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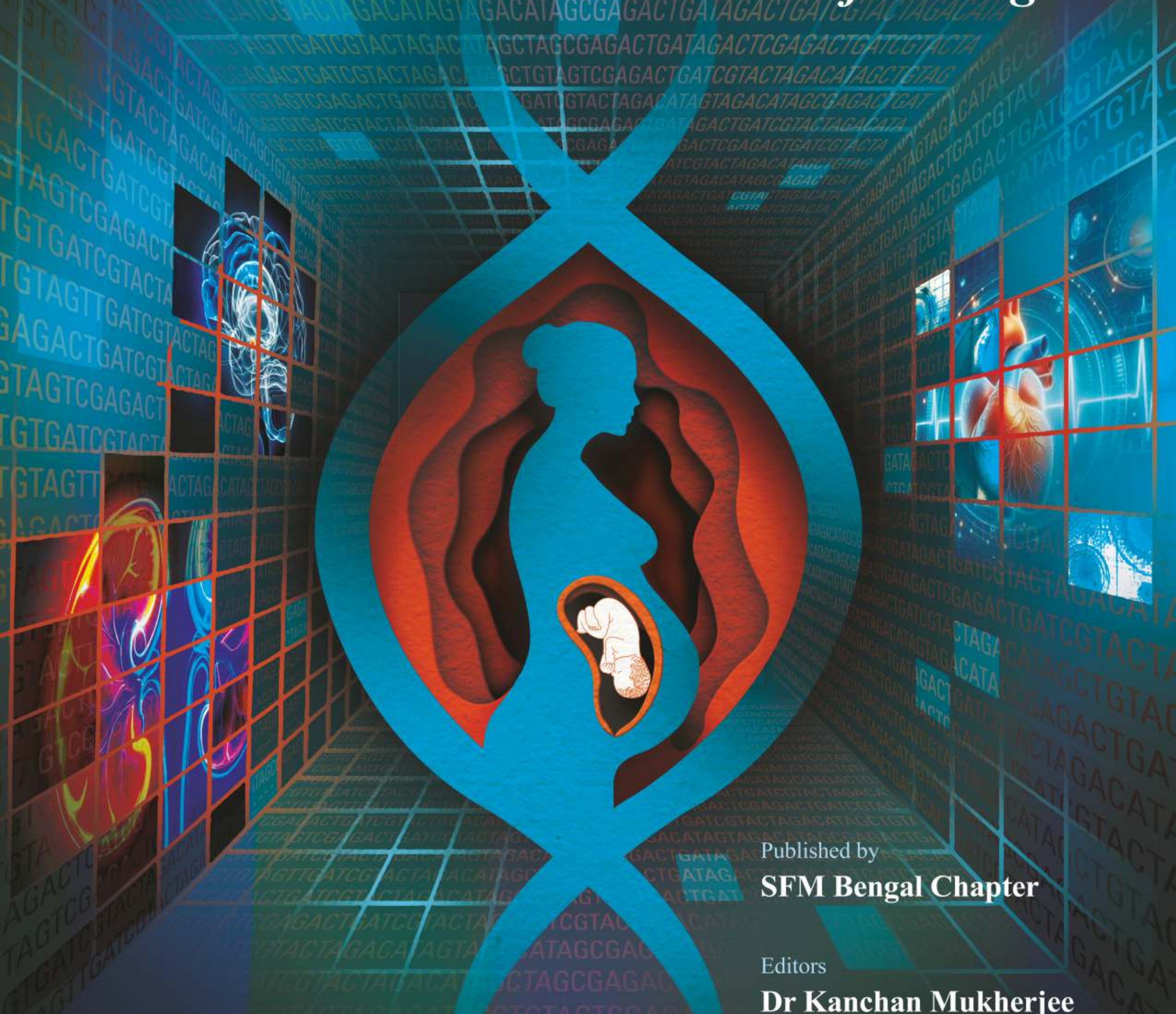
Society of
Fetal Medicine
Bengal Chronicles

SonoSutra

The Seduction of Settings



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INDEX

Happy Setting
Happy Imaging

Dear Friends,

Welcome back! After the resounding success of our earlier newsletter Womb Wise Web, released in February 2025, the Society of Fetal Medicine, Bengal Chapter is back again with yet another one. This time we are 'Back to Basics', and this edition of our newsletter takes you through the essentials of ultrasound—from Physics to Pathology. Here, we revisit the fundamentals not as a refresher but as a framework to reflect on evolving standards, technologies, and clinical applications.

Aptly named Sono Sutra, this newsletter serves as a complete guide to obstetric scanning—starting from buying the right machine, traversing through all the three trimesters, touching on challenging aspects of scanning women with high BMI, and finally ending with a troubleshooting guide.

We are indeed fortunate and privileged to have valuable contributions from experts across our country this time, and we would like to thank each one of them and appreciate the efforts taken for this, despite their busy schedules.

We are immensely grateful to our Mentor Emeritus, Professor Ashok Khurana, and our National President, Dr. Mohit Shah, for giving us this opportunity to come up with this newsletter and especially have it released at our National Conference FETAL BASICON New Delhi.

A big thanks to Dr. Kanchan Mukherjee and Dr. Shankar Dey for editing the entire newsletter and presenting it in such a wonderful way. A special mention to Dr. Krishna Gopal for his generous contribution to this issue. Whether you are a seasoned practitioner or in training, revisiting the basics will ensure sharper insight and better care in an ever-advancing field of Fetal Medicine.

So friends, stay informed, stay updated, but do remain grounded in the fundamentals of Obstetric Ultrasound.

Happy Reading and Happy Relearning!
Long Live SFM
Jai Hind

Dr Seetha Ramamurthy Pal
President, Society of Fetal Medicine, Bengal Chapter

Foreword

Dear Friends,

It is with great pleasure that I present yet another edition of our newsletter from the Bengal Chapter of SFM. They have always come up with innovative ideas and themes that resonate with issues pertaining to daily clinical practice. This issue is dedicated to one of the most critical and yet underdiscussed aspects of obstetric imaging: the optimization of machine settings across the full gestational spectrum—from the earliest detectable signs of pregnancy at 5 weeks to the intricate Doppler assessments required at term.

Ultrasound technology has become the cornerstone of modern prenatal care. Yet, the effectiveness of this tool lies not only in the sophistication of the equipment but in the sonologist's understanding of how to tailor its settings to the developmental stage of the fetus. From the low-frequency transducers ideal for deeper penetration in high BMI patients, to the precise machine adjustments needed in the second trimester for a detailed fetal echocardiography as well as neurosonography. After all, every patient is different. Hence, settings need to be fine-tuned to enhance both image clarity and diagnostic accuracy.So, every stage of pregnancy demands a nuanced approach.

This issue bridges the gap between technical knowledge and clinical application. It provides a systematic guide to fine-tuning parameters such as gain, depth, focal zones, frequency selection, and Doppler indices—each discussed in the context of fetal size, position, and diagnostic goals.

Whether you are a seasoned ultrasound expert or a trainee seeking to build a solid foundation in prenatal ultrasound, this journal issue offers a rich blend of practical guidance.It is our hope that these contributions will help refine your daily practice and ultimately improve outcomes for mothers and their unborn children.

I once again thank TEAM BENGAL for envisioning the relevance of this topic and making this newsletter happen.

Dr Mohit Shah
President Society of Fetal Medicine

How to Purchase an Ultrasound Machine

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Purchasing an ultrasound machine is a significant and long-term investment for any healthcare practitioner or facility. A careful evaluation of technical features, ergonomics, price range, probe types, and service support is essential. This article outlines the key factors one must consider before purchasing an ultrasound machine, enabling informed decision-making tailored to clinical needs and budget

Introduction

Purchasing an ultrasound machine is a costly and multi-year investment. Therefore, before making a decision, it is necessary to be well-versed with the various technical aspects involved.

Types of Ultrasound Equipment

1. Basic Entry-Level Machines:
Suitable for beginners, offering basic imaging capabilities.
2. Mid-Range Shared Services Machines:
These enable the operator to perform abdomen, Ob-Gyn, small parts, and cardiac work on the same equipment with acceptable image quality. Many come with optional 3D/4D capabilities.
3. High-End Machines:
These are focused on a specific area such as general radiology, obstetrics-gynecology, or cardiac imaging. Although costly, they provide a very high level of image quality and greater diagnostic confidence.
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Price Ranges

Price is a very important aspect of the purchase decision. It depends on several technical features such as hardware configuration, software capabilities, types and number of probes, warranty period, etc.

As a general rule, one should purchase the costliest machine one can afford, as higher cost typically correlates with better diagnostic quality. Entry-level ultrasound machines start from 8–10 lakhs, while cutting-edge equipment can go up to 2.0 crore.

Ergonomics

Ergonomics is critical, as ultrasound operators typically work 6 to 8 hours daily. Poorly designed equipment significantly increases the risk of repetitive stress injuries.
• A full HD monitor with adequate brightness is essential for brightly lit rooms.
• The monitor should be height-adjustable, tiltable, and rotatable.
• Machines may have between 2 to 5 probe connectors; more connectors provide greater convenience.
• Prefer machines with higher-positioned connectors to avoid bending, which becomes more difficult with age.
• The keyboard should be adjustable and rotatable.
• Mid and high-end machines often come with touch screens, which reduce keystrokes and simplify software access.

Probe Choice

Different probes serve different clinical purposes:
• Convex and Microconvex Probes: Used for abdominal, Ob-Gyn, and cardiac scans.
• Linear Probes: Used for superficial parts. These range in frequency from 9 MHz to 20 MHz. Linear probe width varies from 15 mm (for musculoskeletal and ophthalmic use) to 50 mm (for breast, testis, thyroid, and other small parts).

Some machines offer compound imaging, converting a linear box-shaped image to a wider trapezoidal view—helpful for covering more area at deeper penetration.
Probe Element count:
• Simple probes: 48–128 elements (adequate for general use)
• High-density probes: 192 elements (better resolution)
• Single crystal probes offer better bandwidth and resolution.
• Matrix probes (900–8400 elements) provide superior spatial resolution and detail.
• 3D/4D matrix probes with in-built beamformers reduce acquisition time to 2 seconds (compared to 8 seconds in conventional probes).

3D/4D and Cutting-Edge Technology

Electronic 4D matrix probes—an advanced technological innovation—are currently offered by only one manufacturer. Other high-end features may be available across multiple brands, but their performance can vary.

Do not rely solely on trade brochures. Always request equipment demos and, if possible, attend CME/training programs to observe real-time performance.

Warranty

Most ultrasound machines come with a 1-year warranty, which is usually comprehensive. Some manufacturers offer 2-, 3-, or even 5-year warranties.

- Always read the warranty conditions carefully.
- Avoid mixing warranty and annual service contracts.
- Warranty should be comprehensive—covering any extent of damage and unlimited faulty probe replacements—unlike service contracts that carry limitations.
- Ensure the warranty is documented on the selling company's letterhead, not the dealer's. A manufacturer is not legally bound to honor terms stated only on the dealer's letterhead.

Service Center Location

Prefer equipment whose service center is located in your city or nearby. This ensures faster handling of breakdowns and minimizes downtime.

Conclusion

Buying an ultrasound machine requires a thoughtful and well-researched approach. From evaluating machine types and ergonomic design to assessing probe variety, warranty coverage, and service logistics—every aspect plays a crucial role. A demo-based, hands-on evaluation supported by real-time observation can help make a confident, cost-effective, and clinically sound purchase decision.

Dive Deeper

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Ultrasound Machine Settings for Early Pregnancy Scans (5–10 Weeks of Gestation): A Detailed Review

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1. Introduction

Ultrasound is the imaging modality of choice for assessing early pregnancy due to its non-invasive nature, real-time imaging capabilities, and safety profile. During the first trimester, especially between 5 and 10 weeks of gestation, ultrasound plays a critical role in confirming intrauterine pregnancy, determining viability, assessing gestational age, and identifying complications such as ectopic pregnancy or early pregnancy loss.

To optimize image quality and diagnostic accuracy, appropriate ultrasound machine settings are essential. This review outlines the general principles of ultrasound imaging and then delves into the specific settings used during early pregnancy scans, providing both theoretical insights and practical guidelines.

2. Basics of Ultrasound Imaging

Ultrasound imaging relies on high-frequency sound waves, typically in the range of 2–18 MHz, which are transmitted into the body via a transducer. These waves are reflected back from tissue interfaces and are then processed into visual images.

Frequency Selection:

- High-frequency probes (e.g., 7.5–10 MHz): Offer better resolution but limited penetration.

- Low-frequency probes (e.g., 3.5–5 MHz): Allow deeper penetration but lower resolution.

In early pregnancy, since the uterus is still within the pelvis, high-frequency transvaginal probes (usually 5–9 MHz) are preferred to capture fine anatomical details.

Modes of Imaging:

- B-mode (Brightness mode): The primary imaging mode used for fetal and maternal anatomical assessment.

- M-mode (Motion mode): Used for assessing fetal heart rate by capturing motion over time.

- Color Doppler and Spectral Doppler: Help assess blood flow; used cautiously in early pregnancy due to thermal concerns.

3. Importance of Proper Machine Settings in Early Pregnancy Scans

Correct machine settings are critical to obtain high-quality images that allow accurate diagnosis without compromising safety. Poor optimization can lead to:
- Missed diagnosis (e.g., anembryonic pregnancy)
- Unclear fetal cardiac activity
- Difficulty confirming intrauterine location

Between 5 and 10 weeks, the structures visualized are small and sensitive to gain, focus, and depth adjustments. Therefore, a tailored approach is essential.

4. Transducer Selection and Positioning

Transvaginal vs Transabdominal Approach:
- Transvaginal ultrasound (TVS):
  - Preferred method at 5 to 8 weeks.
  - Frequency: 5–9 Mhz.
  - Provides higher resolution for embryonic and adnexal structures.
- Transabdominal ultrasound (TAS):
  - Becomes more useful after 8–9 weeks when the uterus ascends from the pelvis.
  - Frequency: 3.5–5 MHz.

Clinical Tip: Start with TAS if the bladder is adequately full; switch to TVS for better resolution if needed.

5. Detailed Ultrasound Machine Settings (5–10 Weeks Gestation)

For transabdominal Viability scans the best choice would be High Frequency Convex probes (C2-9, RM7C or EM6C). For transvaginal Viability scans the recommended probe choice would be again the high frequency ones (RIC10, RIC6-12 or RIC5-9). Moreover for Viability scans we must have very precise and dedicated settings in our system. Explained below are some necessary settings:

• Scan Angle- we must have a smaller scan angle within 35-45 Degree for maintaining a high frame rate (TAS) and 75-95 degrees (TVS)
• Depth – Proper depth adjustments must be done while scanning for getting the pure waves in ROI
• Zoom – We must use HD Zoom (Box Zoom) for enhancing the frame rate and resolution
• Dynamic Contrast – A high dynamic contrast around 8-9 for enhancing the contrast resolution and better visualisation of edges
• Line Density – High Line Density offers better spatial and temporal resolution.
• Frequency – Frequency must be selected at highest level with Tissue Harmonics (HI – High) for getting the best resolution output
• Speckle Reduction (SRI) – High speckle filters reduce unwanted signals as much as possible, set it at around 4 or 5
• Tint Maps – Tint Maps like Sepia and Soft Sepia may enhance the contrast resolution and giving more definition to the edges

These are the main settings for enhancing the 2D output for Viability scan.

For Colour settings we must use HD Flow (Bidirectional Power Doppler) at a low PRF scale (around 1.3) so that we can plot the flow with high sensitivity as well as better flow quantification.

Slow Flow HD is also a great option as it can automatically calculate the PRF and reduce artifacts which generally comes at lower values of PRF and gives us excellent colour sensitivity and smooth pickup.

6. Safety Considerations (Thermal and Mechanical Index)

Thermal Index (TI):

- Indicates tissue heating risk.
- Recommended TI: <0.7

Mechanical Index (MI):

- Indicates non-thermal effects.
- Recommended MI: <1.0 (ideal 0.3–0.7)

ALARA Principle: As Low As Reasonably Achievable — minimize exposure and avoid unnecessary Doppler use.

7. Measurement Guidelines and Clinical Parameters

Structure	Gestational age	Optimal measurement	Expected value
Gestational sac	4.5 – 5 weeks	Mean sac diameter	Grows 1mm/day
Yolk sac	5.5 weeks	Inner diameter	<6 mm
Embryo (CRL)	6 weeks	Crown rump length	1 – 10 mm (5-10 weeks)
Cardiac activity	5.5 – 6 weeks	M mode FHR	90 – 160 bpm

CRL is the most accurate dating method in the first trimester with ±3–5 days accuracy.

8. Role of Doppler in Early Pregnancy

Doppler should be used sparingly due to potential thermal effects.

When to Use:

- Suspected ectopic pregnancy
- Subchorionic hematoma evaluation
- Corpus luteum assessment

Settings Tips:

- Low PRF for low-velocity flows.
- Maintain TI and MI below safety limits.
- Prefer colour over spectral Doppler.

9. Image Documentation and Optimization Tips

Best Practices:

- Document 3 orthogonal planes.
- Include labelled caliper measurements.
- Save cine loops for motion analysis.
- Use M-mode for fetal heart rate.

Image Quality Indicators:

- Double decidual sign
- Defined yolk sac and fetal pole
- Visible cardiac flicker by 6.5 weeks

10. Troubleshooting Common Issues

Issue	Cause	Adjustment
Blurry image	Wrong focus/depth	Adjust depth/focus
No embryo at 6 weeks	Too early/misdated	Rescan in 7 days
Low cardiac flicker	Low frame rate	Increase frame rate
Artifacts	Gas/high gain	Adjust gain, reposition

11. Conclusion

Ultrasound evaluation between 5 and 10 weeks of gestation is a critical step in early pregnancy assessment. High-resolution imaging, achieved through careful adjustment of machine settings—including gain, depth, focus, dynamic range, and frame rate ensures accurate visualization and diagnosis. Safety parameters such as TI and MI should always be considered, and Doppler use should remain limited unless clinically justified.
By optimizing these technical parameters and adhering to safety guidelines, clinicians can ensure both high diagnostic accuracy and safe imaging practices during the most vulnerable stages of pregnancy.

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Dive Deeper

SOCIETY OF FETAL MEDICINE

Optimizing Ultrasound Machine Settings for Comprehensive Assessments at 11–14 Weeks Gestation

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The 11–14 weeks gestational period is pivotal for early fetal assessment, offering opportunities to evaluate fetal anatomy, detect anomalies, and perform aneuploidy screening. Achieving high-quality imaging during this time-window necessitates precise optimization of ultrasound machine settings. This article provides a glimpse into configuring settings for two common ultrasound systems-GE Voluson, and Samsung-to enhance the evaluation of Crown-Rump Length (CRL), Nuchal Translucency (NT), Ductus Venosus flow, Tricuspid Valve flow, and early fetal anatomy.

General Considerations for 11–14 Weeks Ultrasound Scans

Before delving into machine-specific settings, it's essential to consider general factors that influence image quality:

• Transducer Selection: Utilize a high-frequency transducer (5–9 MHz) for superior resolution

• Patient Preparation: Ensure the patient has a comfortably full bladder to optimize the acoustic window

• Operator Experience: Proficiency in early gestation scanning techniques is crucial for accurate assessments

Factors contributing to suboptimal imaging in High BMI pregnant women

Sonographic visualization of fetal structures is degraded by depth of the body fat layer, with resultant increased depth of insonation, absorption of energy by the adipose tissue, and higher back-scatter from refraction. Over 50% of fetal anatomic surveys in women with obesity cannot be completed during the first ultrasound examination. Studies of Mid trimester ultrasound scans have shown that as BMI increases, there is a steady degradation in scan quality, and rates of poor visualization of fetal heart and spine, which correlate linearly with the degree of obesity. One study found that if a repeat ultrasound is performed at 21 weeks, then visualization of the heart improved; however, in 20% of exams, the fetal heart could not be adequately assessed despite several attempts

Machine-Specific Settings

The following tables outline recommended settings for GE Voluson, and Samsung ultrasound systems. These settings serve as starting points and may require adjustments based on patient-specific factors and operator preferences.

Table 1 : GE Voluson Series Settings

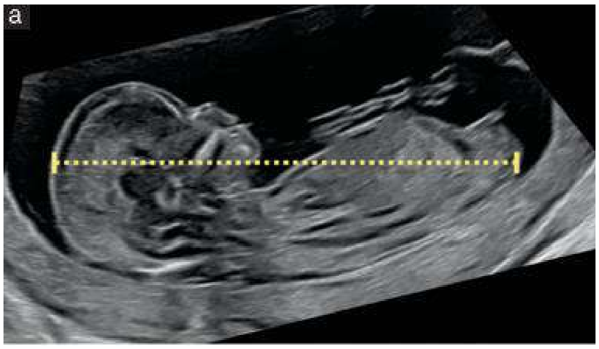
Assessment Area	Preset/Mode	Frequency (MHz)	Gain (%)	Dynamic Range (dB) Comments
CRL Measurement	Obstetric General	7–9	50–60	65–75 Ensure a mid-sagittal plane for accuracy
Nuchal Translucency	Obstetric NT	7–9	50–60	Calipers should be placed inner-to-inner
Ductus Venosus Flow	Obstetric Doppler	5–7	60–70	50–60 Use color Doppler to locate the vessel
Tricuspid Valve Flow	Cardiac Doppler	5–7	60–70	Align Doppler beam parallel to blood flow
Early Anatomy Scan	Obstetric Detailed	7–9	50–60	65–75 Systematic approach to assess all structures

Table 2 : Samsung Ultrasound Systems Settings

Assessment Area	Preset/Mode	Frequency (MHz)	Gain (%)	Dynamic Range (dB) Comments
CRL Measurement	OB Early Trimester	7–9	50–60	95-115 Ensure clear visualization of fetal pole
Nuchal Translucency	NT	7–9	50–60	95-115 Measure at the widest NT space
Ductus Venosus Flow	Fetal Doppler	5–7	60–70	115-125 Identify aliasing to locate the ductus venosus
Tricuspid Valve Flow	Cardiac Doppler	5–7	60–70	90-105 Sample volume just below the valve leaflets
Early Anatomy Scan	Detailed Fetal	7–9	50–60	90-115 Sequential assessment of organ systems

Detailed Assessment Techniques

• **Crown-Rump Length (CRL):** Measure CRL in a true mid-sagittal plane with the fetus in a neutral position. This measurement is crucial for accurate gestational dating

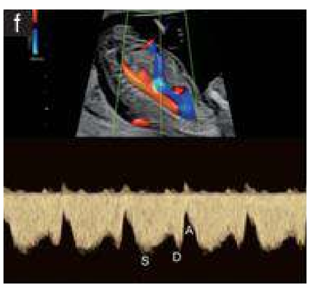


Protocol for measurement

• **Gestational age:** Must be between 11 to 13 weeks + 6 days
• **Crown-rump length (CRL):** Should be between 45–84 mm
• **Image magnification:** Fetal head and thorax should fill the entire screen
• **Mid-sagittal view:**
-Visible: echogenic nasal tip, rectangular palate, translucent diencephalon, nuchal membrane
-Not visible: maxilla (if not midline)

- **Fetal position:** Head aligned with spine (neutral)
  - Hyperextension: May falsely increase measurement
  - Flexion: May falsely decrease measurement
- **Amnion vs skin:** Ensure clear distinction
- **Measurement site:** Widest part of the translucency
- **Calliper placement:**
  - Inner border on the nuchal translucency line
  - Crossbar should blend with white line, not enter nuchal fluid
- **Image gain:** Reduce gain when zooming to avoid underestimation
- **Repetition:** Take multiple measurements; record the maximum valid one
- **Umbilical cord around neck (5% cases):**
  - May falsely increase NT
  - Measure NT **above and below** the cord
  - Use the **average** for risk calculation
- **Nuchal Translucency (NT):** Ensure the fetus occupies at least 75% of the image. Place calipers correctly at the maximum lucency, measuring inner-to-inner edges.

- **Ductus Venosus Flow:** Use color Doppler to identify the ductus venosus. Place the sample volume at the isthmic portion to obtain the characteristic triphasic waveform



Protocol for measurement:

- Gestational age: 11 to 13 weeks + 6 days
- Image magnification: Fetal thorax should occupy most of the screen
- View: Apical four-chamber view of the fetal heart
- Doppler settings:
  - Sample volume: 2.0–3.0 mm
  - Positioned across the tricuspid valve
  - **Angle of insonation:** < 30° to the interventricular septum
- Tricuspid regurgitation diagnosis:
  - Present during at least half of systole
  - Velocity > 60 cm/s (to distinguish from normal arterial flow)
- Sweep speed: High (2–3 cm/s) for clear waveform display
- **Valve interrogation:**
  - Sample volume should be placed at least three times across the valve
  - Ensures complete assessment of all three cusps of the tricuspid valve
- **Early Anatomy Scan:** Perform a systematic evaluation of the fetal anatomy, including the brain, face, spine, heart, abdomen, and limbs. Utilize both grayscale and color Doppler imaging as needed.

Conclusion:

Optimizing ultrasound machine settings at 11–14 weeks gestation fundamental in achieving accurate, high-resolution images that supports early diagnosis and informed clinical decision-making. From precise CRL measurements to subtle Doppler evaluations of the ductus venosus and tricuspid valve, each parameter demands meticulous attention to machine configurations, patient positioning, and operator technique. While this article offers tailored guidance for GE Voluson and Samsung platforms, the core principles of early fetal assessment remain universally applicable: clarity, consistency, and clinical relevance. By standardizing protocols and refining imaging practices, fetal medicine practitioners can enhance the quality and reliability of early pregnancy scans—paving the way for timely interventions and better perinatal outcomes.

Courtesy - ISUOG Practice Guidelines (updated): performance of 11–14-week ultrasound scan for the images

Dive Deeper

SOCIETY OF FETAL MEDICINE

Machine Settings For Anomaly Scan

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SOCIETY OF FETAL MEDICINE

Anomaly scan is a critical mid-trimester ultrasound examination. High-quality imaging is fundamental to its diagnostic accuracy, and this is largely dependent on optimal ultrasound machine settings. This article outlines the essential principles of ultrasound physics and "knobology" relevant to anomaly scans. It addresses key factors influencing image quality—such as attenuation, resolution and noise and offers practical strategies for optimizing each. Techniques such as probe selection, field of view adjustment, gain and dynamic range control, harmonic and compound imaging, and speckle reduction are explored in depth. The role of post-processing, presets, and auto-optimization features in modern ultrasound systems is also discussed. A structured workflow is provided for efficient and consistent image acquisition. By mastering these operators can significantly enhance diagnostic performance, especially in challenging scenarios such as maternal obesity or suboptimal fetal positioning.

INTRODUCTION

Anomaly scan—also called a mid-trimester or Level II scan—is usually performed between 18 and 22 weeks of gestation to evaluate fetal anatomy and detect structural abnormalities. Good imaging is essential for a comprehensive evaluation and accurate diagnosis. Achieving high-quality ultrasound images depends on optimal machine settings, which help visualize anatomical structures and any pathology with clarity and resolution.

A BALANCING ACT

Image clarity in ultrasound is influenced by three main factors: **attenuation, resolution (including axial, lateral, temporal, and contrast), and noise** (Fig. 1). External factors—such as maternal BMI, abdominal wall characteristics, fetal position, and the amount of amniotic fluid—also play a significant role. Achieving optimal image quality requires careful adjustment of machine settings. This balancing act depends on a basic understanding of ultrasound physics and familiarity with the system's controls, commonly referred to as knobology. Importantly, optimizing the grayscale (B-mode) image enhances the quality of other imaging modes, including color Doppler, M-mode, and 3D/4D imaging.

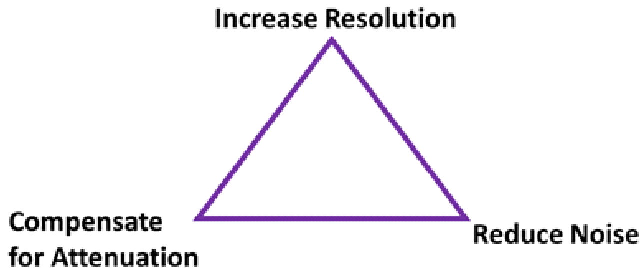

Fig1. The three Cornerstones of acquiring a good image

COMBATING ATTENUATION

Attenuation is a gradual loss of the strength of the ultrasound beam due to reflection, absorption and scattering as it travels through tissues. This can degrade overall image quality, especially in deeper tissues. Few techniques can be used to minimize attenuation while acquiring an ultrasound image. The general principle is to position the target area as close to the probe as possible (Fig. 2).

Utilizing thinner areas of the maternal abdominal wall- such as the suprapubic region, umbilicus, and flanks—can provide better acoustic windows. This is especially important in patients with a high body mass index (BMI), where increased tissue depth can degrade image quality.

Applying gentle pressure with the probe can help bring the fetal part being examined closer to the transducer. This reduces the distance the ultrasound beam must travel, thereby lowering attenuation and enhancing image quality.
High-quality imaging often requires examining the fetus from multiple angles.

Adjusting the angle of the ultrasound beam can help obtain clearer views and minimize artifacts, such as shadowing caused by fetal bones.

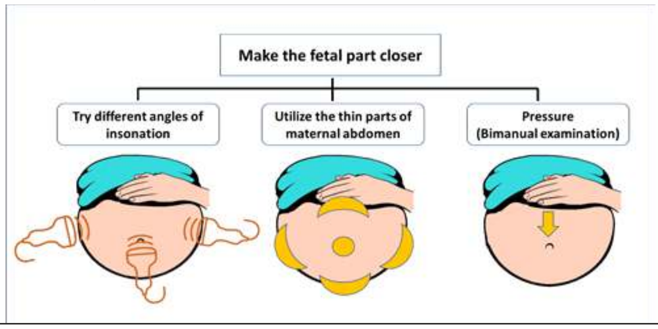

Fig. 2: Methods for combating attenuation

IMPROVING AXIAL RESOLUTION: PROBE SELECTION

The transducer frequency is the main determinant of the axial resolution of the image. Higher frequency probes (5-12 MHz) offer superior resolution. However, as the frequency increases, more attenuation is experienced, which degrades the image quality. Lower frequencies (2-5 MHz) provide greater penetration for visualizing deeper structures but compromise resolution.

Tip: A high-frequency probe should be used whenever possible for second-trimester obstetric scans to ensure better resolution. In patients with a high BMI, a low-frequency probe may be necessary to achieve adequate penetration.

IMPROVING LATERAL RESOLUTION: OPTIMIZING THE FIELD OF VIEW (FOV)

Ultrasound image generation relies on reflected echoes from tissues, which are processed and displayed as pixels in varying shades of gray. This processing occurs along individual lines of data called scan lines. Multiple scan lines are combined to form a single 2D image, or frame. When these frames are displayed in rapid succession, measured as the frame rate (frames per second), they create real-time ultrasound imaging. Scan line density, along with the width of the ultrasound beam, determines the lateral resolution.

The ultrasound system can process and display only a limited number of scan lines per frame, due to constraints in time, processing power, and frame rate. When the field of view is wide, these scan lines are spread over a larger area. This reduces the scan line density, which in turn lowers lateral resolution.

Sector width adjustment is used to modify the width of the image when using a sector probe. Reducing the sector width concentrates the scan lines into a smaller area, resulting in improved lateral resolution and frame rate. Adjusting the sector width is particularly important when evaluating moving structures, such as the fetal heart (Fig.3).

Zoom feature allows for magnification of a specific area. **"Write-zoom"** is used during live scanning. It focuses only on the selected area, ignoring echoes outside it. This increases scan line density within the zoomed region, leading to better resolution. **"Read-zoom"** involves digitally magnifying the pixels in a frozen image, which does not enhance image resolution.

Tip: To begin the examination, it is advisable to use a high depth and wide sector settings to obtain an orientation and overall view of the anatomy. Once the structures of interest have been identified, the depth and sector width should be decreased to minimize the display of irrelevant structures. Whenever possible, utilize write-zoom to avoid compromising image resolution.

IMPROVING TEMPORAL RESOLUTION

Temporal resolution- how well the system can display moving structures over time- is especially important in fetal heart imaging. Optimizing the FOV by reducing sector width and zoom greatly improves the temporal resolution.

Depth adjustment allows for vertical sizing of the imaging window, enabling visualization of structures at different depths within the body. Altering this setting helps in examining superficial or deeper organs as required. Decreasing depth allows faster image acquisition and a higher frame rate, as echo signals return more quickly from superficial structures, with less beam attenuation and fewer noise artifacts (Fig. 3).

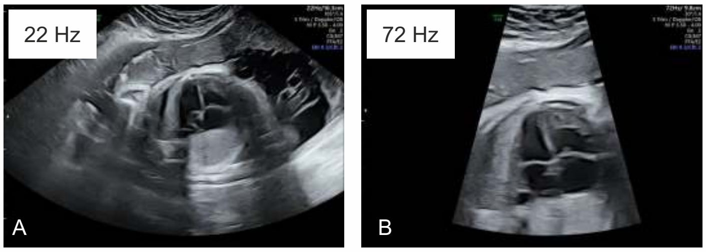

Fig. 3: Effect of adjusting depth and sector width on frame rate
A) Image with high depth and wide sector width showing a low frame rate.
B) Adjusting depth and sector width improves the frame rate.

IMPROVING CONTRAST RESOLUTION

Contrast resolution is essential to distinguish between tissues with different echogenicities. This essentially means adjusting the brightness and contrast of an image.

Overall gain controls the brightness of the ultrasound image by adjusting the strength of returning echo signals. Increasing gain amplifies weak echoes, making more structures visible and potentially improving contrast resolution. However, too much gain can make the image overly bright and washed-out. Decreasing gain reduces brightness from strong echoes, but if set too low, it can make the image too dark, hiding important details.

Time Gain Compensation (TGC) adjusts gain at specific depths to offset sound wave attenuation in deeper tissues, allowing for uniform image brightness.

Tip: Adjust the gain so that normally anechoic structures, like the urinary bladder or gallbladder, appear echo-free without internal noise.

Dynamic range controls the image contrast. It refers to the number of gray shades assigned for displaying the various echo intensities. **A wider dynamic range** provides more subtle gradations of gray, allowing better differentiation between tissues with near similar echogenicity. In contrast, **A narrower dynamic range** increases the difference between light and dark areas, which can improve edge definition but may obscure subtle tissue variations.

Tip: A wider dynamic range is recommended when analysing fetal soft tissues, while a lower dynamic range can be useful when emphasizing anatomical boundaries, such as in fetal heart.

Tissue Harmonic Imaging (THI) uses advanced signal processing to isolate harmonics, which are frequencies generated by tissues at twice the transmitted frequency. This produces images with better resolution, deeper penetration, and reduced noise- especially useful for visualizing near-field or deep structures.

Tip: Keep THI enabled for optimal fetal imaging. However, it may be turned off when assessing fetal bones, as it can smooth out important details.

Compound Imaging combines ultrasound beams from multiple angles or frequencies—unlike traditional ultrasound, which uses a single straight-line beam—to create an image. This enhances image clarity, sharpens edge definition, and reduces artifacts such as speckle noise.

Tip: While compound imaging enhances image quality, it can overly smooth images and may obscure shadowing artifacts.

REDUCING NOISE: POST-PROCESSING

Post-processing techniques play an important role in enhancing the quality and visual perception of ultrasound images. These methods can be applied to both real-time and stored images.

Speckle reduction is a post-processing tool that minimizes graininess caused by noise. This can be achieved through techniques such as **spatial averaging** (blending multiple frames or scan lines), **filtering** to suppress high-frequency noise, and **contrast enhancement**, where brighter areas are emphasized and darker areas are subdued. While these methods can effectively reduce noise, they may also soften the image—potentially decreasing resolution and reducing fine detail.

While the dynamic range defines the total number of gray shades available to represent ultrasound signals, gray map controls the brightness or darkness of each gray tone on screen. Adjusting the **gray map** can either enhance or reduce the perceived image contrast.

In some cases, the grayscale can be replaced with **chromatic (color) maps**. Since the human eye perceives color with greater detail than black and white, applying color maps can improve image contrast and make the image more visually engaging. However, the use of color is highly subjective and varies based on individual preference.

ORGANIZING THE MACHINE SETTINGS

Ultrasound machines allow imaging parameters—such as transducer frequency, depth, gain, TGC, focal zones, and processing settings-to be saved as presets. These presets provide efficient, standardized starting points tailored to specific anatomical regions or clinical needs, helping operators quickly achieve high-quality images.

Many modern systems also offer **auto-optimization**, which uses real-time algorithms to automatically adjust settings for optimal image quality at the touch of a button. While this feature streamlines workflow and provides a solid baseline, **manual fine-tuning** may still be needed for specific cases.

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TYPICAL WORKFLOW

Select the Ultrasound Probe

• Choose a high- or low-frequency probe based on maternal BMI (higher frequency for better resolution in lean patients; lower frequency for better penetration in higher BMI cases).

Choose the Appropriate Preset

• Use presets tailored to the clinical focus, such as fetal anatomy or fetal heart, for efficient and consistent image optimization.

Enable Harmonic Imaging

• Harmonics should always be turned on to enhance image clarity and reduce artifacts.

Adjust Image Settings

• Fine-tune gain, TGC, and dynamic range.
• Use optimal contrast for fetal body imaging.
• Apply high contrast for fetal heart evaluation.

Set Depth and Sector Width

• Start with greater depth and wide sector width for an initial survey.
• Then reduce depth, narrow the sector, and use zoom for detailed views.
• For cardiac imaging, minimize the field of view (FOV) to improve temporal resolution.

Further tweaks

• Adjust contrast further by selecting an appropriate gray map or chromatic (color) map, based on examiner preference.
• Use Speckle reduction for a smoother image.

CONCLUSION

Optimizing ultrasound images is key to accurate diagnosis and improved patient care. By effectively using machine controls and techniques, practitioners can enhance image clarity and resolution (Fig. 4). Tailoring settings to clinical needs, patient factors, and operator skill is essential. Ongoing training and keeping up with technological advances ensure the best use of ultrasound's diagnostic potential.

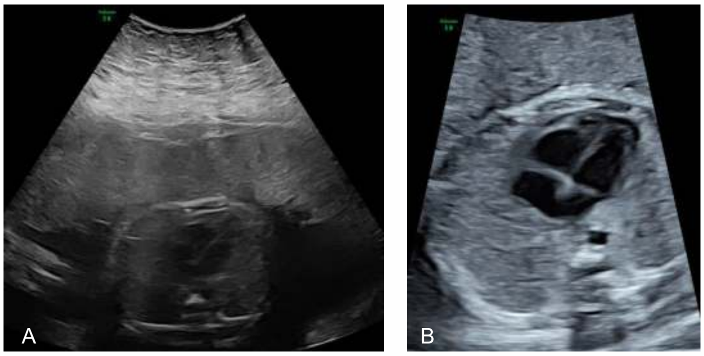

Fig. 4: A) Poor image quality due to attenuation caused by high BMI. B) Optimized image after scanning through the maternal navel to compensate for attenuation, reducing depth and sector width, increasing dynamic contrast, applying speckle reduction, and using a different chromatic map

Dive Deeper
SOCIETY OF FETAL MEDICINE

Optimizing Ultrasound Machine Settings for Fetal Echocardiography

(Enhancing diagnostic accuracy and optimize perinatal outcome)

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Why?

Fetal echocardiography is a cornerstone in prenatal diagnosis of congenital heart disease.

Accurate imaging hinges not only on operator expertise but also on meticulous optimization of machine settings.

Default machine presets for cardiac examination available in all machines, however may not be suitable for all fetuses in all circumstances and hence fine tuning is required to enhance the diagnostic accuracy. (This is akin to a dish cooked by using a standard recipe; may or may not be tasty due to your personal preferences! By altering the ingredient proportion, you would be able to create a wonderful dish. This is only possible if you have understood the ingredients very well) A sound knowledge of principles of ultrasound physics and knobology is essential to achieve the desired effect.

How?

General measures

Applicable to any fetal medicine examination!

1) Choosing the right transducer.

High frequency probes offer a great resolution but at the bargain of depth of penetration.

Preferred: high resolution probe, switch over to low resolution in high BMI

Transvaginal scan (TV probes of 5 to 12 MHz frequency) in first trimester.

2) Finding an acoustic window

Suprapubic, Pfannenstiel region in obese patients is a saviour. Lateral decubitus, sitting up position, asking the mother to cough, eat chocolate, walk around may be necessary.

Tip: in extremely obese patients, using a TV probe to insonate through umbilicus might save your day!

3) Basic image optimization steps

Adjust scan-angle, gain, focus, depth and zoom to display only area of interest.

Specific to fetal echo

1) High frame rate

Frame rate = the number of images (frames) the machine displays per second (fps) 50 Hz or more is desirable!
This is essential to image fast moving fetal heart structures.
Tip: Higher the frame rates higher the information!

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How to increase frame rate

Factor	Mechanism	Practical Tip
Reduce Depth	Less depth ➔ less time needed to send and receive echoes ➔ faster refresh	Set depth to just beyond the fetal heart
Narrow Sector Width	Smaller image width ➔ fewer scan lines needed ➔ faster frame refresh	Narrow the imaging sector to focus only on the heart
Lower Line Density	Fewer scan lines per frame ➔ faster acquisition	Moderate line density if frame rate is critically low
Decrease Persistence	Less frame averaging ➔ more real-time display	Set persistence to Low during dynamic studies
Use Single Focus Point	Multiple focus zones slow down frame rate ➔ use a single focus at the fetal heart level	Focus cursor at mid-heart
Reduce Harmonic Imaging Settings	Tissue harmonics reduce penetration and slow frame rate slightly	Use harmonics wisely; turning it off improves speed
Minimize Use of Color Doppler Box Size	Smaller color box ➔ faster frame rate	Use the smallest color box over valves or vessels only

2) High contrast imaging

High contrast helps to differentiate boundaries between different tissues such as myocardium and lumen.

How to increase contrast: By adjusting the Dynamic Range.

Dynamic range: refers to the range between the smallest and largest echo signals that the system can detect and display. It controls how many shades of gray are used to represent differences in tissue echogenicity.

• Wide (high) dynamic range = More shades of gray → softer, more gradual image.

(preferred in fetal CNS examination)

• Narrow (low) dynamic range = Fewer shades of gray → higher contrast, sharper image.

(preferred in fetal cardiac examination)

Some machines use Dynamic contrast instead of dynamic range !

Beware: Dynamic range and Dynamic contrast = inversely related

(GE voluson: it ranges from 0 to 12)

Preferred: more than 8

3) Image enhancing modalities

a) SRI = Speckle reduction Imaging

Is post processing algorithm that provides significant reduction in "speckle".

It maintains important anatomical detail (e.g., valve leaflets, septal margins) while smoothing out non-informative "salt-and-pepper" texture.

SRI usually adjustable in steps (e.g., SRI 1 to 5):
- Lower SRI (1–2): Preserves natural image texture
- Higher SRI (4–5): More aggressive noise suppression but may blur fine details if overused

(Preferred SRI 2 to 3; higher levels could falsely create defects by masking low level signals also reduce frame rate)

b) CRI = (Cross X Beam, Spatial Compounding) Contrast Resolution Imaging

CRI transmits ultrasound pulses not only perpendicularly but also at oblique angles; which allows for combining multiple frames with different steering angles into a single image; effectively increasing the tissue information gathered.

(Preferred CRI 2 to 3; higher levels may cause over smoothening of image, artefact enhancement and increased processing time and reduced frame rates)

c) CRI filter:

It modifies how the machine displays echo intensities, enhancing real tissue contrast without the graininess associated with simple gain or dynamic range changes. It increases perceived sharpness without significant artifact introduction.

Clinical Relevance in Fetal Echocardiography

Clinical Need	CRI Setting Recommendation
General fetal cardiac survey	**Medium**
Fine valve, septum, or wall analysis	**Medium to High (with caution)**
Rhythm studies (arrhythmias)	**Low to Medium (preserve motion details)**
Complex CHD evaluation (e.g., AVSD, TAPVC)	**Medium to High (emphasize vascular connections and septa)**

Preferred: Medium CRI for most cardiac scans and High CRI cautiously for detailed structural analysis

d) Line filter:

A Line Filter in ultrasound is a spatial smoothing filter that reduces noise by averaging echoes between adjacent scan lines during 2D imaging

Practical Tips:

- Use Low Line Filter to clean the image slightly without sacrificing fine anatomical detail

- Avoid High Line Filter in fetal cardiac imaging:

• High smoothing may blur thin septa (e.g., atrial septum, VSD margins)

• Can mask small lesions (e.g., pulmonary veins, minor valve lesions)

- If very noisy (poor windows, 3rd trimester fetuses), cautiously increase to Medium, but re-check small structures carefully

Clinical Relevance in Fetal Echocardiography

Clinical Need	Line Filter Setting Recommendation
Routine fetal heart survey (4-chamber, outflows)	**Low**
Evaluating fine intracardiac anatomy (e.g., septa, valves)	**Off or Low**
Noisy image due to maternal obesity or high BMI	**Low to Medium**
Very detailed dynamic studies (e.g., valve motion, arrhythmias)	**Off (maximum temporal and spatial resolution)**

Preferred: Low or off. Overusing Line Filter can blur fine cardiac structures

e) Line density: refers to the number of ultrasound scan lines per imaging frame.

It determines how closely spaced the beams are during image acquisition.

Higher Line Density ➔ More scan lines packed into the same sector ➔ Better lateral (side-to-side) resolution.

Lower Line Density ➔ Fewer scan lines ➔ Higher frame rate, but lower spatial resolution.

Clinical Situation	Recommended Line Density
Detailed cardiac structural imaging(valves, septum, walls)	***High Line Density***
General 4 - chamber and outflow tract screening	***Medium Line Density***
Rhythm evaluation, valve motion, or very active fetus	***Medium or Low Line Density (to prioritize frame rate)***

Preferred: High line density

when assessing: Septal defects (VSDs, ASDs) Atrioventricular valve morphology, Pulmonary venous connections, Outflow tracts and arch anatomy

f) Frame filter:

is a temporal smoothing filter that reduces noise and stabilizes the image by blending information across consecutive frames. In simple words: Frame Filter reduces flickering and jitter, producing a smoother, steadier real-time image.

Clinical Context	Frame Filter Recommendation
General fetal cardiac survey (4-chamber, outflows)	**Low**
Fine structural assessment (valves, septa)	**Low to Medium**
Rapid motion analysis (valve opening/closing, arrhythmias)	**Off or Low**
Static structures (slow-moving fetuses, 3rd trimester)	**Medium (only if needed)**

Preferred: Low, High Frame Filter can blur fast motion (like valve dynamics) and mask arrhythmias.

g) Reject

“Reject” as the name suggests, rejects faint echoes, mainly background noise, making the image cleaner by displaying only stronger, more meaningful signals.

Preferred: Low; it would preserve all fine details, Medium; in high BMI

(GE voluson: Reject range from 0 to 255)

h) Gray map:

Gray Map (also called Gray Scale Map) is a predefined curve or function that de termines how different echo intensities are converted into specific shades of gray on the ultrasound screen.

In simple terms: Gray Map controls how "bright" or "dark" an echo of a given strength looks. It adjusts how the ultrasound system visually renders different tissue types and interfaces

Clinical Situation	Recommended Gray Map
Routine fetal cardiac survey- (4 chamber, outflows)	***Gray Map 3 – 4***
Detailed valve and septal anatomy (e.g., VSD, AV valve assessment) *Small structural defects or vascular studies*	***Gray Map 13 –14***

I) Enhance:

Enhance selectively amplifies tissue borders and interfaces, making them appear crisper and more distinct, without significantly affecting internal tissue textures.

Preferred: Medium (2 -3)

Conclusion:

Different machines would have different names for the same function. You need to familiarise and play with them. Settings per se are personal! (Beauty lies in the eyes of beholder!). You customise your settings according to your preference, understanding the physics of ultrasound. Have several premade settings for different examinations to save time. If you are lost, easiest way to find home is going to middle of the range and work your way!

(Please note the attached cheat sheet)

Cheat sheet for Quick reference

General measures

Item	Optimal for cardiac exam	Remarks
Transducer Frequency	Highest transducer frequency possible for visualization	Higher the frequency lowers the penetration
Gain	Optimal gain ; not too bright Ensure walls, septa, and valves are clearly seen without over brightness	Start with moderate gain
Focus	At the level or just below the are of interest	Avoid multiple focal zones, as they reduce frame rate and slows the system
Sector Depth Zoom	Adjust so that heart fills 2/3rd of the screen	Zoom; be kind to your eyes

Specific to cardiac examination

Item	Optimal for cardia	Remarks
Dynamic Contrast	8-9	Higher for better contrast
Harmonic frequency	Mid	Higher would result in reduction in penetration and frame rate
SRI	2-3	Higher levels could falsely create defects
CRI	2-3	Higher levels cause over smoothening
CRI filter	Low	High for detailed structural analysis
Line filter	Low	High can blur the fine cardiac structure
Line Density	Medium	High for septal defects, valves and pulmonary veins
Frame filter	2-3	High could blur fast motion and mask arrythmias
Reject	20	Increase for high BMI
Gray map	3-4	13-14 for valve and septal anatomy
Enhance	2-3	Reduce in low BMI

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Ultrasound Machine Settings for Obstetric Dopplers

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Introduction

Doppler ultrasound is a non-invasive imaging technique that measures the changes in frequency of sound waves reflected off the moving blood cells, allowing assessment of blood flow direction and velocity within the vessels. Obstetric Doppler ultrasound is an essential tool in the surveillance of high-risk pregnancies, providing insights into maternal and fetal hemodynamics. It plays a vital role in diagnosing placental insufficiency, fetal growth restriction (FGR), and other complications like fetal anemia. The effectiveness of these doppler evaluations depends significantly on optimizing ultrasound machine settings, which vary depending on the gestational age and the target vessel. The following sections describe optimal machine settings throughout pregnancy and discuss vessel-specific guidelines for uterine artery, umbilical artery, middle cerebral artery (MCA), ductus venosus, and tricuspid valve flow Doppler studies.

General Doppler Principles and Machine Settings

The primary doppler modalities used in obstetrics include (Fig 1):

- Color Doppler: Visualizes blood flow and aids in localizing vessels.
- Pulsed-Wave (PW) Doppler: Provides velocity waveforms for quantitative analysis.
- Power Doppler: Detects low-velocity flow, less angle-dependent

Fig1: Primary doppler modalities

General Machine Settings:

Pulse Repetition Frequency (PRF): Adjust according to flow velocity of concerned vessel

- Low PRF (0.5–1.5 kHz): Low-velocity flow (e.g. ductus venosus)

- High PRF (2–4 kHz): High-velocity flow (e.g. uterine arteries)

Wall Filter: Set low to detect low-velocity diastolic flow; increase in high-velocity studies to reduce noise

- **Gain:** Adjust to optimize signal-to-noise ratio; over-gain causes spectral broadening

- **Angle Correction:** Maintain insonation angle ≤ 30° when measuring velocities

- **Sample Volume:** Size 1–3 mm; placed at the vessel center

- **Thermal Index (TI) and Mechanical Index (MI):** Keep as low as possible (TI < 1.0), especially in the first trimester to reduce any potential harmful effects on fetus

Apply ALARA (As Low As Reasonably Achievable) principle throughout.

Trimester-Wise Settings:

First Trimester (11–14 weeks):
- Focus: Early prediction of preeclampsia and chromosomal abnormalities
- Vessels: Uterine artery, ductus venosus, tricuspid flow

Second Trimester (18–28 weeks):
- Focus: Structural survey, fetal growth monitoring
- Vessels: Umbilical artery, MCA, uterine artery

Third Trimester (>28 weeks):
- Focus: Fetal well-being, surveillance of high-risk pregnancies
- Vessels: Umbilical artery, MCA, ductus venosus, uterine artery

Vessel Specific Optimal Settings:

Uterine Artery Doppler (Fig 2)

Purpose: Screening for preeclampsia and fetal growth restriction

Timing: Performed at 11–14 weeks and repeated after 20 weeks if necessary

Settings:
- Transducer: 3.5–5 MHz curvilinear probe
- PRF: 0.5–1.2 kHz (low-velocity flow)
- Wall Filter: Low (~50–100 Hz)
- Sample Volume: 2 mm
- Angle: ≤ 30°
- TI/MI: TI < 0.7; MI < 1.0

Technique:
- Identify the uterine artery at its crossover with the external iliac artery
- Measure both sides, record Pulsatality index (PI)

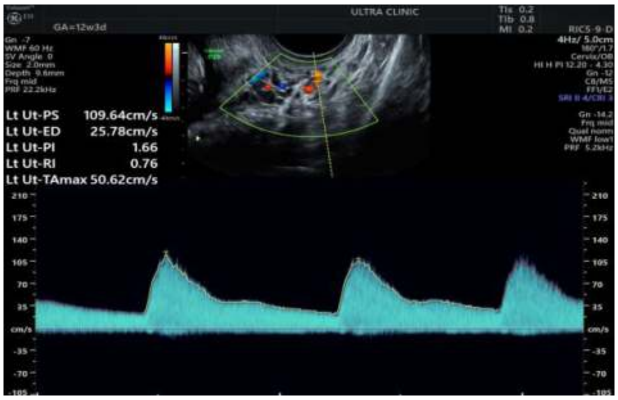

Fig 2: Uterine Artery Doppler

Umbilical Artery Doppler (Fig 3)

Purpose: Assessment of placental resistance and fetal well-being
Timing: Routinely performed in the second and third trimesters in high-risk pregnancies

Settings:
- Transducer: 3.5–5 MHz
- PRF: 1.0–2.0 kHz
- Wall Filter: 100–150 Hz
- Sample Volume: 1–2 mm
- Angle: Angle correction often not necessary
- TI/MI: TI < 1.0

Technique:
- Sample a free-floating loop of the cord
- Measure PI

Interpretation:
Absent or reversed end-diastolic flow indicates severe placental insufficiency

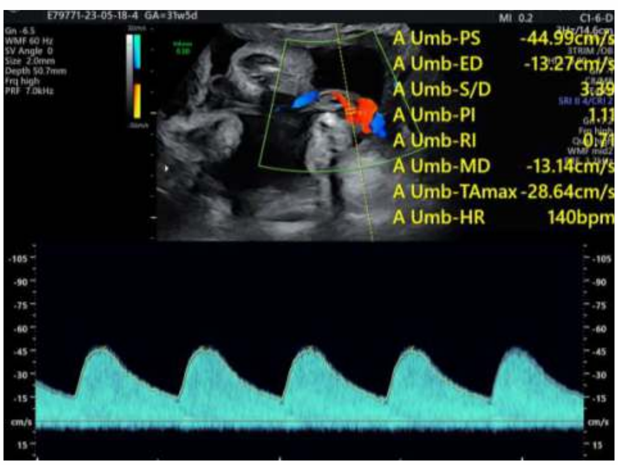

Fig 3:Umbilical Artery Doppler

Middle Cerebral Artery (MCA) Doppler (Fig 4)

Purpose: Evaluation of fetal anemia and brain-sparing in IUGR
Timing: Second and third trimesters

Settings:
- Transducer: 3.5–5 MHz
- PRF: 1.5–2.5 kHz
- Wall Filter: 100–150 Hz
- Sample Volume: 1–2 mm
- Angle: Keep as parallel as possible, ≤ 15° (angle correction recommended)
- TI/MI: TI < 1.0

Technique:
- Obtain axial view of fetal head at level of thalami
- Sample proximal third of MCA near its origin from the circle of Willis

Interpretation:
- Peak systolic velocity (PSV) >1.5 MoM: Indicates fetal anemia
- Low PI (<1.0 in late gestation) suggests brain-sparing effect

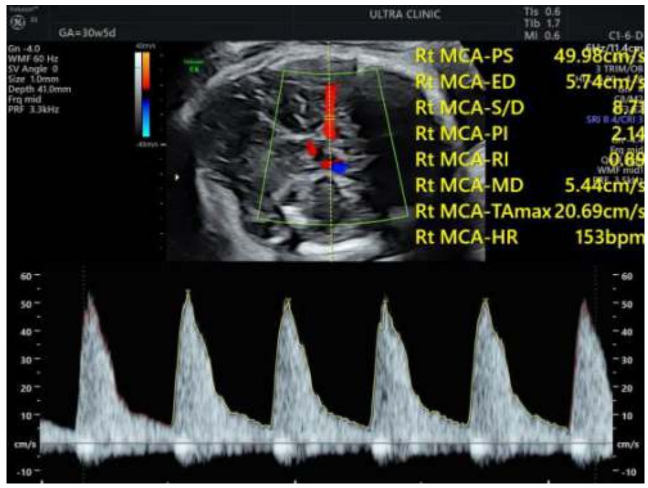

Fig 4: MCA Doppler

Ductus Venosus Doppler (Fig 5)

Purpose: First trimester aneuploidy screening; third-trimester fetal compromise assessment
Timing: 11–14 weeks and >28 weeks in IUGR
Settings:
- Transducer: High-frequency linear or curvilinear probe (5–8 Mhz)
- PRF: 2.0–3.0 kHz
- Wall Filter: Low 50 – 70 Hz to allow visualization of the whole waveform
- Sample Volume: 0.5–1 mm
- Angle: < 30°

Sweep Speed 2 -3 cm/Sec, so that the waveforms are widely spread out for better assessment of the a-wave
- TI/MI: TI < 0.7

Technique:
- Obtain midsagittal view of fetus; locate ductus between the umbilical vein and inferior vena cava
- Waveform should show triphasic flow (S, D, and A waves)

Interpretation:
- Normal: Forward flow during atrial contraction (positive 'a'-wave)
- Abnormal: Reversed or absent a-wave linked to aneuploidy or cardiac dysfunction

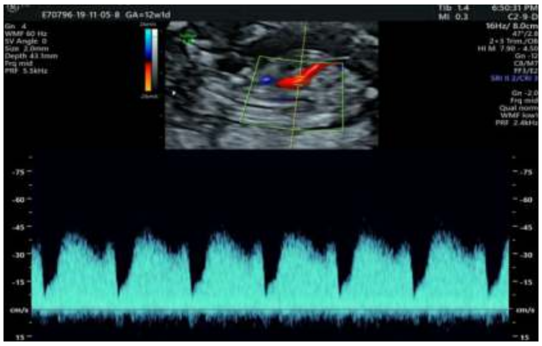

Fig 5: Ductus Venosus Doppler

Tricuspid Flow Doppler (Fig 6)

Purpose: Screening for cardiac defects and chromosomal abnormalities

Timing: First trimester (11–14 weeks)

Settings:

- Transducer: High-frequency transducer (5–9 Mhz)
- PRF: 1.0–1.5 kHz
- Wall Filter: 100–150 Hz
- Sample Volume: 2-3 mm across the tricuspid valve
- Angle: ≤ 30° angle correction
- TI/MI: TI < 0.7

Technique:

- Obtain apical four-chamber view
- Insonate through the tricuspid valve during diastole

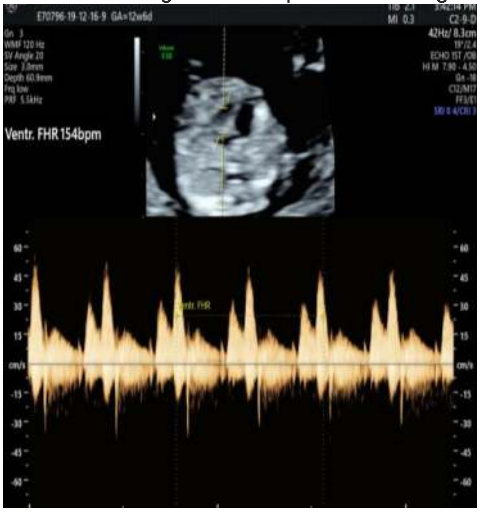

Fig 6: Tricuspid Flow Doppler

Conclusion:

Obstetric Doppler ultrasound offers critical insights into maternal and fetal circulation. Machine settings must be meticulously tailored for each vessel and gestational age to obtain accurate and reproducible results.

Optimizing PRF, wall filters, gain, and sample volume while maintaining safety indices is essential for effective Doppler imaging.

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Presets for Neurosonogram

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PRESETS	EFFECTS	OPTIMISATION	RECOMMENDATION
Acoustic Output	More information from depth Less scatter	Keep as per ALARA principle AO – 70-80	Increase in troublesome situation (high BMI)
Scan Angle	Frame rate and Resolution improves by narrowing angle	Adjust to snugly fit ROI (fetal head)	Start with wide angle ➡ Narrow the angle
Scan Depth	Frame rate and Resolution improves by reducing depth	Appropriate depth to get best view	Start with high depth and then reduce it
B-mode Gain	Signal : noise ratio is enhanced by augmenting gain	As low as possible to avoid overexposure	Compare with texture of surrounding amniotic fluid
Magnification /zoom	Blows up the image with pixels intact (true/HD zoom) or pixels scattered (pan zoom)	Preferably use true/HD zoom before freezing	Practically use combination of true/HD + pan zoom
Focal zone	Concentrate the sound beam to the ROI	Place focal spot at the level of ROI or just below it	Use single focal zone rather than multiple
Selection of transducer	Higher the frequency better the resolution at the cost of depth information	Scan with highest resolution probe preferably transvaginal	Trade off between spatial resolution and depth information
Dynamic range	Effectively packs 256 shades of grey in smaller band width	Low dynamic contrast to have maximum shades of grey	Highest possible contrast resolution (256 shades of grey)
Rejection	Allows to cut down on shades of grey	Keep rejection to as low as possible	Settle with least or zero rejection
Gray map	Trade off between brightness and echo intensity	Keep grey map linear or subtle concave upwards	Lowest possible grey map score
Harmonic imaging	Better spatial and contrast resolution	Keep HI active for better resolution	Optimum HI improves resolution and reduces reverberation
CRI and SRI	Better contrast resolution, edge enhancement	Keep CRI and SRI active but may reduce temporal resolution	Low CRI/SRI improves resolution and reduces artefacts
Line density	Higher line density improves spatial resolution but reduces frame rate	Keep line density to normal with low line filter	TVS – High line filter TAS – Low line filter

High BMI: Overcoming the Imaging Challenges

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Obesity has become an overwhelming epidemic worldwide. Roughly one in five adults could be obese with many countries experiencing even higher rates. By 2025, one billion adults or 12% of the world's population will be living with obesity.

Obesity is a major clinical risk factor for adverse outcomes for both mother and fetus. Women with obesity experience increased risks of maternal complications of gestational diabetes, preeclampsia, caesarean delivery, thromboembolism, and postpartum haemorrhage. Maternal obesity is also associated with increased risk of fetal structural anomalies, especially cardiac defects, neural tube defects, sacral agenesis, anal atresia, and limb reduction abnormalities.

Challenges in imaging High BMI pregnant women

In addition to the risk of structural anomalies, technical challenges associated with sonographic imaging result in a significantly lower detection rate of congenital anomalies especially cardiac anomalies, as well as an increased risk of missing markers of aneuploidy. The percentage of overweight women who have suboptimal fetal echocardiography is 17.4% when compared to 6.4% in normal-weight patients.

Factors contributing to suboptimal imaging in High BMI pregnant women

Sonographic visualization of fetal structures is degraded by depth of the body fat layer, with resultant increased depth of insonation, absorption of energy by the adipose tissue, and higher back-scatter from refraction. Over 50% of fetal anatomic surveys in women with obesity cannot be completed during the first ultrasound examination. Studies of Mid trimester ultrasound scans have shown that as BMI increases, there is a steady degradation in scan quality, and rates of poor visualization of fetal heart and spine, which correlate linearly with the degree of obesity. One study found that if a repeat ultrasound is performed at 21 weeks, then visualization of the heart improved; however, in 20% of exams, the fetal heart could not be adequately assessed despite several attempts

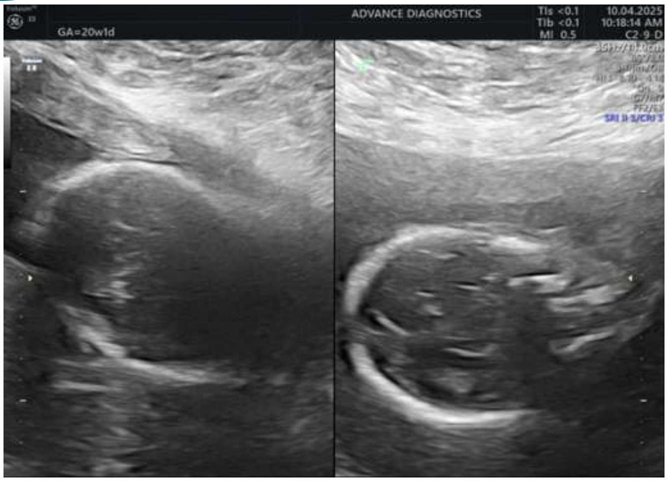

Fig1. Showing thick layer of anterior abdominal fat causing scattering of the ultrasound waves with poor visualization of the fetal anatomy.

Techniques to improve Imaging

Images obtained while scanning a patient with obesity are often of poor resolution secondary to backscatter, artifacts, and noise. There are several techniques that can result in better sonographic imaging of these patients. The primary goal is to reduce the distance between the transducer and the fetus, and to leverage advanced ultrasound technologies for post-processing.

Proper patient positioning

The panniculus limits visualization due to absorption of ultrasound energy by the adipose tissue, as well as increasing depth of insonation. Because the basic tenet of good ultrasound technique is placement of the organ of interest as close as possible to the transducer, scanning at a point away from the thickest portion of the pannus (between the umbilicus and pubic symphysis) may improve image quality. Scanning through the flanks may be useful in many such women. Placing patients in alternate positions, such as lateral decubitus, oblique, semi-recumbent or upright may allow the sonographer to scan away from the areas of most depth, yielding better images. The lateral decubitus position causes the pannus to fall away, allowing the practitioner to use the lateral flank as a window, while pointing the transducer medially. Sometimes, suprapubic approach is also useful in these women. The pannus can also be lifted by an assistant or by the patient herself, and scanning can be performed from the infra-pannicular crease to minimize the distance to the target of the ultrasound, the fetus. Using multiple positions throughout the course of a single visit can result in more optimal views of fetal anatomy and maternal structures. In addition, after the first trimester, it may be necessary to move the fetus into a different position, using a free hand.

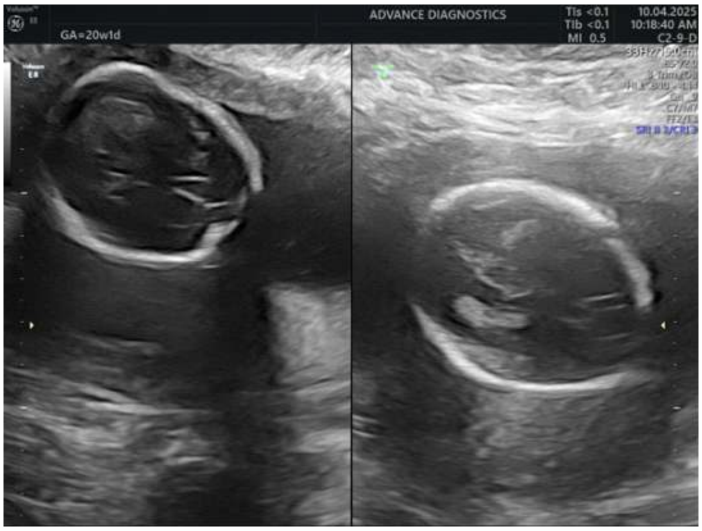

Fig 2- The same images shown in Fig 1, there is improved visualization by bringing the fetal anatomy closer to the transducer

Distended Bladder

Distended bladder, displaces the uterus cephalad, where the adipose tissue of the anterior abdominal wall may be thinner.

Optimal Probe Selection

A lower-frequency transducer (e.g. 1 MHz), as opposed to the traditional 2-to 5-MHz abdominal probe, can be combined with beam-forming algorithms to allow for better modelling in overweight patients. Because absorption is proportional to ultrasound frequency, lower-frequency transducers allow for less absorption, less attenuation, and more penetration, at the expense of less resolution. Using tissue aberration programs that correct and adjust for the speed changes that occur in adipose tissue also allows for improved resolution and greater depth of penetration. Real-time multiplanar imaging provided by isotropic and new crystal array transducers may also be helpful in patients who are obese.

Transvaginal Probe

Because the probe can be placed closer to the fetal structures when used with a transvaginal approach, it is particularly useful in patients with excess adiposity. A transvaginal approach should be considered routine in suboptimal imaging in the first trimester and in scenarios where fetal parts close to the cervix are suboptimally visualized (i.e., intracranial anatomy in a cephalic presentation, or fetal extremities and sacral spine in a breech fetus). The vaginal probe can also be placed directly in the umbilicus, using it as an acoustic window, and has been shown to improve the fetal cardiac exams.

Focus Settings

The focus setting of an ultrasound machine determines the region where the ultrasound waves are concentrated for the highest resolution. In cases of obesity, the increased distance between the probe and the fetus means the focal point may need adjustment. Typically, the focus should be placed at the region of interest to ensure optimal image quality. While scanning in obese patients, adjusting the focus to accommodate deeper tissue layers is vital. Most modern ultrasound machines allow multiple focal zones to be set, and utilizing more than one focus zone can help improve the resolution in deep areas, providing clearer visualization of the fetal structures.

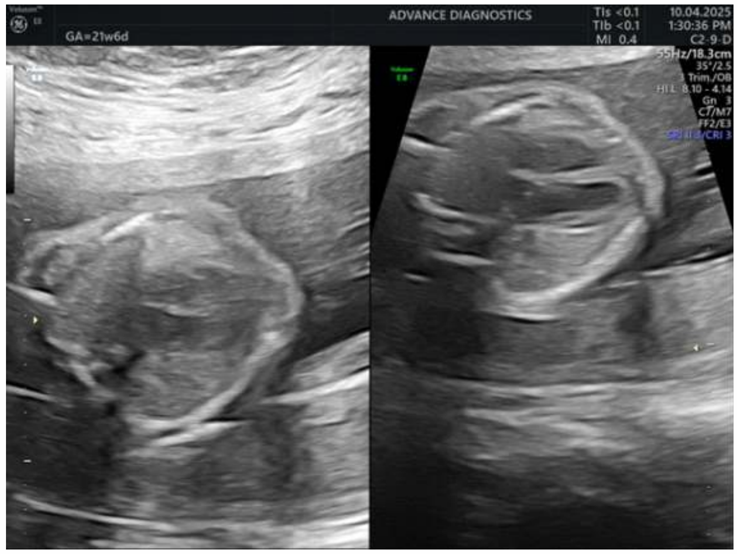

Fig 3A and B – in figure 3a there is poor visualization of fetal heart, In figure 3b the visualization improved by scanning between the ribs

Image acquisition and optimizing techniques/alterations

Use of specialized advanced imaging technologies allows for post-image capture enhancements. Increased signal-to-noise ratios and improved margin definition are easier with post-processing techniques. Use of compound imaging and tissue harmonic imaging has also vastly improved the quality of images that can be obtained from standard ultrasound techniques. The principle behind compound imaging is to combine multiple slices of images that have been obtained from different angles to generate an improved composite sonographic image. Tissue harmonic sonography, on the other hand, is a gray-scale sonographic technique that markedly improves sonographic contrast resolution, particularly in patients who are difficult to image with conventional techniques

Fig 4a, 4b – Fig 4a shows poor visualization of fetal heart due to shadowing by fetal spine. Focusing the same image with lateral placement of transducer in Fig 4b shows improved visualization of fetal heart

Special considerations

Ergonomic tips to prevent injury to the operators

Taking into account good ergonomic practices is especially important for a practitioner performing ultrasonography on patients who are obese. When performing ultrasound regularly, repetitive injury is common, due to forceful or awkward positions, applying pressure for extended periods of time, and improper positioning. Musculoskeletal injuries particularly of neck, shoulders and hands are common in sonographers who work in the OBG setting, and it is imperative that they remain aware of hand positions and proper posture and avoid awkward twisting movements while doing scans to avoid injury.

Avoiding bias against patients who are obese

Most importantly, operators and other healthcare workers must not hold strong implicit bias about patients with obesity and those biases need to be addressed at the systematic and training levels. Because many of these patients might have already experienced negative reactions from others, it is even more important to provide them with compassionate care, and to avoid any unconscious bias against patients with obesity, especially because they are more likely to have complications during pregnancy and will need to be able to trust that their doctor treats them with respect and dignity.

Medico-Legal Aspects

Ultrasound operators may face significant legal consequences if they fail to detect congenital anomalies, especially in cases involving obese women where thick abdominal walls can impede clear imaging and reduce detection rates. Such oversights may be considered medical negligence if the standard of care is not met, potentially resulting in lawsuits seeking compensation for the child's medical care and the parents' emotional distress. To mitigate this risk, thorough counseling is essential. Operators must clearly inform pregnant women—particularly those with a high body mass index—about the limitations of ultrasound in detecting fetal anomalies. They should also discuss the possibility of additional investigations, such as MRI or referral to a specialist. This approach may reinforce informed consent and help manage expectations.

Conclusion

Obesity is a growing epidemic. Patients who are obese are at increased risk of fetal anomalies and overall, adverse outcomes are increased in both mothers who are obese and their fetuses. Pregnant patients who are obese present significant technical challenges to those performing ultrasonography. Providers should leverage a patient position, optimize probe selection, and acquire an understanding of post-processing abilities of their ultrasound machines to maximize image quality and facilitate appropriate counseling of pregnant women who are obese. These patients often require additional ultrasounds to complete anatomical surveys, and have a higher utilization of healthcare resources during and after their pregnancies. The economic impacts of obesity cannot be ignored and working with our patients to improve their health before, during, and after their pregnancies can improve the health of the society over long term.

Dive Deeper

SOCIETY OF FETAL MEDICINE

Behind the Beeps: Troubleshoot Like a Pro!

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SOCIETY OF FETAL MEDICINE

Day-to-day ultrasound scanning can occasionally be disrupted by technical glitches. Knowing how to manage these hiccups efficiently can save valuable time and ensure uninterrupted patient care. Below is a practical troubleshooting guide for some common issues:

1. Probe Not Detected / Mirror Image Display

Problem: Probe not sensed or displays mirror image.
Solution:

- Disconnect the probe and reconnect it properly.
- Ensure the **probe lock is securely fastened.**
- Some specialty probes are port-specific; verify with service support whether the probe is connected to the correct port.

2. DICOM Printer Not Printing

Problem: Printer suddenly stops functioning.
Solution:

- Check **LAN icon** on the monitor:

- **Green:** Network is fine. Call the service team if printing fails.

- **Red or crossed:** Check LAN cable connections at both the machine and server ends.

3. USB Printer Not Responding

Solution:

- Try changing the USB cable.
- If the issue persists, contact the printer service provider.

4. Probe Cleaning Do's and Don'ts

Recommendations:

- Clean with **plain water or H_2O_2- based solutions** only.
- **Avoid using spirit or alcohol-based products** which may damage the probe.

5. Interference Artifacts (Fanning or Moving Stripes)

Problem: Intermittent visual artifacts during scanning.
Likely Cause: External electromagnetic interference.
Solution:

- Disconnect **LAN wires** and switch off **LED lights** in the room to identify the interference source.

6. Black Marks / Crystal Failure

Problem: Artifacts originating from the probe head.
Likely Cause: Crystal failure.
Solution:

- Run a **probe self-test** (if supported).
- Immediately **contact service** provider for repair or replacement.

7. USB Drive Usage Tips

Problem: Risk of virus infection or software crash.
Solution:

- Use a **dedicated virus-free USB drive** for ultrasound systems.
- Always **eject safely** before removing to prevent software crashes.

8. System Freeze / Black Touchpad

Problem: Machine hangs or touchpad goes dark.
Solution:

Press and hold ON/OFF button until the machine shuts down.

Wait a few minutes and **restart** the system.

If the problem recurs, **report it to your service provider**.

9. "No Power" at Startup

Problem: System does not start.

Solution:

- Check whether the power cord is securely connected.
- If power is still unavailable, do not attempt repeated restarts—call service provider.

10. EDD Not Displayed in First Trimester Report

Problem: EDD missing despite CRL measurement.

Solution:

- Look for a checkbox beside the CRL entry—ensure it is ticked to auto-generate the EDD.

11. Fetal Weight Not Calculated in Late Trimester

Problem: EFW missing despite all measurements.

Solution:

- Under the **EFW tab**, check the **weight estimation method** (e.g., BPD/HC/AC/FL).
- Select the appropriate formula to enable correct calculation.

12. Missing Biometry or Doppler Graphs / Percentile Charts

Problem: Graphs not visible in report.

Solution:

Navigate through the following steps to enable:

- **Utility > System Setup > Measure Setup > Parameter Page > Obstetric > Calculation**
- Tick the box **above the ratio and calculation table** to enable graphs.

13. Volume Probe "Motor Control Error"

Problem: Error message while using volume probe.

Solution:

- Try connecting the probe to **another connector.**
- If the error persists, it may be a **hardware issue-contact service provider.**

For persistent or unresolvable issues, always escalate to your **service provider.** Timely reporting can prevent downtime and ensure peak performance of your ultrasound system.

Happy scanning.

Dive Deeper

SOCIETY OF FETAL MEDICINE

Dear Fetal Pilgrims,

As you walk the holy path of presets and controls, SonoSutra is your playbook. Releasing an issue themed on machine settings couldn't be more apt—especially at BASICON. Thanks to Dr Krishna Gopal for the wonderful concept, and to Conferences International for helping us piece together this newsletter in style. But the loudest cheer goes to the Society of Fetal Medicine for letting us go full geek. But what are we really dealing with here?

Buying an ultrasound machine is less of shopping and more of an arranged marriage—dowries included, sometimes up to 2 crore! So don't fall for any brochure-glamour or the razzle-dazzle of demos. Apply your grey cells before choosing the grayscale.

Early pregnancy scans? No peekaboo! They are high-res hunts for heartbeats—more suspenseful than any OTT trailer. Crank the frequency, zoom like a pro, but keep the heat low. Remember, ALARA isn't just policy — it's your daily dose of do-no-harm.

The Netflix of Nuchal—where tech meets stakes. You become the ultrasound DJ adjusting gain, swapping probes, diving into the depths. If the fetus refuses to pose like in yoga, don't despair. This isn't just point-and-shoot photography-this is fetal filmmaking at its finest.

Anomaly scans are all about negotiation. One hand on the probe, other one dancing on the console; eyes on the screen, and ears tuned to the mother. Baby turns away, BMI throws a tantrum, and you're left navigating the fog. Stay calm, the knob-knowledge may come to your rescue.

Doing fetal echo with factory presets? That's like cooking biryani with Maggi masala. Tweak, twist, twirl those controls. Master the fingertip finesse and transform your screen from Doordarshan 1982 to Dolby Digital.

Who doesn't know arteries whoosh and veins whisper? But it's PRF that sets the tempo, wall filters that hush the hiss, and then Doppler that does the disco.

A neurosonogram with the right presets can turn fetal brain images into a Renaissance sculpture.

Between the fat and the frustration lies the physics. Scanning in obesity is all about making peace with tech upgrades, body origami, and bladder acrobatics.

But what if your ultrasound machine throws a tantrum? Don't panic. Turn every beep into a solvable Scooby-Doo mystery.

And finally, behind every perfect image isn't just a preset—but a person who knows when to outsmart it. That's the true art of obstetric ultrasound.

Truly yours
In fetal frequency,
The Fetus Uncle

Where Science Meets Satire