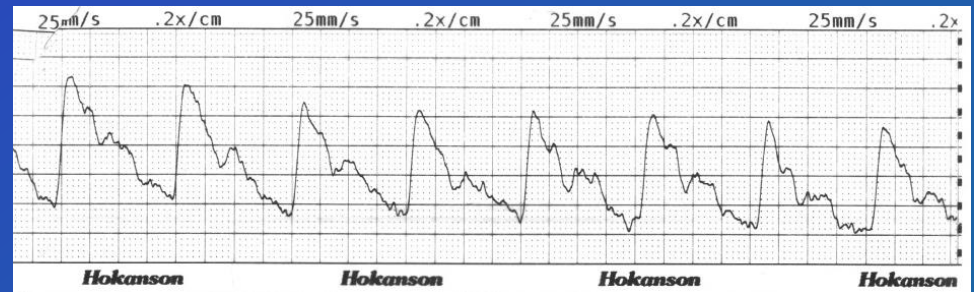
- At rest and with manual compression of the DAF
- 2 techs or 3 hands are useful!



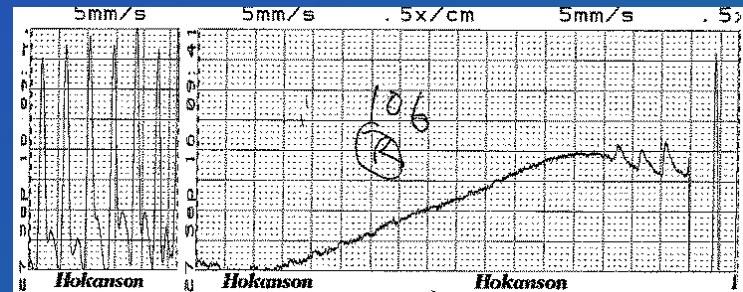
**Fig. 62-2.** Different types of pulse-wave abnormalities. Pulse curve can be divided into anacrotic (A) and catacrotic parts (C). Vasospastic abnormalities are A<sub>1</sub> (slanting type), C<sub>1</sub> (high dicrotic notch), and C<sub>2</sub> (fragmented downstroke and low amplitude). Type A<sub>2</sub> is most commonly seen abnormality in occlusive arterial disease. (From Thulesius, O.: Acta Chir. Scand. Suppl. 465:53, 1976.)

# Examples of PPG Pressures and Waveforms\*

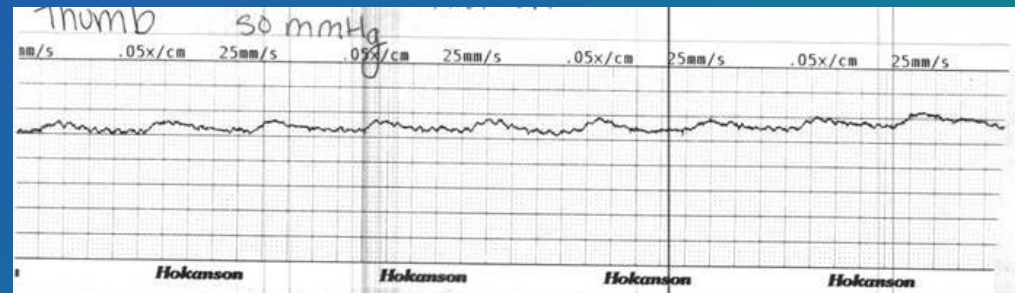
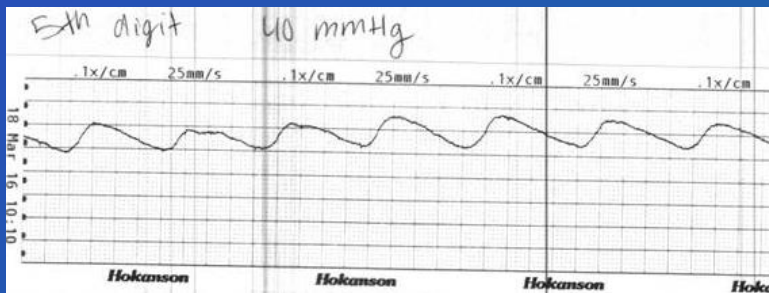
- Normal PPG waveform



- Measuring PPG pressure



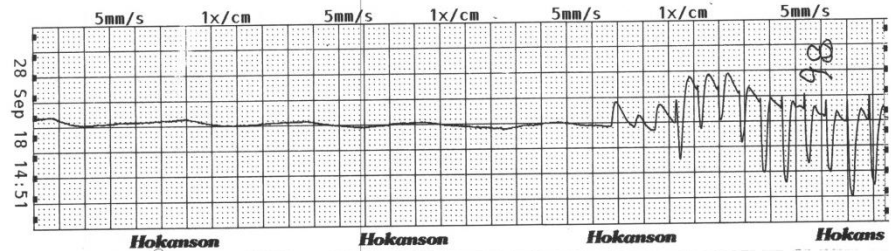
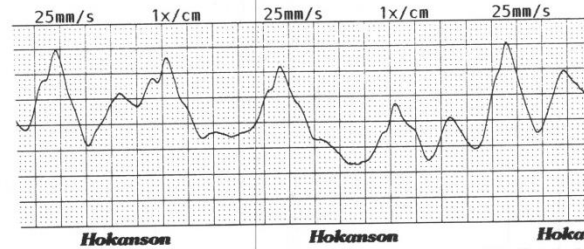
- Abnormal PPG waveforms



\* These are *volume pulse* waveforms (not flow waveforms)

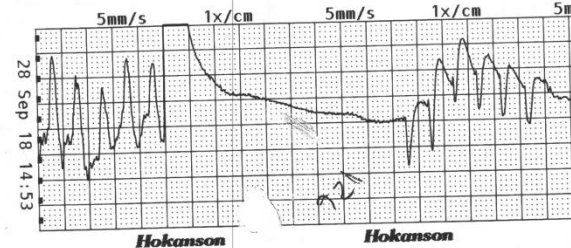
# Examples of PPG Pressures and Waveforms With DAF Compression- Asymptomatic

At rest



At rest - 86

With DAF compression



DAF compressed - 126

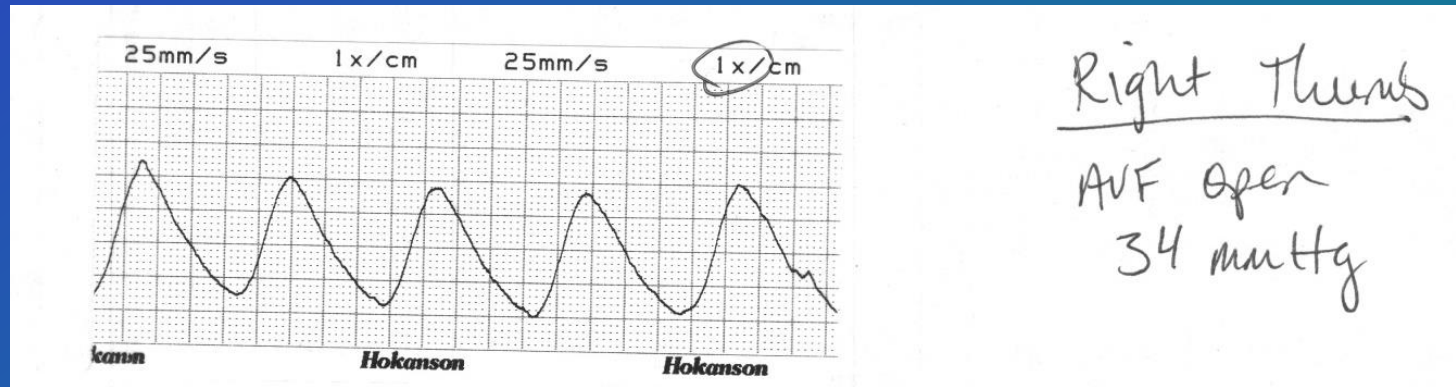
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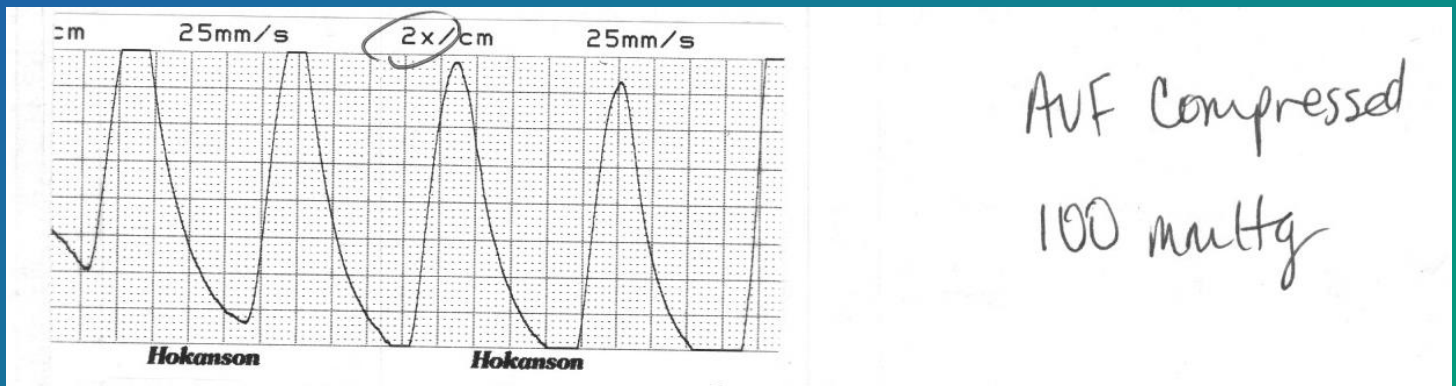
Ⓟ 3rd

# Examples of PPG Pressures and Waveforms Abnormal Due to STEAL

At rest



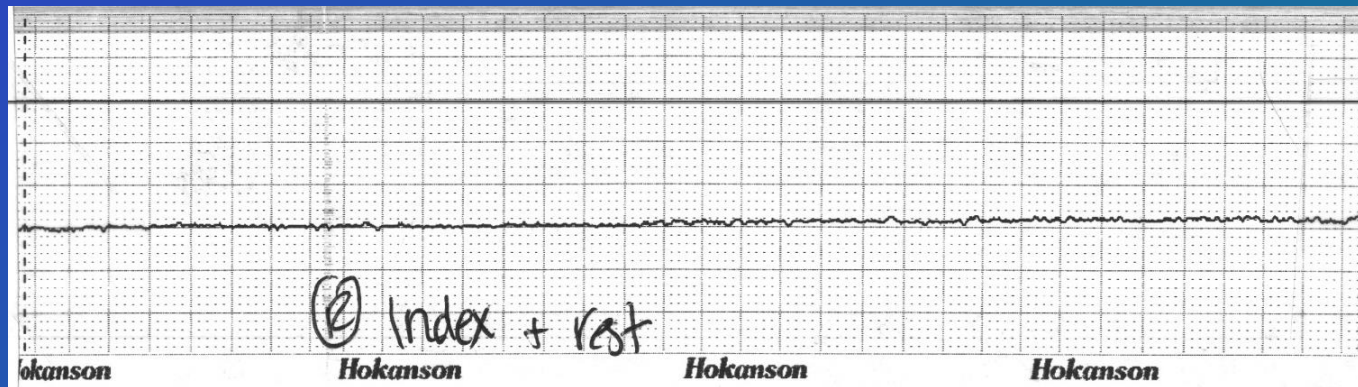
With DAF compression



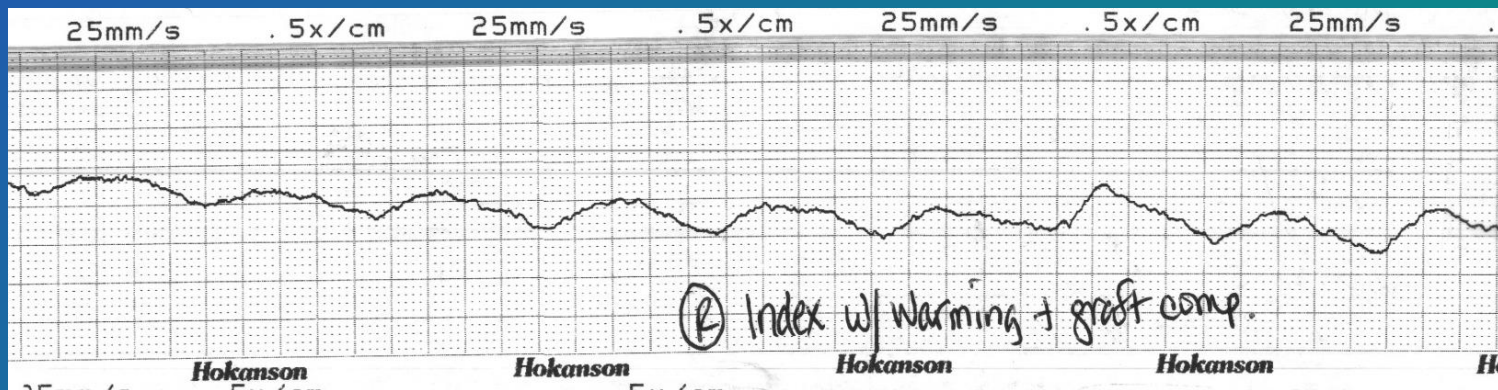


# Examples of PPG Pressures and Waveforms Abnormal Due to STEAL

At rest - pressure was not measurable



With DAF compression- Pressure was 42 mmHg



## Assessing Digit PPG pressure

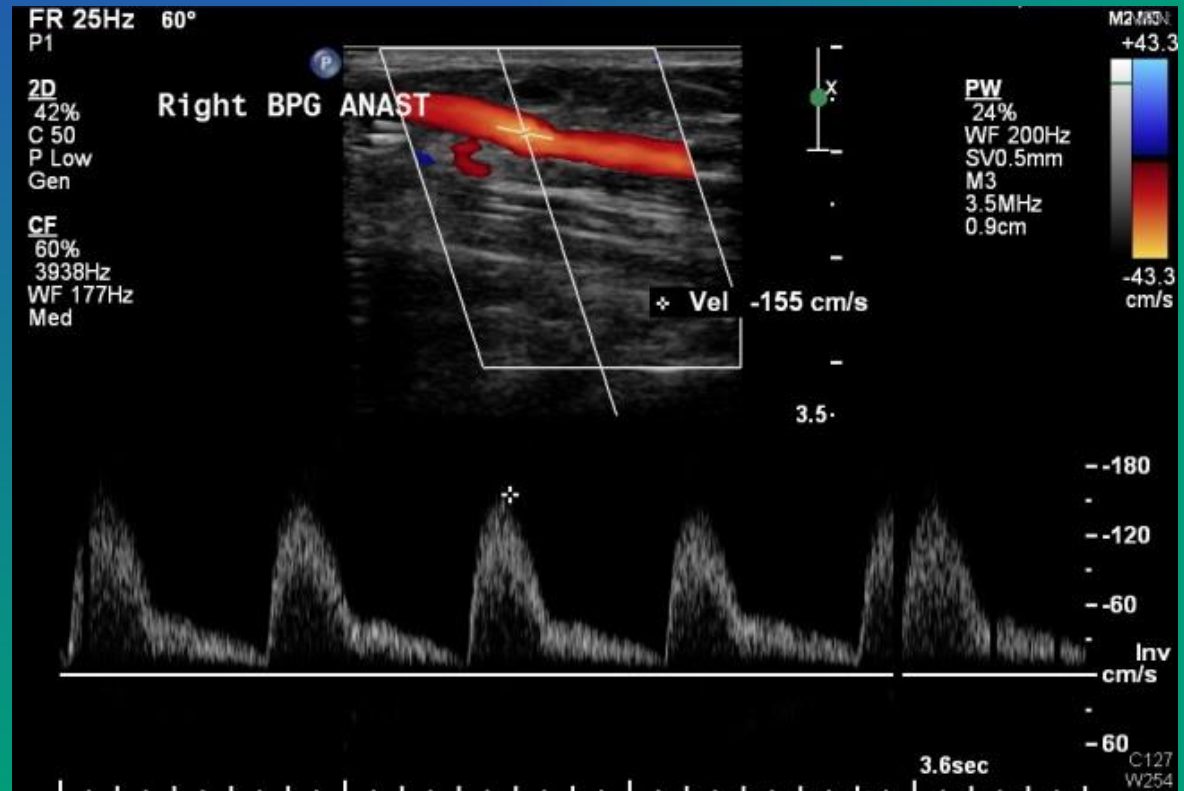
- Digit systolic blood pressure is normally within 20 to 30 mmHg of *contralateral* brachial systolic pressure
- Digit to brachial systolic pressure index of greater than 0.80 is considered normal.
- Digit pressures of less than 60 mmHg are consistent with clinically significant or symptomatic hand ischemia

# Assessing Pressure- CW Doppler Systolic Pressures

- A useful adjunct if digit PPG pressures cannot be obtained due to low flow or wounds.
- If there is enough room to place a BP cuff distal to the AVF.
- Recent case example-
  - Right Radial 60 mmHg to 110mmhg with DAF comp
  - Right Ulnar 45 mmHg to 130 with DAF comp

# There are treatment options!

- Plication with banding or clipping.
- DAF relocation or revision
- DRIL procedure



# Conclusion

Physiologic capabilities of the vascular lab can readily assess the decreased pressure and flow resulting from steal phenomenon.

Useful for diagnosis and to help predict the response to treatment.

PPG digit pressures at rest (fistula open) and with manual compression of the dialysis access fistula or graft are perhaps the Gold Standard for diagnosing steal phenomenon.