chapter 6

Range Equation

Ultrasound systems measure "*time-of-flight*" and relate that measurement to distance traveled.

Since the average speed of US in soft tissue (**1.54 km/sec**) is known, the time-of-flight and distance that US travels in the body are directly related. ψ

Time-of-flight

The time needed for a pulse to travel **to and from** the transducer and the reflector is called:

» **go-return time** ψ or **time-of-flight** ψ

When one reflector is twice as deep as another reflector, the pulse's time-of-flight is doubled for the deeper reflector. In other words, the time-of-flight will be increased by a factor of two. ψ

When time-of-flight is known, we can determine the distance.

Equations

$$\text{distance to boundary (mm)} = \frac{\text{go-return time } (\mu s) \times \text{speed } (mm/\mu s)}{2}$$

In soft tissue:

$$\text{distance to boundary (mm)} = \text{time } (\mu s) \times 0.77 \ \frac{mm}{\mu s}$$

The 13 Microsecond Rule

- *In soft tissue, every 13μs of go-return time means the reflector is 1cm deeper in the body.* ψ

Note

On the exam, pay attention to the subtle difference in the words *depth* and *distance*.

Time-of-Flight	Reflector Depth	Total Distance Traveled
13 μs	1 cm	2 cm
26 μs	2 cm	4 cm
52 μs	4 cm	8 cm
130 μs	10 cm	20 cm