

**Know Your Knob!**  
A practicum of Ultrasonography  
Alan Bielsky MD

## Objectives

- To learn basic ultrasound physics
- To learn the important knobs on the machine
- To improve real time needle guidance skills
- To improve your image and transfer skills across all models of ultrasounds.

## Full Disclosure

- This presentation borrows heavily from Brull et al in *Regional Anesthesia and Pain Medicine*, Vol 35, No.2, Supplement 1, March/April 2010.

REVIEW ARTICLE

**Practical Knobology for Ultrasound-Guided Regional Anesthesia**

Richard Brull, MD, FRCP(C)\*, Alan J.K. Macfarlane, MRCR, MRCP, FRCA† and Cyrus C.H. Tin, BS\*\*

**Abstract:** This article provides an extensive review of the essential features needed to adjust different machines to use for regional anesthesia practice. An understanding of machine knobology is integral to performing safe and successful ultrasound-guided regional anesthesia. *Reg Anesth Pain Med* 2010; 35: 257-272.


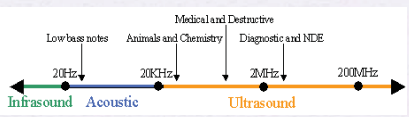
**Keywords:** This article provides an extensive review of the essential features needed to adjust different machines to use for regional anesthesia practice. An understanding of machine knobology is integral to performing safe and successful ultrasound-guided regional anesthesia. *Reg Anesth Pain Med* 2010; 35: 257-272.

**Although understanding of machine "knobology" is essential to the safe and successful practice of ultrasound (US)-guided regional anesthesia, knobology is the least discussed of our relationship with this technology. Knobology, the relationship of all US machines, often the same operator, suggests that an individual should be comfortable in operating settings. These knobs are not necessarily in obvious places. These knobs are the knobs for frequency, gain, depth, time gain compensation.**

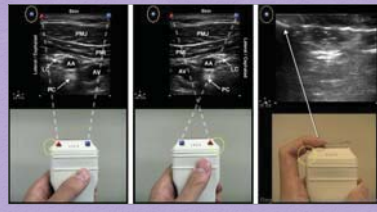
Increasing adjustment values on changing the appropriate beam diameter according to the required depth of the target. Maximum penetration can be obtained via high (12 MHz), medium (6-10 MHz), and low (2-5 MHz) frequency ranges. Once the appropriate frequency is selected, the operator can then fine tune the frequency of the US wave coming from the transducer by actively adjusting the gain, time, or axial resolution within each transducer's frequency range. Fine-tune adjustments are made by rotating an axial resolution value on every US machine (eg, Philips Healthcare, Andover, MA) or by adjusting the axial resolution (AR) against a 20% increment. Based on other machines (eg, GE Healthcare, Waukesha, WI), which correspond to the upper 50% of axial resolution of the transducer's range.

## What is ultrasound?

- Cyclic sound pressure beam which penetrates a medium, and then measures the reflection signature, creating an image

## This is what an ultrasound beam looks like



Brull, Richard, Macfarlane, Alan J.K., Tin, Cyrus C.H. *Regional Anesthesia and Pain Medicine*, 35(2):568-573, March/April 2010.

Wolters Kluwer | Lippincott Williams & Wilkins

## The dials you need to know

- Power
- Frequency
- Gain
- Time Gain Compensation
- Depth
- Focus

## Key Word: Resolution

- Axial resolution: the ability to distinguish between 2 objects at different depths in line with the axis of a beam
- Lateral resolution: the ability to distinguish between 2 objects beside one another at the same depth, perpendicular to the beam
- Temporal resolution: rate at which the images are produced

### Higher frequency means less depth

### Lower Frequency Means More Depth

FIGURE 1. Attenuation (energy loss) is directly proportional to the frequency of the sound waves and the distance that the sound waves must travel. Note how the lower-frequency US waves are less attenuated compared with the higher-frequency (10 MHz) wave at any given distance (depth).

Brull, Richard; Macfarlane, Alan J.R.; Tso, Cyrus C.H. Regional Anesthesia and Pain Medicine. 35(2):568-573, March/April 2010.

## Gain

- Changes amplification of raw returning signal
- Increases brightness
- Increases background noise and artifact

Just Right      Too Much Gain Too Bright      Too Little Gain Too Dull

Brull, Richard; Macfarlane, Alan J.R.; Tso, Cyrus C.H. Regional Anesthesia and Pain Medicine. 35(2):568-573, March/April 2010.


## Time Gain Compensation (TGC)

- Allows you to adjust gain and different field depth
- Should help counter attenuation at deeper depth and different tissue densities

Brull, Richard; Macfarlane, Alan J.R.; Tso, Cyrus C.H. Regional Anesthesia and Pain Medicine. 35(2):568-573, March/April 2010.

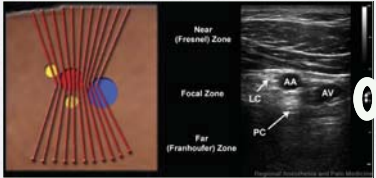

## Depth

- Maximizes temporal resolution
- Selects appropriate aspect ratio (ratio of width to height)



## Focus

- Sets where the beam converges (Frenzel Zone) to its narrowest point (Focal Zone) and then diverges (Fraunhofer Zone).
- Maximizes lateral resolution



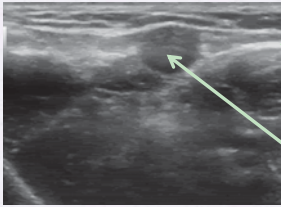
Brull, Richard; Macfarlane, Alan J.R.; Yin, Cyrus C.H. Regional Anesthesia and Pain Medicine. 35(2):3568-573, March/April 2010.

## Other Terminology

“In Plane”	“Out of Plane”
	

Greg Rutkowski... Fellow..Hand Model

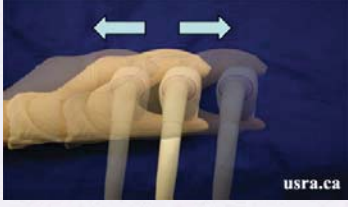
## Other Terminology



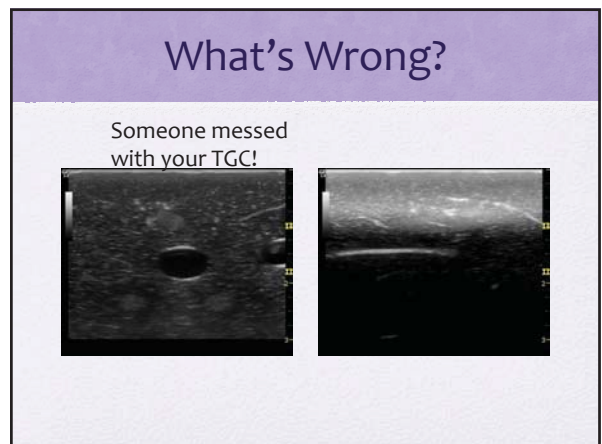
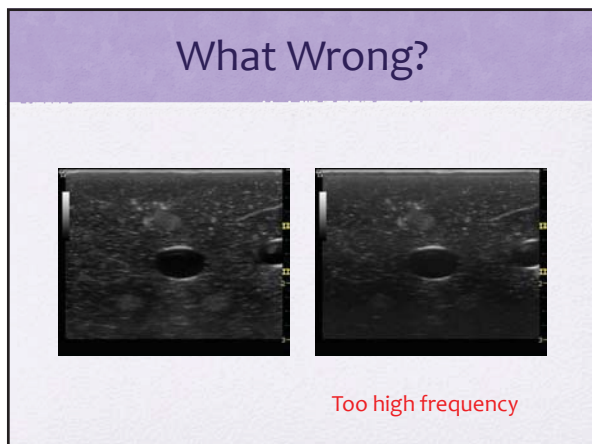
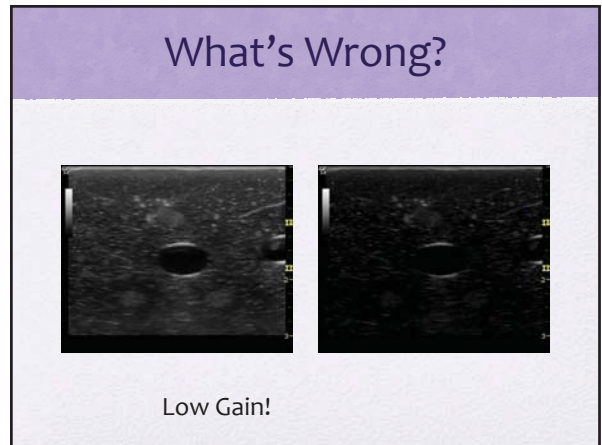
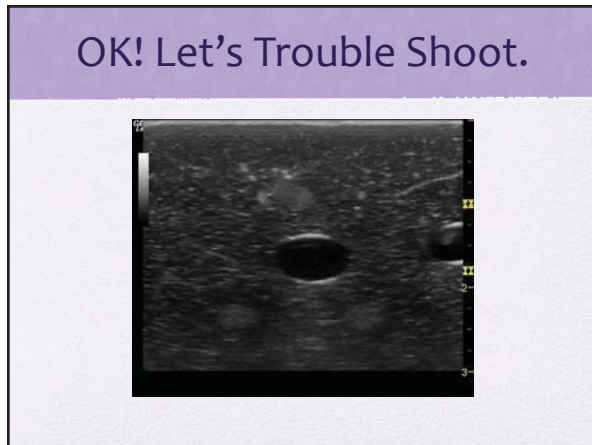
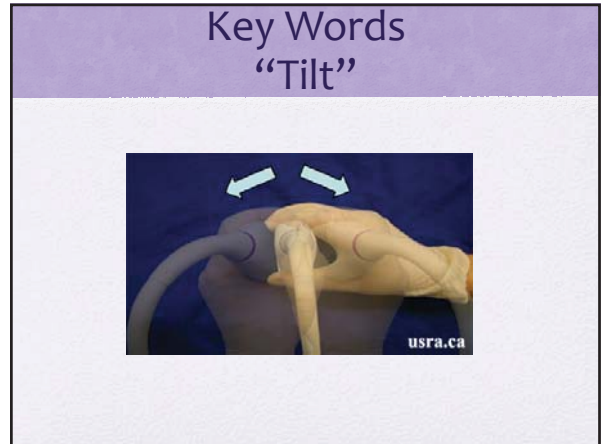
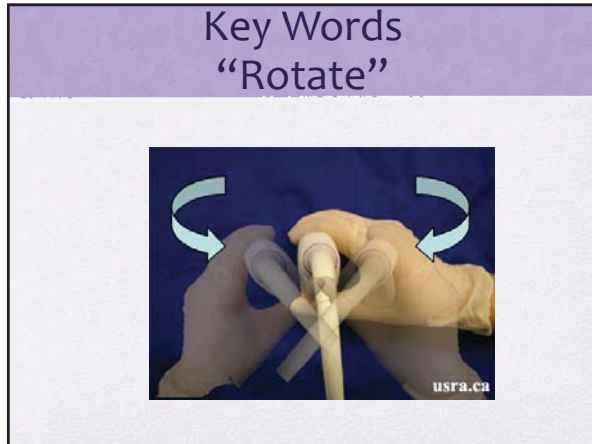
Hyperechoic

Hypoechoic

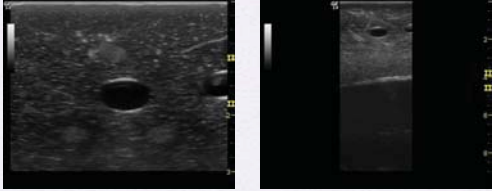
## Key Words “Align”



USFA.ca

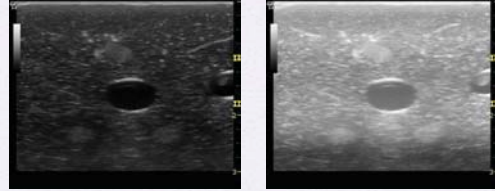


### What's Wrong?



In too deep!

### What's Wrong?



Gain Too High!