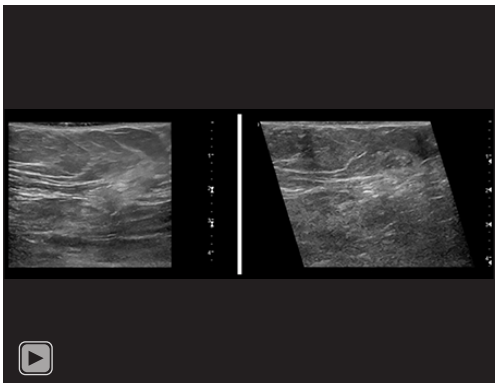
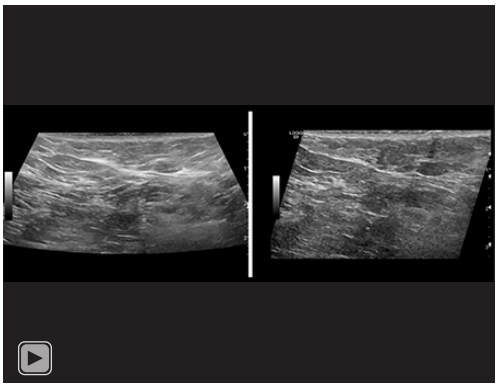
Supplementary



Video S1 This ultrasound cine clip demonstrates a fine-needle aspiration of an axillary lymph node without (left) and with (right) steering. The needle and its tip are seen (arrows).



Video S2 This is another ultrasound cine clip demonstrating a fine-needle aspiration of an axillary lymph node without (left) and with (right) steering. The needle and its tip are seen (arrows).

https://dx.doi.org/10.21037/tbcr-24-30

Appendix 1

Penguins Can't Fly Gracefully South

Probe

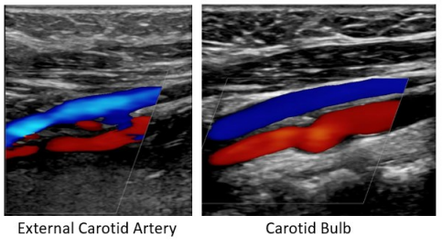
- GE Loqiq E9 & E10

Parameter	ML6-15	9L	C1-6
B-mode for Breast	Excellent	Mid-range	Poor
Twinkling	Poor	Mid-range	Excellent
Depth	Superficial	Mid-range	Deep (Abdominal)
Color Doppler Frequencies	6.3, 7.5, 8.3, 10.0, 11.9,12.5 MHz	3.1, 3.6, 4.2, 5.0, 6.3 MHz	1.7, 1.9, 2.1, 2.5, 3.1, 3.6 MHz

- Transducer names imply frequency bandwidth (range)
- ACR Breast Ultrasound Requirements: ML6-15

Color Doppler

- Most often used for blood flow quantification
- B-mode Transmit Frequency
  - Determines frequency used for grayscale image
- Color Doppler Transmit Frequency
  - Used for flow velocity evaluation



External Carotid Artery Carotid Bulb

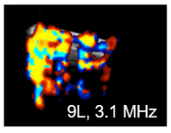
$$f_d = \frac{2 f_0 v \cos\theta}{c}$$

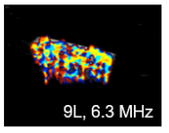
$$v = \frac{f_d c}{2 f_0 \cos\theta}$$

f_d: Doppler shift, Hz
f_0: Doppler transmit frequency, MHz
v: Flow velocity, m/s (cm/s)
c: Sound speed (1540 m/s)
θ: Angle between US beam and vessel

Frequency

- Frequency is selectable and will change the scale due to the relationship between transmit frequency and velocity for a given Doppler shift.
  - This can be changed to see if twinkling improves.
  - Typically, lower transmit frequencies lead to better twinkling.

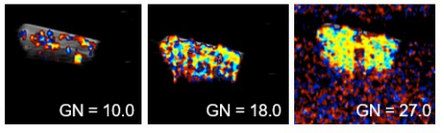




Parameter	ML6-15	9L	C1-6
Color Doppler Frequencies	6.3, 7.5, 8.3, 10.0, 11.9,12.5 MHz	3.1, 3.6, 4.2, 5.0, 6.3 MHz	1.7, 1.9, 2.1, 2.5, 3.1, 3.6 MHz

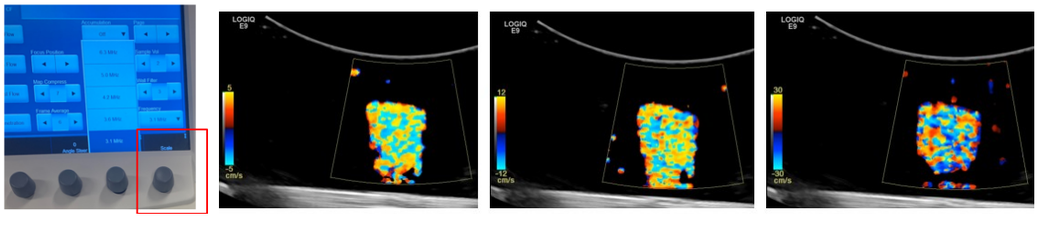
Gain

- The Doppler gain is related to the strength of the ultrasound signal and will affect the appearance of the twinkling.
  - Typical starting values are 15-20
- High values of gain may introduce noise from hand motion.
- Low values of gain may suppress twinkling signals.



Scale

- If the twinkling is strong, scale may not change the appearance drastically.
- If the twinkling is weak, lowering the scale is advised.



June 19, 2024

https://dx.doi.org/10.21037/tbcr-24-30