Facial ultrasound in medical aesthetics

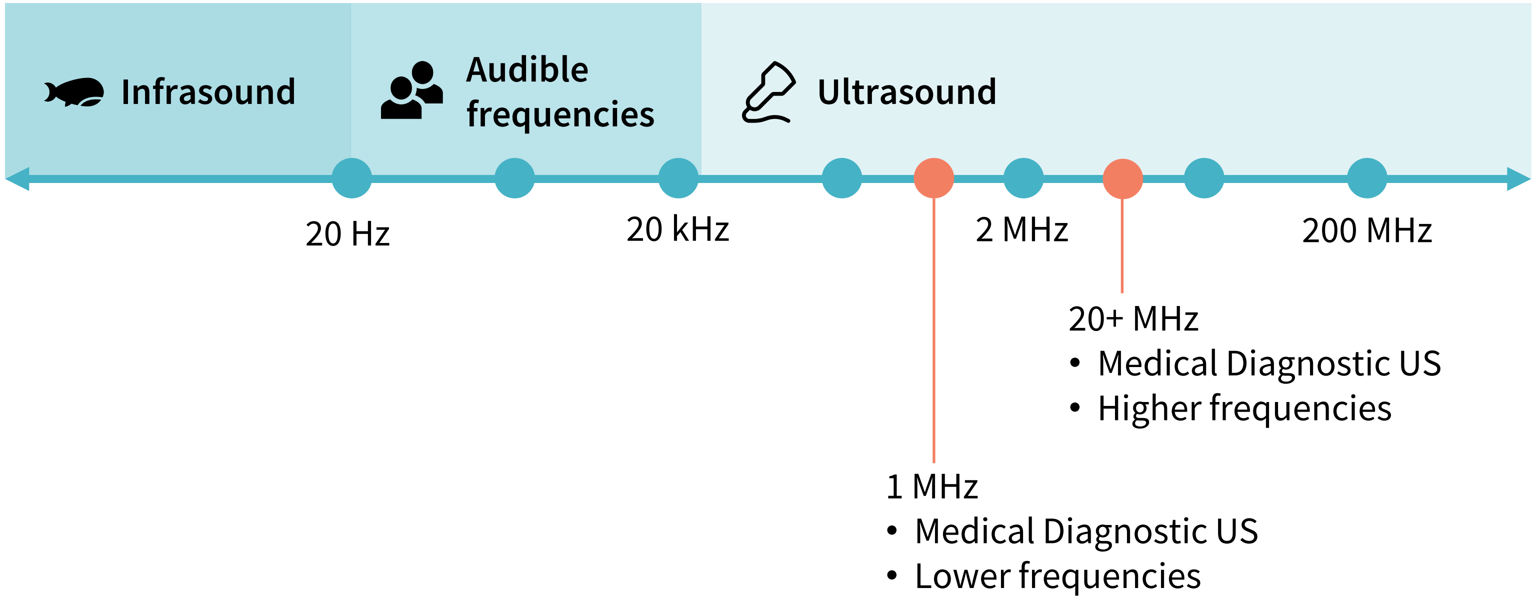
GE HealthCare

Ultrasound basics

What is ultrasound?

Ultrasound is an imaging technique that uses high-frequency **sound waves** to create real-time images of organs, tissues, and other structures inside the body.

Hertz, often abbreviated Hz, is like the ruler for how fast sound waves move, telling us the number of cycles they complete in one second (unit of sound. Cycles per second).



Number of cycles or waves per second	Frequency (SI units)
1	1 hertz (Hz)
1,000	1 kilohertz (kHz)
1,000,000	1 Megahertz (MHz)
1,000,000,000	1 gigahertz (GHz)
1,000,000,000,000	1 terahertz (THz)
1,000,000,000,000,000	1 Petahertz (PHz)
1,000,000,000,000,000,000	1 exahertz (EHz)

How is the sound produced?

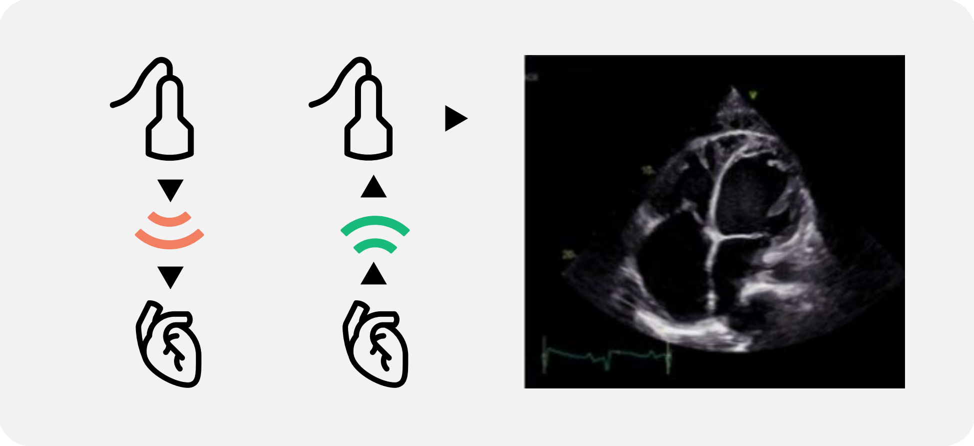
Piezoelectric effect in ultrasound

How is an Ultrasound image created?

The piezoelectric effect is the scientific process that produces ultrasound waves.

The application of an electric field to a crystal causes changes that allow for the conversion of electrical energy into kinetic or mechanical energy.

1. Probe **transmits** electrical energy → mechanical energy (sound waves)
2. Probe **receives** mechanical energy (reflected sound waves → Electrical energy (processed by CPU to form an image)



Speed of sound in different mediums

Structures of the body can be considered as a medium for ultrasound to pass through

- Different structures of the body have different densities or stiffness
- As a result, they reflect the soundwaves differently
  - Stiffer the medium → Higher the density → Faster the sound will travel
  - Stiffer mediums have tighter particles to propagate the ultrasound wave and therefore the velocity is greater

Bone
Highest speed of sound, most dense, most reflective

Soft tissue (muscle)

Blood

Fat

Lung (air)
Lowest speed of sound, least dense, least reflective

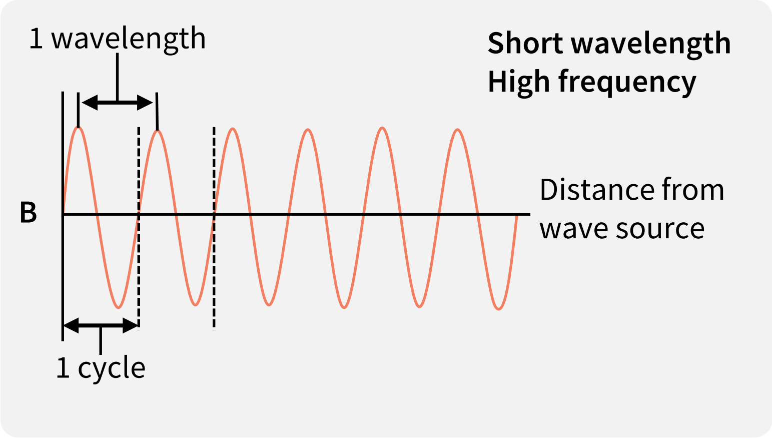
Frequency

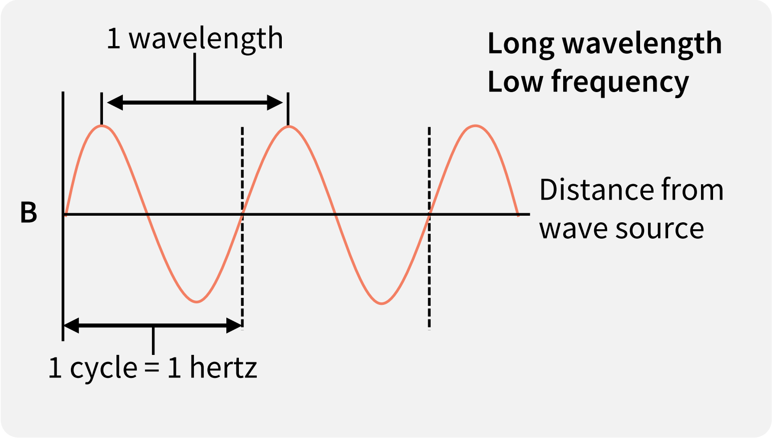
Since ultrasound is sound waves, the frequency of those waves determines the quality of the image we create.

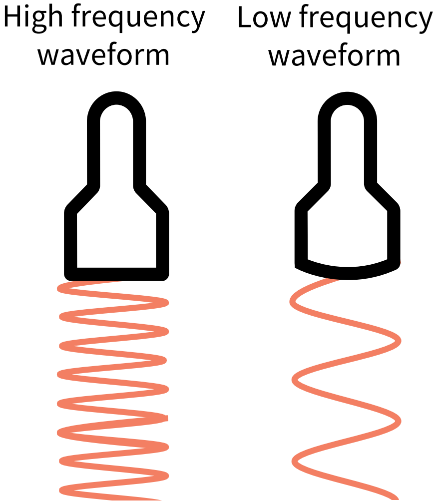
As sound waves travel through the body; some are absorbed while the rest are bounced back to the transducer to produce an image. The frequency determines how much of the wave is absorbed and therefore how much detail is in the resultant image.

High frequency = High resolution, Low penetration → **Less wavelength**

Low frequency = Low resolution, High penetration → **More wavelength**





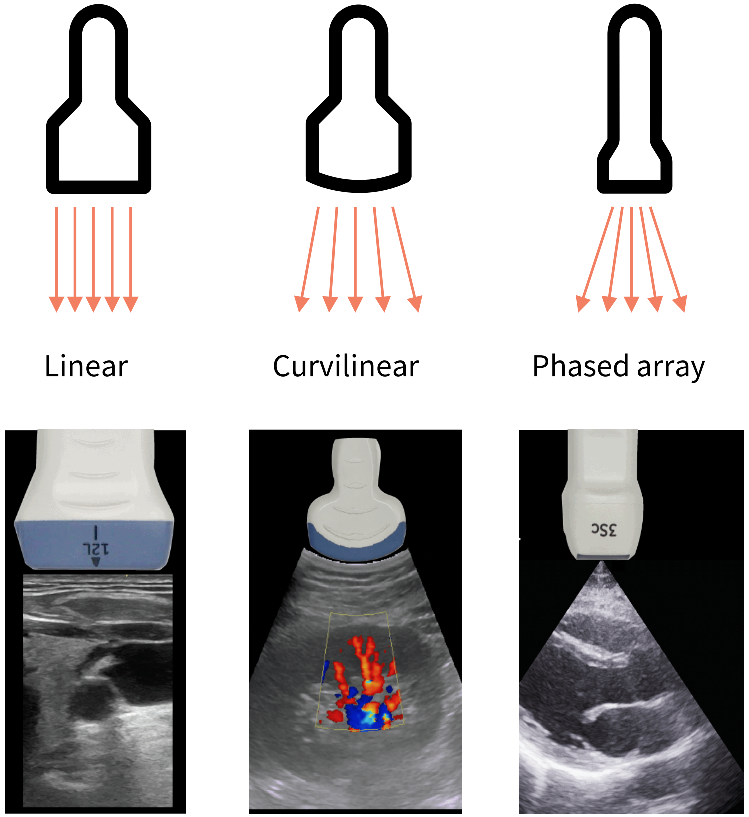


Using this image as a reference, notice how the high frequency waveform has more opportunity to gather details as the waves are denser while the in the lower frequency, the waves are more stretched out and therefore catch fewer details.

Transducers/probes

Transducers (probes) come in different shapes and sizes to image of different parts of the body.

Name	Linear	Convex	Sector/Phased
Shape	Flat	Curved	Small, square shape
Image	Rectangular High resolution Superficial	Wider Diverging field of view Deeper penetration	Narrow, sector-shaped beam
Uses	Skin, muscles, tendons, blood vessels, fascia, nerves	Abdominal, pelvic organs	Cardiac imaging
Frequencies	Higher 4 – 22 MHz	Lower 1 – 5 MHz	Lower 1 – 5 MHz



Resolution

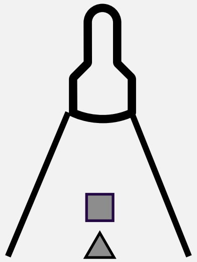
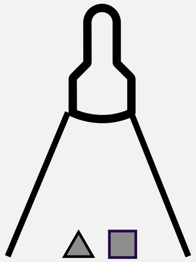
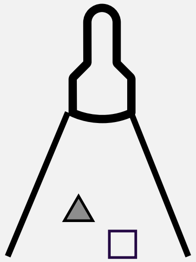
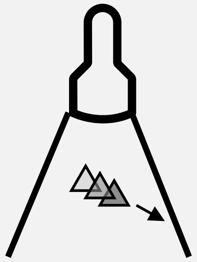
Resolution is the key to ultrasound. Resolution is the ability to image structures accurately and clearly.

Spatial resolution: The ability of the ultrasound system to detect and display structures that are close together

- **Axial resolution:** The ability to separate two objects that are longitudinal to each other and parallel to the ultrasound beam
- **Lateral resolution:** the ability to separate two objects that are adjacent to each other

Temporal resolution: The time from the beginning of one frame to the next; it represents the ability of the ultrasound system to distinguish between instantaneous events of rapidly moving structures, for example, during the cardiac cycle.

Frequency helps adjust resolution, but also…

Resolution	Axial	Lateral	Contrast	Temporal
Representation				
Primary determinants	Pulse length frequency	Beam width, depth, gain	Preprocessing, postprocessing, size	Depth, sweep angle, line density, PRF

Contrast

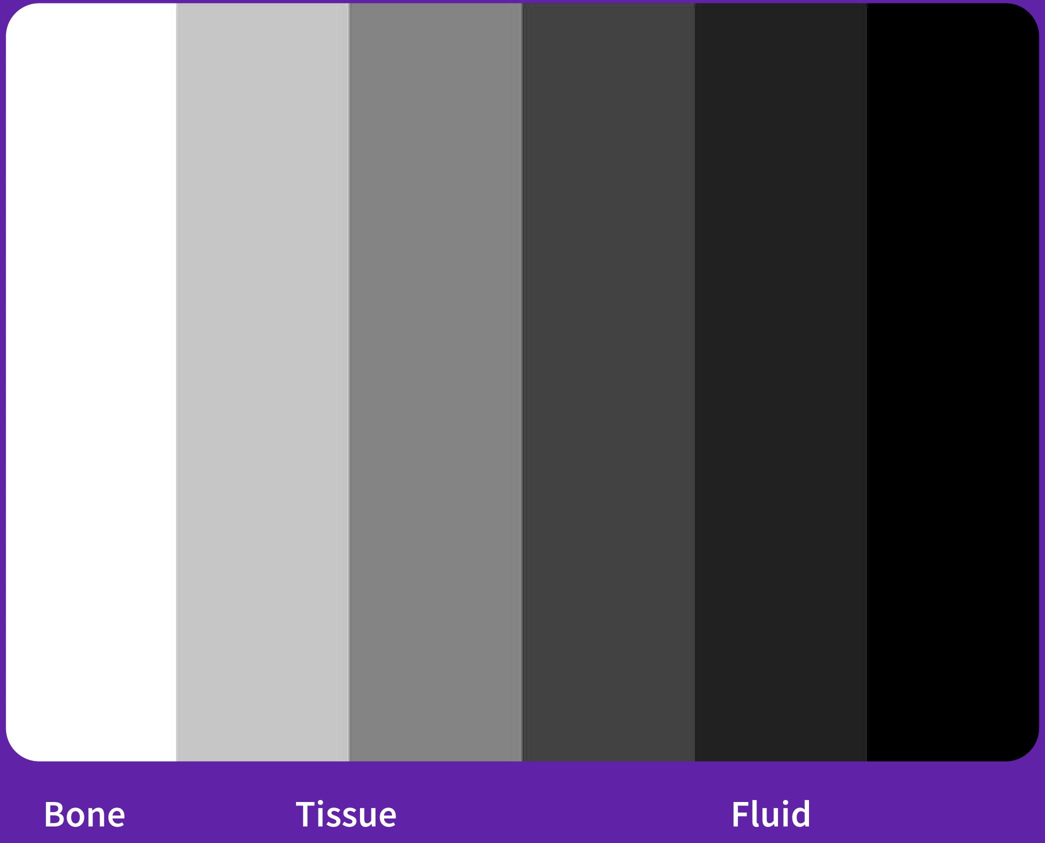
Contrast resolution refers to the ability to distinguish between different echo amplitudes of adjacent structures.

It's ability to distinguish between differences in image intensity (because of different structural densities)

Low contrast: more gray, homogenous

High contrast: less gray, clear difference in blacks and whites

Dynamic Range helps adjust contrast

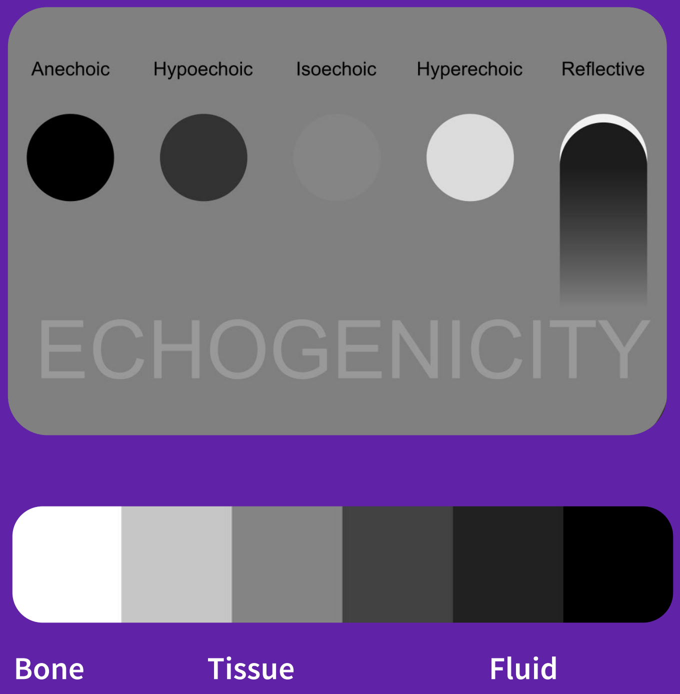


Important terms used in ultrasound

Structures that reflect a lot of sound waves appear bright white (*hyperechoic*), while those that reflect few waves appear dark gray (*hypoechoic*) or black (*anechoic*)

The terms are relative and used to compare the brightness of a structure to its surroundings, which helps in diagnosing tissue conditions.

1. **Hyperechoic:** **Brighter** than surrounding tissue, meaning it reflects more sound waves
2. **Hypoechoic:** **Darker** than surrounding tissue, meaning it reflects fewer sound waves
3. **Anechoic:** Complete or **near absence of echoes** — the area is **black**
4. **Isoechoic:** Has the **same brightness** as the surrounding tissue, meaning it has the same echogenicity



Ultrasound echogenicity is the **ability of a tissue to reflect ultrasound waves,** which determines its appearance on an ultrasound image

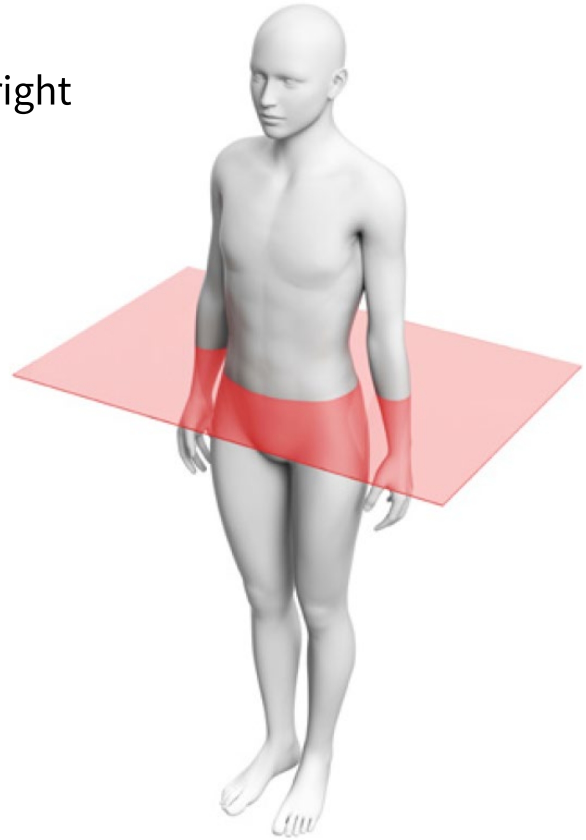
Scanning planes and terminologies

Long axis

- Longitudinal/Sagittal
- Probe position: Vertical
- Marker towards the patient's head
- Left part of screen: Cranial
- Right part of screen: Caudal

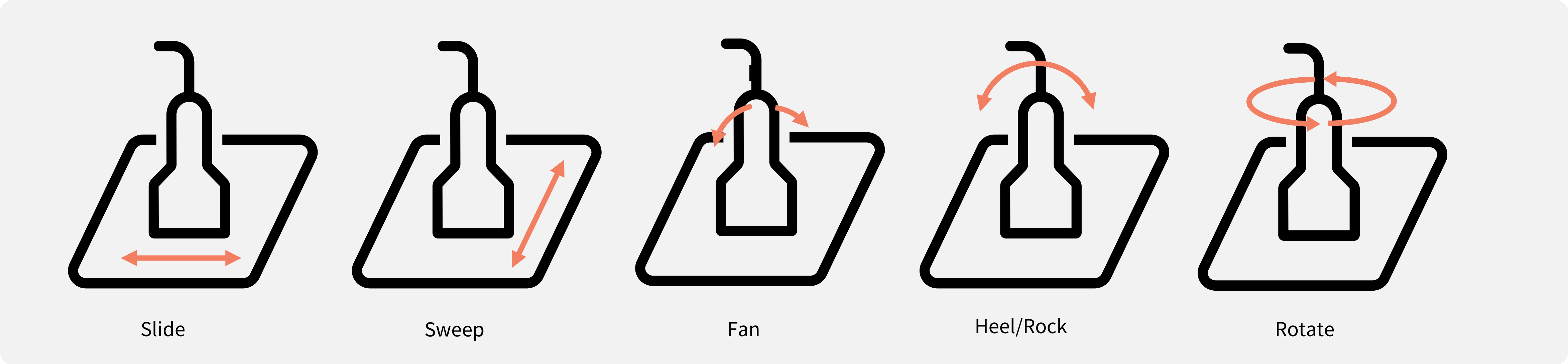
Short axis

- Cross sectional view/Transverse
- Probe position: Horizontal
- Marker towards the patient’s right
- Left part of screen: Right side of the patient anatomy
- Right part of screen: Left side of patient anatomy



Probe manipulation techniques

Basic probe movements



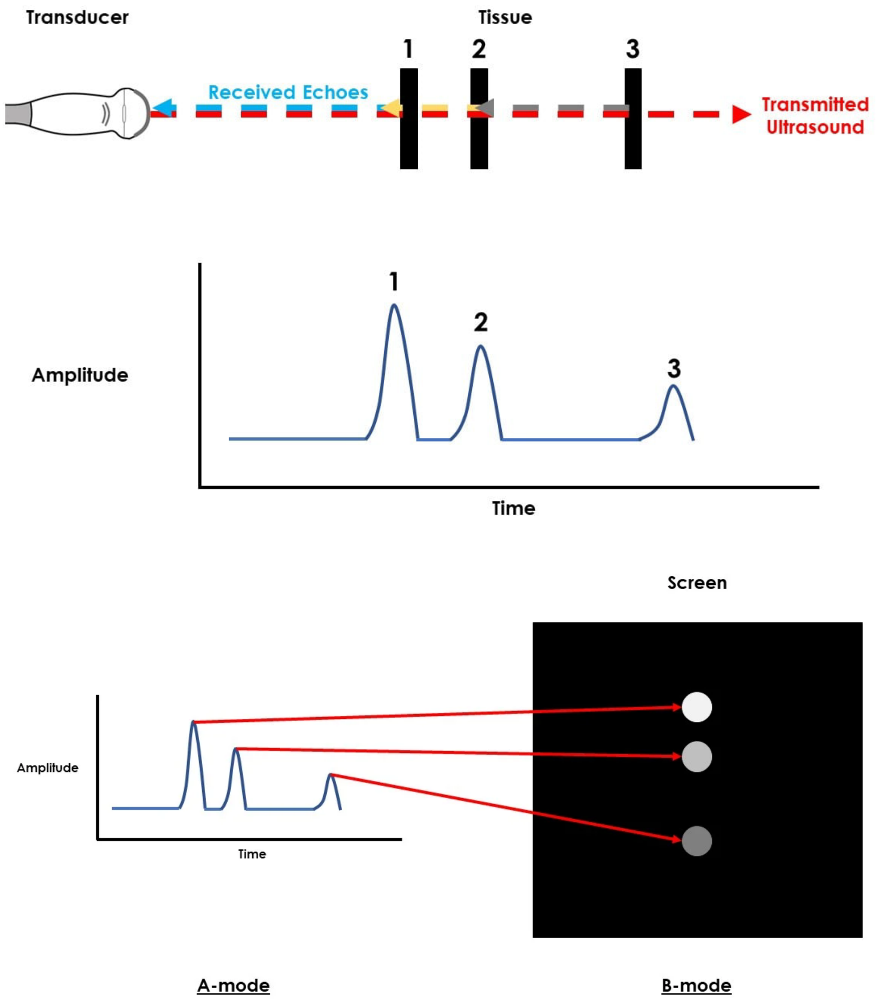
Sliding: Moving the probe along the skin's surface in a side-to-side or up-and-down motion.

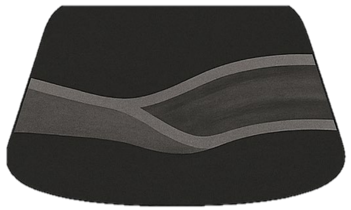
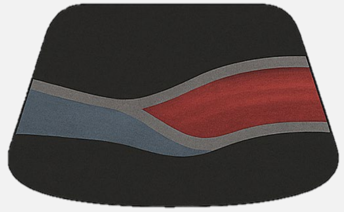
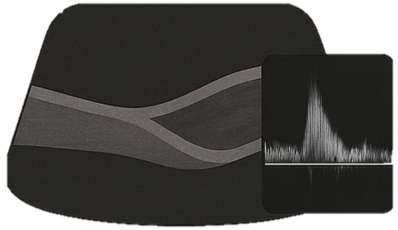
Heeling/Rocking: Leaning the probe back and forth on its top or bottom to adjust the angle of the sound beam without changing the probe's position.

Sweeping/Fanning: Moving the probe across the short face of the transducer, like a fan, to scan a large area and create different slices of the organ.

Rotation: Pivoting the probe around a central point or anchoring one end and rotating the other to change the orientation of the image.

Ultrasound modes



Mode	Purpose	Description	Image
B-Mode	Basic grayscale imaging of anatomy	A cross-sectional/ longitudinal image showing organs/tissues in shades of gray	
Color Mode	Visualizes blood flow presence and direction	Same grayscale image with red and blue overlays indicating blood flow toward/away probe	
Doppler Mode	Quantifies blood flow velocity and pattern Produces sound of the blood flow	A waveform graph showing velocity over time, alongside grayscale image	

Color mode

What do the colors on ultrasound mean?

This mode allows you to see the movement of blood movement in arteries and veins with blue and red patterns on the ultrasound screen.

Red means there is flow **towards** the ultrasound probe and **blue** means that there is flow **away** from the ultrasound probe.

It is a misconception that red is arterial, and blue is venous.

It just depends on the direction blood is flowing relative to the angle of your ultrasound beam.

An easy way to remember — **BART mnemonic:**

Blue Away, Red Towards.

Color Doppler

Ultrasound beam angle

POCUS 101

Blood flow

Perpendicular = **Black**

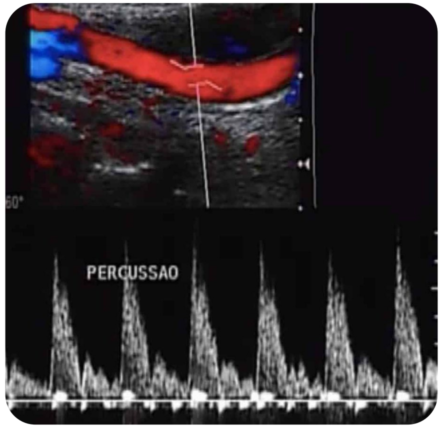
Towards probe = **Red**

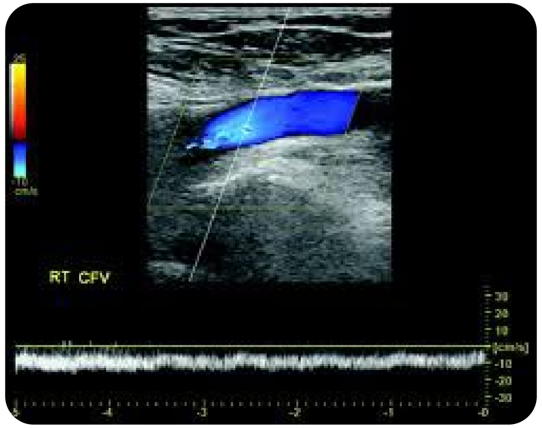
Away from probe = **Blue**

"BART"
Blue
Away
Red
Towards

PW doppler

- Allows us to hear blood flow
- Measure velocities of the blood flow
- Can confirm arterial flow vs. venous flow





Arterial	Venous
Dynamic flow	Phasic with respiration
Clear ‘peaks’ and ‘valleys’	Phasic flow
Rhythmic, pulsatile, higher pitch	Continuous, non-pulsatile, lower pitch

Image optimization

Basic image optimization

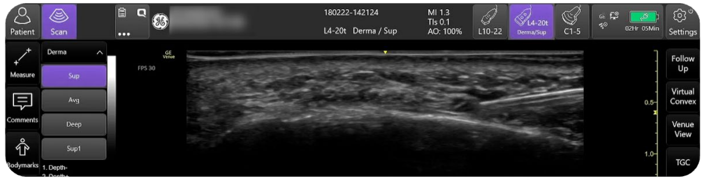
B Mode	Color Mode	PW Mode
Gain	Color Gain	PW cursor position
Depth	Color Box Size	PW cursor sample volume
Frequency	Color Box Position	Baseline adjustment

Portfolio

Venue™ family*

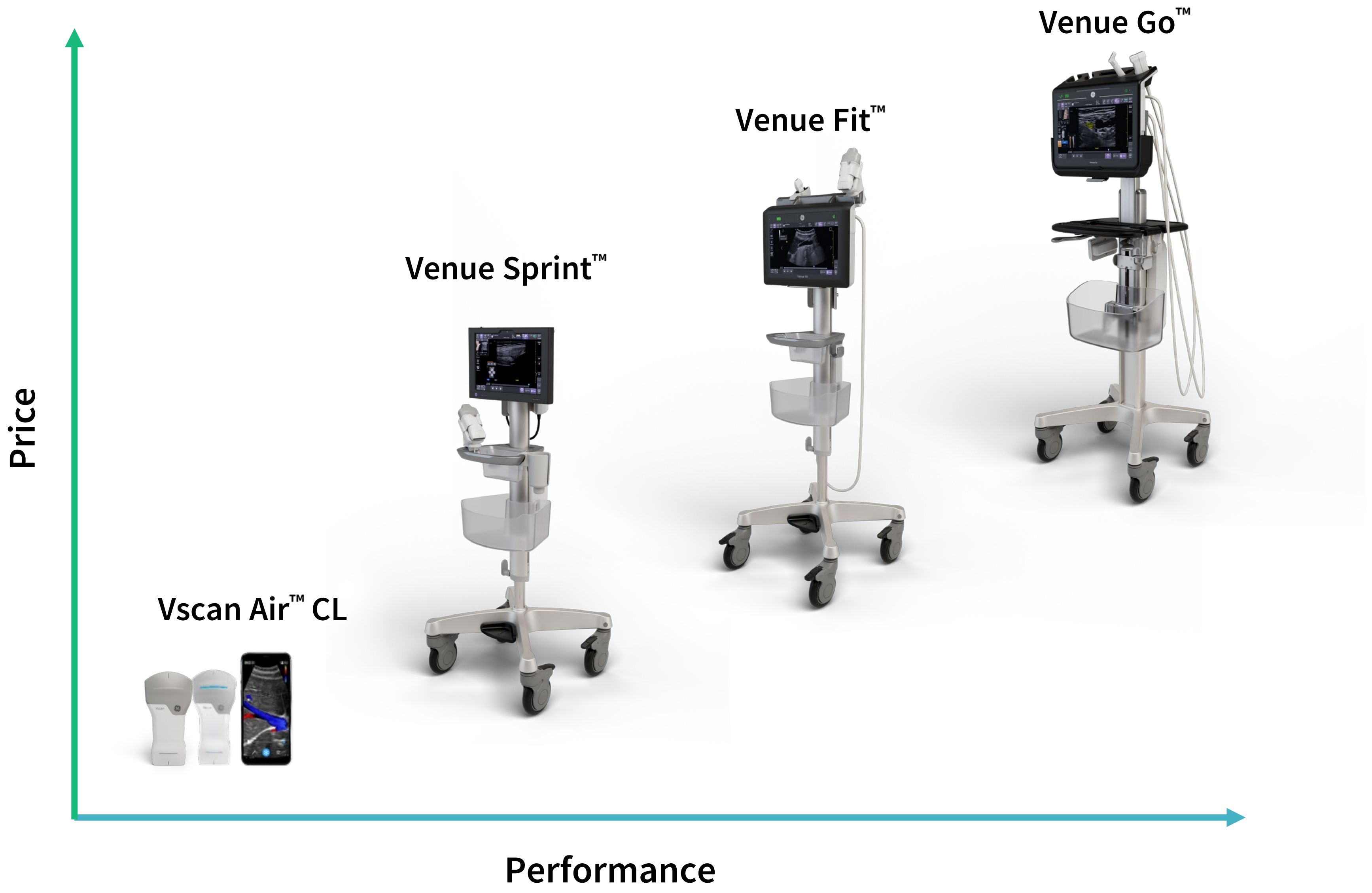
Precision wherever you practice aesthetics

- Portable and simple to use
- Excellent image quality
- Seamless touchscreen
- Dedicated derma and aesthetic presets
- Enhanced color flow settings for facial vascular mapping
- Clear needle visualization
- Lightweight probes — doesn't compress superficial vessels



* Venue family is intended to be used in hospitals and medical clinics.

Aesthetic ultrasound portfolio



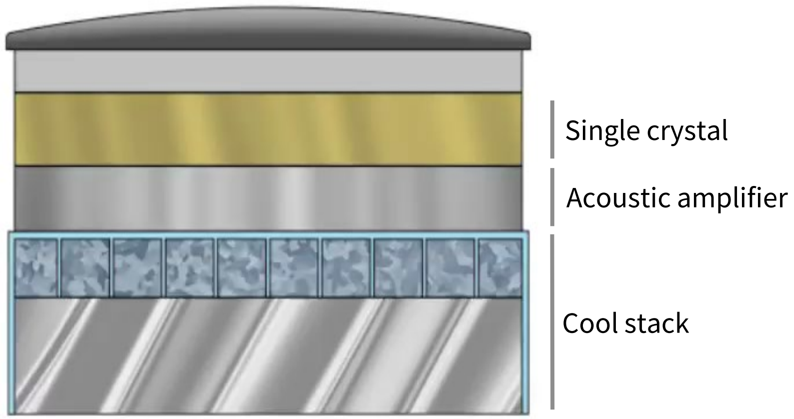
Venue Fit™

High-end aesthetic ultrasound solution

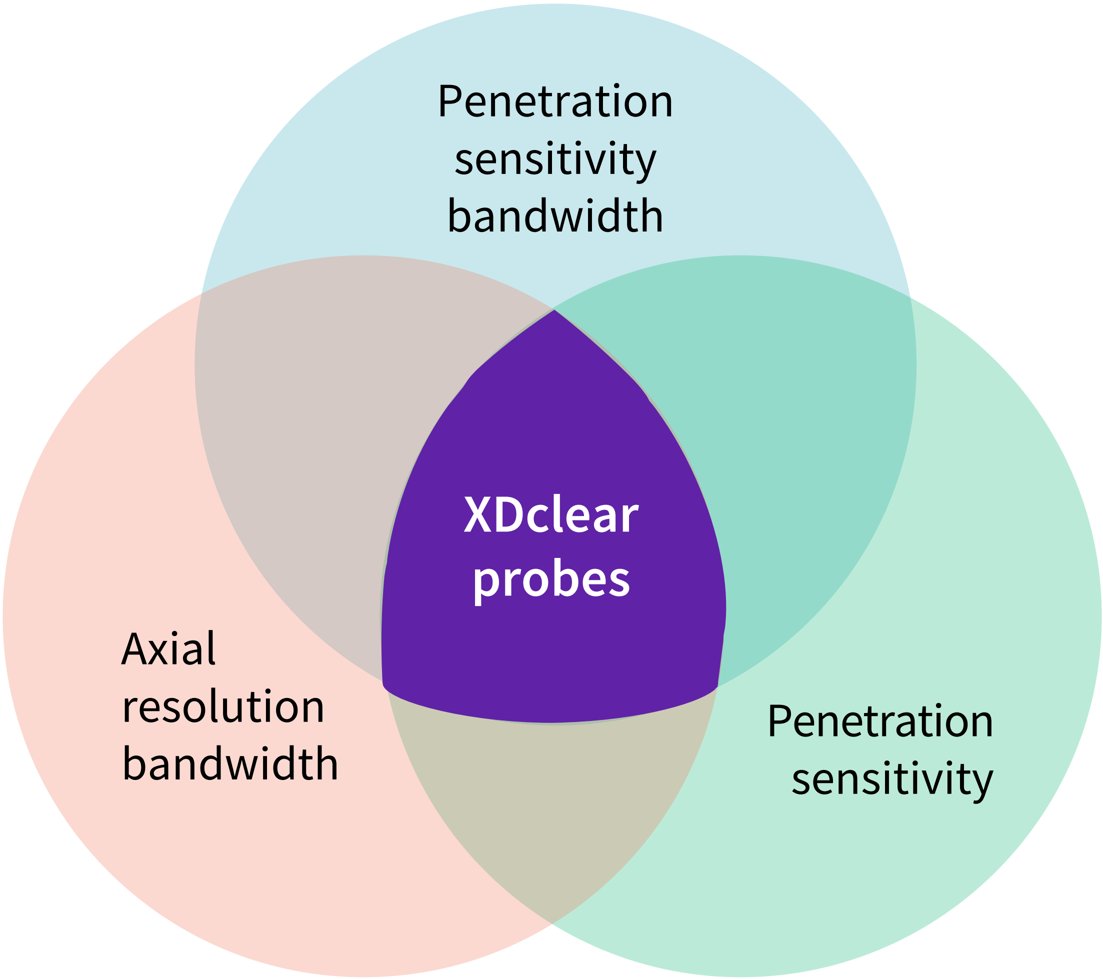
- Seamless flat touchscreen display
- 14-inch, high-resolution monitor
- Up to one-hour battery — continuous scanning
- 2 active probe ports (wired)
- Additional: Wireless probe option available
- Seamless flat display
- Supports **ultra-high frequency XDclear™** wired probes

XDclear™ probes

Three elements that deliver exceptional image quality



1 | Cool stack



2 | Single crystal

3 | Acoustic amplifier

Please consult your local GE HealthCare representative for availability and warranty term information in your region.

Versatility that meets your needs

The broad range of high-frequency probes that are compatible with Venue family systems gives you options for understanding the underlying vascular anatomy of lips, cheeks and around the eyes. Center line markers can assist with out-of-plane procedures.

The L4-20t-RS XDclear™

The L4-20t-RS XDclear lightweight button probe enables professionals to gain high-frequency imagery of superficial structures while also being able to penetrate deeper without compromising image quality. It assists when performing needle procedures as you can control multiple parameters from the probe with one hand.

L8-18i-RS

The L8-18i-RS is a compact probe that's well suited for tight spaces and generating images for superficial and small structures.

L10-22-RS

The L10-22-RS probe is a smaller ultrasound transducer for assessing contour areas around the nose and eyes.

Vscan Air™ CL

The Vscan Air CL offers wireless freedom and maximum portability. Both a shallow and deep probe are on the same device, delivering uncompromised image quality.

Venue Sprint™

Value-range aesthetic ultrasound solution

- Seamless, flat touchscreen display
- 13.6-inch monitor
- Dual-probe solution
- Up to 50 minutes scanning on fully charged battery
- Advanced Venue™ family software with aesthetic presets
- Wireless probe integration only (up to 12 MHz)

Vscan Air™ CL

Entry level aesthetic ultrasound solution

- Paired with mobile or tablet through Vscan Air App on Appstore or Playstore
- Ultra-portable
- Dual probe solution (linear and convex)
- Up to 50 minutes of battery
- Wireless probe integration only (up to 12 MHz)

Vscan Air CL (curved/linear)

Clinical applications

Facial ultrasound

How can it be applied?

Before treatment

- Assess patient anatomy
- Differentiate layers of the face
- Identify previous fillers
- Identify anatomical variations
- Locate and map vascular structures
- Differentiate arterial vs venous flow
- Measure depth, distance and thickness of different facial layers/structures for treatment planning

During treatment

- Guide injections with clear visualization of needle path and tip
- Inject in the correct layer and depth
- Steer clear of vessels during injection
- Recommended for high risk areas: forehead, temple and nose
- Ultrasound guided filler dissolving — accurate, targeted, long lasting results guaranteeing patient satisfaction

After treatment

- Monitor filler placement in the correct layer
- Assess vascularity to reconfirm no complications
- Measure depth of layer where treatment was performed
- Save images to document for patient records

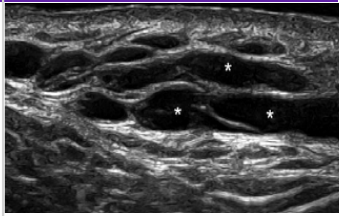
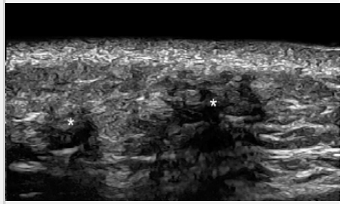
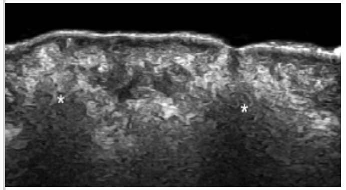
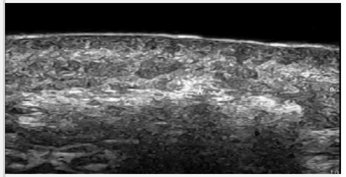
Facial ultrasound

How can it be applied?

Complication management

- Vascular occlusion diagnosis
- Vascular compression diagnosis
- Swelling
- Localized tissue reactions: nodules, granulomas
- Filler migration
- Targeted dissolving in case of VAE’s

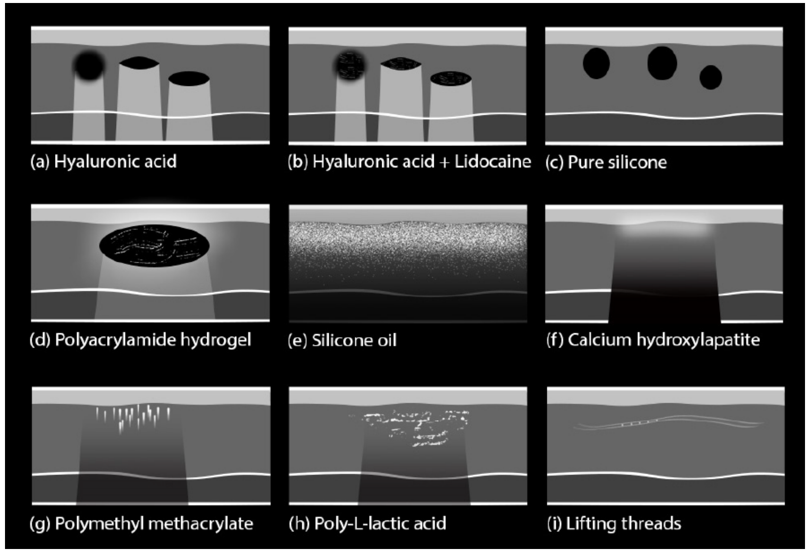
Identifying filler types

Filler type	US characterization	Images
Hyaluronic acid (HA)	• Multiple round or oval-shaped • Anechoic • Pseudo cystic • Usually generates a posterior acoustic enhancement artifact	
Polycaprolactone (PCL)	• Synthetic filler • Hypoechoic matrix containing multiple hyperechoic spots • Showing amini-comettail artifact	
Silicone oil	• Ill-defined hyperechoic deposits posterior acoustic reverberation – called a ’snowstorm pattern’	
Calcium hydroxy apatite (CaHA)	• Hyper echoic deposits • May vary in the intensity of the posterior acoustic shadowing artifact according to the dilution	

Ultrasonographic evaluation of common cosmetic fillers

Ultrasound is the first-choice imaging technique to detect and identify common cosmetic fillers. These exogenous agents are identified according to their intrinsic echogenicity patterns and generated artifacts (Fig. 8a–g) [3–7,16,29–36]. It is crucial to perform ultrasound evaluation of fillers, as patients often do not recall or report the specific substances that were injected. This lack of information can complicate diagnosis and treatment, underscoring the importance of thorough imaging assessment.

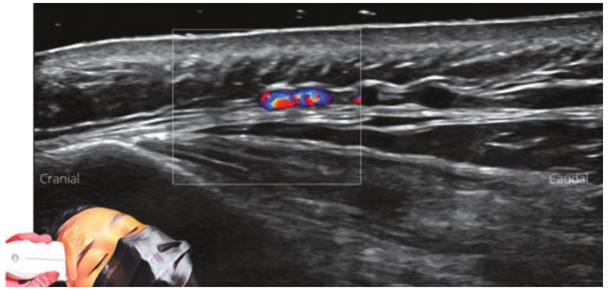
WFUMB Position Paper: Consensus on Best Practice in Aesthetic Dermatologic Ultrasound

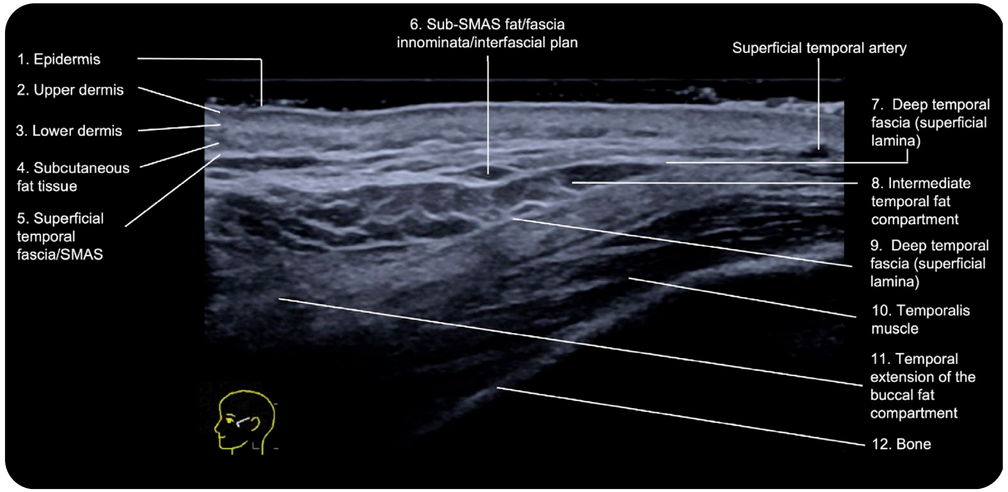


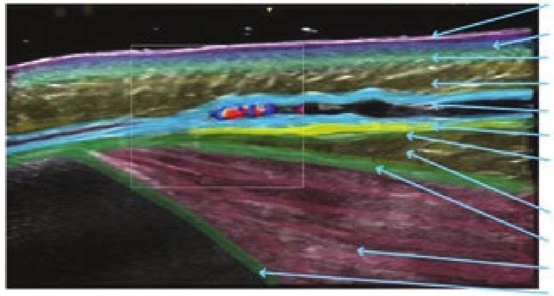
Upper face
Temple

Superficial temporal A/V

No.	Layer	Ultrasound appearance	Key features
1	Epidermis	Hyperechoic line	Outer skin surface
2	Upper dermis	Hypoechoic homogeneous layer	Uniform texture
3	Lower dermis	More echogenic than upper dermis	Slightly brighter
4	Subcutaneous fat tissue	Hypoechoic layer with hyperechoic septae	Fat lobules separated by septae
5	Superficial temporal fascia/SMAS	Linear hyperechoic layers	**Envelops superficial temporal artery and vein**
6	Sub-SMAS fat (innominate fascia)	Hypoechoic layer	Loose connective tissue and fat lobules; interfascial plane
7	Superficial lamina of deep temporal fascia	Hyperechoic line	Adjacent to intermediate temporal fat compartment
8	Intermediate fat compartment	Hypoechoic triangular layer with hyperechoic septae	**Contains middle temporal vein**
9	Deep lamina of deep temporal fascia	Hyperechoic line	Deep to intermediate fat compartment
10	Temporal muscle	Large hypoechoic structure	Above bone; contains anterior and posterior deep temporal arteries
11	Temporal extension of buccal fat	Hypoechoic fat compartment	Adjacent to lateral orbital rim; moves with mouth opening
12	Bone	Thin hyperechoic line with acoustic shadowing	Deepest layer



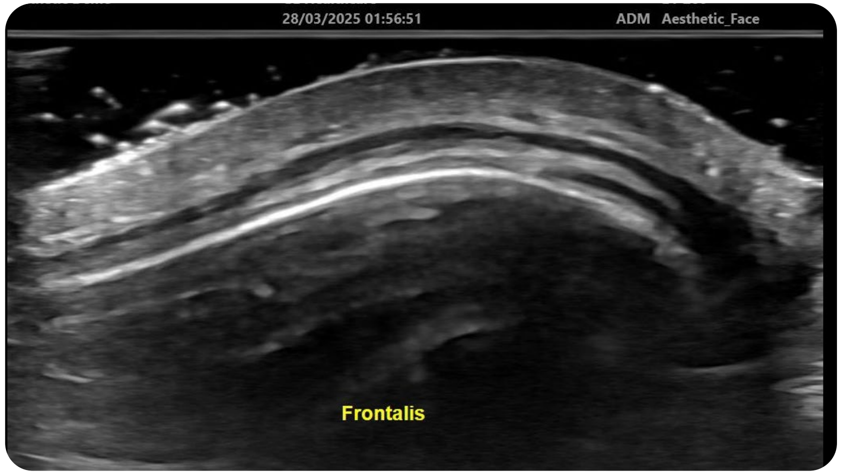


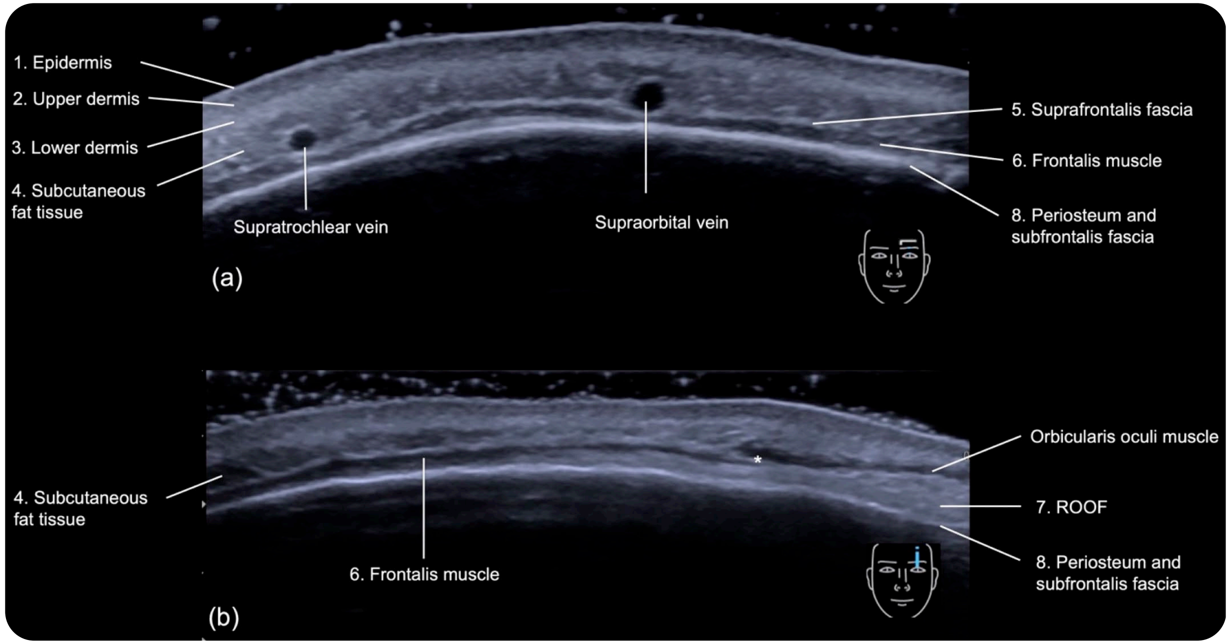


Upper face
Forehead

Supratrochlear A/V
Supraorbital A/V

No.	Layer	Ultrasound appearance	Key features
1	**Epidermis**	Hyperechoic line	Outer skin surface
2	**Upper dermis**	Hypoechoic homogeneous layer	Uniform texture
3	**Lower dermis**	Hyperechoic layer	Brighter than upper dermis
4	**Subcutaneous fat tissue**	Hypoechoic layer with hyperechoic septae	Fat lobules separated by septae
5	**Suprafrontalis fascia**	Thin hyperechoic layer	Upper layer of galea aponeurotica
6	**Frontalis muscle**	Hypoechoic band-like structure	Located beneath suprafrontalis fascia
7	**ROOF (Retro-Orbicularis Oculi Fat)**	Hyperechoic fibrous fat layer	Separates frontalis muscle from bone; seen inferolaterally
8	**Periosteum and subfrontalis fascia**	Hyperechoic line with acoustic shadowing	Combined imaging; mirror artifact due to frontal bone convexity



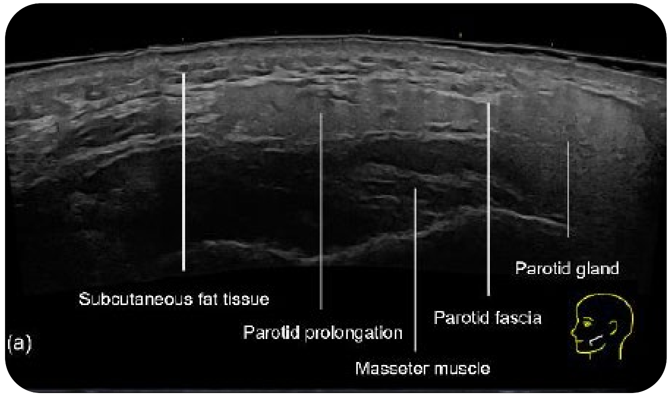


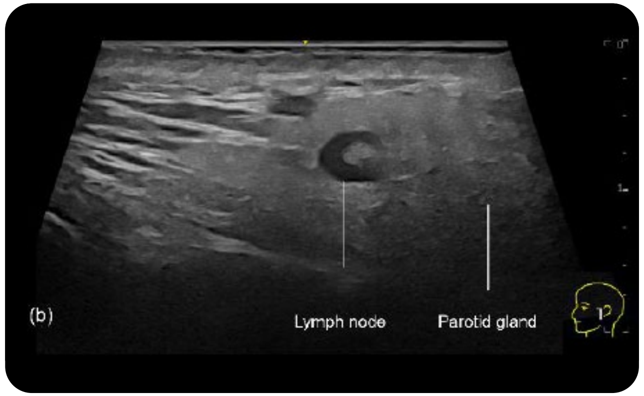
Facial A/V

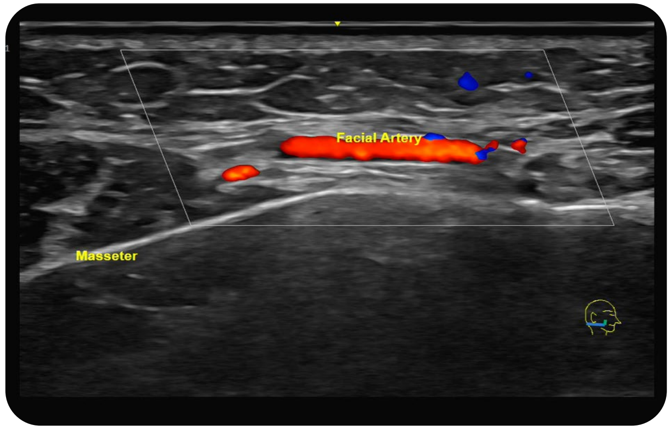
★ Midface

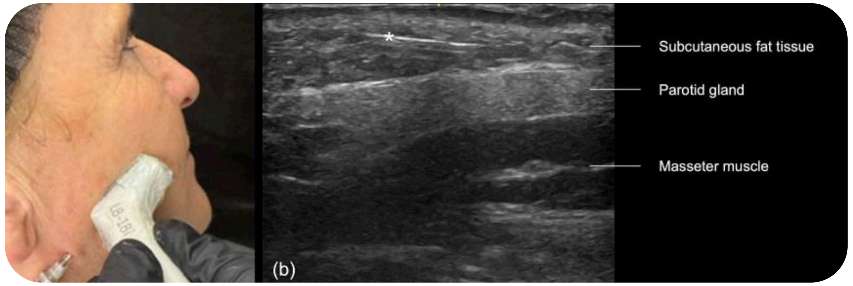
Cheek/Periauricular

No.	Layer	Ultrasound appearance	Key features
1	Skin	Superficial layer	Covers the periauricular region
2	Subcutaneous fat	Hypoechoic	Very thin (2–4 mm), increases risk of filler reaching parotid gland
3	SMAS (Superficial Musculoaponeurotic System)	Hyperechoic linear layer	Lies beneath subcutaneous tissue
4	Transverse facial artery	Tubular structure with Doppler flow	Course varies; critical to identify for injections
5	Parotid fascia	Hyperechoic line	Encloses parotid gland
6	Parotid gland	Hypoechoic heterogeneous structure	Risk of inflammation or abscess if filler enters







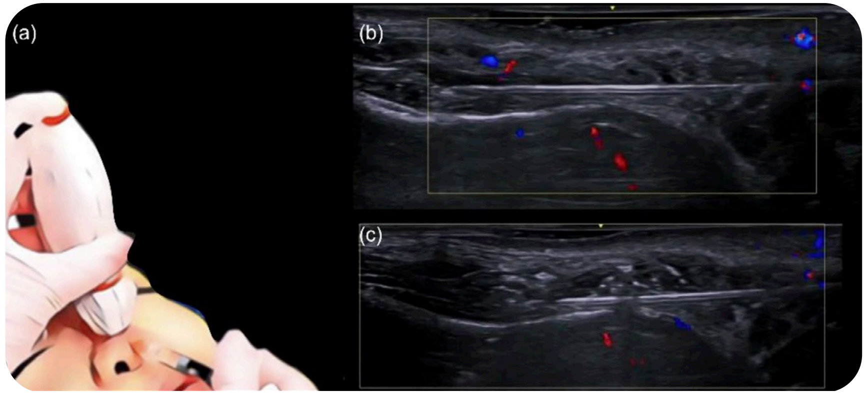


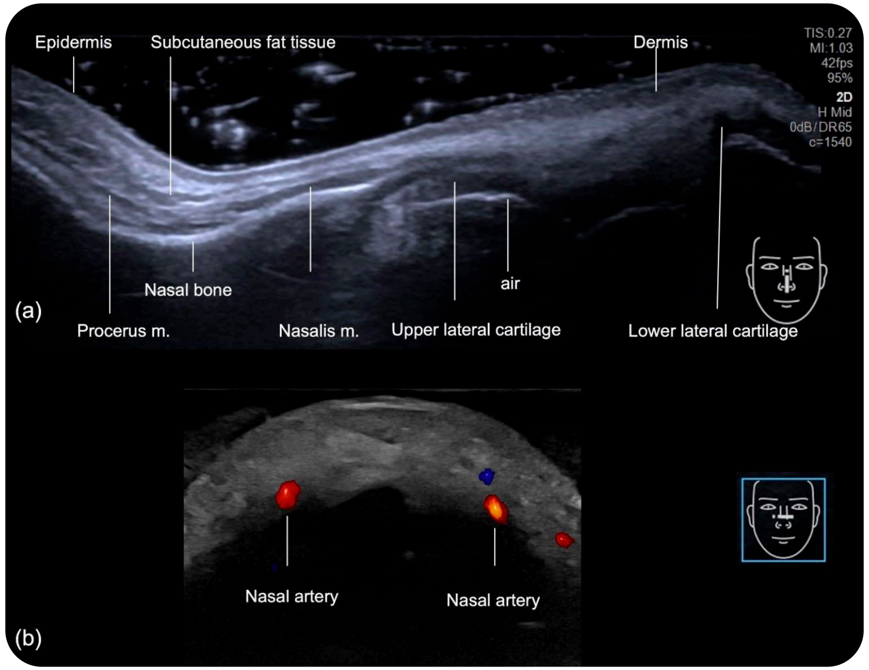
Midface

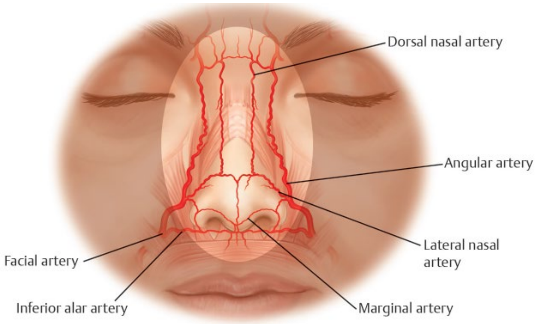
Nose

Lateral Nasal A
Dorsal Nasal A

No.	Layer	Ultrasound appearance	Key features
1	Skin	Most superficial layer	Increased thickness at nasal tip
2	Hypodermis (fibroadipose tissue)	Hyperechoic	Less prominent fatty lobules
3	Procerus muscle	Hypoechoic	Located at the radix
4	Nasalis muscle	Hypoechoic	Extends along nasal dorsum
5	Nasal bones	Hyperechoic linear structures	Bright lines representing bone
6	Upper and lower lateral cartilages	Hypoechoic convex formations	Cartilaginous structures of nose
7	Air interface beneath cartilage	Linear hyperechoic line	Indicates air in nasal cavity; mirror artifact possible





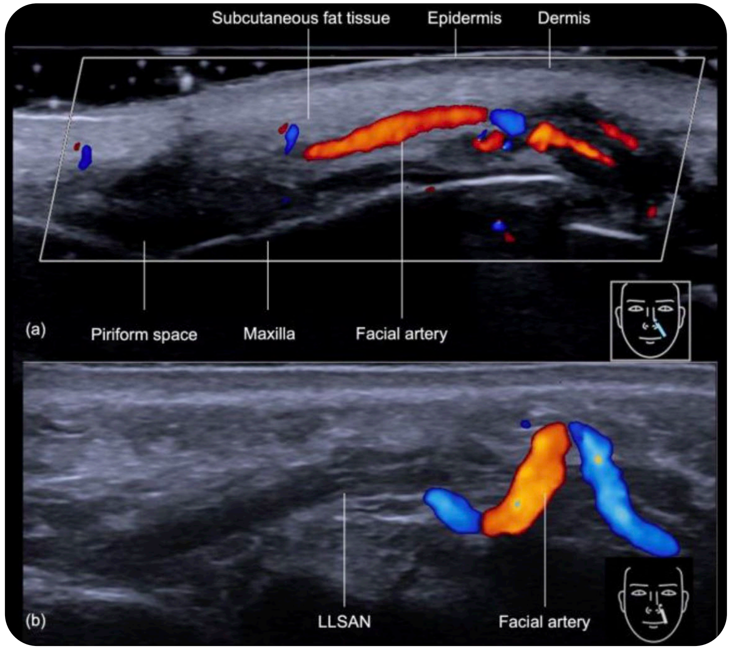


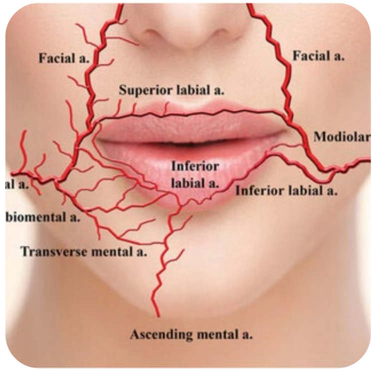
Facial A
Angular A

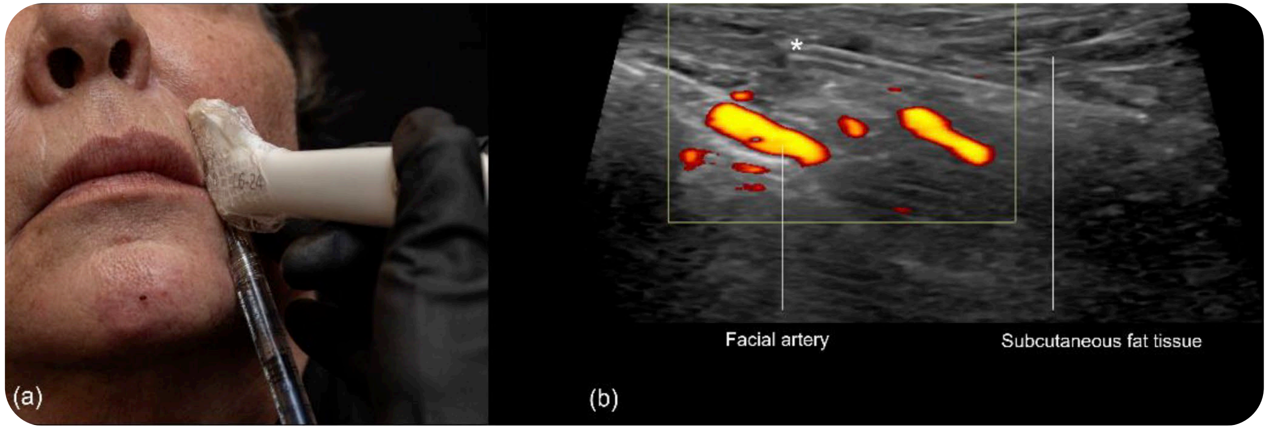
Midface

Nasolabial folds

No.	Layer	Ultrasound appearance	Key features
1	Epidermis and dermis	Superficial layers	Outer skin surface
2	Subcutaneous tissue	Hypoechoic	Located beneath dermis
3	Muscular layer	Hypoechoic distinct structures	Includes levator labii superioris alaeque nasi and levator anguli oris
4	Angular artery	Variable depth and position	Can be lateral or medial to nasolabial fold; may change planes
5	Bone (maxilla)	Hyperechoic line with shadowing	Deepest structure





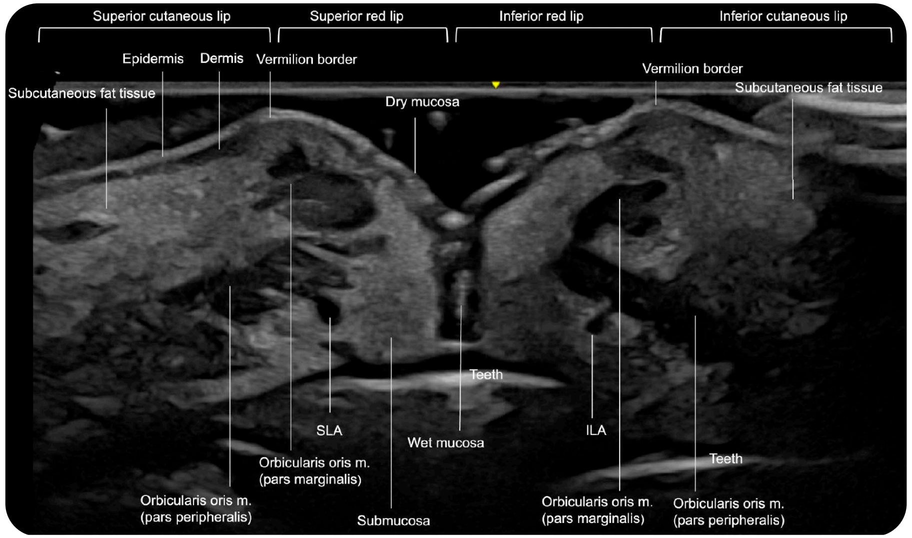


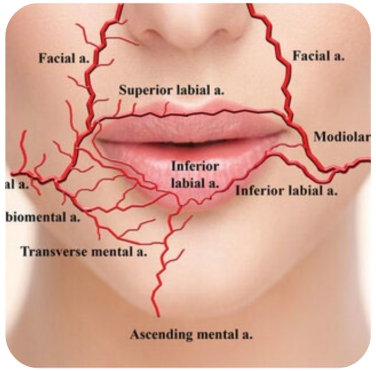
Lower face

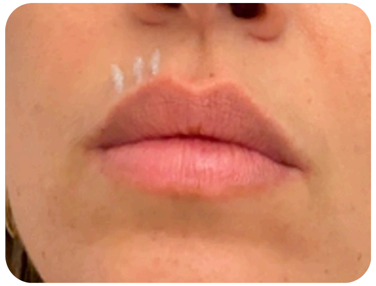
Lips

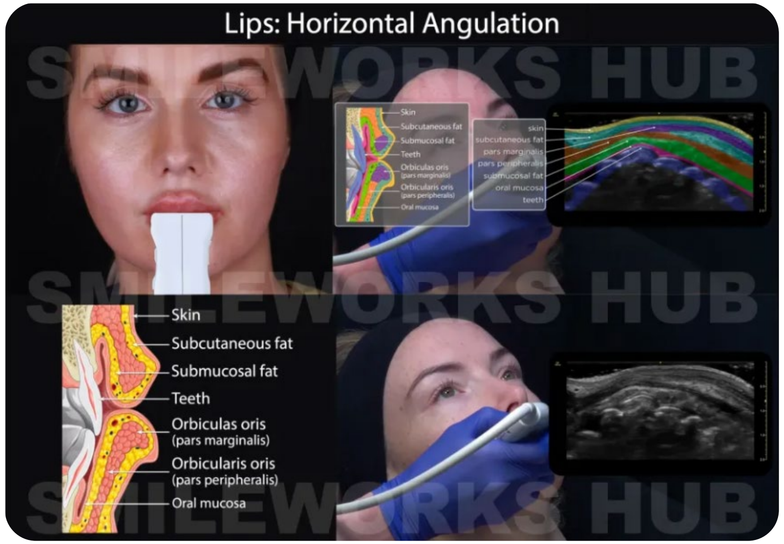
Superior Labial A
Inferior Labial A

No.	Layer	Ultrasound appearance	Key features
1	Epidermis	Hyperechoic line	Outermost layer
2	Dermis	Slightly hypoechoic	Beneath epidermis
3	Subcutaneous fat	Increased echogenicity	Dense fibrous components
4	Orbicularis oris muscle (OOM)	Hypoechoic bands	Single band in cutaneous lip; two bands in vermilion (pars marginalis and pars peripheralis)
5	Submucosa	Hyperechoic layer	Contains minor salivary glands (hypoechoic, rounded)
6	Mucosa–oral vestibule interface	Hyperechoic line	Marks transition to oral cavity
7	Teeth	Prominent hyperechoic structures	Deepest visible layer
8	Labial arteries	Variable location	Most commonly submucosal (58.5%), then intramuscular (36.2%), subcutaneous (5.3%)









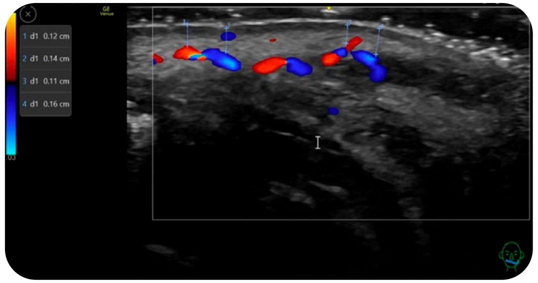


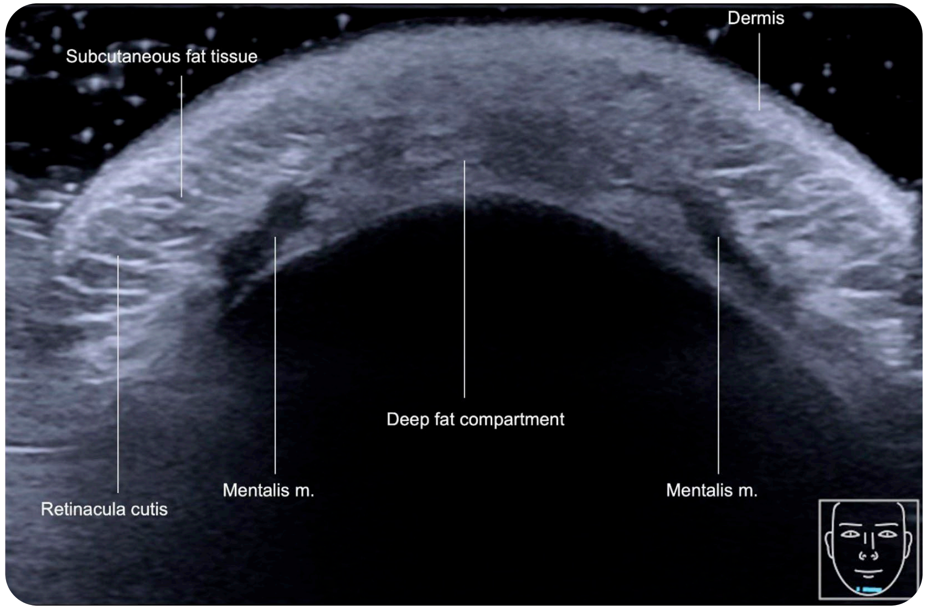
Image courtesy of https://smileworks-hub.co.uk/

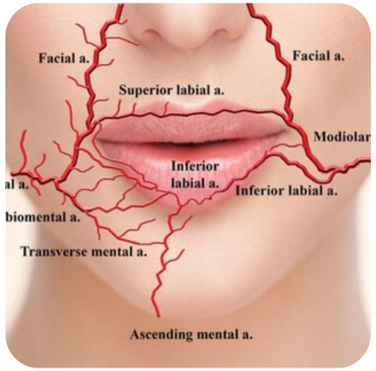
Lower face

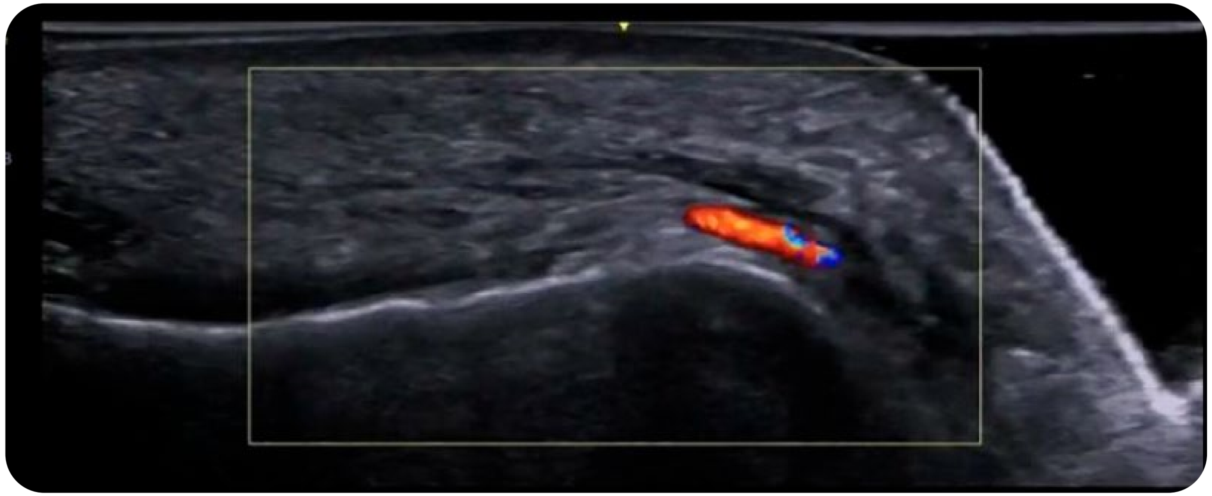
Chin

Submental A
Mental A

No.	Layer	Ultrasound appearance	Key features
1	**Epidermis**	Hyperechoic line	Outermost layer
2	**Upper dermis**	Hypoechoic	Homogeneous layer beneath epidermis
3	**Lower dermis**	Hyperechoic	Brighter than upper dermis
4	**Fibro-fatty layer**	Hyperechoic, poorly defined	Lies beneath dermis
5	**Mentalis muscle**	Two symmetric hypoechoic bellies	Located deep to fibro-fatty layer
6	**Deep chin fat pad**	Hyperechoic	Positioned between mentalis muscle bellies
7	**DAO and depressor labii inferioris**	Hypoechoic extensions	Medial extensions visible in some scans
8	**Vascular structures**	Variable course	Includes submental, mental, inferior labial, and labiomental arteries; multiple anastomoses







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