MX3/MX5/MX6 Series

Diagnostic Ultrasound System

Operator's Manual

[Advanced Volume]

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About This Manual

This operator’s manual describes the operating procedures for MX3/MX3S/MX3T/MX3 Exp/MX3 Pro/MX3 Super/MX3P/MX3Q/MX3W/MXC/MX3 BW/MX2/MX2 BW/MX CU/MX CB/MX CR/MX2S/MX2T/MX2 Exp/MX2 Pro/MX2 Super/MX QA/MX QB/MX QC/ MX5/MX5S/ MX5T/MX5 Exp/MX5 Pro/MX5 Super/MX5P/MX5Q/MX5W/MXI/Emerus MX5/Emerus MX5S/ Emerus MX5 Exp/Anesus MX5/Anesus MX5S/Anesus MX5 Exp/Crius MX5/Crius MX5S/Crius MX5 Exp/MX IT/MX IC/MX IR/MX3H/MX HA/MX HB/MX HC/MX6/MX6S/MX6T/MX6 Exp/MX6 Pro/MX6 Super/MX6P/MX6Q/MX6W/MXG/Emerus MX6/Emerus MX6S/Emerus MX6 Exp/Anesus MX6/Anesus MX6S/Anesus MX6 Exp/Crius MX6/Crius MX6S/Crius MX6 Exp/MX GA/MX GT/MX GN/MX5E/MX EA/MX EB/MX EC Diagnostic Ultrasound System. To ensure safe and correct operation, carefully read and understand the manual before operating the system.

When operating the system, refer to the following manuals:

- Operator’s Manual [Basic Volume]

  Describes the basic functions and operations of the system, safety precautions, exam modes, imaging modes, preset, maintenance and acoustic output, etc.
- Operator’s Manual [Acoustic Power Data and Surface Temperature Data]

  Contains data tables of acoustic output for transducers.

Software Interfaces in this Manual

Depending on the software version, preset settings and optional configuration, the actual interfaces may be different from those in this manual.

NOTE:

The functions described in this manual are not provided for all systems sold in all regions. The functions available depend on the specific system purchased.

All the menus and screens in this manual take the system in full configuration as an example.

Meaning of Signal Words

In this manual, the signal words ⚠**DANGER**, ⚠**WARNING**, ⚠**CAUTION**, **NOTE** and **TIP** are used regarding safety and other important instructions. The signal words and their meanings are defined as follows. Please understand their meanings clearly before reading this manual.

Signal word	Meaning
⚠ **DANGER**	Indicates an imminently hazardous situation that, if not avoided, will result in death or serious injury.
⚠ **WARNING**	Indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury.
⚠ **CAUTION**	Indicates a potentially hazardous situation that, if not avoided, may result in minor or moderate injury.
NOTE	Indicates a potentially hazardous situation that, if not avoided, may result in prop-erty damage.
TIP	Important information that helps you to use the system more effectively.

Conventions

In this manual, the following conventions are used to describe the buttons on the control panel, items in the menus, buttons in the dialog boxes and some basic operations:

- <Buttons>: angular brackets indicate buttons, knobs and other controls on the control panel or on the keyboard.
- [Items in menu or buttons in dialog box]: square brackets indicate items in menus, on the soft menu or buttons in dialog boxes.
- Click [Items or Buttons]: move the cursor to the item or button and press <Set> or use the soft key corresponding to the soft menu.
- [Items in menu] > [Items in submenu]: select a submenu item following the path.

Meaning of Safety Symbols

Symbol	Description
⚠	General warning, caution, risk of danger.

Contents

1 Overview of Measurements

There are two kinds of measurement tools.

- General tools: basic measurement tools in General Measurement, such as the “distance” and “Area.”
- Application tools: the measurement tools in Application Measurement. These items are classified and combined in clinical application packages such as Abdomen, Obstetric, etc. For example, HC (head circumference) in the Obstetric measurements is one of the application tools.

Please observe the following precautions to ensure patient and operator safety when using this system.

⚠CAUTION

- Select the proper patient image and measurement tools. Only qualified professionals can decide the appropriate measurements and results.
- Confine measurement calipers to the actual Region of Interest (ROI). Measurements that extend beyond the ROI will be incorrect.
- Before examining a new patient, it is necessary to end the current scan and delete the patient information and data. Failure to do so will result in new patient data being combined with the previous patient’s data.
- When the system is turned OFF or end the exam, all unsaved data are lost.
- Pressing the <Clear> key will clear the measurement caliper and all data in the result window, such as comments and body marks.
- In dual-B imaging mode, the measurement results of the merged image can be inaccurate. Therefore, the results are provided for reference only, not for confirming diagnoses.
- The quality of the extended image constructed in iScape (panoramic imaging) is dependent on the skill of the operator. Extra attention should be paid during the iScape measurement since the results could be inaccurate.
- Ensure that measurement data correctly corresponds to the fetus during the Obstetric Measurement.
- Fully understand the functionality of this system by referring to the Operator’s Manual - Basic Volume.
- When the result of auto trace does not match the image exactly, perform the measurement manually.

NOTE:

- Most application tools use the general measurement method while measuring, e.g., an “Area” tool is used when measuring the HC. Only the application measurement results are recorded in the report.

- The measurement tools listed in this manual are configured in the system. The application measurement packages provided in this system are generally different combinations of measurement tools.

1.1 Measurement Preset

Before measuring, preset the following parameters:

- Measurement Parameters Preset
- Obstetric Preset
- General Measurement Preset
- Application Measurement Preset
- Report Preset

For detailed information about Measurement Preset, see *Basic Manual*.

1.2 Basic Operations and Buttons

The following descriptions for buttons and keys are used during performing measurements:

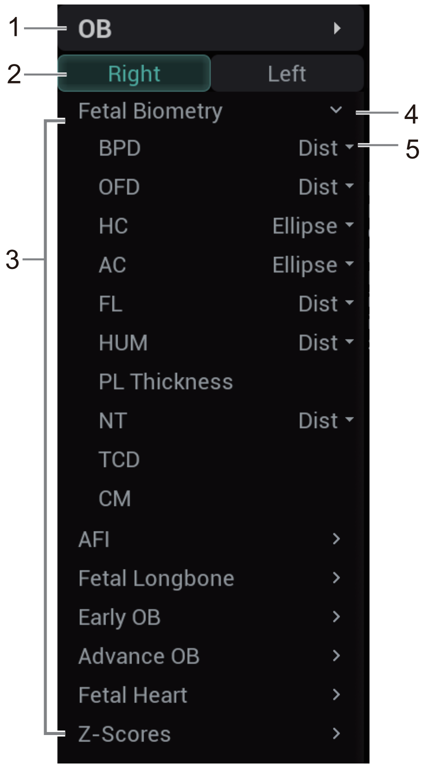
Keys	Basic Operations
Measure	To enter/exit the application measurement.
Caliper	To enter/exit the general measurement.
Left/right Set key	Press <Set> to confirm and end the current operation during measurement.
Update	To switch between the fixed end and active end of the caliper during a measurement. In iWorks status, press to enter a measurement according to the prompt.
Clear	Short press: to return to the previous measurement step or delete the caliper backwards. Long press: to clear all measurement calipers on the screen and data in the results window.
Report	To enter/exit the report page.
Cursor	To show/hide the cursor.
Trackball/touchpad	To move the cursor.

For detailed information about button functions, see *Basic Volume*.

1.3 Measurement Menu

Press <Caliper>/ <Measure> to enter the general/application measurement.

Take application measurement menu as example, measurement menu on the screen is shown as follows.



Items	Description
1.	Measurement library
2.	Measurement location
3.	Measurement tools (main menu)
4.	Measurement tools (Submenu)
5.	Select method

NOTE:

- The order of the measurement items can be preset.
- A measurement tool can be activated by tapping the item on the touch screen. It is described as “Select ... in the measurement menu” in the following procedures.

Measurement Location

The location buttons are used to select the measurement locations.

- Side (Left/Right): belongs to items (e.g., kidney) that contain measurements of left/right side parameters respectively.
- Location (Prox./Mid./Dist.): belongs to items (e.g., vascular) that contain measurements of Proximal, Middle or Distal parameters.
- Location (Far/near): belongs to items (e.g., carotid) that contain measurements of anterior or posterior parameters.
- Pole (U/M/L): belongs to items (e.g., some abdomen vessels) that contain measurements of upper, middle or lower parameters.

Measurement Tool

Tap the item on the touch screen to select the tool.

NOTE:

A performed application item/tool is marked with a "√." (If one or some items in a submenu (extended menu) of a study are already performed, this study will be marked as measured.)

Measurement Mode

Click the mode tab to switch to other measurement menus available for other modes.

Measurement Library Switching

During application measurement, tap the library drop-down list to select from the available measurement libraries under the current probe of the current exam mode.

Measurement Method

Some measurement tools have multiple methods to select.

Tap the drop-down list to select the method.

Adjust Frame

Select [Adjust Frame] and use < Angle > to select an appropriate frame to perform measurements.

Edit Measurement Caliper

Select [Edit]. Select the measurement caliper by using the trackball/touchpad and <Set> button. Move the pointer of the measurement caliper. The measurement is updated in the result window.

1.4 Measurement, Calculation and Study

There are three kinds of measurement items.

Measurement

Results of measurements are directly obtained via the measurement tools, which are indicated by "" in the preset screen.

For example, "Distance" in the 2D general measurement or "HC" in the OB measurement.

On the touch screen, measurement tools are displayed using square button.

Calculation

Results of calculations are automatically derived by the system using other measured or calculated values as parameters, they are indicated by "" in the preset screen.

For example, EFW (Estimated Fetal Weight) in the OB measurement.

If all measurements related to a calculation tool are completed, the system will automatically calculate the result. If some measurement tools are performed again, the system will automatically update the calculation result using the latest measurement results.

On the touch screen, calculation tools are displayed using square button.

Study

A group of measurements and/or calculations for a specific clinical application, which are indicated by "" in the preset screen.

For example, AFI in the OB measurement.

Fold/unfold the study to hide/show the measurement or calculation items included.

On the touch screen, study items are displayed with an arrow indicating the tools to be selected.

1.5 Measurement Caliper

A measurement caliper is a graphic consisting of several points and a straight line or curve drawn on the ultrasound image.

Fixed/Active End

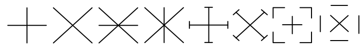
The ends of calipers can be active or fixed. The active end is called a Cursor.

Caliper Color

An active caliper appears green, while a fixed one appears white in the system default preset.

Caliper End Symbols

8 symbols are used as caliper ends, as shown in the figure below.



NOTE:

The cursor type can be preset between Symbol and Number.

1.6 Results Window

The measurement window displays the conducted measurement's result and the engaging measurement in real time.

1.6.1 Results Display

Select [Hide] in the soft menu and the latest results display in the results window in time sequence.

- When viewing the results: If the results window is full, the oldest value will be replaced according to the "first in, first out" rule.

  A maximum of 16 results can display in the results window and a maximum of two graphical results windows can display in the screen.
- To identify the measurement results, symbols or numbers are used in the numerical results window (B-histogram, B-profile) while "No:1" or "No:2" is used in the graphical results window.
- The result displays as digits when the value obtained is within the clinical range. If the value display is abnormal, perform the measurement again.

1.6.2 Moving the Results Window

To move the results window:

1. Place the cursor on the results window title and press <Set>.
2. Move the cursor to place the results window in the desired position.
3. Press <Set> to fix the results window

1.6.3 Results Window Assignment

An application measurement result can be assigned to a general measurement item from the results window. The application item can be an existing item in the system or a new user-defined one.

NOTE:

Re-assignment for the assigned general result is not available.

Assigning an Existing Application Item

Perform the following procedure:

1. Move the cursor to a general measurement value in the results window. Press <Set> and the matching list appears as shown below.

   Application items that meet the following requirements are displayed:

   – Contained in the current application package.
   – The item to be assigned and the assigner should use the same general measurement tool for the result.

   Application items in the current measurements that use the “Distance” method are listed as shown above.

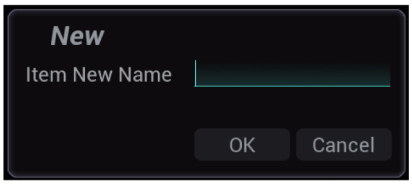
2. Select an application item from the list, then press <Set>.
3. The assigned value displays in the results window and is saved in the exam report.

Assigning a New Application Item

When no (desired) item displays in the matching list, you can create a new application item.

Perform the following procedure:

1. Select [new] at the bottom of the matching list.
2. The following dialog box appears, type in the new name.



3. Click [Confirm] to assign the general result to the new item.

Exiting Result Assignment

Click other area or select [Cancel] in the matching list to exit.

Auto-Spectrum Calculation Assignment

Like a general measurement result, you can assign the auto-spectrum calculation results to an application item, using the same steps as described above.

NOTE:

The application item to assign should be an item using D trace in the current application package.

1.7 Cross-window Measurement

For linear probing, cross-window measurement is available in dual-B mode when the left and right windows are imaging with the same probe, depth and invert mode.

Under Free Xros M mode (option), you can perform cross-window measurement of time and HR.

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2 General Measurement

Press < Caliper > to enter general measurement.

There are 2D (B/Color/Power), M and Doppler (PW/CW) basic measurement tools.

2.1 2D General Measurements

2.1.1 Depth

Sectoral surface probe: the depth is the distance from the center of the sector to the cursor.

Convex array or linear array probe: the depth is the distance from the transducer surface to the measuring cursor in the direction of the ultrasonic wave.

NOTE:

The real-time depth displays in the results window only before the <Set> key is pressed to fix the starting point. The history value of the depth is not displayed in the results window.

Perform the following procedure:

1. Select [Depth] in the measurement menu.

   The cursor appears on the screen.
2. Move the cursor to the desired point.
3. Press <Set> to set the measurement point and the result displays in the results window.

2.1.2 Distance

Measures the distance between two points on the image.

Perform the following procedure:

1. Select [Distance] in the measurement menu.

   The cursor appears on the screen.
2. Move the cursor to the starting point.
3. Press <Set> to set the starting point.
4. Move the cursor to the end point.
   – Press <Clear> to cancel setting the starting point.
   – Press <Update> to switch between the fixed end and the active end of the caliper.
5. Press <Set> to set the end point and the result displays in the results window.

2.1.3 Distance P-L

Measures the distance between two parallel line segments.

Perform the following procedure:

1. Select [Distance P-L] in the measurement menu.

The cursor appears on the screen.

2. Move the cursor to the starting point.
3. Press <Set> to set the starting point.
4. Move the cursor to the end point.
   – Press <Clear> to cancel setting the starting point.
   – Press <Update> to switch between the fixed end and the active end of the caliper.
5. Press <Set> to set the end point and the result displays in the results window.

2.1.4 Angle

Measures the angle of two crossing planes on the image and the range is: 0° to 180°.

Perform the following procedure:

1. Select [Angle(2L)] / [Angle(3P)] in the measurement menu.

   The cursor appears on the screen.

2. Set two line segments as described in section see 2.1.2.

   The angle appears in the results window after setting the line segments.

2.1.5 Area & Circumference

Measures the area and circumference of a closed region on the image. Four measurement methods are available:

- Ellipse: fix an ellipse region by two equal-cut perpendicular axes.
- Trace: fix a closed region by free tracing.
- Spline: fix a spline curve by a series of points (12 points at most).
- Cross: fix a closed region with two axes perpendicular to each other. The starting point and the end point of the axes can both be fixed freely.

These four methods are also applicable to other measurement items and will not be repeated when mentioned below.

Ellipse

Perform the following procedure:

1. Select [Ellipse] in the measurement menu.

   The cursor appears on the screen.

2. Move the cursor to an area of interest.
3. Press <Set> to set the starting point of the first axis of the ellipse.
4. Move the cursor to position the end point of the first axis of the ellipse.
   – Press <Update> to switch between the fixed end and the active end of the first axis.
   – Press <Clear> to cancel the start point of the first axis.
5. Press <Set> to set the end point of the first axis of the ellipse.

   The second axis appears on the screen.

6. Moving the cursor will increase or decrease the ellipse from the fixed axis. Move the cursor to trace the area of interest as closely as possible.

   Or, press the <Update> or <Clear> key to return to the step before setting the first axis.

7. Press <Set> to anchor the ellipse region.

The measurement result will be displayed in the results window.

Trace

Perform the following procedure:

1. Select [Trace] in the measurement menu.

   The cursor appears on the screen.

2. Move the cursor to an area of interest.
3. Press <Set> to fix the starting point.
4. Move the cursor along the target to trace the outline of the target.

   To modify the trace line, rotate the <Angle> knob:

   – Anticlockwise: to cancel a series of points.
   – Clockwise: to resume a series of points. You may also resume the points by moving the cursor back.

5. Press <Set> and the trace line will be closed with a straight line connecting the start and end points.

   The trace will also be closed when the cursor is very near to the starting point.

Spline

Perform the following procedure:

1. Select [Spline] in the measurement menu.

   The cursor appears on the screen.

2. Move the cursor to an area of interest.
3. Press <Set> to set the first reference point of the spline.
4. Move the cursor along the area of interest and press <Set> to anchor the second reference point.
5. Move the cursor again and a spline defined by three points of the first and second reference points and the active cursor appears on the screen.
6. Move the cursor along the edge of the target and set more reference points (12 at most) to make the spline approach the target region as closely as possible.

   To correct a previous point, press <Clear>.

7. Press <Set> twice to anchor the last reference point.

   The spline is fixed and the results display in the results window.

Cross

Perform the following procedure:

1. Select [Cross] in the measurement menu.

   The cursor appears on the screen.

2. Move the cursor to an area of interest.
3. Press <Set> to fix the starting point of the first axis.
4. Move the cursor to position the end point of the first axis and then press <Set>.

   – Press <Update> to switch between the start point and the end point of the first axis.
   – Press <Clear> to cancel setting the starting point of the first axis.

5. Press <Set> to set the end point of the first axis. The second axis (perpendicular to the first axis) of the cross appears on the screen.
6. Move the cursor and press <Set> to fix the starting point of the second axis.
7. Move the cursor to the end point of the second axis.
   – Press <Update> to switch between the start point and the end point of the first axis.
   – Press <Clear> to cancel setting the starting point of the first axis.
8. Press <Set> to set the end point of the second axis and fix the region.

   The results appear in the result window.

2.1.6 Smart Trace

Helps the operator to trace the contour of the target by automatically recognizing the margin of the target and measures the lengths of major axis and minor axis, area and circumference of the closed region.

NOTE:

Smart Trace should be performed on frozen images.

Perform the following procedure:

1. After the image is frozen, select [Smart Trace] in the measurement menu.
2. Move the cursor to an area of interest.
3. Press <Set> to fix the starting point.
4. Move the cursor along the target to trace the outline of the target.

   During tracing, you can move the cursor backwards to delete latest tracing. Or, you can press <Set> to fix the traced contour.

   The faster the cursor moving speed, the bigger the cursor, and the lager the recognized area.
5. Press <Set> twice and the trace line will be closed with a straight line connecting the start and end points.

   The trace will also be closed when the cursor is very near to the starting point.

2.1.7 Volume

Measures the volume of the target object.

Volume (3 Dist.)

For calculating the object’s volume with 3 axes of two images scanned in the plane perpendicular to each other in B Mode. The calculation formula is as follows:

$$\mathrm{V}olume\ (cm^3)=\frac{\pi}{6}\times D1(cm)\times D2(cm)\times D3(cm)$$

Where D1, D2 and D3 are the length of three axes of the target object.

Perform the following procedure:

1. Select [Volume] in the measurement menu.

   The cursor appears on the screen.
2. Here D1, D2 and D3 are the lengths of three axes of the target object.

   For detailed procedures, see “2.1.2 Distance”.

Generally D1, D2 and D3 should belong to different scanning planes.

Volume (Ellipse)

To calculate the object's volume by its horizontal section area. The calculation formula is as follows:

$$Volume\ (cm^3) = \frac{\pi}{6} \times a(cm) \times b^2(cm)$$

Where a is the length of the major axis of the ellipse while b the minor.

Perform the following procedure:

1. Select [Volume (Ellipse)] in the measurement menu.

   The cursor appears on the screen.
2. The procedure is similar to that of Ellipse in the area measurement.
3. For details, see “2.1.5 Area & Circumference”.

Volume (Ellipse Dist.)

To calculate the object's volume by its horizontal and vertical section area. The calculation formula is as follows:

$$Volume\ (cm^3) = \frac{\pi}{6} \times a(cm) \times b(cm) \times m(cm)$$

Here a, b and m indicate the length of the major, minor and the third axis of the ellipse respectively.

Perform the following procedure:

1. Select [Volume (E+ Dist.)] in the measurement menu.

   The cursor appears on the screen.
2. Use the Ellipse method to measure the vertical section area.

   The procedure is similar to that of Ellipse in the Area measurement, see “2.1.5 Area & Circumference” for details.
3. Unfreeze the image. Rescan the area of interest perpendicular to the previous image.
4. Measure the length of the third axis with the Distance measurement method, see “2.1.2 Distance” for detailed procedures.

2.1.8 Double Dist.

Measures the lengths of line segments A and B perpendicular to each other.

Perform the following procedure:

1. Select [Double Dist.] in the measurement menu.

   The cursor appears on the screen.
2. Move the cursor to the measurement starting point.
3. Press <Set> to set the starting point of the first line segment.
4. Move the cursor to position the end point of the first axis and then press <Set>.
   - Press <Update> to switch between the start point and the end point of the first axis.
   - Press <Clear> to cancel setting the starting point of the first axis.
5. Press <Set> to set the starting point of the first line segment. The second line segment perpendicular to the fixed line segment appears on the screen.

6. Move the cursor to the starting point of the second line segment.
7. Press <Set> to set the starting point of the second line segment. Or, press <Update> or <Clear> to return to the last step.
8. Move the cursor to the end point of the second line segment. Then
   – Press <Update> to switch between the starting point and the end point of the second axis.
   – Press <Clear> to cancel setting the starting point of the second axis.
9. Press <Set> to confirm the end point of the second line segment.

2.1.9 Parallel

Measures the distance between every two line segments of five parallel line segments, namely, four distances in total.

Perform the following procedure:

1. Select [Parallel] in the measurement menu.

   Two lines perpendicular to each other appear on the screen. The intersection is the starting point of the line segment.
2. Use the <Angle> to change the angle of the lines and press <Set> to confirm.
3. Move the cursor to the starting point of the line segment.
4. Press <Set> to confirm the starting point and the first line.
5. Move the cursor and press <Set> to confirm the other four parallel lines when the last parallel line is set and the end point of the line that is perpendicular to the five parallel lines is confirmed.

   During the measurement, press <Set> twice to set the last parallel line and complete the measurement.

2.1.10 Curve Length

Measures the length of a curve on the image. Measurement methods available include Trace and Spline.

Trace

Perform the following procedure:

1. Select [Trace Len] in the measurement menu.

   The cursor appears on the screen.
2. Move the cursor to an area of interest.
3. Press <Set> to fix the starting point.
4. Move the cursor along the target to trace the outline of the target.

   To modify the trace line, touch and rotate the <Angle>:
   – Anticlockwise: to cancel a series of points.
   – Clockwise: to resume a series of points. You may also resume the points by moving the cursor back.
5. Press <Set> to anchor the end point of the trace line.

Spline

Perform the following procedure:

1. Select [Trace Len (Spline)] in the measurement menu.

The cursor appears on the screen.

2. Move the cursor to an area of interest.
3. Press <Set> to fix the starting point.
4. Move the cursor along the target and press <Set> to anchor the second, third, fourth, etc., points.

   A maximum of 12 points can be anchored.

   To correct a previous point, press <Clear>.
5. Press <Set> twice to set the end point of the spline.

2.1.11 Ratio (D)

Measures the lengths of two line segments and then calculates their ratio.

Perform the following procedure:

1. Select [Ratio (D)] in the measurement menu. The cursor appears on the screen.
2. Measure the length of the two line segments, see “2.1.2 Distance” for detailed procedures.

   The results display in the results window after the measurement of the second line is completed.

2.1.12 Ratio (A)

Measures the area of two closed regions and then calculates their ratio. The methods are Ellipse, Trace, Cross and Spline.

Perform the following procedure:

1. Select [Ratio (A)] in the measurement menu.

   The cursor appears on the screen.
2. Measure the area of the two closed regions; you may select different measurement methods for each region, see “2.1.5 Area & Circumference” for details.

2.1.13 B-Profile

Measures the gray distribution of ultrasonic echo signals on a line.

NOTE:

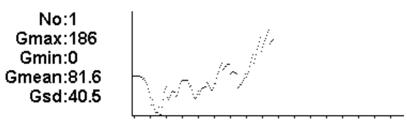
The following operations are performed on Freeze images by default.

Perform the following procedure:

1. Select [B-Profile] in the measurement menu.

   The cursor appears on the screen.
2. Set a line segment, see “2.1.2 Distance” for detailed procedures.

   The result is shown in the figure below:



Where

– No: The number of the graph. Value: 1 or 2. The last two results will be displayed on the screen.
– Gmax: The maximum gray.
– Gmin: The minimum gray.
– Gmean: The average gray.
– Gsd: The variance of gray.

2.1.14 B-Hist.

Function: measures and counts the gray distribution of ultrasonic echo signals within a closed region. The methods to set a closed region are Ellipse, Trace, Spline and Rect. (Rectangle).

NOTE:

The following operations are performed on Freeze images by default.

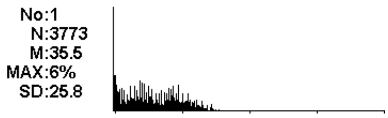
B-Hist. (Rectangle)

Rect. sets a rectangle with two points on the cross.

Perform the following procedure:

1. Select [B-Hist. (Rectangle)] in the measurement menu.

   The cursor appears on the screen.
2. Move the cursor to the first vertex of the rectangle, press <Set>.
3. Move the cursor to the second vertex of the rectangle, press <Set>. The result is shown in the following figure:



   Where

   – Horizontal axis: The gray of the image
   – The vertical axis: The gray distribution percentage.
   – No: The number of the graph. The last two results will be displayed on the screen.
   – N: The total pixel number in the area to be measured.
   – M: $M = \sum Di / N$;
   – MAX: MAX = the pixel number in the maximum gray/N×100%
   – SD: Standard deviation. $SD = (\sum Di^2/N-(\sum Di/N)2)^{1/2}$

     Di: the gray at each pixel point

     $\sum Di$: the total grays of all pixels.

B-Hist. (Ellipse/Trace/Spline)

For detailed procedures, see “2.1.5 Area & Circumference”.

2.1.15 Color Vel.

NOTE:

• This measurement item is meant for a general estimation, not for accurate measurement.

- The following operations are performed on Freeze images by default.

Measures the velocity of blood flow on the Color Mode image.

Perform the following procedure:

1. Select [Color Vel] in the measurement menu.

   The cursor appears on the screen.
2. Move the cursor to the point to be measured for blood flow velocity.
3. Press <Set> to fix the point, a floating line is displayed in the direction parallel to the ultrasonic wave beam at that point.

   The compensation angle is currently 0°. You can change the angle (0°-80°) by rotating the <Angle> knob to align the floating line in the same direction as the blood flow at the point to be measured.
4. Press <Set> to set the direction of the blood flow.

   The result displays in the results window.

2.1.16 Volume Flow

Measures blood flow through a vascular cross section per unit time.

For details, see “2.3.8 Volume Flow”.

2.1.17 IMT

IMT (Intima-Media Thickness) measures the distance between LI (Lumen-Intima) and MA (Media-Adventia).

NOTE:

The IMT should be performed on frozen images.

2.1.18 Strain

Support making measurement and calculation of the strain in a region.

NOTE:

Only elastography imaging supports this function. For details, see *Basic Volume*.

Perform the following procedure:

1. Under Strain Elasto Mode, acquire the image and freeze. Select [Strain] in the measurement menu.
2. Adjust the circle size by touching and rotating <Angle> after select [Strain (Circle)]. Set the shell thickness and select whether to turn on the shadow function.
   - In B+E dual display Mode, tap [Sync] on the touch screen to On. Measurements on either of the two windows will be displayed in the other window.
   - Tap [Shell Thick] and rotate < Angle > to set the mass shell size.

     After the strain is measured, select the [Shell Thick] to be more than 0 mm. The system extends from lesion A automatically according to the shell thick value.
3. Perform measurements.

You may select different measurement methods for each region. For details, see “2.1.12 Ratio (A)”.

2.1.19 Strain Ratio

Measures the strain ratio in the image, strain ratio = strain (normal tissue)/strain (lesion).

NOTE:

- The Strain Ratio should be performed on frozen images.
- Only elastography imaging supports this function. For details, see *Basic Volume*.

In the image, the region selected from lesions is defined as A, and the region selected from normal tissue is defined as B, where A' is the region extended from lesions and shell thick. Refers to the thickness of the mass shell.

Tissue strain is related to forces on the probe and tissue depth. It is recommended to use regions of the same depth and same area for comparison.

Perform the following procedure:

1. Under elastography imaging mode, acquire the image and freeze. Select [Strain Ratio] in the measurement menu.
2. Adjust the circle size by rotating <Angle> after select [Strain Ratio (Circle)].
3. Set the shell thickness and select whether to turn on the shadow function.
   – In B+E dual display Mode, tap [Sync] on the touch screen to On. Measurements on either of the two windows will be displayed in the other window.
   – Tap [Shell Thick] and rotate < Angle > to set the mass shell size.
4. Perform measurements.

   You may select different measurement methods for each region. For details, see “2.1.12 Ratio (A)”.

   After the strain ratio is measured, select the [Shell Thick] to be more than 0 mm. The system extends from lesion A automatically according to the shell thick value. The results window will display the results: B/A’, B/Shell, A/Shell.

2.1.20 Color Pixel Percentage

NOTE:

- This feature should be performed on frozen images.
- It is not suggested to perform CPP measurement on color mixing area.

Function: measures the pixel proportion of blood flow signal in the region of interest under Color or Power mode.

The feature is not supported under TDI mode.

CPP(Ellipse)

Perform the following procedure:

1. Select [CPP(Ellipse)] in the measurement menu. The ellipse appears on the screen.
2. Select [CPP ROI] to adjust the ellipse of the ROI, and use the trackball/touchpad to move the ellipse to the desired position.

   The ellipse should be in the color ROI.

3. Press <Set> to fix the ellipse.

CPP(Rect)

Perform the following procedure:

1. Select [CPP(Rect)] in the measurement menu. The rectangle appears on the screen.
2. Select [CPP ROI] to adjust the rectangle of the ROI, and use the trackball/touchpad to move the rectangle to the desired position.

   The rectangle should be in the color ROI.
3. Press <Set> to fix the rectangle.

CPP(Trace)

Perform the following procedure:

1. Select [CPP(Trace)] in the measurement menu.
2. For details on procedure see “2.1.5 Area & Circumference”.

CPP(Recall)

Select [CPP(Recall)] in the measurement menu to repeat the last CPP measurement.

If CPP measurement has not been performed since the ultrasound system is powered on, the measurement result is based on the default size and position of an ellipse.

2.1.21 Smart Calc

Perform the following procedure:

1. Select [Smart Calc] in the measurement menu.
2. Use the trackball/touchpad to make the "+" in the center of the lesion, and adjust the circle to cover the cystic area.

   NOTE:

   - Select [Set] to confirm the "+" position.
   - Press <Update> and use the trackball/touchpad to cover the cystic area.
3. After the caliper is fixed, the system automatically detects the lesion contour and displays the measurement and calculation results

   The scale can be edited.

   NOTE:

   - Select [Set] to accept the results.
   - Or use the trackball/touchpad to the contour and select [Set] to edit.

2.2 M General Measurements

2.2.1 Distance

Measures the distance between two points on the M Mode image.

Perform the following procedure:

1. Select [Distance] in the measurement menu.

   Two dotted lines perpendicular to each other appear on the screen.
2. Move the crossing point of the dotted lines to the measurement starting point and press <Set>.

3. Move the crossing point to the end point. The crossing point can then only be moved in a vertical direction.
   – Press <Update> to switch between the fixed end and active end of the caliper.
   – Press <Clear> to cancel setting the starting point.
4. Press <Set> to set the end point.

2.2.2 Time

Measures the time interval between two points on the M Mode image.

Perform the following procedure:

1. Select [Time] in the measurement menu.

   Two dotted lines perpendicular to each other appear on the screen.
2. Move the crossing point of the dotted lines to the measurement starting point and press <Set>.
3. Move the crossing point to the measurement end point.

   The crossing point can only be moved in a horizontal direction.
   – Press <Update> to switch between the fixed end and active end of the caliper.
   – Press <Clear> to cancel setting the starting point.
4. Press <Set> to set the end point.

2.2.3 Slope

Measures the distance and time between two points on the M Mode image and calculates the slope between the two points.

Perform the following procedure:

1. Select [Slope] in the measurement menu. Two dotted lines perpendicular to each other appear on the screen.
2. Move the crossing point of the dotted lines to the measurement starting point and press <Set>.
3. Move the crossing point to the measurement end point.

   The crossing point is connected to the starting point by a dashed line.
   – Press <Update> to switch between the fixed end and active end of the caliper.
   – Press <Clear> to cancel setting the starting point.
4. Press <Set> to set the end point.

2.2.4 Velocity

Measures the distance and time between two points on the M Mode image and then calculates the average velocity between the two points.

Perform the following procedure:

1. Select [Velocity] in the measurement menu.

   Two dotted lines perpendicular to each other appear on the screen.
2. Move the crossing point of the dotted lines to the measurement starting point and press <Set>.
3. Move the crossing point to the end point. The crossing point can then only be moved in a vertical direction.
   – Press <Update> to switch between the fixed end and active end of the caliper.
   – Press <Clear> to cancel setting the starting point.
4. Press <Set> to set the end point.

2.2.5 HR

Measures the time interval of n (n≤8) cardiac cycles on the M Mode image and calculates the heart rate.

The number of cardiac cycles "n" can be preset, see *Basic Volume* for details.

⚠CAUTION

During the measurement, the number of cardiac cycles between the measurement start and end points must be exactly the same as preset. Otherwise, misdiagnosis may occur.

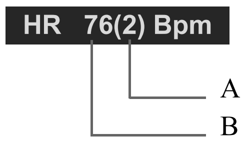
Perform the following procedure:

1. Select [HR] in the measurement menu.

   Two dotted lines perpendicular to each other appear on the screen.

2. Select n cardiac cycles.

   The HR result in the results window displays the measured heart rate value and the preset number of cardiac cycles, as shown in the figure below.



A	Number of Cardiac Cycles	B	Heart Rate

2.2.6 HR (R-R)

Measures the time interval between the R peaks of n (n≤8) cardiac cycles on the ECG image and calculates the heart rate.

The number of cardiac cycles "n" can be preset, see *Basic Volume* for details.

⚠CAUTION

During the measurement, the number of cardiac cycles between the measurement start and end points must be exactly the same as preset. Otherwise, misdiagnosis may occur.

Perform the following procedure:

1. Select [HR (R-R)] in the measurement menu.

   Two dotted lines perpendicular to each other appear on the screen.

2. Move the cursor onto the starting R peak point and press <Set>.
3. Move the cursor onto the end R peak point and press <Set>.

2.3 Doppler General Measurements

2.3.1 Time

Measures the time interval between two points on the Doppler image.

The operations are similar to the Time measurement in M Mode, see “2.2.2 Time” for details.

2.3.2 HR

Function: measures the time interval between n (n≤8) cardiac cycles on the Doppler Mode image and calculates the number of heart beats per minute (BPM).

The operations are similar to the Heart Rate measurement in M Mode, see “2.2.5 HR” for details.

2.3.3 HR (R-R)

Measures the time interval between R peaks of n (n≤8) cardiac cycles on the ECG image and calculates the number of heart beats per minute (BPM).

The operations are similar to the Heart Rate (R-R) measurement in M Mode, see “2.2.6 HR (R-R)” for details.

2.3.4 D Velocity

Measures the velocity, pressure gradient and correction angle of a certain point on the Doppler spectrum.

NOTE:

The real-time velocity displays in the results window only before the <Set> key is pressed to fix the starting point. The history value of the velocity is not displayed in the results window.

Perform the following procedure:

1. Select [Vel] in the measurement menu.

   The cursor appears on the screen.
2. Move the cursor to the point to be measured for velocity.
3. Press <Set> and the result displays in the results window.

2.3.5 Acceleration

Measures the velocities of two points and their time interval on the Doppler image, and calculates the acceleration, pressure gradient, velocity difference and correction angle.

Perform the following procedure:

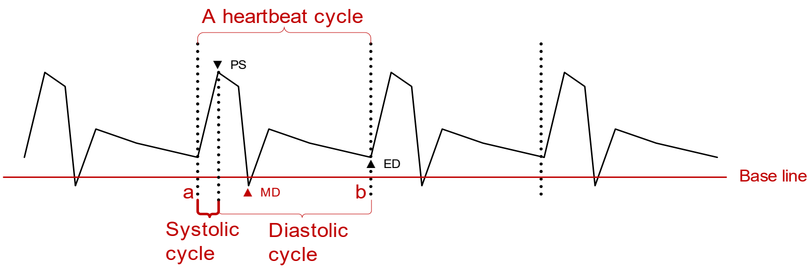
1. Select [Acceleration] in the measurement menu.

   The cursor appears on the screen.
2. Move the cursor to the first point to be measured for velocity.
3. Press <Set> to fix the first point.
4. Move the cursor to the second point to be measured for velocity.
5. Press <Set> to fix the second point. The results display in the results window.

2.3.6 D Trace

Measures clinical indices using spectral Doppler tracing. Measurement methods available are Manual Trace, Auto Trace, and Spline Trace.

A sketch of a Doppler spectrum is shown below:



NOTE:

When doing D trace, please set systolic starting time as the starting point and diastolic ending time as end point. That is, by tracing the Doppler spectrum from systolic to diastolic to calculate indices.

Result parameters

The results obtained from D trace are:

Parameters	Descriptions	
PS	Peak Systolic Velocity	The highest velocity of the red blood cells crossing the sample volume.
ED	End-Diastolic Velocity	Measures the blood velocity at the end of the cardiac cycle.
MD	Min-Diastolic Velocity	Minimum absolute Velocity in the diastolic cycle.
TAMAX	/	TAMAX (Time Averaged Maximum Velocity): $\text{TAMAX}(cm/s) = \int_{Ta}^{Tb} V(t)dt \Big/ (T_b - T_a)$ Where V(t) is the maximum velocity
VTI	Velocity-Time Integral	Velocity-time integral. The integral of the product of Doppler instantaneous velocity and the total time interval. $VTI(m) = \int_{T_a}^{T_b} V(t)dt$
HR	Heart Rate	Calculates the heart rate per minute by measuring the time interval of one cardiac cycle.
S/D	/	PS/ED S/D (No unit) = PS (m/s) / ED (m/s)
PI	Pulsative Index	Pulsatility index. PI (No unit) = |(PS (m/s) - ED (m/s)) / TAMAX (m/s)|
RI	Resistive Index	Resistance index.RI (No unit) = |(PS (m/s) - ED (m/s)) / PS (m/s)|

Parameters	Descriptions

NOTE:

- In the formulae above, T means time, the unit is s; V means the velocity at each point during T, the unit is cm/s; a is the traced starting point, while b is the traced end point.
- The above parameters are all the information obtained in D trace, while in application the system only displays part of them according to the operation and preset.

The measurement method varies according to the result selected.

Spline Trace

Perform the following procedure:

1. Select items using the [Spline] method from the measurement menu.
2. Move the cursor to the starting point to be measured and press <Set> to fix the point.
3. Move the cursor along the edge of the desired region. Continue to fix the second, third, etc., point (50 points at most) of the spectrum.
4. Press <Set> twice to anchor the last reference point. Or the measurement ends automatically when there are 50 reference points.

Manual Trace

Perform the following procedure:

1. Select items using the [Manual Trace] method from the measurement menu.

   The cursor appears on the screen.
2. Move the cursor to the starting point to be measured, and press <Set> to fix the starting point.
3. Move the cursor around the object to draw a trace line overlapping the spectrum as much as possible
4. Press <Set> to anchor the end point of the trace line.

Auto Trace

Perform the following procedure:

1. Select items using the [Auto Trace] method from the measurement menu.

   The cursor appears on the screen.
2. Move the cursor to the starting point to be measured, and press <Set> to fix the starting point.
3. Move the cursor to anchor the end point of the trace line, and press <Set>.

   The system will draw a trace line overlapping the spectrum automatically, and recognize a complete cardiac cycle to calculate.

2.3.7 PS/ED

Measures the Peak Systolic (PS) velocity and End Diastolic (ED) velocity on the Doppler spectrum, and calculates their resistance index (RI), S/D and correction angle.

Perform the following procedure:

1. Select [PS/ED] in the measurement menu.

   The cursor appears on the screen.
2. Move the cursor to the Systolic Peak and press <Set> to fix the point.
3. Move the cursor to the Diastolic End and press <Set> to fix the point.

2.3.8 Volume Flow

Measures blood flow through a vascular cross section per unit time.

Perform the following procedure:

1. Select [Volume Flow] in the measurement menu. The submenu displays.
   – Select [Vas. Area] to select the method for calculating the area: dist. or trace.
   – Select [PW Scope] to select the scope to be traced.
2. Measure the vascular area.
3. Tap [TAMEAN] or [TAMAX] to calculate the volume flow.

Item		Description	Methods or formulae
Vas Area	Dist.	Obtain the area by measuring the vascular diameter.	Vas. Area = π × Vas Diam $(cm)^2$/ 4
	Trace	Obtain the area using the trace method.	Area in 2D General Measurements
TAMEAN		Vol Flow(Area) - TAMEAN	Vol Flow(A) (ml/min) = |Vas TAMEAN (cm/s)| × Vas. Area (cm^2) × 60 (s) Vas. TAMEAN - Time Averaged Mean Velocity, obtained from the Vas. Trace measurement.
TAMAX		Vol Flow(Area) - TAMAX	Vol Flow(A) (ml/min) = |Vas TAMAX (cm/s)| × Vas Area (cm^2) × 60 (s) Vas. TAMAX - Time Averaged Maximum Velocity, obtained from the Vas. Trace measurement.

2.3.9 Velocity Ratio

Measures two D velocity values on one or two spectrums and calculate the ratio to analyze the flow information.

Perform the following procedure:

1. Select [Ratio (Vel)] in the measurement menu.

   The cursor appears on the screen.
2. Move the cursor and press <Set> to obtain two velocity values.
3. The system calculates the ratio automatically.

   Where

$$Vel\ Ratio(\ Nounit\ ) = \left| \mathrm{Vel1}(\ cm / s\ ) / \mathrm{Vel2}(\ cm / s\ ) \right|$$

2.3.10 VTI Ratio

Measures two VTI values on the spectrum and calculate the ratio.

Perform the following procedure:

1. Select [Ratio (VTI)] in the measurement menu.

   The cursor appears on the screen.

2. Move the cursor to obtain VTI1 and VTI2 values using the D trace method.
3. The system calculates the ratio automatically.

   Where

$$\mathrm{VTI\,Ratio}(\,Nounit\,) = \left|\mathrm{VTI\,1}(\,cm\,) / \mathrm{VTI\,2}(\,cm\,)\right|$$

2.4 References

3 Dist. Volume

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D/S

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Volume Flow(Diam)-TAMAX

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Volume Flow(Area)-TAMAX

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3 Abdomen

3.1 Basic Measurement Procedures

1. Press <Patient> on the control panel and enter the patient information.
2. Perform the scanning to acquire the desired image.
3. Press <Measure> to enter the Application Measurement.
4. Select the measurement tool from the measurement menu to start the measurement.
   - For measurement tools, see “3.2 Abdomen Measurement Tools”.
   - For measurement methods, see “2 General Measurement”.

   The system calculates and displays the results after the measurement tools have been completed.

3.2 Abdomen Measurement Tools

3.2.1 2D Mode

Measurement

Tools	Descriptions	Methods or formulae
Liver	/	Distance in 2D General Measurements
Renal L	Renal Length	
Renal H	Renal Height	
Renal W	Renal Width	
Cortex	Renal Cortical Thickness	
Adrenal L	Adrenal Length	
Adrenal H	Adrenal Height	
Adrenal W	Adrenal Width	
CBD	Common bile duct	
Portal V Diam	Portal Vein Diameter	
CHD	Common hepatic duct	
GB L	Gallbladder Length	
GB H	Gallbladder Height	
GB wall th	Gallbladder wall thickness	
Panc duct	Pancreatic duct	
Panc head	Pancreatic head	

Tools	Descriptions	Methods or formulae
Panc body	Pancreatic body	Distance in 2D General Measurements
Panc tail	Pancreatic tail	
Spleen L	Spleen Length	The system automatic calculates Spleen Vol. value. $\text{Spleen Vol} = \frac{\pi}{6} \times \text{Spleen L} \times \text{Spleen W} \times \text{Spleen H}$
Spleen W	Spleen Width	
Skin-L.Capsule Dist.	/	
Spleen H	Spleen Height	
Spleen Area	/	Area in 2D General Measurements
Spleen V Diam	Spleen vein Diam	Distance in 2D General Measurements
Spleen A Diam	Spleen artery Diam	
Aorta Diam. H	Aorta Diameter Height	
Aorta Diam. W	Aorta Diameter Width	
Aorta Aneurysm H	Aorta Aneurysm Height	
Aorta Aneurysm W	Aorta Aneurysm Width	
Aorta Aneurysm L	Aorta Aneurysm Length	
Aorta Bif	Aorta Bifurcation	
Iliac Diam.	Iliac Diameter	
Hepatic Lesion1-3, d1-3	/	
Hepatic Cyst1-3, d1-3	/	
Renal Cyst1-3, d1-3	/	
Renal Lesion1-3, d1-3	/	
Pre-BL L	Pre-void Bladder Length	
Pre-BL H	Pre-void Bladder Height	
Pre-BL W	Pre-void Bladder Width	
Post-BL L	Post-void Bladder Length	
Post-BL H	Post-void Bladder Height	
Post-BL W	Post-void Bladder Width	
Ureter	/	
Hepatic Lesion1~3 Elas.	Hepatic Lesion1~3 Elastography	Elastography in 2D General Measurements
LSM	Liver Stiffness Measurement	

Calculation

Tools	Descriptions	Methods or formulae
Aorta Sten D	Aorta Stenosis Diameter	Aorta Stenosis D (No unit) = (Normal Diam. (cm) - Resid Diam. (cm)) / Normal Diam. (cm) × 100% Stenosis D (No unit) = | (D1-D2) / MAX(D1, D2)|*100% Where D1 and D2 refer to the measured Aorta diameter, and MAX (D1, D2) represents the larger value of the two.
Aorta Sten A	Aorta Stenosis Area	Stenosis A (No unit) = | (A1-A2) / MAX (A1, A2) |*100% Where A1 and A2 refer to the measured Aorta area, and MAX (A1, A2) represents the larger value of the two.
Renal Vol.	Renal Volume	Renal L, Renal H and Renal W **NOTE:** The left and right sides respectively need to be measured.
Pre-BL Vol.	Pre-void Bladder Volume	Pre-BL L, Pre-BL H and Pre-BL W **NOTE:** The Mictur.Vol is displayed in the report if the Post-BL Vol is measured.
Post-BL Vol.	Post-void Bladder Volume	Post-BL L, Post-BL H and Post-BL W **NOTE:** The Mictur.Vol is displayed in the report if the Pre-BL Vol is measured.
Mictur. Vol.	Micturated Volume	Pre-BL Vol. and Post-BL Vol. **NOTE:** The Post-BL Vol. and Mictur.Vol. are calculated automatically, the Post-BL Vol. is displayed in the report.

Study

Tools	Methods or formulae
Spleen	Spleen L, Spleen W, Spleen H, Spleen Area
Aorta Aneu-rysm	Aorta Aneurysm H, Aorta Aneurysm W, Aorta Aneurysm L
Hepatic Lesion1-3	Hepatic Lesion1-3 d1-3
Hepatic Cyst1-3	Hepatic Cyst1-3 d1-3
Renal Cyst1-3	Renal Cyst1-3 d1-3
Renal Lesion1-3	Renal Lesion1-3 d1-3

Tools	Methods or formulae
Kidney	Renal L, Renal H and Renal W
Adrenal	Adrenal L, Adrenal H and Adrenal W
Bladder	Pre-BL L, Pre-BL H, Pre-BL W, Post-BL L, Post-BL H and Post-BL W
Hepatic Lesion1~3 ElasRatio	Elastography ratio in 2D General Measurements

3.2.2 Doppler Mode

Measurements

Tools	Descriptions	Methods or formulae
Ren. A Org.	Renal Artery Origin	D trace in General D measurements
Arcuate A	Arcuate Artery	
Segment A	Segmental Artery	
Interlobar A	Interlobar Artery	
Renal A	Renal Artery	
M Renal A	Main Renal Artery	
Renal V	Renal Vein	
Aorta	/	
Celiac Axis	/	
SMA	Superior Mesenteric Artery	
IMA	Inferior Mesenteric Artery	D trace and PS/ED in 2D General Measurements
C Hepatic A	Common Hepatic Artery	D trace in General D measurements
Hepatic A	Hepatic Artery	
Splenic A	Splenic Artery	
IVC	Inferior Vena Cava	
IVC Reflux	Inferior Vena Cava Reflux	Time in M General Measurements
Portal V	Portal Vein	D trace in General D measurements
M Portal V	Main Portal Vein	
Hepatic V	Hepatic Vein	
Lt Hepatic V	Left Hepatic Vein	
Rt Hepatic V	Right Hepatic Vein	
M Hepatic V	Middle Hepatic Vein	
Splenic V	Splenic Vein	
SMV	Superior Mesenteric Vein	
IMV	Inferior Mesenteric Artery	Distance in 2D General Measurements

Calculation

Tools	Descriptions	Methods or formulae
RAR	Ratio of Renal Artery PS the Abdominal Aorta PS	RAR (no unit) = |Renal A PS (cm/s)/ Aorta PS (cm/s)|
SMA/Ao	Ratio of Superior Mesenteric Artery PS and Abdominal Aorta PS	SMA/Ao (no unit) = |SMA PS (cm/s)/ Aorta PS (cm/s)|
CA/Ao	Ratio of Celiac Axis PS and Abdominal Aorta PS	CA/Ao (no unit) = |Celiac Axis PS (cm/s)/ Aorta PS (cm/s)|

3.3 Abdomen Measurement Operations

TIP:

- For measurement tools and methods see “3.2 Abdomen Measurement Tools”.
- For the definitions of measurement, calculation and study, see “1.4 Measurement, Calculation and Study”.

3.3.1 Smart Bladder

NOTE:

- Smart Bladder must be used with convex-wide probe.
- Smart Bladder is available in Single/Dual B imaging mode.

Function: measure the volume of the urine in the bladder.

1. Select an appropriate probe and exam mode.
2. Scan and obtain the transverse section image of the bladder.
3. Press <Freeze> to freeze the image and tap [Smart Bladder] in the measurement menu.

   Two diameters d1 and d2 (perpendicular to each other by default) are recognized by the system.
4. If the current result is satisfactory, tap [Accept Result] or press <Set> to save the result.

   Or, if the result is not satisfactory:

   a. Select [Auto Detect] to update the result.
   b. Select [Accept Result] to save the result.
5. Press <Freeze> to unfreeze the image.
6. Select [Smart Bladder]. Scan and obtain the longitudinal section image of the bladder.

   The diameter d3 is recognized by the system automatically.
7. If the current result is satisfactory, select [Accept Result] or press <Set> to save the result.

   Or, if the result is not satisfactory:

   a. Select [Auto Detect] to update the result.
   b. Select [Accept Result] to save the result.

8. The measurement results will be displayed in the results window.

3.3.2 Auto HRI Measurement (Smart HRI)

Smart HRI is an auto measurement method for Hepatorenal Index (HRI). HRI is the brightness ratio of liver to right renal cortex. The procedure is as follows:

1. Scan the proper image.
2. Select the Smart HRI measurement item from the menu.
3. The system positions the ROI of Liver (marked by L) and the ROI of right renal (marked by RC) automatically. The measurement results are displayed on the screen

   If necessary, you can use the trackbal/touchpadl to move the ROI or touch and rotate the <Angle> to adjust the size of the ROI. Press <Update> to switch ROIs.

4. Press <Set> to confirm the measurement.

4 Obstetrics

Obstetric measurements are used to estimate the GA and EDD and calculate the growth indices, including the EFW. The growth estimate is determined by the growth curve and fetal biophysical profile.

⚠**CAUTION**

Ensure the system date is correct, otherwise the GA and EDD calculated will be wrong.

4.1 Basic Measurement Procedures

1. Press <Patient> on the control panel and enter the patient information.
2. Perform the scanning to acquire the desired image.
3. Press <Measure> to enter the Application Measurement.
4. Select the measurement tool from the measurement menu to start the measurement.
   – For measurement tools, see “3.2 Abdomen Measurement Tools”.
   – For measurement methods, see “2 General Measurement”.

   The system calculates and displays the results after the measurement tools have been completed.

4.2 Obstetric Measurement Tools

NOTE:

- The Smart NT must be used with convex-wide probe and good image quality. If an evident inaccurate recognition exists, confirm the target profile manually and adjust the result.
- If the results of the calculation items of CI, FL/BPD, FL/AC, HC/AC and FL/HC exceed the clinical range, the result value displays as “value*.”

4.2.1 2D Mode

Measurement

Tools	Descriptions	Methods or formulae
GS	Gestational Sac Diameter	Distance in 2D General Measurements
YS	Yolk Sac	

Tools	Descriptions	Methods or formulae
CRL	Crown Rump Length	Dist (same as Distance in 2D General Measurements), Trace, Spline
NT	Nuchal Translucency	Distance in 2D General Measurements (Support Smart NT method if the Smart NT function is configured)*
BPD	Biparietal Diameter	Distance in 2D General Measurements (Support Smart OB method if the Smart OB function is configured)
OFD	Occipital Frontal Diameter	
FL	Femur Length	The system automatic calculates GA value.
HC	Head Circumference	Circumference in 2D General Measurements (Support Smart OB method if the Smart OB function is configured) **NOTE:** Head Circumference: in the HC measurement, if the measurement cursor of BPD appears on the screen, then the measurement starting point will be automatically positioned at the measurement cursor starting point of the last BPD. If you use “Ellipse” to measure the HC, the measurement cursor of the last BPD will be the first axis of the ellipse in the default status.
AC	Abdominal Circumference	Circumference in 2D General Measurements (Support Smart OB method if the Smart OB function is configured).
IT	Intracranial Translucency	Distance in 2D General Measurements
TAD	Abdominal Transversal Diameter	
APAD	Anteroposterior Abdominal Diameter	
TCD	Cerebellum Diameter	
Cist Magna	Cist Magna	
LVW	Lateral Ventricle Width	
HW	Hemisphere Width	
OOD	Outer Orbital Diameter	
NBL	Nasal Bone Length	

Tools	Descriptions	Methods or formulae
IOD	Inter Orbital Diameter	Distance in 2D General Measurements
HUM	Humerus Length	
Ulna	Ulna Length	
RAD	Radius Length	
Tibia	Tibia Length	
FIB	Fibula Length	
CLAV	Clavicle Length	
Vertebrae	Length of Vertebrae	
MP	Middle Phalanx Length	
Foot	Foot Length	The GA is calculated automatically after foot measurements are completed.
Ear	Ear Length	Distance in 2D General Measurements
APTD	Anteroposterior trunk diameter	
TTD	Transverse trunk diameter	
FTA	Fetal Trunk Cross-sectional Area	Area in 2D General Measurements
THD	Thoracic Diameter	Distance in 2D General Measurements
HrtC	Heart Circumference	Area in 2D General Measurements
TC	Thoracic circumference	
Umb. VD	Umbilical Vein Diameter	Distance in 2D General Measurements
F-kidney	Fetal kidney Length	
Mat. Kidney	Matrix Kidney Length	
Cervix L	Cervical Length	
AF	Amniotic Fluid	
NF	Nuchal Fold	
Orbit	Orbit	
PL Thickness	Placental Thickness	
Sac Diam1	Gestational Sac Diameter 1	
Sac Diam2	Gestational Sac Diameter 2	
Sac Diam3	Gestational Sac Diameter 3	
AF1	Amniotic Fluid 1	
AF2	Amniotic Fluid 2	
AF3	Amniotic Fluid 3	
AF4	Amniotic Fluid 4	
LVIDd	Left Ventricular Internal Diameter at End-diastole	

Tools	Descriptions	Methods or formulae
LVIDs	Left Ventricular Internal Diameter at End-systole	Distance in 2D General Measurements
LV Diam.	Left Ventricular Diameter	
LA Diam.	Left Atrium Diameter	
RVIDd	Right Ventricular Internal Diameter at End-diastole	
RVIDs	Right Ventricular Internal Diameter at End-systole	
RV Diam.	Right Ventricular Diameter	
RA Diam.	Right Atrium Diameter	
IVSd	Interventricular Septal Thickness at End-diastole	Distance in 2D General Measurements
IVSs	Interventricular Septal Thickness at End-systole	
IVS	Interventricular Septal Thickness	
LV Area	Left Ventricular Area	
LA Area	Left Atrium Area	
RV Area	Right Ventricular Area	
RA Area	Right Atrium Area	
Ao. Diam.	Aorta Diameter	
MPA Diam.	Main Pulmonary Artery Diameter	
LVOT Diam.	Left Ventricular Outflow Tract Diameter	
RVOT Diam.	Right Ventricular Outflow Tract Diameter	
Facial Angle	Angle of the two lines: one from fetus nasal base to forehead and the other from nasal base to ear base.	Angle in 2D General Measurements
HrtA	Heart area	Area in 2D General Measurements

Tools	Descriptions	Methods or formulae
MV Diam(Z-Score)	Mitral Valve diameter	Distance in 2D General Measurements
PV Diam(Z-Score)	Pulmonary Valve Diameter	
Ao. Asc. Diam(Z-Score)	Ascending Aorta Diameter	
Ao. Desc. Diam(Z-Score)	Descending Aorta Diameter	
Duct. Art. Diam(Z-Score)	Ductus Arteriosus Diameter	
TV Diam(Z-Score)	Tricuspid Valve Diameter	
LPA Diam(Z-Score)	Left Pulmonary Artery Diameter	
RPA Diam(Z-Score)	Right Pulmonary Artery Diameter	
AV Diam(Z-Score)	Aorta Valve Diameter	
IVC Diam(Z-Score)	Inferior Vena Cava Diameter	
MPA Diam(Z-Score)	/	
RV Diam(Z-Score)	/	
LV Diam(Z-Score)	/	
RV Area(Z-Score)	/	
LV Area(Z-Score)	/	
RVIDd(Z-Score)	/	
lVIDd(Z-Score)	/	
UT L	Uterine Length	Distance, Trace and Spline in 2D General Measurements
UT H	Uterine Height	Distance in 2D General Measurements
UT W	Uterine Width	
Endo.	Endometrium Thickness	
AC (c)	/	Cross for area in 2D General Measurements AC(c) = π(TAD+APAD)/2

Calculation

Tools	Descriptions	Methods or formulae
Mean Sac Diam	Mean Gestational Sac Diameter	The average value of three sac diameters
AFI	/	Measure the maximum AFs of the four amniotic fluid pockets of pregnant woman. AFI = AF1+AF2+AF3+AF4

Tools	Descriptions	Methods or formulae
EFW	Estimated Fetal Weight 1	EFW is calculated by the default EFW formula, based on multiple measured parameters. The formula can be reselected in the OB report.
EFW2	Estimated Fetal Weight 2	
HC/AC	/	HC/AC
FL/AC	/	FL/AC×100
FL/BPD	/	FL/BPD ×100%
AXT	/	APTD × TTD
CI	/	BPD/OFD ×100%
FL/HC	/	FL/AC×100
HC(c)	/	$HC(c) = 2.325\times(BPD^2 + OFD^2)^{1/2}$
HrtC/TC	/	HrtC/TC
TCD/AC	/	TCD/AC
LVW/HW	/	LVW/HW × 100%
LVD/RVD	/	LV Diam/RV Diam
LAD/RAD	/	LA Diam/RA Diam
AoD/MPAD	/	Ao Diam/MPA Diam
LAD/AoD	/	LA Diam/Ao Diam
UT Vol.	UT Volume	UT L, UT H, UT W
Uterus Body	/	UT L,UT H, UT W Uterus Body (cm) = UT L (cm) + UT H (cm) + UT W (cm)
UT-L/ CX-L	/	UT L, Cervix L UT-L/CX-L (No unit) = UT L (cm) / Cervix L (cm)

Study

Tools	Methods or formulae
AFI	AF1, AF2, AF3, AF4 AFI=AF1+AF2+AF3+AF4
Uterus	UT L, UT H, UT W, Endo **NOTE:** If the Uterus and Cervix L has been measured, the system also calculates the UT-L/CX-L.

4.2.2 M Mode

Measurement

Tools	Descriptions	Methods or formulae
OB_FHR(M)	Fetal Heart Rate	Heart Rate in M General Measurements
LVIDd	Left ventricular short-axis diameter at end diastole	Distance in 2D General Measurements
LVIDs	Left ventricular short-axis diameter at end systole	
RVIDd	Right ventricular short-axis diameter at end diastole	
RVIDs	Right ventricular short-axis diameter at end systole	
IVSd	interventricular septal thickness at end diastole	
IVSs	interventricular septal thickness at end systole	
RVIDd(Z-Score)	/	
LVIDd(Z-Score)	/	

4.2.3 Doppler Mode

Measurement

Tools	Descriptions	Methods or formulae
Umb A	Umbilical Artery	D trace in General D measurements
Placenta A	Placenta Artery	
MCA	Middle Cerebral Artery	
Fetal Ao.	Fetal Aorta	
Desc. Aorta	Descending Aorta	
Ut. A	Uterine Artery	
Ovarian A	Ovarian Artery	
Duct. Veno	Ductus Veno	D trace in General D measurements Acquire Duct Veno D by 3-PT method to measure peak value of ventricular systole (S), peak value of early diastole (D) and minimum value of atrial contraction (a).
OB_FHR(Doppler)	Fetal Heart Rate	HR in General D measurements

Tools	Descriptions	Methods or formulae
Asc. Aorta	Ascending Aorta	D trace in General D measurements
RVOT	Right Ventricle Outflow Tract	
LVOT	Left Ventricle Outflow Tract	

4.3 Auto OB Measurement (Smart OB)

There is an auto measurement method for commonly-used OB measurement items (BPD, HC, AC, FL, HUM, OFD and etc.).

Perform the following procedure:

1. Scan the proper image.
2. Select the OB measurement item from the menu and select the [Auto] method.
3. The measurement caliper is drawn on the image automatically.

   If the result of the auto measurement does not match the image exactly, press <Update> and use the trackball to modify the caliper.
4. Press <Set> to confirm the measurement.

4.4 Auto NT Measurement (Smart NT)

There is an auto measurement method for NT measurement item.

Perform the following procedure:

1. Scan the proper image.
2. Select the NT measurement item from the menu and select the [Auto] method.
3. The measurement caliper is drawn on the image automatically.

   You can move the cursor to modify the caliper if the result of the auto measurement does not match the image exactly.
4. Press <Set> to confirm the measurement.

   Or, press <Update>/<Clear> to modify the caliper for a more accurate result.

4.5 Multi-Fetus Exam

NOTE:

Ensure that the fetus displayed in the multi-fetus measurement menu is the one on which you intend to perform the measurements.

The system allows multi-fetus examination (4 at most). In a similar way to the OB measurement:

Perform the following procedure:

1. Set the number of fetuses in [Gestations] via [Info] > [OB].

   If [Gestations] is set to be more than 1, the [Fetus] widget displays in the OB measurement menu, You can switch between [Fetus A], [Fetus B], [Fetus C] or [Fetus D] via the [Fetus] button on the touch screen.
2. Carry out the measurement of the fetus respectively.

The measurement results in the results window are marked with fetus label A, B or C.

3. In the Obstetric report, select [Fetus A], [Fetus B], [Fetus C] or [Fetus D] to switch between the results for different fetuses.
4. Tap [Fetus Compare] on the touch screen to see a visualized comparison result.
5. In the [OB Graph] dialog box, select [A], [B], [C] or [D] to display the growth curves of the different fetuses.
   - Data of Fetus: different symbols are used on the growth curves to identify measurement data of different fetuses.
   - Historic/current data: symbol size is used to differentiate, with historic data appearing in smaller symbols.

TIP:

You can select whether to print multi-fetus data in one report via [Report] > [Setting].

4.6 GA

4.6.1 Clinical GA

The GA (Gestational Age) and EDD (Estimated Delivery Date) are calculated according to clinical parameters.

Tap [Info] on the touch screen and register the patient information in the [Patient Info] > [OB] dialog box. The system automatically calculates the GA and EDD after entering the relative information. The clinical GA is shown at the top of the obstetric report.

The calculation methods are listed as follows:

- LMP: enter the LMP, the system will calculate the GA and EDD.
- DOC: enter the DOC, the system will calculate the GA and EDD.
- IVF: after you enter IVF, the system will calculate the GA and EDD.
- PRV: enter the date and GA of the last exam, the system will calculate a new GA and EDD.
- BBT: after you enter BBT, the system will calculate the GA and EDD.
- EDD: enter the EDD, the system will calculate the GA and LMP.

NOTE:

The latest EDD and GA calculation is considered as the final value if more than one EDD and GA calculations are valid.

4.6.2 Ultrasound GA

The ultrasound GA and ultrasound EDD are calculated according to the parameters obtained in the measurements.

- GA in OB Items
- AUA (Average Ultrasound Age)
- CUA (Composite Ultrasound Age)

GA in OB Items

The GA in the OB items is calculated from the related GA tables/formulae. It is independent from the clinical GA.

Perform the following procedure:

1. Preset the GA formulae and whether to display the EDD or not.

   See *Basic Volume* for details.

2. The GA and other measurement values display in the results window after a measurement.

   If the Diagnostic GA exceeds the threshold, an OOR (out of range) displays in the results window and this result is not recorded in the report.

   The GA of an OB item displays to the right of the item measurements.

3. For result values used to calculate GA (Gestational Age) and EDD (Estimated Date of Delivery), the formula used in this calculation can be selected from [Formula].

AUA

AUA is the average of the valid GAs that are calculated according to the biparietal diameter (BPD), head circumference (HC), abdomen circumference (AC), femur length (FL), Gestational Sac (GS), crown rump length (CRL), etc.

All valid values of all the above items will be included in the AUA calculation in the system default method.

Click the checkboxes to the right of the related items to select whether to include the item in the AUA calculation or not. The AUA value varies according to the selection.

CUA

The CUA is calculated according to formulae based on certain measurement items (the items involved include the biparietal diameter (BPD), head circumference (HC), abdomen circumference (AC) and femur length (FL)). To calculate the CUA, all the GA formulae of the parameters involved must be Hadlock, the unit of the parameters is cm and unit of CUA is week. The formulae are listed as follows:

- $CUA(BPD) = 9.54+1.482\times BPD+0.1676\times BPD^2$
- $CUA(HC) = 8.96+0.540\times HC+0.0003\times HC^3$
- $CUA(AC) = 8.14+0.753\times AC+0.0036\times AC^2$
- $CUA(FL) = 10.35+2.460\times FL+0.170\times FL^2$
- $CUA(BPD, HC) = 10.32+0.009\times HC^2+1.3200\times BPD+0.00012\times HC^3$
- $CUA(BPD, AC) = 9.57+0.524\times AC+0.1220\times BPD^2$
- $CUA(BPD, FL) = 10.50+0.197\times BPD\times FL+0.9500\times FL+0.7300\times BPD$
- $CUA(HC, AC) = 10.31+0.012\times HC^2+0.3850\times AC$
- $CUA(HC, FL) = 11.19+0.070\times HC\times FL+0.2630\times HC$
- $CUA(AC, FL) =10.47+0.442\times AC+0.3140\times FL^2 - 0.0121\times FL^3$
- $CUA(BPD, HC, AC) = 10.58+0.005\times HC^2 +0.3635\times AC+ 0.02864\times BPD\times AC$
- $CUA(BPD, HC, FL) = 11.38+0.070\times HC\times FL+0.9800\times BPD$
- $CUA(BPD, AC, FL) = 10.61+0.175\times BPD\times FL+0.2970\times AC+0.7100\times FL$
- $CUA(HC, AC, FL) = 10.33+0.031\times HC\times FL+0.3610\times HC+0.0298\times AC\times FL$
- $CUA(BPD, HC, AC, FL)=10.85+0.060\times HC\times FL+0.6700\times BPD+0.1680\times AC$

The default method of calculating the CUA is to use the formula that involves more measurement items. You can also select the parameters by clicking the checkboxes to the right of the related items.

OB Growth Percentile

The obstetric growth percentile is used to estimate the fetal growth. It calculates the difference between the ultrasound measurement results and the measurement results corresponding to the clinical GA in the FG table. The percentile will not be calculated when there is no clinical GA, or no FG table, or the SD Type of the FG table is set to “None.”

The premise is: data in the FG table are (approximately) normally distributed and support “lower-limit < average value < upper-limit.”

The system does not calculate the OB growth percentile if:

- An FG table is not normally distributed.
- There is no upper/lower deviation set in the FG table.
- The FG table has the upper/lower deviation set, but certain clinical GA values have no upper/ lower deviation or the deviation value is not plus. The fetal growth curve is not affected. E.g. Jeanty FG table of RAD.

The OB growth percentile is displayed in the results window, the measurement report, the exported PDF/RTF report and the OB structured report, and it supports print viewing and printing.

4.7 Obstetric Formula

The obstetric formulae are used in the GA, EFW calculations and Fetal Growth Curve.

4.7.1 GA and FG Formulae

GA will be automatically calculated after the corresponding measurements are completed. The system will recalculate the GA after new measurements are completed.

The GA and FG formulae are shown in the table below:

NOTE:

“/” means no formula provided for the item.

Tools	GA	FG
EFW/EFW2	Tokyo Hadlock	Hadlock Hansmann Tokyo Brenner William CFEF_2014 Persson IG-21
GS	Tokyo Rempen Hansmann China	Tokyo Hellman Rempen Hansmann

Tools	GA	FG
CRL	Tokyo Jeanty Hadlock Nelson Robinson Rempen Hansmann China ASUM Daya RobinsonBMUS Daya Verburg IG-21	Tokyo Hadlock Robinson Rempen Hansmann ASUM Medvedev IG-21
BPD	Tokyo Hadlock Jeanty Kurtz Hansmann Merz Rempen ChittyOI Osaka China Nicolaides ASUM CFEF Verburg	Tokyo Hadlock Kurtz Jeanty Sabbagha Hansmann Merz Rempen ChittyOI Osaka Nicolaides ASUM CFEF_2000/2006 Medvedev Verburg IG-21
HC	Hadlock Jeanty Hansmann Nicolaides ASUM CFEF Chitty	Hadlock Merz Jeanty Hansmann Nicolaides ASUM CFEF_2000/2006 Chitty IG-21 Medvedev Verburg

Tools	GA	FG
AC	Hadlock Jeanty Merz Nicolaides ASUM CFEF Hansmann Chitty	Hadlock Jeanty Merz Nicolaides ASUM CFEF_2000/2006 Hansman Chitty Medvedev Verburg IG-21
FL	Hadlock Tokyo Jeanty Hohler Merz Hansmann Warda Chitty Osaka China Nicolaides ASUM CFEF	Hadlock Tokyo Jeanty Merz Hansmann O'Brien Warda Chitty Osaka Nicolaides ASUM CFEF_2000/2006 Medvedev Verburg IG-21
OFD	Hansmann Nicolaides ASUM Jeanty	Merz Hansmann Nicolaides ASUM Jeanty Medvedev IG-21
APAD	/	Merz
TAD	CFEF	Merz
FTA	OSAKA	OSAKA
THD	Hansmann	Hansmann
HUM	Jeanty ASUM	Jeanty Merz ASUM Medvedev
Ulna	Jeanty	Merz Jeanty Medvedev

Tools	GA	FG
Tibia	Jeanty	Merz Jeanty Medvedev
RAD	Jeanty	Merz
FIB	Jeanty	Merz Jeanty
CLAV	Yarkoni	Yarkoni
TCD	Hill Nicolaides	Goldstein Hill Nicolaides Verburg
OOD	Jeanty	Jeanty
Cist Magna	/	Nicolaides
Mean Sac Diam	Daya Hellman	/
MCA PI	/	JSUM
MCA RI	/	JSUM
Umb A PI	/	JSUM
Umb A RI	/	JSUM
Ut A PI	/	Merz
Ut A RI	/	Merz
AFI	/	Moore
FL/HC (Hadlock)	/	Hadlock
HC/AC (Campbell)	/	Campbell
AC(c)	Hadlock	Chitty Hadlock
Ut A PI	/	Merz
Ut A RI	/	Merz
Duct Veno PIV	/	Baschat
Duct Veno PVIV	/	Baschat
Duct Veno PLI	/	Baschat
Duct Veno S/a	/	Baschat
Foot	Mercer	Mercer
NBL	/	Bunduki Sonek

4.7.2 Fetal Weight Formulae

EFW is a calculation item. If all tools required for the EFW formula have been performed, EFW will be obtained automatically. The system will recalculate the EFW after new measurements are completed.

Formulae of EFW and EFW2 of GA/FG are different from those on the [Fetal Calc] page ([Setup] > [System Preset] > [OB] page).

- EFW formulae of GA/FG are used to perform the GA calculation or the Fetal Growth Curve based on EFW.
- EFW formulae on the [Fetal Growth] page are used in the EFW calculation based on certain OB measurement results (e.g., AC).

The Fetal Weight formulae are shown in the following table:

Formulae	Descriptions	Units	
		EFW	Item
Hadlock (AC, FL)	EFW= 10^(1.304+ (0.05281×AC)+ (0.1938×FL)- (0.004×AC×FL))	g	cm
	SD=0.154×EFW SD Type=±2SD	g	g
Hadlock (AC, FL, BPD)	EFW= 10^(1.335 -(0.0034×AC×FL) + (0.0316×BPD) + (0.0457×AC) + (0.1623×FL))	g	cm
	SD=0.146×EFW SD Type=±2SD	g	g
Hadlock (AC, FL, HC)	EFW= 10^(1.326-(0.00326×AC×FL)+ (0.0107×HC)+ (0.0438×AC)+ (0.158×FL))	g	cm
	SD=0.148×EFW SD Type=±2SD	g	g
Hadlock (AC, FL, HC, BPD)	EFW= 10^(1.3596- (0.00386×AC×FL)+ (0.0064×HC)+ (0.00061×BPD×AC)+ (0.0424×AC)+ (0.174×FL))	g	cm
	SD=0.146×EFW SD Type=±2SD	g	g
Hadlock (AC, BPD)	EFW = 10^ (1.1134 + 0.05845*AC -0.000604* (AC^2) - 0.007365* (BPD^2) + 0.000595* (BPD*AC) + 0.1694*BPD)	g	cm
Shepard (AC, BPD)	EFW = 10^(-1.7492+ (0.166×BPD)+ (0.046×AC)- (2.646×AC×BPD/1000))	kg	cm
	SD=0.202×EFW SD Type=±2SD	g	g
Merz1 (AC, BPD)	EFW=-3200.40479+(157.07186×AC)+(15.90391×(BPD^2))	g	cm
Merz2 (AC)	EFW=0.1×(AC^3)	g	cm
Hansmann (BPD, THD)	EFW = (-1.05775×BPD)+ (0.0930707×(BPD^2))+ (0.649145×THD)- (0.020562×(THD^2))+ 0.515263	kg	cm
Tokyo (BPD, APTD, TTD, FL)	EFW=(1.07×(BPD^3))+(3.42×APTD×TTD×FL)	g	cm
Osaka (FL, BPD, FTA)	EFW=(1.25674×(BPD^3))+(3.50665×FTA×FL)+6.3	g	cm
Campbell (AC)	EFW = EXP (-4.564+(0.282×AC)-(0.00331× (AC^2)))	kg	cm
Schild(HC, AC, FL)	EFW = 5381.193 + 150.324×HC + 2.069×FL^3 + 0.0232×AC^3 - 6235.478×log(HC)	g	cm

Formulae	Descriptions	Units	
		EFW	Item
Person(BPD, FL, MAD)	EFW = (BPD×10)^0.972 × (MAD×10)^1.743× (FL×10)^0.367 ×10^(-2.646)	g	cm
IG-21 (AC, HC)	log(EFW) = 5.084820 - 54.06633*(AC/100))^3 - 95.80076*(AC/100))^3*log(AC/100) + 3.136370*(HC/100)	g	cm

4.7.3 Weight Percentile for Age

The Clinical Percentile (CP) and Ultrasound Percentile (UP) is calculated and displayed in the report in the following format according to the formula selected for EFW calculation.

- CP (Calc Method) (Formula) ××.××%: Where Calc Method may be LMP, PRV, IVF, BBT, DOC and EDD.
- UP (Calc Method) (Formula) ××.××%: Where Calc Method may be AUA, CUA.

Clinical Percentile (CP)

Find the average value and calculate the threshold range in the formula (to calculate EFW) in the FG table according to the clinical GA (obtained in patient information such as LMP, IVF).

If the actual EFW value is in the following range, keep calculating. If not, the CP will not be displayed.

average EFW x1.25 > EFW > average EFW x0.75

E.g. EFW-GP(LMP) is the EFW Clinical Percentile calculated from the LMP obtained from the patient information.

Ultrasound Percentile (UP)

This has the same calculation method as CP except for using the ultrasound GA instead of clinical GA.

E.g. EFW-GP(AUA) and EFW-GP(CUA) is the EFW Clinical Percentile calculated from the AUA and CUA respectively.

4.8 References

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5 Cardiology

NOTE:

- The heartbeat of the traced spectrum in VTI measurement should be equal to that preset, otherwise the obtained HR (Heart Rate) will be incorrect, see *Basic Volume* for the relevant preset.
- Some application items in the measurement preset library (and matching list in the results assignment) are displayed different from those in the measurement menu and results window.

  In the preset library (and matching list in the results assignment), the item is followed with the word indicating the mode or location.

5.1 Basic Measurement Procedures

1. Press <Patient> on the control panel and enter the patient information.
2. Perform the scanning to acquire the desired image.
3. Press <Measure> to enter the Application Measurement.
4. Select the study tool, and select measurement tool from the measurement menu to start the measurement.
   - For measurement tools, see "5.2 Measurement Tools".
   - For measurement methods, see "2 General Measurement".

   The system calculates and displays the results after the measurement tools have been completed.

5.2 Measurement Tools

5.2.1 2D Mode

Measurement

Tools	Descriptions	Methods or formulae
LA Diam	Left Atrium Diameter	Distance in 2D General Measurements
LA Major	Left Atrium Major Diameter	
LA Minor	Left Atrium Minor Diameter	
RA Major	Right Atrium Major Diameter	
RA Minor	Right Atrium Minor Diameter	
LV Major	Left Ventricular Major Diameter	
LV Minor	Left Ventricular Minor Diameter	
RV Major	Right Ventricular Major Diameter	
RV Minor	Right Ventricular Minor Diameter	
LA Area	Left Atrium Area	Area in 2D General Measurements
RA Area	Right Atrium area	
LV Area(d)	Left Ventricular area at end-diastole	The system automatic calculates FAC value. FAC=((LV Area(d)- LV Area(s))/ LV Area(d))×100%
LV Area(s)	Left Ventricular area at end-systole	
RV Area(d)	Right Ventricular area at end-diastole	The system automatic calculates RV FAC value. RV FAC=((RV Area(d)- RV Area(s))/ RV Area(d))×100%
RV Area(s)	Right Ventricular area at end-systole	
LVAd sax MV	Left Ventricular Area at Mitral Valve level at End-diastole in Short-axis view	Area in 2D General Measurements
LVAs sax MV	Left Ventricular Area at Mitral Valve level at End-systole in Short-axis view	
LVAd apical	Left Ventricular Long-axis Area at End-diastole in apical view	
LVAs apical	Left Ventricular Long-axis Area at end-systole in apical view	
LVAd sax Epi	Left Ventricular Epicardial Area at Papillary Muscle level at end-diastole in Short-axis view	
LVAd sax Endo	Left Ventricular Endocardial Area at Papillary Muscle level at end-diastole in Short-axis view	

Tools	Descriptions	Methods or formulae
LVIDd	Left Ventricular Internal Diameter at end-diastole	The system automatic calculates RWT value. RWT=(LVPWd(cm)×2)/LVIDd(cm)
LVPWd	Left Ventricular Posterior wall thickness at end-diastole	
LVIDs	Left Ventricular Internal Diameter at end-systole	Distance in 2D General Measurements
RVDd	Right Ventricular Diameter at end-diastole	
RVDs	Right Ventricular Diameter at end-systole	
LVPWs	Left Ventricular Posterior wall thickness at end-systole	
RVAWd	Right Ventricular Anterior wall thickness at end-diastole	
RVAWs	Right Ventricular Anterior wall thickness at end-systole	
IVSd	Interventricular Septal Thickness at end-diastole	
IVSs	Interventricular Septal Thickness at end-systole	
LVLd apical	Left Ventricular Long-axis Length at End-diastole in apical view	
LVLs apical	Left Ventricular Long-axis Length at End-systole in apical view	
Ao Diam	Aorta Diameter	
Ao Arch Diam	Aorta Arch Diameter	
Ao Asc Diam	Ascending Aorta Diameter	
Ao Desc Diam	Descending Aorta Diameter	
Ao Isthmus	Aorta Isthmus Diameter	
Ao st junct	Aorta ST Junction Diameter	
Ao Sinus Diam	Aorta Sinus Diameter	
Duct Art Diam	Ductus Arteriosus Diameter	
Pre Ductal	Previous Ductal Diameter	
Post Ductal	Posterior Ductal Diameter	
ACS	Aortic Valve Cusp Separation	
LVOT Diam	Left Ventricular Outflow Tract Diameter	
AV Diam	Aorta Valve Diameter	
AVA	Aortic Valve Area	Area in 2D General Measurements

Tools	Descriptions	Methods or formulae
PV Diam	Pulmonary Valve Diameter	Distance in 2D General Measurements
LPA Diam	Left Pulmonary Artery Diameter	
RPA Diam	Right Pulmonary Artery Diameter	
MPA Diam	Main Pulmonary Artery Diameter	
RVOT Diam	Right Ventricular Outflow Tract Diameter	
MV Diam	Mitral Valve diameter	
MVA	Mitral Valve Area	Area in 2D General Measurements
MCS	Mitral Valve Cusp Separation	Distance in 2D General Measurements
MV EPSS	Distance between point E and Interventricular Septum when mitral valve is fully open	
TV Diam	Tricuspid Valve Diameter	
TVA	Tricuspid Valve Area	Area in 2D General Measurements
IVC Diam(Insp)	Inferior Vena Cava Inspiration Diameter	The system automatically calculates IVC Depth(Expir), IVC Depth(Insp), IVC Diam(Expir), IVC Diam(Insp), SVC Depth(Insp), SVC Diam(Insp), SVC Depth(Expir), SVC Diam(Expir), IVC-CI, IVC-DI, SVC-CI, SVC-DI value. IVC-CI = |IVC Diam(Expir) - IVC Diam(Insp)| / Max (IVC Diam(Expir), IVC Diam(Insp)) • IVC-DI = |IVC Diam(Expir) - IVC Diam(Insp)| / Min (IVC Diam(Expir), IVC Diam(Insp)) • SVC-CI = |SVC Diam(Expir) - SVC Diam(Insp)| / Max (SVC Diam(Expir), SVC Diam(Insp)) • SVC-DI = |SVC Diam(Expir) - SVC Diam(Insp)| / Min (SVC Diam(Expir), SVC Diam(Insp))
IVC Diam(Expir)	Inferior Vena Cava Expiration Diameter	
SVC Diam(Insp)	Superior Vena Cava Inspiration Diameter	
SVC Diam(Expir)	Superior Vena Cava Expiration Diameter	
LCA Diam	Left Coronary Artery	Distance in 2D General Measurements
RCA Diam	Right Coronary Artery	
VSD Diam	Ventricular Septal Defect Diameter	
ASD Diam	Atrial Septal Defect Diameter	
PDA Diam	Patent Ductus Arteriosus Diameter	
PFO Diam	Patent Oval Foramen Diameter	
PEd	Pericardial Effusion at diastole	
PEs	Pericardial Effusion at systole	
HR	Heart Rate	Heart Rate in M General Measurements

Tools	Descriptions	Methods or formulae
Diastole	End-diastolic Left Ventricular Measurement	FoldLine in 2D mode
Systole	End-systolic Left Ventricular Measurement	
RA Vol(A4C)	Right Atrium Volume (4-chamber)	see “5.4.1 Left Ventricular Function”
AutoEF	Automatic measuring of the diastolic and systolic sectional planes	see “5.3.2 AutoEF”
RAP	Right Atrium Pressure	Select from the pop-up dialog box or enter a value manually, see “5.4.7 RVSP (Right Ventricular Systolic Pressure)”

Calculation

Tools	Descriptions	Methods or formulae
LA/Ao	Left Atrium Diameter/ Aorta Diameter	LA Diam (cm) / Ao Diam (cm)

Study

For details, see “5.4 Study Tool Operations”.

5.2.2 M Mode

Measurement

Tools	Descriptions	Methods or formulae
LA Diam.	Left Atrium Diameter	Distance in M General Measurements
LVIDd	Left Ventricular Internal Diameter at end-diastole	The system automatic calculates RWT value. RWT=(LVPWd(cm)×2)/ LVIDd(cm)
LVPWd	Left Ventricular Posterior wall thickness at end-diastole	

Tools	Descriptions	Methods or formulae
LVIDs	Left Ventricular Internal Diameter at end-systole	Distance in M General Measurements
RVDd	Right Ventricular Diameter at end-diastole	
RVDs	Right Ventricular Diameter at end-systole	
LVPWs	Left Ventricular Posterior wall thickness at end-systole	
RVAWd	Right Ventricular Anterior wall thickness at end-diastole	
RVAWs	Right Ventricular Anterior wall thickness at end-systole	
IVSd	Interventricular Septal Thickness at end-diastole	
IVSs	Interventricular Septal Thickness at end-systole	
Ao. Diam.	Aorta Diameter	
Ao. Arch Di-am.	Aorta Arch Diameter	
Ao. Asc. Di-am.	Ascending Aorta Diameter	
Ao. Desc. Diam.	Descending Aorta Diameter	
Ao. Isthmus	Aorta Isthmus Diameter	
Ao. ST Junct.	Aorta ST Junction Diameter	
Ao. Sinus Diam.	Aorta Sinus Diameter	
LVOT Diam.	Left Ventricular Outflow Tract Diameter	
ACS	Aortic Valve Cusp Separation	
LPA Diam.	Left Pulmonary Artery Diam-eter	
RPA Diam.	Right Pulmonary Artery Diameter	
MPA Diam.	Main Pulmonary Artery Diameter	
RVOT Diam.	Right Ventricular Outflow Tract Diameter	
MV E Amp.	Amplitude of the Mitral Valve E wave	
MV A Amp.	Amplitude of the Mitral Valve A wave	
MV E-F Slope	Mitral Valve E-F slope	Slope in M General Measurements
MV D-E Slope	Mitral Valve D-E slope	

Tools	Descriptions	Methods or formulae
MV D-E Amp	Amplitude of the Mitral Valve DE wave	Distance in M General Measurements
MCS	Mitral Valve Cusp Separation	
MV EPSS	Distance between point E and the interventricular septum	
PEd	Pericardial Effusion at dias-tole	
PEs	Pericardial Effusion at systole	
LVPEP	Left Ventricular pre-ejection period	Time in M General Measurements
LVET	Left Ventricular Ejection Time	
RVPEP	Right Ventricular Pre-Ejection Period	
RVET	Right Ventricular Ejection Time	
HR	Heart Rate	Heart Rate in M General measurements
Diastole	End-diastolic Left Ventricular Measurement	Parallel method in M mode
Systole	End-systolic Left Ventricular Measurement	
MAPSE	Mitral Annular Plane Systolic Excursion	Time in M General Measurements
TAPSE	Tricuspid Annular Plane Systolic Excursion	Distance in M General Measurements
MV ALL	M wave measurement of mitral valve anterior leaflet	see “5.3.1 MV ALL”

Calculation

Tools	Descriptions	Methods or formulae
LA/Ao	Left Atrium Diameter/ Aorta Diameter	LA Diam (cm) / Ao Diam (cm)

Study

For details, see “5.4 Study Tool Operations”.

5.2.3 Doppler Mode

Measurement

Tools	Descriptions	Methods or formulae
MV Vmax	Mitral Valve Maximum Velocity	D Vel. in Doppler General Measurements
MV E Vel.	Mitral Valve E-wave Velocity	
MV A Vel.	Mitral Valve A-wave Velocity	

Tools	Descriptions	Methods or formulae
MV E VTI	Mitral Valve E-wave Velocity-Time Integral	D Trace in Doppler General Measurements
MV A VTI	Mitral Valve A-wave Velocity-Time Integral	
MV VTI	Mitral Valve Velocity-Time Integral	
MV AccT	Mitral Valve Acceleration Time	Acceleration in Doppler General Measurements
MV DecT	Mitral Valve Deceleration Time	
IVRT	Mitral Valve Isovolumic Relaxation Time	Time in Doppler General Measurements
IVCT	Mitral Valve Isovolumic Con-traction Time	
MV E Dur.	Mitral Valve E-wave Duration	
MV A Dur.	Mitral Valve A-wave Duration	
LVOT Vmax	Left Ventricular Outflow Tract Maximum Velocity	D Vel. in Doppler General Measurements
LVOT VTI	Left Ventricular Outflow Tract Velocity-Time Integral	D Trace in Doppler General measurements
LVOT AccT	Left Ventricular Outflow Tract Acceleration Time	Acceleration in Doppler General Measurements
AAo Vmax	Ascending Aorta Maximum Velocity	D Vel. in Doppler General Measurements
DAo Vmax	Descending Aorta Maximum Velocity	
AV Vmax	Aorta Valve Maximum Velocity	
AV VTI	Aorta Valve Velocity-Time Integral	D Trace in Doppler General measurements
LVPEP(Doppler)	Left Ventricular Pre-Ejection Period	Time in Doppler General Measurements
LVET(Doppler)	Left Ventricular Ejection Time	
AV AccT	Aorta Valve Acceleration Time	
AV DecT	Aorta Valve Deceleration Time	
RVET(Doppler)	Right Ventricular Ejection Time	Time in Doppler General Measurements
RVPEP(Doppler)	Right Ventricular Pre-Ejection Period	
TV Vmax	Tricuspid Valve Maximum Velocity	D Vel. in Doppler General Measurements
TV E Vel.	Tricuspid Valve E-wave Flow Velocity	
TV A Vel.	Tricuspid Valve A-wave Flow Velocity	
TV VTI	Tricuspid Valve Velocity-Time Integral	D Trace in Doppler General measurements
TV AccT	Tricuspid Valve Acceleration Time	Acceleration in Doppler General Measurements
TV DecT	Tricuspid Valve Deceleration Time	
TV A Dur.	Tricuspid Valve A-wave Duration	Time in Doppler General Measurements

Tools	Descriptions	Methods or formulae
RVOT Vmax	Right Ventricular Outflow Tract Maximum Velocity	D Vel. in Doppler General Measurements
RVOT VTI	Right Ventricular Outflow Tract Velocity-Time Integral	D Trace in Doppler General measurements
PV Vmax	Pulmonary Valve Maximum Velocity	D Vel. in Doppler General Measurements
PV VTI	Pulmonary Valve Velocity-Time Integral	D Trace in Doppler General measurements
PV AccT	Pulmonary Valve Acceleration Time	Acceleration in Doppler General Measurements
PR DecT	Pulmonary Artery Regurgatation Deceleration Time	Acceleration in Doppler General Measurements
MPA Vmax	Main Pulmonary Artery Maximum Velocity	D Vel. in Doppler General Measurements
RPA Vmax	Right Pulmonary Artery Maximum Velocity	
LPA Vmax	Left Pulmonary Artery Maximum Velocity	
PVein S Vel.	Pulmonary Vein S-wave Flow Velocity	D Vel. in Doppler General Measurements
PVein D Vel.	Pulmonary Vein D-wave Flow Velocity	
PVein A Vel.	Pulmonary Vein A-wave Flow Velocity	
PVein A Dur.	Pulmonary Vein A-wave Duration	Time in Doppler General Measurements
PVein S VTI	Pulmonary Vein S-wave Velocity-time Integral	D Trace in Doppler General measurements
PVein D VTI	Pulmonary Vein D-wave Velocity-time Integral	
PVein DecT	Pulmonary Vein Deceleration Time	Time in Doppler General Measurements
IVC Vel. (Insp.)	Inferior Vena Cava Inspiration Maximum Velocity	D Vel. in Doppler General Measurements
IVC Vel. (Expir.)	Inferior Vena Cava Expiration Maximum Velocity	
SVC Vel. (Insp.)	Superior Vena Cava Inspiration Maximum Velocity	
SVC Vel. (Expir.)	Superior Vena Cava Expiration Maximum Velocity	
MR Vmax	Mitral Valve Regurgitation Maximum Velocity	
MR VTI	Mitral Valve Regurgitation Velocity-Time Integral	D Trace in Doppler General measurements
MS Vmax	Mitral Valve Stenosis Maximum Velocity	D Vel. in Doppler General Measurements

Tools	Descriptions	Methods or formulae
dP/dt	Rate of Pressure change	dP/dt Measurement
AR Vmax	Aortic Valve Regurgitation Maximum Velocity	D Vel. in Doppler General Measurements
AR VTI	Aortic Valve Regurgitation Velocity-Time Integral	D Trace in Doppler General measurements
AR DecT	Aortic Valve Regurgitation Deceleration Time	Acceleration in Doppler General Measurements
AR PHT	Aortic Valve Regurgitation Pressure Half Time	Doppler Measurement
AR Ved	Aortic Valve Regurgitation Velocity at end-Diastole	D Vel. in Doppler General Measurements
TR Vmax	Tricuspid Valve Regurgitation Maximum Velocity	
TR VTI	Tricuspid Valve Regurgitation Velocity-Time Integral	D Trace in Doppler General measurements
PR Vmax	Pulmonary Valve Regurgitation Maximum Velocity	D Vel. in Doppler General Measurements
PR VTI	Pulmonary Valve Regurgitation Velocity-Time Integral	D Trace in Doppler General measurements
PR PHT	Pulmonary Valve Regurgitation Pressure Half Time	Doppler Measurement
PR Ved	Pulmonary Valve Regurgitation Velocity at end-Diastole	D Vel. in Doppler General Measurements
VSD Vmax	Ventricular Septal Defect Maximum Velocity	
ASD Vmax	Atrial Septal Defect Maximum Velocity	
PDA Vel(d)	Patent Ductus Arteriosus Velocity at End-diastole	
PDA Vel(s)	Patent Ductus Arteriosus Velocity at End-systole	
Coarc. Pre-Duct.	Coarctation of Pre-Ductus	
Coarc. Post-Duct.	Coarctation of Post-Ductus	
AV/TV/MV/PV HR	Heart Rate	HR in Doppler General Measurements
RAP	Right Atrium Pressure	Select from the pop-up dialog box or enter a value manually. For RAP measurements, see "5.4.7 RVSP (Right Ventricular Systolic Pressure)"
Hepatic V S Vel.	Hepatic Vein Systolic Peak Velocity	D Vel. in Doppler General Measurements
Hepatic V D Vel.	Hepatic Vein Diastolic Peak Velocity	

Calculation

Tools	Descriptions	Methods or formulae
MV E/A	Mitral Valve E-Vel./A-Vel.	MV E Vel. (cm/s)/MV A Vel. (cm/s)
MVA(PHT)	Mitral Valve Orifice Area (PHT)	MVA(PHT) (cm^2) = 220 / MV PHT (ms)
TV E/A	Tricuspid Valve E-Vel./A-Vel.	TV E/A=TV E Vel(cm/s)/TV A Vel(cm/s)
TVA(PHT)	Tricuspid Valve Orifice Area (PHT)	TVA(PHT)=220/TV PHT(cm^2)

Study

For details, see “5.4 Study Tool Operations”.

5.2.4 TDI Cardiac Measurements Tools

Measurement

The following measurement items are performed in TDI mode.

Tools	Descriptions	Methods or formulae
MV Aa(medial)	Mitral Valve medial Late diastolic motion	D Vel. in Doppler General measurements D Vel. in Doppler General measurements
MV Sa(medial)	Mitral Valve medial Systolic motion	
MV Aa(lateral)	Mitral Valve lateral Late diastolic motion	
MV Sa(lateral)	Mitral Valve lateral Systolic motion	
MV ARa(medial)	Mitral Valve medial AcceleRation Rate	Acceleration in Doppler General Measurements
MV DRa(medial)	Mitral Valve medial DeceleRation Rate	
MV ARa(lateral)	Mitral Valve lateral AcceleRation Rate	
MV DRa(lateral)	Mitral Valve lateral DeceleRation Rate	
MV Ea(lateral)	Mitral Valve lateral Early diastolic motion	Measure MV E Vel item to get E/Ea result. D Vel. in Doppler General measurements *1
MV Ea(medial)	Mitral Valve medial Early diastolic motion	Measure MV E Vel item to get E/Ea result. D Vel. in Doppler General measurements *2

*1 means:

$$E / Ea(medial + lateral)(Nounit) = \frac{\text{MV E Vel}(cm / s)}{\left(Ea(medial)(cm / s) + Ea(lateral)(cm / s)\right)/2}$$

*2 means:

$$E / Ea(lateral)(Nounit) = \frac{\text{MV E Vel}(cm/s)}{Ea(lateral)(cm/s)}$$

Study

For details, see “5.4 Study Tool Operations”.

5.3 Measurement Tool Operations

5.3.1 MV ALL

Measure M wave of mitral valve anterior leaflet.

Measure items:

Item	Description
MV D Point	End of systolic, immediately before the opening of the Mitral Valve.
MV E Point	The anterior leaflet of the mitral valve opens, it peaks at E.
MV F Point	Lowest point of the initial diastolic closing.
MV A Point	In atria systole, blood is propelled through the mitral orifice and the mitral leaflets reopen. The peak of this phase of mitral valve motion is indicated as A.
MV C Point	Complete closure occurs after the onset of the ventricular systole.

Measurement Result:

Item	Description	Method
MV E Amp	Amplitude of the Mitral Valve E wave to C point	Distance in M General Measurements
MV D-E Amp	Distance between the onset of the opening of the mitral valve at D and the maximum opening of the anterior mitral valve leaflet at E.	Distance in M General Measurements
MV D-E Slope	The rate of change that exists between two point (D, E).	Slope in M General Measurements
MV E-F Slope	The rate of change that exists between two point (E, F).	Slope in M General Measurements
MV A Amp	Amplitude of the Mitral Valve A wave to C point	Distance in M General Measurements
MV A-C Interval	The time interval between the A point and the C point.	Time in M General Measurements

Perform the following procedure:

1. Select the [MV ALL] in the measurement menu.
2. Move the cursor, press <Set> to fix points D, E, F, A and C in turn. Corresponding character symbol will display at the right side of the point.
3. After D point and E point are fixed, MV D-E Amp and MV D-E Slope values are acquired.
4. MV E-F Slope value is acquired by fixing F point.

5. MV E Amp, MV A Amp and MV A-C Interval values are acquired by fixing A point and C point.
6. You can end measurement in advance by pressing <Set> twice on point E, F, A or C.

5.3.2 AutoEF

Measure the diastole and diastole planes automatically.

TIP:

- Only cardiac exam mode supports this function.
- Recommend to connect ECG, capture the cine of standard A2C and A4C planes, and select cardiac cycles which have the clear plane of the cardiac muscle and less interference to perform AutoEF measure.

Measure items:

Item	Description
LVLd (A2C)	Left ventricular long-axis length at end diastole (A2C)
LVAd (A2C)	Left ventricular long-axis area at end diastole (A2C)
LVLs (A2C)	Left ventricular long-axis length at end systole (A2C)
LVAs (A2C)	Left ventricular long-axis area at end systole (A2C)
LVLd (A4C)	Left ventricular long-axis length at end diastole (A4C)
LVAd (A4C)	Left ventricular long-axis area at end diastole (A4C)
LVLs (A4C)	Left ventricular long-axis length at end systole (A4C)
LVAs (A4C)	Left ventricular long-axis area at end systole (A4C)

Measurement Result:

Item	Description
EDV (A2C/A4C/BP)	End-diastolic Left Ventricular Volume
EDV Index (A2C/A4C/BP)	End-diastolic Left Ventricular Volume Index
ESV (A2C/A4C/BP)	End-systolic Left Ventricular Volume
ESV Index A2C/A4C/BP)	End-systolic Left Ventricular Volume Index
SV (A2C/A4C/BP)	Stroke Volume
SI (A2C/A4C/BP)	SV Index
EF (A2C/A4C/BP)	Ejection Fraction
CO (A2C/A4C/BP)	Cardiac Output
CI (A2C/A4C/BP)	Cardiac output index

Perform the following procedure:

1. Select the [AutoEF] in the measurement menu.
2. In apical two-chamber view, measure the following parameters:
   – Left ventricular endocardium at end-diastolic, the EDV (A2C), SV(A2C), EF(A2C) is obtained automatically.

– Left ventricular endocardium at end-systolic, the ESV (A2C), SV(A2C), EF(A2C) is obtained automatically.

3. In apical four-chamber view, measure the following parameters:
   – Left ventricular endocardium at end-diastolic, the EDV (A4C), SV(A4C), EF(A4C) is obtained automatically.
   – Left ventricular endocardium at end-systolic, the ESV (A4C), SV(A4C), EF(A4C) is obtained automatically.

   If the height and weight have already been entered, the SI, EDV Index and ESV Index are calculated.

4. Select the HR source: ECG or entered.

   ECG obtains the HR automatically. If ECG is not connected, it should start HR on the menu.

   The CO and CI are calculated automatically using the entered height and weight values.

5.4 Study Tool Operations

5.4.1 Left Ventricular Function

This group of studies estimates the Left Ventricular (LV) diastolic and systolic capabilities using a series of clinical indices measured on the B or M image. As well as calculating the left ventricular volume and end diastole and end systole, they may calculate the following indices (not all indices are calculated in every study, see the Study Results table for each study for reference).

Result	Description	Formulae
SV	Stroke Volume	SV(ml) = EDV(ml)-ESV(ml)
CO	Cardiac Output	CO(l/min) = SV(ml)×HR(bpm)/1000
EF	Ejection Fraction	EF(No unit) = SV(ml)/EDV(ml)
SI	SV Index	SI(No unit) = SV(ml)/ Body Surface Area (m^2)
CI	Cardiac output in-dex	CI(No unit) = CO(l/min)/Body Surface Area (m^2)
FS	Fractional Short-ening	FS (No unit) = (LVIDd (cm) - LVIDs [cm]) / LVIDd (cm)
MVCF	Mean Velocity of Circumferential Fiber Shortening	MVCF = (LVIDd(cm) - LVIDs(cm)) / (LVIDd (cm) × ET (s))

NOTE:

The HR value entered manually should be within the range 1~999.

S-P Ellipse

Study Items:

Tools	Descriptions	Operations
LVLd apical	Left Ventricular Long-axis Length at End-diastole in apical view	Distance in 2D General measurements
LVAd apical	Left Ventricular Long-axis Area at End-diastole in apical view	Area in 2D General Measurements

Tools	Descriptions	Operations
LVLs apical	Left Ventricular Long-axis Length at End-systole in apical view	Distance in 2D General measurements
LVAs apical	Left Ventricular Long-axis Area at end-systole in apical view	Area in 2D General Measurements
HR	Heart Rate	Obtained by ECG, HR(R-R) measurement or entered di-rectly

Study Results:

Tools	Descriptions	Formulae
EDV(SP Ellipse)	End-diastolic Left Ventricular Volume	$\text{EDV(SP Ellipse)}(ml) = \frac{8}{3\pi} \times \frac{\text{LVAd apical}(cm^2)^2}{\text{LVLd apical}(cm)}$
ESV(SP Ellipse)	End-systolic Left Ventricular Volume	$\text{ESV(SP Ellipse)}(ml) = \frac{8}{3\pi} \times \frac{\text{LVAs apical}(cm^2)^2}{\text{LVLs apical}(cm)}$
EDV Index(SP Ellipse)	End-diastolic Left Ventricular Volume Index	EDV Index=EDV/BSA
ESV Index(SP Ellipse)	End-systolic Left Ventricular Volume Index	ESV Index=ESV/BSA
SV(SP Ellipse)	Stroke Volume	see “5.4.1 Left Ventricular Function”
CO(SP Ellipse)	Cardiac Output	
EF(SP Ellipse)	Ejection Fraction	
SI(SP Ellipse)	SV Index	
CI(SP Ellipse)	CO Index	

Perform the following procedure:

1. Select [S-P Ellipse] in the measurement menu.
2. In apical long-axis view at end-diastole, measure the following parameters:
   – LVLd apical
   – LVAd apical

   The EDV value is then calculated.
3. In apical long-axis view at end-systole, measure the following parameters:
   – LVLs apical
   – LVAs apical

   The ESV value is then calculated.

   The system calculates the SV and EF.

If the height and weight have already been entered, the SI, EDV Index and ESV Index are calculated.

4. Select the HR source: HR(R-R) measurement, ECG or entered.

   The CO and CI are calculated automatically using the entered height and weight values.

B-P Ellipse

Study Items:

Tools	Descriptions	Operations
LVIDd	Left Ventricular Internal Diameter at End-diastole	Distance in 2D General Measurements
LVIDs	Left Ventricular Internal Diameter at End-systole	
LVAd sax MV	Left Ventricular Area at Mitral Valve level at End-diastole in Short-axis view	Area in 2D General measurements
LVAs sax MV	Left Ventricular Area at Mitral Valve level at End-systole in Short-axis view	
LVAd apical	Left Ventricular Long-axis Area at End-diastole in apical view	
LVAs apical	Left Ventricular Long-axis Area at end-systole in apical view	
HR	Heart Rate	Obtained by ECG, HR(R-R) measurement or entered directly

Study Results:

Tools	Descriptions	Formulae
EDV(BP Ellipse)	End-diastolic Left Ventricular Volume	*1
ESV(BP Ellipse)	End-systolic Left Ventricular Volume	*2
EDV Index(BP Ellipse)	End-diastolic Left Ventricular Volume Index	EDV Index=EDV/BSA
ESV Index(BP Ellipse)	End-systolic Left Ventricular Volume Index	ESV Index=ESV/BSA
SV(BP Ellipse)	Stroke Volume	see "5.4.1 Left Ventricular Function"
CO(BP Ellipse)	Cardiac Output	
EF(BP Ellipse)	Ejection Fraction	
SI(BP Ellipse)	SV Index	
CI(BP Ellipse)	CO Index	

*1 means:

$$\text{EDV(BP Ellipse)}(ml)= {}^{8}\!/_{3\pi} \times \text{LVAd apical}(cm^2) \times \text{LVAd sax MV}(cm^2) \Big/ LVIDd(cm)$$

*2 means:

$$ESV(\text{BP Ellipse})(ml)= {}^{8}\!/_{3\pi} \times \text{LVAs apical}(cm^2) \times \text{LVAs sax MV}(cm^2) \Big/ LVIDs(cm)$$

Perform the following procedure:

1. Select [B-P Ellipse] in the measurement menu.
2. In left ventricular short-axis view, measure the following parameters:
   – At end diastole: LVIDd
   – At end systole: LVIDs
3. In short-axis view at mitral valve level, measure the following parameters:
   – At end diastole: LVAd sax MV
   – At end systole: LVAs sax MV
4. In apical long-axis view, measure the following parameters:
   – LVAd apical, the EDV is calculated
   – LVAs apical, the ESV is calculated

   The system calculates the SV and EF after the LVAs apical has been measured.

   If the height and weight have already been entered, the SI, EDV Index and ESV Index are calculated.
5. Use the menu to select the HR source: ECG, HR(R-R) measurement or entered.

   The CO and CI are calculated automatically using the entered height and weight values.

Bullet

Study Items:

Tools	Descriptions	Operations
LVLd apical	Left Ventricular Long-axis Length at End-diastole in apical view	Distance in 2D General Measurements
LVLs apical	Left Ventricular Long-axis Length at End-systole in apical view	
LVAd sax MV	Left Ventricular Area at Mitral Valve level at End-diastole in Short-axis view	Area in 2D General measurements
LVAs sax MV	Left Ventricular Area at Mitral Valve level at End-systole in Short-axis view	
HR	Heart Rate	Obtained by ECG, HR(R-R) measurement or entered directly

Study Results:

Tools	Descriptions	Formulae
EDV(Bullet)	End-diastolic Left Ventricular Volume	EDV(ml) = 5/6×LVLd apical(cm)×LVAd sax MV(cm^2)
ESV(Bullet)	End-systolic Left Ventricular Volume	ESV(ml) = 5/6×LVLs apical(cm)×LVAs sax MV(cm^2)
EDV Index(Bullet)	End-diastolic Left Ventricular Volume Index	EDV Index=EDV/BSA

Tools	Descriptions	Formulae
ESV Index(Bullet)	End-systolic Left Ventricular Volume Index	ESV Index=ESV/BSA
SV(Bullet)	Stroke Volume	see “5.4.1 Left Ventricular Function”
CO(Bullet)	Cardiac Output	
EF(Bullet)	Ejection Fraction	
SI(Bullet)	SV Index	
CI(Bullet)	CO Index	

Perform the following procedure:

1. Select [Bullet] in the measurement menu.

   In apical long-axis view, measure the following parameters:

   – At end diastole: LVLd apical

   – At end systole: LVLs apical.

2. In short-axis view at mitral valve level, measure the following parameters:

   – At end diastole: LVAd sax MV, the EDV is calculated

   – At end systole: LVAs sax MV, the ESV is calculated

   The system calculates the SV and EF.

   If the height and weight have already been entered, the SI, EDV Index and ESV Index are calculated.

3. Use the menu to select the HR source: ECG, HR(R-R) measurement or entered.

   The CO and CI are calculated automatically using the entered height and weight values.

Mod.Simpson

Study Items:

Tools	Descriptions	Operations
LVLd apical	Left Ventricular Long-axis Length at End-diastole in apical view	Distance in 2D General Measurements
LVLs apical	Left Ventricular Long-axis Length at End-systole in apical view	
LVAd sax MV	Left Ventricular Area at Mitral Valve level at End-diastole in Short-axis view	Area in 2D General measurements
LVAs sax MV	Left Ventricular Area at Mitral Valve level at End-systole in Short-axis view	
LVAd sax PM	Left Ventricular Area at Papillary Muscle level at end-diastole in short axis view	
LVAs sax PM	Left Ventricular Area at Papillary Muscle level at end-systole in short axis view	
HR	Heart Rate	Obtained by ECG, HR(R-R) measurement or entered directly

Study Results:

Tools	Descriptions	Formulae
EDV(Mod.Simpson)	End-diastolic Left Ventricular Volume	*1
ESV(Mod.Simpson)	End-systolic Left Ventricular Volume	*2
EDV Index(Mod.Simpson)	End-diastolic Left Ventricular Volume Index	EDV Index=EDV/BSA
ESV Index(Mod.Simpson)	End-systolic Left Ventricular Volume Index	ESV Index=ESV/BSA
SV(Mod.Simpson)	Stroke Volume	see "5.4.1 Left Ventricular Function"
CO(Mod.Simpson)	Cardiac Output	
EF(Mod.Simpson)	Ejection Fraction	
SI(Mod.Simpson)	SV Index	
CI(Mod.Simpson)	CO Index	

*1 means:

$$EDV[\,mL\,] = \frac{\text{LVLdapical}[\,cm\,]}{9} \times \left(\frac{4 \times \text{LVAdsax MV}[\,cm^2\,] + 2 \times \text{LVAd}}{\text{sax PM}\ [\,cm^2\,] + \sqrt{\text{LVAdsax MV}[\,cm^2\,] \times \text{LVAdsax PM}[\,cm^2\,]}} \right)$$

*2 means:

$$ESV[\,mL\,] = \frac{\text{LVLsapical}[\,cm\,]}{9} \times \left(\frac{4 \times \text{LVAssax MV}[\,cm^2\,] + 2 \times \text{LVAs}}{\text{sax PM}\ [\,cm^2\,] + \sqrt{\text{LVAssax MV}[\,cm^2\,] \times \text{LVAssax PM}[\,cm^2\,]}} \right)$$

Perform the following procedure:

1. Select [Mod.Simpson] in the measurement menu.
2. In apical long-axis view, measure the following parameters:
   – At end diastole: LVLd apical
   – At end systole: LVLs apical
3. In short-axis view at mitral valve level, measure the following parameters:
   – At end diastole: LVAd sax MV
   – At end systole: LVAs sax MV
4. In short-axis view at papillary muscle level, measure the following parameters:
   – At end diastole: LVAd sax PM, the EDV is calculated
   – At end systole: LVAs sax PM, the ESV is calculated

   The system calculates the SV and EF.

   If the height and weight have already been entered, the SI, EDV Index and ESV Index are calculated.
5. Use the menu to select the HR source: ECG, HR(R-R) measurement or entered.

   The CO and CI are calculated automatically using the entered height and weight values.

Simpson

You may select to measure single plane (A2C or A4C) only or both planes (A2C and A4C) to study.

Study Items:

Tools	Descriptions	Operations
A2Cd	Left ventricular long-axis length at end diastole in A2C view	Simpson measurement (Trace/ Spline/Auto)
A2Cs	Left ventricular long-axis length at end systole in A2C view	
A4Cd	Left ventricular long-axis length at end diastole in A4C view	
A4Cs	Left ventricular long-axis length at end systole in A4C view	
HR	Heart Rate	Obtained by ECG, HR(R-R) measurements or entered directly

Study Results:

Tools	Descriptions	Formulae
EDV(A2C/ A4C)	End-diastolic Left Ventricular Volume (A2C/A4C)	$EDV(ml)=\pi\times\frac{\text{LVLd apical}(cm)}{20}\times\sum_{i=1}^{20} r_i^2\,(cm)$ LVLd apical: Left Ventricular Long-axis Length at End-diastole in apical view, i.e. the long-axis length obtained in measurement. r_i : Radii obtained from diastolic measurement
EDV (BP)	End-diastolic Left Ventricular Volume (BP)	*1
ESV(A2C/ A4C)	End-systolic Left Ventricular Volume (A2C/A4C)	$ESV(ml)=\pi\times\frac{\text{LVLs apical}(cm)}{20}\times\sum_{i=1}^{20} r_i^2\,(cm)$ LVLs apical: Left Ventricular Long-axis Length at End-systole in apical view, i.e. the long-axis length obtained in measurement. r_i : Radii obtained from systolic measurement
ESV (BP)	End-systolic Left Ventricular Volume (BP)	*2
EDV Index (A2C/A4C/ BP)	End-diastolic Left Ventricular Volume Index (A2C/A4C/BP)	EDV Index=EDV/BSA
ESV Index (A2C/A4C/ BP)	End-systolic Left Ventricular Volume Index (A2C/A4C/BP)	ESV Index=ESV/BSA
SV	Stroke Volume	see “5.4.1 Left Ventricular Function”
CO	Cardiac Output	
EF	Ejection Fraction	
SI	SV Index	
CI	CO Index	

*1 means:

$$EDV(ml) = \pi \times MAX\{LVLd_{2i}(cm), LVLd_{4i}(cm)\} / 20 \times \sum_{i=1}^{20} (r_{2i}(cm) \times r_{4i}(cm))$$

*2 means:

$$ESV(ml) = \pi \times MAX\{LVLs_{2i}(cm), LVLs_{4i}(cm)\} / 20 \times \sum_{i=1}^{20} (r_{2i}(cm) \times r_{4i}(cm))$$

Calculate the LV volume on the apical 2-chamber view image:

$$EDV\ 2(ml) = \pi \times LVLd_{2i}(cm) / 20 \times \sum_{i=1}^{20} r_{2i}^{2}(cm)$$

$$ESV\ 2(ml) = \pi \times LVLs_{2i}(cm) / 20 \times \sum_{i=1}^{20} r_{2i}^{2}(cm)$$

Calculate the LV volume on the apical 4-chamber view image:

$$EDV\ 4(ml) = \pi \times LVLd_{4i}(cm) / 20 \times \sum_{i=1}^{20} r_{4i}^{2}(cm)$$

$$ESV\ 4(ml) = \pi \times LVLs_{4i}(cm) / 20 \times \sum_{i=1}^{20} r_{4i}^{2}(cm)$$

Where

$LVLd_{2i}$ – Left ventricular long-axis length at end diastole at apical two-chamber view, which is the long-axis length obtained by EDV (A2C) measurement

$LVLd_{4i}$ – Left ventricular long-axis length at end diastole at apical four-chamber view, which is the long-axis length obtained by EDV (A4C) measurement

$LVLs_{2i}$ – Left ventricular long-axis length at end systole at apical two-chamber view, which is the long-axis length obtained by ESV (A2C) measurement

$LVLs_{4i}$ –Left ventricular long-axis length at end systole at apical four-chamber view, which is the long-axis length obtained by ESV (A4C) measurement

r_{2i} – Radii obtained by EDV (A2C) or ESV (A2C) at apical two-chamber view

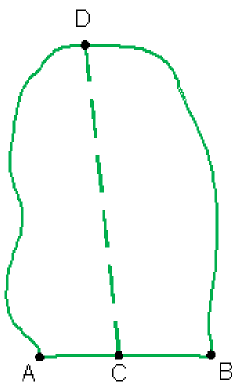
r_{4i} – Radii obtained by EDV (A4C) or ESV (A4C) at apical four-chamber view

Simpson: Simpson single plane measurement (measure apical A2C or A4C only)

Perform the following procedure:

1. Select [Simpson] in the measurement menu.
2. Measure the endocardium.

The endocardium can be measured using trace, spline or auto, click items on the menu to select the method.

Methods	Operations
Trace	Trace the endocardium along the edge of the target area using a method similar to Trace method in 2D Area measurements, then set the long axis.
Spline	Set reference points (up to 12) along the edge of the endocardium using a method similar to Spline method in 2D Area measurements, then set the long axis.
Auto	Follow the steps below: 1. Set points A and B using the trackball and <Set> key, where A: Left ventricular interventricular septal and mitral valve junction; B: Left ventricular wall and mitral valve junction; 2. After setting A and B, the cursor will be automatically displayed at point D (where is considered as the apical part by system detecting). After point D is set, the long axis (line segment CD) and the line that traces the endocardium are displayed. Where C: Midpoint of A and B. D: Apical part of left ventricle.  3. You can do the following operations: Adjust the long axis: Move the cursor on the long axis (which turns yellow), then press <Set>; Move the cursor to adjust point D (with point C unchanged) after the cursor changes to . Adjust the trace line: Move the cursor to position the cursor on the trace line (which turns yellow), and then press <Set>; Move the cursor along the endocardium edge to adjust the line after the cursor changes to . 4. Press <Set> outside the line to confirm the adjustment.

– Measure the left ventricular endocardium at end-diastolic and set the long axis, the EDV is obtained.

– Measure the left ventricular endocardium at end-systolic and set the long axis, the ESV is obtained.

The system calculates the SV and EF.

If the height and weight have already been entered, the SI, EDV Index and ESV Index are calculated.

3. Use the menu to select the HR source: ECG, HR (R-R) measurement or entered.

   The CO and CI are calculated automatically using the entered height and weight values.

Simpson: Simpson Bi-plane measurement

⚠CAUTION

When using Simpson to measure LV function, be sure to keep the apical four-chamber view and apical two-chamber view perpendicular. Otherwise the measurement result will be incorrect.

Perform the following procedure:

1. Select [Simpson] in the measurement menu.
2. In apical two-chamber view, measure the following parameters:
   – Left ventricular endocardium at end-diastolic and set the long axis, the EDV(A2C) is obtained
   – Left ventricular endocardium at end-systolic and set the long axis, the ESV(A2C) is obtained
3. In apical four-chamber view, measure the following parameters:
   – Left ventricular endocardium at end-diastolic and set the long axis, the EDV(A4C) is obtained
   – Left ventricular endocardium at end-systolic and set the long axis, the ESV(A4C) is obtained

   If the height and weight have already been entered, the SV, EF, SI, EDV Index and ESV Index are calculated.
4. Use the touch screen to select the HR source: ECG, HR(R-R) measurement or entered.

   The CO and CI are calculated automatically using the entered height and weight values.

LV (2D)

Study Items:

Tools	Descriptions	Operations
Diastole	End-diastolic Left Ventricular Measurement	FoldLine in 2D mode Parallel method in M mode
Systole	End-systolic Left Ventricular Measurement	
LVIDd	Left Ventricular Internal Diameter at End-diastole	Distance in 2D/M General measurements
LVIDs	Left Ventricular Internal Diameter at End-systole	
HR	Heart Rate	Obtained by ECG, HR(R-R) measurements or entered directly

Study Results:

Tools	Descriptions	Formulae
IVSd	Interventricular Septal Thickness at End-diastole	Distance in 2D/M General Measurements
LVPWd	Left Ventricular Posterior Wall Thickness at End-diastole	
IVSs	Interventricular Septal Thickness at End-systole	
LVPWs	Left Ventricular Posterior Wall Thickness at End-systole	
EDV	End-diastolic Left Ventricular Volume	EDV(ml)= LVIDd(cm)3
ESV	End-systolic Left Ventricular Volume	ESV(ml)= LVIDs(cm)3
EDV Index	End-diastolic Left Ventricular Volume	EDV Index=EDV/BSA
ESV Index	End-systolic Left Ventricular Volume	ESV Index=ESV/BSA
SV	Stroke Volume	see "5.4.1 Left Ventricular Function"
CO	Cardiac Output	
EF	Ejection Fraction	
FS	Fractional Shortening	
MVCF	Mean Velocity of Circumferential Fiber Shortening	
SI	SV Index	
CI	CO Index	

TIP:

- In the [Setup] > [System] > [Application] screen, you can set the method for the Cube/ Teichholz/HR study.
- Click [Property] in [Setup] > [Measure] to select formula for LV measurement by selecting result items: Cube, Teichholz or Gibson.

Taking the method using LVIDd, LVIDs, HR as an example.

Perform the following procedure:

1. Select [LV (2D)] in the measurement menu.
2. Measure LVIDd in 2D or M mode.

   The LVIDd and EDV are obtained.
3. Measure the LVIDs in 2D or M mode.
   – The LVIDs and ESV are obtained.
   – The system calculates the SV, EF and FS.
4. Using the menu to select the HR source: ECG, HR(R-R) measurement or entered.

   If the height and weight have already been entered, the SI, CO, CI, EDV Index and ESV Index are calculated.

   The MVCF is calculated if the LVET is measured.

5.4.2 Left Ventricular Mass (LV Mass)

Estimates the Index of Left Ventricular Mass (LV Mass-I) by calculating the LV Mass.

LV MASS-I (No unit) = LV Mass (g) / Body Surface Area (m^2)

LV Mass (Cube)

Study Items:

Tools	Descriptions	Operations
IVSd	Interventricular Septal Thickness at End-diastole	Distance in 2D/M General Measurements
LVIDd	Left Ventricular Internal Diameter at End-diastole	
LVPWd	Left Ventricular Posterior Wall Thickness at End-diastole	

Study Results:

Tools	Descriptions	Formulae
LV Mass (Cube)	Left Ventricular Mass	LV Mass (g) = 1.04 × ((LVPWd(cm) + IVSd(cm) + LVIDd(cm))^3 - LVIDd(cm)^3) - 13.6
LV MASS-I (Cube)	Index of Left Ventricular Mass	LV MASS-I (No unit) = LV Mass(g) / Body Surface Area(m^2)

Perform the following procedure:

1. Select [LV Mass (Cube)] in the measurement menu.
2. At end diastole, measure the following parameters:
   - IVSd
   - LVIDd
   - LVPWd

   The LV Mass (Cube) is calculated.

   If the height and weight have already been entered, the LV Mass-I(Cube) is calculated.

LV Mass (A-L)

Study Items:

Tools	Descriptions	Operations
LVAd sax Epi	Left Ventricular Epicardial Area at Papillary Muscle level at end-diastole in Short-axis view	Area in 2D General Measurements
LVAd sax Endo	Left Ventricular Endocardial Area at Papillary Muscle level at end-diastole in Short-axis view	
LVLd apical	Left Ventricular Long-axis Length at End-diastole in apical view	Distance in 2D General Measurements

Study Results:

Tools	Descriptions	Formulae
LV Mass (A-L)	Left Ventricular Mass	*1

Tools	Descriptions	Formulae
LV MASS-I (A-L)	Index of Left Ventric-ular Mass	LV MASS-I (No unit) = LV Mass(g) / Body Surface Area(m^2)

*1 means:

$$\begin{aligned} \text{LV Mass(g)} = {} & 1.05 \times 5/6 \times (\text{LVAd sax Epi}(cm^2) \times (\text{LVLd apical}(cm) + t(cm)) \\ & - \text{LVAd sax Endo}(cm^2) \times \text{LVL}(cm)) \end{aligned}$$

Where

$$t\,(cm) = \sqrt{(\text{LVAdsax Epi}(cm^2)/\pi)} - \sqrt{(\text{LVAdSax Endo}(cm^2)/\pi)}$$

Perform the following procedure:

1. Select [LV Mass (A-L)] in the measurement menu.
2. In long-axis view at end diastole, measure the LVLd apical.
3. In short-axis view at papillary muscle level at end diastole, measure the following parameters:
   – Endocardium area: LVAd sax Endo
   – Epicardium area: LVAd sax Epi

   The LV Mass (A-L) is calculated.

   If the height and weight have already been entered, the LV Mass-I(A-L) is calculated.

LV Mass (T-E)

Study Items:

Tools	Descriptions	Operations
LVAd sax Epi	Left Ventricular Epicardial Area at Papillary Muscle level at end-diastole in Short-axis view	Area in 2D General measurements
LVAd sax Endo	Left Ventricular Endocardial Area at Papillary Muscle level at end-diastole in Short-axis view	
a	Semi-major axis from widest minor axis radius to apex	Distance in 2D General Measurements
d	Truncated semi-major axis from widest minor axis radius to mitral annulus plane	

Except for the values in the upper table, the following results can be obtained in this study:

Tools	Descriptions	Formulae
LV Mass (T-E)	Left Ventricular Mass	*1
LV MASS-I (T-E)	Index of Left Ventric-ular Mass	LV MASS-I (No unit) = LV Mass(g) / Body Surface Area(m^2)

*1 means:

$$\text{LV Mass(g)} = 1.05\pi \times \{(b+t)^2 \times [\frac{2(a+t)}{3} + d - \frac{d^3}{3(a+t)^2}] - b^2 \times (\frac{2a}{3} + d - \frac{d^3}{3a^2})\}$$

Where units of a, b, d, t are cm.

- a: Semi-major axis from widest minor axis radius to apex
- d: Truncated semi-major axis from widest minor axis radius to mitral annulus plane
- t: Thickness of the myocardium

$$t\ (\mathrm{cm}) = \sqrt{(\mathrm{LVAd\ sax\ Epi}(\mathrm{cm}^2)/\pi)} - \sqrt{(\mathrm{LVAd\ Sax\ Endo}(\mathrm{cm}^2)/\pi)}$$

- b: Short axis radius, usually measured where the radius is largest.

$$b(\mathrm{cm}) = \sqrt{(\mathrm{LVAd\ Sax\ Endo}(\mathrm{cm}^2)/\pi)}$$

Perform the following procedure:

1. Select [LV Mass (T-E)] in the measurement menu.
2. In short-axis view at papillary muscle level at end diastole, measure the following parameters:
   – Endocardium area: LVAd sax Endo
   – Epicardium area LVAd sax Epi
3. Measure a and d.

   The LV Mass (T-E) is calculated.

   If the height and weight have already been entered, the LV Mass-I(T-E) is calculated.

5.4.3 Mitral Valve Area (MVA)

The Mitral Valve Area (MVA) can be calculated using two methods: pressure half time (PHT) or velocity-time integral (VTI).

The MVA Calculation by PHT method should be performed in CW mode.

$$\mathrm{MVA\ (PHT)\ (cm^2) = 220\ /\ MV\ PHT\ (ms)}$$

Study Items:

Tools	Descriptions	Operations
LVOT Diam.	Left Ventricular Outflow Tract Diameter	Distance in 2D General Measurements
LVOT VTI	Left Ventricular Outflow Tract Velocity-Time Integral	D trace in General D measurements
MV VTI	Mitral Valve Velocity-Time Integral	

Except for the values in the upper table, the following results can be obtained in this study:

Tools	Descriptions	Formulae
MVA(VTI)	Mitral Valve Area	$\mathrm{MVA(VTI)(cm^2)} = \dfrac{\pi \times \lvert \mathrm{LVOT\ VTI(cm)} \rvert \times \mathrm{LVOT\ Diam(cm^2)}^2}{4 \times \lvert \mathrm{MV\ VTI(cm)} \rvert}$

See the table above for methods and formulae for the measurement items.

5.4.4 AVA (VTI)

The Aortic Valve Area (AVA) can be calculated by velocity-time integral (VTI). The measurements should be performed on 2D and Doppler images

Study Items:

Tools	Descriptions	Operations
LVOT Diam.	Left Ventricular Outflow Tract Diameter	Distance in 2D General Measurements
LVOT VTI	Left Ventricular Outflow Tract Velocity-Time Integral	D trace in General D measurements
AV VTI	Aortic Valve Velocity-Time Integral	

Except for the values in the upper table, the following results can be obtained in this study:

Tools	Descriptions	Operations
AVA(VTI)	Aortic Valve Area	$\text{AVA(VTI)}(\text{cm}^2) = \dfrac{\pi \times \lvert \text{LVOT VTI(cm)} \rvert \times \text{LVOT Diam}(\text{cm}^2)^2}{4 \times \lvert \text{AV VTI(cm)} \rvert}$

See the table above for methods and formulae for the measurement items.

5.4.5 LA Vol

LA Vol. (Left Atrium Volume) used to estimate the size of the left atrium.

LA Vol(A-L)

Estimates the Left Atrium Volume using area and length.

Study Items:

Tools	Descriptions	Operations
LA apical	Left Atrium Diameter	Distance in 2D General Measurements
LAA(A2C)	Left Atrium Area at apical 2-chamber view	Area in 2D General Measurements
LAA(A4C)	Left Atrium Area at apical 4-chamber view	

Except for the values in the upper table, the following results can be obtained in this study:

Tools	Descriptions	Operations
LA Vol(A-L)	Left Atrium Area	$\text{LA Vol(A-L)(ml)} = \frac{8\pi}{3} \text{LAA(A4C)}(\text{cm}^2) \times \text{LAA(A2C)}(\text{cm}^2) \big/ \text{LA apical(cm)}$
LA Vol Index (A-L)	Left Atrium Area	LA Vol Index= LA Vol/ BSA

See the table above for methods and formulae for the measurement items.

LA Vol (Simp)

Estimates the left atrium volume using the Simpson method. Performed at apical two-chamber view and apical four-chamber view.

Study Items and Results:

Tools	Descriptions	Operations
LA Vol.(A2C)	Left Atrium Volume at apical 2-chamber view	Same as the Simpson SP measurement
LA Vol.(A4C)	Left Atrium Volume at apical 4-chamber view	
LA Vol. Index (A2C/A4C)	Left Atrium Volume Index	LA Vol. Index = LA Vol./BSA

5.4.6 LV Tei Index

The LVIMP (Left Ventricular Index of Myocardial Performance) is used to analyze the integrative ventricular diastolic and systolic capabilities.

Study Items:

Tools	Descriptions	Operations
MV C-O Dur.	Mitral Valve Close-Open Duration	Time in M/Doppler General Measurements
LVET	Left Ventricular Ejection Time	

Except for the values in the upper table, the following results can be obtained in this study:

Tools	Descriptions	Operations
LV Tei Index	Left Ventricular Index of Myocardial Performance	$\text{LV TEI(Nounit)} = \frac{\text{MV C - O dur(s) - LVET(s)}}{\text{LVET(s)}}$

See the table above for methods and formulae for the measurement items.

5.4.7 RVSP (Right Ventricular Systolic Pressure)

The RVSP measures the right ventricular systolic pressure.

Study Items:

Tools	Descriptions	Operations
TR Vmax	Tricuspid Valve Regurgitation Maximum Velocity	D Vel. in Doppler General Measurements
RAP	Right Atrium Pressure	See below

Except for the values in the upper table, the following results can be obtained in this study:

Tools	Descriptions	Operations
TR PGmax	Tricuspid Valve Regurgitation Pressure Gradient	TR PGmax (mmHg) = 4 × TR Vmax $(m/s)^2$
RVSP	Right Ventricular Systolic Pressure	$\text{RVSP(mmHg)} = RAP(mmHg) + 4 \times (TR\,V\max(m/s))^2$

Perform the following procedure:

1. Select [RVSP] in the measurement menu.
2. Measure the TR Vmax in Doppler mode.

   The TR PGmax is calculated.
3. Select [RAP] in the [RVSP] sub-menu and select (or enter) the pressure in the dialog box which appears, as shown in the figure below:

   The range of input values is [0, 50.0 mmHg].
4. Click [OK] after selecting (or entering) the pressure. The RAP is obtained.

   RVSP is calculated.

5.4.8 PAEDP (Pulmonary Artery End Diastolic Pressure)

The PAEDP measures the pulmonary artery end diastolic pressure.

Study Items

Tools	Descriptions	Operations
PR Ved	Pulmonary Valve Regurgitation Velocity at end-Diastole	D Vel. in Doppler General Measurements
RAP	Right Atrium Pressure	See RAP measurement in 5.4.7

Except for the values in the upper table, the following results can be obtained in this study:

Tools	Descriptions	Operations
PR PGed	Pulmonary Valve Regurgitation Pressure Gradient at end-Diastole	/
PAEDP	Pulmonary Pressure at end-Diastole	$\text{PAEDP(mmHg)} = RAP(mmHg) + 4 \times (PR\ Ved(m/s))^2$

See the table above for methods and formulae for the measurement items.

5.4.9 RVIMP (RV Tei Index)

The measurement of RVIMP (Right Ventricular Index of Myocardial Performance) is similar to that of LVIMP.

Study Items:

Tools	Descriptions	Operations
TV C-O Dur.	Tricuspid Valve Close-Open Duration	Time in Doppler General Measurements
RVET	Right Ventricular Ejection Time	

Except for the values in the upper table, the following results can be obtained in this study:

Tools	Descriptions	Formulae
RV Tei Index	Right Ventricular Index of Myocardial Performance	$\text{RV TEI(Nounit)} = \dfrac{\text{TV C-O dur(s)} - \text{RVET(s)}}{\text{RVET(s)}}$

See the table above for methods and formulae for the measurement items.

5.4.10 Qp/Qs

Flow ratio of pulmonary circulation and systemic circulation.

Study Items:

Tools	Descriptions	Operations
RVOT Diam.	Right Ventricular Outflow Tract Diameter	Distance in 2D General measurements
LVOT Diam.	Left Ventricular Outflow Tract Diameter	
RVOT VTI	Right Ventricular Outflow Tract Velocity-Time Integral	D Trace in Doppler General Measurements
LVOT VTI	Left Ventricular Outflow Tract Velocity-Time Integral	

Except for the values in the upper table, the following results can be obtained in this study:

Item	Description	Operations
RVOT SV	Right Ventricular Outflow Tract Stroke Volume	Obtained from the RVOT VTI measurement
RVOT CO	Right Ventricular Outflow Tract Cardiac Output	
RVOT SI	Right Ventricular Outflow Tract SV Index	
RVOT CI	Right Ventricular Output Tract CO Index	
RVOT Vmax	Right Ventricular Outflow Tract Maximum Velocity	
RVOT Vmean	Right Ventricular Outflow Tract Minimum Average Velocity	
RVOT PGmax	Right Ventricular Outflow Tract Maximum Pressure Gradient	
RVOT PGmean	Right Ventricular Outflow Tract Average Pressure Gradient	
LVOT SV	Left Ventricular Outflow Tract Stroke Volume	Obtained from the LVOT VTI measurement
LVOT SI	Left Ventricular Outflow Tract SV Index	
LVOT CO	Left Ventricular Outflow Tract Cardiac Output	
LVOT CI	Left Ventricular Output Tract CO Index	
LVOT Vmax	Left Ventricular Outflow Tract Maximum Velocity	
LVOT PGmax	Left Ventricular Outflow Tract Maximum Pressure Gradient	
LVOT Vmean	Left Ventricular Outflow Tract Average Velocity	
LVOT PGmean	Left Ventricular Outflow Tract Minimum Pressure Gradient	
Qp/Qs	Flow ratio of Pulmonary circulation and Systemic circulation	*1
Qp-Qs	Flow difference of Pulmonary circulation and Systemic circulation	

*1:

$$Qp(ml) = \text{RVOT SV(ml)} = \pi(\text{RVOT Diam(cm)}/2)^2 \times \text{RVOT VTI(cm)}$$

$$Qs(ml) = \text{LVOT SV(ml)} = \pi(\text{LVOT Diam(cm)}/2)^2 \times \text{LVOT VTI(cm)}$$

$$Qp/Qs(Nounit) = \frac{\text{RVOT SV}(ml)}{\text{LVOT SV}(ml)}$$

$$Qp - Qs(Nounit) = \text{RVOT SV}(ml) - \text{LVOT SV}(ml)$$

See the table above for methods and formulae for the measurement items.

5.4.11 PISA

The PISA (Proximal Isovelocity Surface Area) is used in the quantitative analysis of the mitral valve regurgitation (PISA MR), aortic valve regurgitation (PISA AR), tricuspid valve regurgitation (PISA TR) and pulmonary valve regurgitation (PISA PR) in color mode.

The PISA measurement procedure is as follows:

1. Start PISA and move the semicircular caliper by using the trackball.
2. Fix the center of the semicircular caliper by pressing <Set>.
3. Adjust the radius length orientation of the semicircular caliper by using the trackball.
4. Press <Set> to fix the caliper.

PISA MR

Mitral valve regurgitation (PISA MR) needs to be measured in Color and Doppler modes.

Study Items:

Tools	Descriptions	Operations
MR Rad	Mitral Valve Stenosis Radius	PISA measurement
MR VTI	Mitral Valve Regurgitation Velocity-Time Integral	D Trace in Doppler General Measurements
MR Als.Vel.	Mitral Valve Regurgitation Aliasing Maximum Velocity	You can choose to use the top aliasing velocity or bottom aliasing velocity, or enter the value directly.

Study Results:

Tools	Descriptions	Operations
MR Vmax	Mitral Regurgitation Maximum Velocity	Obtained from the MR VTI measurement
MR Flow	Mitral Regurgitation Flow	$\text{MR Flow(ml)} = \frac{2\pi \text{MR Rad(cm)}^2 \times \text{MR Als.Vel(cm/s)}}{\lvert\text{MRV max(cm/s)}\rvert} \times \lvert\text{MR VTI(cm)}\rvert$
MR Flow Rate	Mitral Regurgitation Flow Rate	$\text{MR Flow Rate(ml/s)} = 2\pi\text{MR Rad(cm)}^2 \times \text{MR Als.Vel(cm/s)}$

Tools	Descriptions	Operations
MR Fraction	Mitral Valve Regurgitation Fraction	$\text{MR Fraction (Nounit)} = \frac{\text{MR Flow(ml)}}{\text{MV SV(ml)}} \times 100\ \%$
MR EROA	Mitral Valve Effective Regurgitant Orifice Area	$\text{MR EROA(cm)}^2 = \frac{2\pi \text{MR Rad(cm)}^2 \times \text{MR Als.Vel(cm/s)}}{\lvert \text{MR Vmax(cm/s)} \rvert}$

Perform the following procedure:

1. Enter color mode and adjust the color map until the aliasing appears.
2. Select [PISA MR] in the measurement menu.
3. Measure MR Rad using the PISA caliper.

   Input MR Als.Vel.
4. Measure the MR spectrum using D trace to obtain:
   – MR Vmax
   – MR VTI

   The MR Flow, MR Flow Rate and MR EROA are calculated automatically.

   If the MV SV is measured, the MR Fraction will be calculated automatically.

PISA AR

Aortic valve regurgitation (PISA AR) needs to be measured in Color and Doppler modes.

Study Items:

Tools	Descriptions	Operations
AR Rad.	Aortic Valve Stenosis Radius	PISA measurement
AR VTI	Aortic Valve Regurgitation Velocity-Time Integral	D Trace in Doppler General Measurements
AR Als.Vel.	Aortic Valve Regurgitation Aliasing Maximum Velocity	You can choose to use the top aliasing velocity or bottom aliasing velocity, or enter the value directly.

Study Results:

Tools	Descriptions	Operations
AR Vmax	Aortic Regurgitation Maximum Velocity	Obtained from the AR VTI measurement
AR Flow	Aortic Regurgitation Flow	$\text{AR Flow(ml)} = \frac{2\pi \text{AR Rad(cm)}^2 \times \text{AR Als.Vel(cm/s)}}{\lvert \text{ARV max(cm/s)} \rvert} \times \lvert \text{AR VTI(cm)} \rvert$
AR Flow Rate	Aortic Regurgitation Flow Rate	$\text{AR Flow Rate(ml/s)} = 2\pi \text{AR Rad(cm)}^2 \times \text{AR Als.Vel(cm/s)}$

Tools	Descriptions	Operations
AR Fraction	Aortic Valve Regurgitation Fraction	$\text{AR Fraction (Nounit)} = \frac{\text{AR Flow(ml)}}{\text{AV SV(ml)}} \times 100\ \%$
AR EROA	Aortic Valve Effective Regurgitant Orifice Area	$\text{AR EROA(cm)}^2 = \frac{2\pi \text{AR Rad(cm)}^2 \times \text{AR Als.Vel(cm/s)}}{\lvert \text{ARVmax(cm/s)} \rvert}$

Operating procedures is the same as the PISA MR measurement.

PISA TR

Tricuspid valve regurgitation (PISA TR) needs to be measured in Color and Doppler modes.

Study Items:

Tools	Descriptions	Operations
TR Rad.	Tricuspid Valve Stenosis Radius	PISA measurement
TR VTI	Tricuspid Valve Regurgitation Velocity-Time Integral	D Trace in Doppler General Measurements
TR Als.Vel.	Tricuspid Valve Regurgitation Aliasing Maximum Velocity	You can choose to use the top aliasing velocity or bottom aliasing velocity, or enter the value directly.

Study Results:

Tools	Descriptions	Operations
TR Vmax	Tricuspid Regurgitation Maximum Velocity	Obtained from TR VTI measurement
TR Flow	Tricuspid Regurgitation Flow	$\text{TR Flow(ml)} = \frac{2\pi \text{TR Rad(cm)}^2 \times \text{TR Als.Vel(cm/s)}}{\lvert \text{TRV max(cm/s)} \rvert} \times \lvert \text{TR VTI(cm)} \rvert$
TR Flow Rate	Tricuspid Regurgitation Flow Rate	$\text{TR Flow Rate(ml/s)} = 2\pi \text{TR Rad(cm)}^2 \times \text{TR Als.Vel(cm/s)}$
TR Fraction	Tricuspid Valve Regurgitation Fraction	$\text{TR Fraction (Nounit)} = \frac{\text{TR Flow(ml)}}{\text{TV SV(ml)}} \times 100\ \%$
TR EROA	Tricuspid Valve Effective Regurgitant Orifice Area	$\text{TR EROA(cm)}^2 = \frac{2\pi \text{TR Rad(cm)}^2 \times \text{TR Als.Vel(cm/s)}}{\lvert \text{TR Vmax(cm/s)} \rvert}$

Operating procedures are the same as the PISA MR measurement.

PISA PR

Pulmonary valve regurgitation (PISA PR) needs to be measured in Color and Doppler modes.

Study Items:

Tools	Descriptions	Operations
PR Rad.	Pulmonary Valve Stenosis Radius	PISA measurement
PR VTI	Pulmonary Valve Regurgitation Velocity-Time Integral	D Trace in Doppler General Measurements
PR Als.Vel.	Pulmonary Valve Regurgitation Aliasing Maximum Velocity	You can choose to use the top aliasing velocity or bottom aliasing velocity, or enter the value directly.

Study Results:

Tools	Descriptions	Operations
PR Vmax	Pulmonary Regurgitation Maximum Velocity	Obtained from PR VTI measurement
PR Flow	Pulmonary Regurgitation Flow	$\text{PR Flow(ml)} = \frac{2\pi \text{PR Rad(cm)}^2 \times \text{PR Als.Vel(cm/s)}}{\lvert \text{PRV max(cm/s)} \rvert} \times \lvert \text{PR VTI(cm)} \rvert$
PR Flow Rate	Pulmonary Regurgitation Flow Rate	$\text{PR Flow Rate(ml/s)} = 2\pi \text{PR Rad(cm)}^2 \times \text{PR Als.Vel(cm/s)}$
PR Fraction	Pulmonary Valve Regurgitation Fraction	$\text{PR Fraction (Nounit)} = \frac{\text{PR Flow(ml)}}{\text{PV SV(ml)}} \times 100\ \%$
PR EROA	Pulmonary Valve Effective Regurgitant Orifice Area	$\text{PR EROA(cm)}^2 = \frac{2\pi \text{PR Rad(cm)}^2 \times \text{PR Als.Vel(cm/s)}}{\lvert \text{PR Vmax(cm/s)} \rvert}$

Operating procedures are the same as the PISA MR measurement.

5.4.12 TDI Mode

Study Items:

Tools	Descriptions	Operations
MV Sa(medial)	Mitral Valve medial Systolic motion	D Vel. in Doppler General Measurements
MV Ea(medial)	Mitral Valve medial Early diastolic motion	
MV Aa(medial)	Mitral Valve medial Late diastolic motion	
MV ARa(medial)	Mitral Valve medial Acceleration Rate	Acceleration in Doppler General Measurements
MV DRa(medial)	Mitral Valve medial Deceleration Rate	

Tools	Descriptions	Operations
MV Sa(lateral)	Mitral Valve lateral Systolic motion	D Vel. in Doppler General Measurements
MV Ea(lateral)	Mitral Valve lateral Early diastolic motion	
MV Aa(lateral)	Mitral Valve lateral Late diastolic motion	
MV ARa(lateral)	Mitral Valve lateral Acceleration Rate	Acceleration in Doppler General Measurements
MV DRa(lateral)	Mitral Valve lateral Deceleration Rate	

Study Results:

Tools	Descriptions	Formulae
MV Ea/Aa(medial)	MV medial E-Vel./A-Vel.	$\text{Ea/Aa(medial)(Nounit)} = \frac{\text{Ea(medial)}}{\text{Aa(medial)}}$
ATa(medial)	MV medial E-wave Acceleration Time	Obtained from the ARa(medial) measurement
DTa(medial)	MV medial E-wave Deceleration Time	Obtained from the DRa(medial) measurement
MV Ea/Aa(lateral)	MV lateral E-Vel./A-Vel.	$\text{Ea/Aa(lateral)(Nounit)} = \frac{\text{Ea(laterall)}}{\text{Aa(laterall)}}$
MV E/Ea(medial)	Used to estimate the diastolic function of left ventricular	Calculate after measuring MV E Vel and MV Ea(medial): $\text{MV E/Ea(medial)(Nounit)} = \frac{\text{MV E Vel}}{\text{MV Ea(medial)}}$
MV E/Ea(lateral)		Calculate after measuring MV E Vel and MV Ea(lateral): $\text{MV E/Ea(lateral)(Nounit)} = \frac{\text{MV E Vel}}{\text{MV Ea(lateral)}}$
MV E/ Ea(medial+lateral)		Calculate after measuring MV E Vel, MV Ea(medial) and MV Ea(lateral) $E/Ea(medial+lateral)(Nounit) = \frac{\text{MV E Vel}(cm/s)}{(MVEa(medial)(cm/s)+MVEa(lateral)(cm/s))/2}$
ATa(lateral)	MV lateral E-wave Acceleration Time	Obtained from the ARa(lateral) measurement
DTa(lateral)	MV lateral E-wave Deceleration Time	Obtained from the DRa(lateral) measurement

See the table above for methods and formulae for the measurement items.

5.4.13 Z Score

Z Score indicates the standard deviation of the individually measured value against the mean value. Referenced pediatric cardiac value is corrected by the height, weight, and body surface. Z Scores that is standardly transformed is used to evaluate the cardiac measurement values, to define the distribution of the measurement result of an individual pediatric among those of the healthy pediatrics.

The Z-Score study is effective for pediatrics aged under 18 years old.

Formula:

Z-Score = (measured actual value - population mean value)/population standard deviation

1. Input the DOB (age), weight, and height in the <Patient> > [CARD];
2. Select Z-Score related items in the measurement menu for performing measurement.
3. Check the Z-Score result in the <Report> page.

5.5 References

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6 Vascular

Vascular measurements are mainly used for carotid, cerebral, upper and lower extremity vessels. The system supports the following 2D and Doppler vascular measurements.

6.1 Basic Measurement Procedures

1. Press <Patient> on the control panel and enter the patient information.
2. Perform the scanning to acquire the desired image.
3. Press <Measure> to enter the Application Measurement.
4. Select the measurement tool from the measurement menu to start the measurement.
   – For measurement tools, see “6.2 Measurement Tools”.
   – For measurement methods, see “2 General Measurement”.

   The system calculates and displays the results after the measurement tools have been completed.

6.2 Measurement Tools

6.2.1 2D Mode

Measurement

Tools	Descriptions	Methods or formulae
CCA IMT	Common Carotid Artery IMT	ROI measurement in IMT
Bulb IMT	Bulbillate IMT	
ICA IMT	Internal Carotid Artery IMT	
ECA IMT	External Carotid Artery IMT	

Calculation

Tools	Descriptions	Methods or formulae
Stenosis D	Stenosis Diameter	Stenosis D (No unit) = (Normal Diam. (cm) – Resid Diam. (cm)) / Normal Diam. (cm) × 100% Stenosis D (No unit) = | (D1-D2) / MAX (D1, D2)|*100% Where D1 and D2 refer to the measured vascular diameter, and MAX (D1, D2) represents the larger value of the two.

Tools	Descriptions	Methods or formulae
Stenosis A	Stenosis Area	Stenosis A (No unit) = | (A1-A2) / MAX (A1, A2) |*100% Where A1 and A2 refer to the measured vascular area, and MAX (A1, A2) represents the larger value of the two.

Study

Tools	Descriptions	Methods or formulae
IMT	Intima-Media Thickness	see “6.3.1 IMT”
Stenosis A	/	Stenosis (No unit) = |(A1-A2)/ MAX(A1,A2)|*100% Where A1 and A2 refer to the measured vascular area, and MAX (A1, A2) represents the larger value of the two. You may select different method for the two area measurement.

6.2.2 Doppler Mode

Measurement

Tools	Descriptions	Methods or formulae
CCA	Common Carotid Artery	D trace in General D measurements
Bulb	Bulbillate	
ICA	Internal Carotid Artery	
ECA	External Carotid Artery	
Vert. A	Vertebral Artery	
Innom. A	Innominate Artery	
Subclav. A	Subclavian Artery	
Axill. A	Axillary Artery	D trace in General D measurements
Brachial A	Brachial Artery	
Ulnar A	Ulnar Artery	
Radial A	Radial Artery	
Subclav. A	Subclavian Artery	
Axill. V	Axillary Vein	

Tools	Descriptions	Methods or formulae
Cephalic V	Cephalic Vein	D trace in General D measurements
Basilic V	Basilic Vein	
Ulnar V	Ulnar Vein	
Radial V	Radial Vein	
C.Iliac A	Common Iliac Artery	
Ex.Iliac A	External Iliac Artery	
CFA	Common Femoral Artery	
SFA	Superficial Femoral Artery	
Pop. A	Popliteal Artery	
TP Trunk A	Tibial Peroneal Trunk Artery	
Peroneal A	Peroneal Artery	
P.Tib. A	Posterior Tibial Artery	
A.Tib. A	Anterior Tibial Artery	
Dors.Ped. A	Dorsalis Pedis Artery	
C.Iliac V	Common Iliac Vein	
Ex.Iliac V	External Iliac Vein	
Femoral V	Femoral Vein	
Saph. V	Great Saphenous Vein	
Pop. V	Popliteal Vein	
TP Trunk V	Tibial Peroneal Trunk Vein	
Sural V	Sural Vein	
Soleal V	Soleal Vein	
Peroneal V	Peroneal Vein	
P.Tib. V	Posterior Tibial Vein	
A.Tib. V	Anterior Tibial Vein	
ACA	Anterior Cerebral Artery	
MCA	Middle Cerebral Artery	
PCA	Posterior Cerebral Artery	
AComA	Ant.communicating br.	
PComA	Post.communicating br.	
BA	Basilar Artery	

Tools	Descriptions	Methods or formulae
IIA	Internal Iliac Artery	D trace in General D measurements
DFA	Deep Femoral Artery	
Ba V	Basilar Vein	
Brachial V	Brachial Vein	
IIV	Internal Iliac Vein	
CFV	Common Femoral Vein	
SFV	Superficial Femoral Vein	
DFV	Deep Femoral Vein	
SSV	Small Saphenous Vein	
C.Iliac V Reflux	Common Iliac Vein Reflux	Time in General D measurements
Ex.Iliac V Reflux	External Iliac Vein Reflux	
Femoral V Reflux	Femoral Vein Reflux	
Saph. V Reflux	Great Saphenous Vein Reflux	
Pop. V Reflux	Popliteal Vein Reflux	
TP Trunk V Reflux	Tibial Peroneal Trunk Vein Reflux	
Sural V Reflux	Sural Vein Reflux	
Soleal V Reflux	Soleal Vein Reflux	
Peroneal V Reflux	Peroneal Vein Reflux	
P.Tib. V Reflux	Posterior Tibial Vein Reflux	
A.Tib. V Reflux	Anterior Tibial Vein Reflux	
IIV Reflux	Internal Iliac Vein Reflux	
CFV Reflux	Common Femoral Vein Reflux	
SFV Reflux	Superficial Femoral Vein Reflux	
DFV Reflux	Deep Femoral Vein Reflux	
SSV Reflux	Small Saphenous Vein Reflux	
ASP	Ankle Systolic Pressure	Type in
BSP	Brachial Systolic Pressure	

Calculation

Tool	Method or formulae
ICA/CCA(PS)	Measure the flow velocity ratio between ICA and CCA to calculate the stenosis. 1. Select [ICA/CCA (PS)] in the measurement menu. 2. Measure the PS value of the ICA and CCA using the 2 PT method in D trace, and the system calculates the stenosis. Where, the ICA value adopts the maximum PS value of proximal, middle and distal and the CCA adopts the latest measured value after changing the Prox./Mid./Dist. attribute (the default CCA adopts the distal PS value).

Study

Tool	Methods or formulae
ABI	see “6.3.2 ABI”

6.3 Study Tool Operations

6.3.1 IMT

NOTE:

- The IMT function is unavailable on the product not configured with IMT.
- The IMT measurement is available on frozen (or history) linear array images only.

TIP:

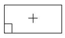
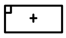
- Make sure that you select the correct vessel wall (Near/Far) before the IMT measurement. Otherwise the intima may be recognized incorrectly due to different algorithms that are applied in near/far wall recognition.
- To achieve a good trace result, try to place the ROI box parallel with the vessel and adjust the box size to reduce unwanted interference.

IMT (Intima-Media Thickness) measures the distance between LI (Lumen-Intima) and MA (Media-Adventia).

The IMT values at 4 positions: CCA (Common Carotid Artery), ICA (Internal Carotid Artery), ECA (External Carotid Artery) and Bulb (Bulbillate) need to be measured here.

Perform the following procedure:

1. Enter the IMT exam mode, scan and freeze the image (or review a historic image).
2. Select [IMT] in the measurement menu and enter the IMT measurement.
3. Select the side (Left/Right), angle and vessel wall (Near/Far).

4. Select an item such as [ICC, IMT], and the ROI box displays on the screen.
   - It appears as  when Near is selected
   - It appears as  when Far is selected
5. Move the ROI box to the desired position, then press <Set>. Two auto trace lines appear in the box.

   While the ROI box is green, you can:
   - Adjust the size of the ROI box.
   - Trace manually

     Move the cursor to a trace line. The trace line turns yellow. Press <Set>.

     Move the cursor along the interface of the vessel. Press <Set> to confirm the trace after re-adjusting.
   - Erase the trace lines inside the box by pressing <Clear>. (Long press <Clear> to clear all measurement calipers on the screen.)
6. Press <Set> outside the box to confirm the adjustment result after the manual trace is complete. The results are recorded in the IMT report.

   The system calculates:
   - IMT Max.
   - IMT Min.
   - IMT Mean
   - IMT SD
   - IMT ROI Length
   - IMT Measure Length
   - IMT Quality Index

   The Quality Index indicates the reliability of one measurement. Manual trace or re-scan of an image with clear endocardium edges is recommended if the Quality Index value is small.

   For multiple measurements on the same side, vessel and angle, the system calculates the following parameters in the report:
   - Average Mean IMT
   - Average Max IMT
   - Standard deviation

   It also provides the Composite Mean IMT, which is an overall mean value of all IMT mean values derived from the measured items.

6.3.2 ABI

Calculate the Ankle Brachial Index (ABI) by measuring the Ankle Systolic Pressure (ASP) and the Brachial Systolic Pressure (BSP) on a Doppler image.

ABI = ASP/BSP

TIP:

The left and right sides respectively need to be measured.

Perform the following procedure:

1. Select [ABI] in the measurement menu.
2. Click [ASP] from the [ABI] menu and enter the value.

3. Click [BSP] from the [ABI] menu and enter the value.
4. The ABI is calculated by the system automatically.

6.4 References

Stenosis D

Honda, Nobuo, et al., “Echo-Doppler Velocimeter in the Diagnosis of Hypertensive Patients: The Renal Artery Doppler Technique,” Ultrasound in Medicine and Biology, 1986, Vol. 12(12), pp. 945-952.

Stenosis A

Jacobs, Norman M., et al., “Duplex Carotid Sonography: Criteria for Stenosis,Accuracy,and Pitfalls,” Radiology, 1985, 154:385-391.

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7 Urology

7.1 Basic Measurement Procedures

1. Press <Patient> on the control panel and enter the patient information.
2. Perform the scanning to acquire the desired image.
3. Press <Measure> to enter the Application Measurement.
4. Select the measurement tool from the measurement menu to start the measurement.
   – For measurement tools, see “7.2 Urology Measurement Tools”.
   – For measurement methods, see “2 General Measurement”.

The system calculates and displays the results after the measurement tools have been completed.

7.2 Urology Measurement Tools

7.2.1 2D Mode

Measurement

Tools	Descriptions	Methods or formulae
Renal L	Renal Length	Distance in 2D General measurements
Renal H	Renal Height	
Renal W	Renal Width	
Cortex	Renal Cortical Thickness	
Cortex(Renal Transplant1-2)	Renal Cortical Thickness	
Renal V Diam(Renal Transplant1-2)	Renal Vein Diameter	
Ureter Diam(Renal Transplant1-2)	Ureter Diameter	
Adrenal L	Adrenal Length	
Adrenal H	Adrenal Height	
Adrenal W	Adrenal Width	
Prostate L	Prostate Length	
Prostate H	Prostate Height	
Prostate W	Prostate Width	

Tools	Descriptions	Methods or formulae
Seminal L	Seminal Vesicle Length	Distance in 2D General measurements
Seminal H	Seminal Vesicle Height	
Seminal W	Seminal Vesicle Width	
Testis L	Testicular Length	
Testis H	Testicular Height	
Testis W	Testicular Width	
Ureter Diam	Ureter Diameter	
Ureter	/	
Pre-BL L	Pre-void Bladder Length	
Pre-BL H	Pre-void Bladder Height	
Pre-BL W	Pre-void Bladder Width	
Post-BL L	Post-void Bladder Length	
Post-BL H	Post-void Bladder Height	
Post-BL W	Post-void Bladder Width	
Renal Cyst1-3 d1-3	/	
Renal Lesion1-3 d1-3	/	
Prostate Mass1 d1-3	/	
Prostate Mass2 d1-3	/	
Prostate Mass3 d1-3	/	
Testis Mass1 d1-3	/	
Testis Mass2 d1-3	/	
Testis Mass3 d1-3	/	
Epididymis L	Epididymis Length	
Epididymis W	Epididymis Width	
Epididymis H	Epididymis Height	
Scrotal Wall Thickness	/	

Calculation

Tools	Descriptions	Methods or formulae
Renal Vol.	Renal Volume	Renal L, Renal H, Renal W **NOTE:** Needs to be measured on the left and right sides respectively.

Tools	Descriptions	Methods or formulae
Prostate Vol.	Prostate Volume	Prostate L, Prostate H and Prostate W If [Serum PSA] in [Patient Info] > [URO] has been entered, PSAD (Prostate Special Antigen Density) will also be calculated. • PPSA (ng/ml) = PPSA Coefficient (ng/ml^2) × Prostate Vol (ml) • PSAD (ng/ml^2) = Serum PSA (ng/ml) / Prostate Vol. (ml) Here, the PPSA Coefficient and Serum PSA are entered in the [Patient Info] > [URO] dialog box. The default value of the PPSA Coefficient is 0.12.
Testicular Vol.	Testicular Volume	Testis L, Testis H, Testis W **NOTE:** Needs to be measured on the left and right sides respectively.
Pre-BL Vol.	Pre-void Bladder Volume	Pre-BL L, Pre-BL H, Pre-BL W The Mictur.Vol is displayed in the report if the Post-BL Vol is measured.
Post-BL Vol.	Post-void Bladder Volume	Post-BL L, Post-BL H, Post-BL W The Mictur.Vol is displayed in the report if the Pre-BL Vol is measured.
Mictur. Vol.	Micturated Volume	Pre-BL Vol, Post-BL Vol The Post-BL Vol. and Mictur.Vol. are calculated automatically, the Post-BL Vol. is displayed in the report.

Study

Tools	Methods or formulae
Kidney	Renal L, Renal H, Renal W **NOTE:** Needs to be measured on the left and right sides respectively.
Adrenal	Adrenal L, Adrenal H, Adrenal W **NOTE:** Needs to be measured on the left and right sides respectively.
Prostate	Prostate L, Prostate H, Prostate W If [Serum PSA] in [Patient Info] > [URO] has been entered, PSAD (Prostate Special Antigen Density) will also be calculated. • PPSA (ng/ml) = PPSA Coefficient (ng/ml^2) × Prostate Vol (ml) • PSAD (ng/ml^2) = Serum PSA (ng/ml) / Prostate Vol. (ml) Here, the PPSA Coefficient and Serum PSA are entered in the [Patient Info] > [URO] dialog box. The default value of the PPSA Coefficient is 0.12. The PSAD displays in the report if the PSA value is entered.

Tools	Methods or formulae
Seminal Vesicle	Seminal L, Seminal H, Seminal W **NOTE:** Needs to be measured on the left and right sides respectively.
Testis	Testis L, Testis H, Testis W **NOTE:** Needs to be measured on the left and right sides respectively.
Bladder	Pre-BL L, Pre-BL H, Pre-BL W; Post-BL L, Post-BL H, Post-BL W
Mass1-10	Distance in 2D General measurements
Prostate mass 1-3	
Testis mass 1-3	
Epididymis	Epididymis L, Epididymis H, Epididymis W **NOTE:** Needs to be measured on the left and right sides respectively.
Renal Cyst1-3 d1-3	Distance in 2D General measurements
Renal Lesion1-3 d1-3	
Kidney(Superior)	
Kidney(Mid)	
Kidney(Inferior)	
Kidney(Renal Transplant1-2)	
Adrenal(Renal Transplant1-2)	
Finding 1-6(Renal Transplant1-2)	

7.2.2 Doppler Mode

Measurement

Tools	Descriptions	Methods or formulae
Testicular A	Testicular Aorta	Distance in 2D General measurements
Testicular V	Testicular Vein	
Epididymis A	Epididymis Aorta	
Epididymis V	Epididymis Vein	

7.3 References

PPSA

Peter J. Littrup M.D., Fed LeE. M.D., Curtis Mettin. P.D. Prostate Cancer Screening: Current Trends and Future Implications. CA-A CANCER JOURNAL FOR CLINICIANS, Jul/Aug 1992, Vol.42, No.4

PSAD

MITCHELL C. BENSON, IHN SEONG, CARL A. OLSSON, J., McMahon, WILLIAM H.COONER. The Use of Prostate Specific Antigen Density to Enhance the Predictive Value of the Intermediate Levels of Serum Prostate Specific Antigen. THE JOURNAL OF UROLOGY, 1992, Vol.147, p817-821

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8 Gynecology

8.1 Basic Measurement Procedures

1. Press <Patient> on the control panel and enter the patient information.
2. Perform the scanning to acquire the desired image.
3. Press <Measure> to enter the Application Measurement.
4. Select the measurement tool from the measurement menu to start the measurement.
   - For measurement tools, see “8.2 Gynecology Measurement Tools”.
   - For measurement methods, see “2 General Measurement”.

   The system calculates and displays the results after the measurement tools have been completed.

8.2 Gynecology Measurement Tools

Measurement

Tools	Descriptions	Methods or formulae
UT H	Uterine Height	Distance in 2D General measurements
UT W	Uterine Width	
UT L	Uterine Length	Distance, Trace and Spline in 2D General Measurements
Cervix L	Uterine Cervix Length	
Cervix H	Uterine Cervix Height	Distance in 2D General measurements
Cervix W	Uterine Cervix Width	
Endo	Endometrium Thickness	
Ovary L	Ovary Length	
Ovary H	Ovary Height	
Ovary W	Ovary Width	
Follicle1~16 L	Follicle 1~16 Length	
Follicle1~16 W	Follicle 1~16 Width	
Follicle1~16 H	Follicle1~16 Height	
Fibroid1-3 d1-3	/	
GYN Lesion1-3 d1-3	/	
Ovarian Cyst1-3 d1-3	/	
DWT	Detrusor Wall Thickness	

<table>
<tr><th>Tools</th><th>Descriptions</th><th>Methods or formulae</th></tr>
<tr><td>Intus. Depth</td><td>Intussusceptions Depth</td><td>Distance in 2D General measurements</td></tr>
<tr><td>BSD (R)</td><td>Bladder Neck-Symphysis Distance (Rest)</td><td rowspan="8">Parallel in 2D General Measurements</td></tr>
<tr><td>BSD (Va)</td><td>Bladder Neck-Symphysis Distance (Valsalva)</td></tr>
<tr><td>Cx-SP Dist. (R)</td><td>Cervix - Symphysis Publis Distance (Rest)</td></tr>
<tr><td>Cx-SP Dist. (Va)</td><td>Cervix - Symphysis Publis Distance (Valsalva)</td></tr>
<tr><td>RA-SP Dist. (R)</td><td>Rectal Ampulla - Symphysis Publis Distance (Rest)</td></tr>
<tr><td>RA-SP Dist. (Va)</td><td>Rectal Ampulla - Symphysis Publis Distance (Valsalva)</td></tr>
<tr><td>Rectocele Depth</td><td>/</td></tr>
<tr><td>Shuttle (R)</td><td>Bladder Neck-Symphyseal Distance (Rest)</td><td rowspan="2">The system automatically calculates BSD, BPW-SP Dist., Cx-SP Dist. and RA-SP Dist. values.
The measurement of reference line distance: measure the distance from BN, front point, middle point, back point of pelvis floor to the reference line of the symphysis pubis.
1. Move the bigger cursor to a certain point.
2. Touch and rotate <Angle> to adjust the orientation of the reference line.
3. Press <Set> to fix the reference line.
4. Press <Set> to fix BN position. Measure the distance from this point to the reference line (BN distance). Then, measure BPW-SP Dist., Cx-SP Dist. and RA-SP Dist..
Press <Clear> to remove the last measurement result. Double-click <Set> to complete the measurement in advance. Press <Update> to start a new measurement.</td></tr>
<tr><td>Shuttle (S)</td><td>Bladder Neck-Symphyseal Distance (Stress)</td></tr>
</table>

Tools	Descriptions	Methods or formulae
RVA (R)	Retrovesical Angle (Rest)	Angle in 2D General measurements
RVA (S)	Retrovesical Angle (Stress)	
UTA (R)	Urethral Tilt Angle (Rest)	
UTA (S)	Urethral Tilt Angle (Stress)	
URA	Urethral Rotation Angle	
PVA (R)	Pubovesical Angle (Rest)	
PVA (S)	Pubovesical Angle (Stress)	
PUA (R)	Pubourethral Angle (Rest)	
PUA (S)	Pubourethral Angle (Stress)	
ARA (R)	Anorectal Angle (Rest)	
ARA (S)	Anorectal Angle (Stress)	
ARA (C)	Anorectal Angle (Contraction)	
LH AP Diam (R)	Levator Hiatal Anteroposterior Diameter (Rest)	Distance in 2D General Measurements
LH AP Diam (S)	Levator Hiatus Anteroposterior Diameter (Stress)	
LH AP Diam (C)	Levator Hiatus Anteroposterior Diameter (Contraction)	
LH Lateral Diam (R)	Levator Hiatus Lateral Diameter (Rest)	
LH Lateral Diam (S)	Levator Hiatus Lateral Diameter (Stress)	
LH Lateral Diam (C)	Levator Hiatus Lateral Diameter (Contraction)	
LA Thickness (R)	Levator Ani Thickness (Rest)	
LA Thickness (S)	Levator Ani Thickness (Stress)	
LA Thickness (C)	Levator Ani Thickness (Contraction)	
LH Area (R)	Levator Hiatus Area (Rest)	Area in 2D General measurements
LH Area (S)	Levator Hiatus Area (Stress)	
LH Area (C)	Levator Hiatus Area (Contraction)	
LA Angle (R)	Levator Ani Angle (Rest)	Angle in 2D General measurements
LA Angle (S)	Levator Ani Angle (Stress)	
LA Angle (C)	Levator Ani Angle (Contraction)	

Tools	Descriptions	Methods or formulae
LUG (R)	Levator Urethra Gap (Rest)	Distance in 2D General Measurements
LUG (S)	Levator Urethra Gap (Stress)	
LUG (C)	Levator Urethra Gap (Contraction)	
BPW-SP Dist. (S)	Bladder Post Wall - Symphysis Publis Distance (Stress)	Parallel in 2D General Measurements
BPW-SP Dist. (Va)	Bladder Post Wall - Symphysis Publis Distance (Valsalva)	
GYN Lesion1~3 Strain	/	Strain in 2D General measurements

Calculation

Tools	Descriptions	Methods or formulae
Ovary Vol.	Ovary Volume	Ovary L, Ovary H, Ovary W **NOTE:** Needs to be measured on the left and right sides respectively.
UT Vol.	UT Volume	UT L, UT H, UT W
Uterus Body	/	UT L, UT H, UT W Uterus Body (cm) = UT L (cm) + UT H (cm) + UT W (cm)
UT-L/ CX-L	/	UT L, Cervix L UT-L/CX-L (No unit) = UT L (cm) / Cervix L (cm)
Follicle 1-16	/	Length, height and width of follicle 1~16
Mean DWT	Mean Detrusor Wall Thickness	Distance in 2D General Measurements Mean DWT = (DWT1 + DWT2 + DWT3) /3
IAS Damage	/	Damage ratio= the length of sphincter muscle of anus damage / the length of sphincter muscle of anus
EAS Damage	/	

Study

Tools	Descriptions	Methods or formulae
Uterus	/	Length, height and width of uterus, endometrium thickness
Uterine Cervix	/	Length, height and width of uterine cervix
Ovary	/	Length, height and width of ovary
Follicle 1~16	/	Length, height and width of follicle 1~16

Tools	Descriptions	Methods or formulae
Fibroid1-3 d1-3	/	Distance in 2D General Measurements
GYN Lesion1-3 d1-3	/	
Ovarian Cyst1-3 d1-3	/	
BL Height	Bladder Height	The system automatic calculates Residual Urine value. • Dietz formula: Residual Urine (ml) = BL Height (cm) × BL Depth (cm)× 5.6, or • Haylen formula: Residual Urine (ml) = BL Height (cm)× BL Depth (cm) ×5.9 - 14.6, or • Dicuio formula: Residual Urine (ml) = BL Height (cm) × BL Depth (cm) × BL Transverse Diameter (cm)× 0.52
BL Depth	Bladder Depth	
GYN Lesion1~3 StrRatio		Strain Ratio in 2D General Measurements

Where, the methods and formulae for follicle volume are as follows:

- Average Diameter
  - 2-distance

$$\text{Average Diam} = (Length + Width)/2$$

  - 3-distance

$$\text{Average Diam} = (Length + Width + Height)/3$$

- Follicle Volume
  - 1-distance

$$\text{Vol} = \frac{\pi}{6}(Length)^3$$

  - 2-distance

$$\text{Vol} = \frac{\pi}{6}(Length)^2 \times Width$$

  - 3-distance

$$\text{Vol} = \frac{\pi}{6} length \times Width \times Height$$

8.3 References

Uterus Body

Feng Kui, Sun Yanling, Li Hezhou. Ultrasonic diagnosis of adenomyosis. Journal of Henan Medical University, 1995; 30 (2).

UT-L/ CX-L

Ji Jindi, et al. Ultrasonographic study of the intersex problems and the internal genitalia abnormalities. Journal of China medical ultrasound. 1996, Volume 12, No8 P40.

Residual Urine

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- Cassadó, J., Espu?a-Pons, M., Díaz-Cuervo, H., Rebollo, P. and on behalf of the GISPEM Group (2015), How can we measure bladder volumes in women with advanced pelvic organ prolapse?. Ultrasound Obstet Gynecol, 46: 233–238. doi:10.1002/uog.14678

Levator Hiatus Diam, Area, Thickness and LA Angle

- 3-Dimensional transvaginal ultrasonography evaluation of femal pelvic floor structure and function.
- Dan V. Valsky, MD, Simcha Yagel, MD. Three-Dimensional Transperineal Ultrasonography of he Pelvic Floor. J Ultrasound Med 2007; 26:1373–1387.

LUG (Levator Urethra Gap)

H. P. DIETZ, A. ABBU and K. L. SHEK. The levator–urethra gap measurement: a more objectivemeans of determining levator avulsion? Ultrasound Obstet Gynecol 2008; 32: 941–945.

Smart Pelvic

- Svabik K, Shek KL, Dietz HP. How much does the levator hiatus have to stretch during childbirth? BJOG 2009;116:1657–62
- Abdool Z, Shek KL, Dietz HP. The effect of levator avulsion on hiatal dimensions and function. Am J Obstet Gynecol 2009;201(1). 89.e1–5.
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- Dietz H, De Leon J, Shek K. Ballooning of the levator hiatus. Ultrasound Obstet Gynecol 2008; 31: 676–680.
- Eisenberg VH, Chantarasorn V, Shek KL, Dietz HP. Does levator ani injury affect cystocele type? Ultrasound Obstet Gynecol 2010; 36: 618–623.
- Oerno A, Dietz H. Levator co-activation is a significant confounder of pelvic organ descent on Valsalva maneuver.Ultrasound Obstet Gynecol 2007; 30: 346–350.
- Dietz H, Lanzarone V. Levator trauma after vaginal delivery.Obstet Gynecol 2005;106: 707–712.
- Dietz HP, Abbu A, Shek KL. The levator–urethra gap measurement:a more objective means of determining levator avulsion? Ultrasound Obstet Gynecol 2008; 32: 941–945.
- Dietz HP, Schierlitz L. Pelvic floor trauma in labour—myth or reality? Aust N Z J Obstet Gynaecol 2005;45:3–11.
- Dietz H, Abbu A, Shek K (2008) The levator urethral gap measurement: a more objective means of determining levator avulsion? Ultrasound Obstet Gynecol 32:941–945
- Valsky DV, Yagel S. Three-dimensional transperineal ultrasonography of the pelvic floor: improving visualization for new clinical applications and better functional assessment. J Ultrasound Med 2007; 26: 1373–1387
- Dietz HP. Pelvic floor ultrasound: a review. Am J Obstet Gynecol 2010; 202: 321–334

9 Small Parts

9.1 Basic Measurement Procedures

1. Press <Patient> on the control panel and enter the patient information.
2. Perform the scanning to acquire the desired image.
3. Press <Measure> to enter the Application Measurement.
4. Select the measurement tool from the measurement menu to start the measurement.
   - For measurement tools, see “9.2 Small Parts Measurement Tools”.
   - For measurement methods, see “2 General Measurement”.

   The system calculates and displays the results after the measurement tools have been completed.

9.2 Small Parts Measurement Tools

9.2.1 2D Mode

Measurement

Tools	Descriptions	Methods or formulae
Thyroid L	Thyroid Length	Distance in 2D General measurements
Thyroid H	Thyroid Height	
Thyroid W	Thyroid Width	
Isthmus H	Isthmus height	
Testis L	Testicular Length	
Testis H	Testicular Height	
Testis W	Testicular Width	
Epididymis L	Epididymis Length	
Epididymis W	Epididymis Width	
Epididymis H	Epididymis Height	
Scrotal Wall Thickness	/	
Breast Mass1~10 L	Mass Length	
Breast Mass1~10 W	Mass Width	
Breast Mass1~10 H	Mass Height	
Nip.-Mass 1~10 Dist.	Distance between nipple and mass	
Skin-Mass 1~10 Dist.	Distance between skin and mass	

Tools	Descriptions	Methods or formulae
Thyroid Mass 1-3 d1-3	Thyroid mass	Distance in 2D General measurements
Thyroid Nodule 1-3 d1-3	/	Distance in 2D General measurements
Thyroid Cyst 1-3 d1-3	/	
Testicular Mass 1-3 d1-3	Testicular mass	
THY Mass1~3 Strain	Thyroid Mass Strain	Strain in 2D General measurements
THY Nodule1~3 Strain	Thyroid Nodule Strain	
Breast Mass1~10 Strain	/	
THY Mass1~3 Elas.	Thyroid Mass Elastography	Elastography in 2D General Measurements
THY Nodule1~3 Elas.	Thyroid Nodule Elastography	
Breast Mass1~10 Elas.	Breast Mass Elastography	

Calculation

Tools	Descriptions	Methods or formulae
Thyroid Vol.	Thyroid Volume	Thyroid Vol. (cm^3) = k × Thyroid L (cm) × Thyroid H (cm) × Thyroid W (cm) Where k= 0.479 or 0.523
Testicular Vol.	Testicular Volume	Testis L, Testis H, Testis W **NOTE:** Needs to be measured on the left and right sides respectively.

Study

Tools	Descriptions	Methods or formulae
Thyroid		Same formulae as in the Thyroid Vol. calculation
Testis	/	Testis L, Testis H and Testis W, calculates the Testis Vol.
Epididymis	/	Epididymis L, Epididymis H and Epididymis W
Breast Mass1~10	/	Volume (3 Dist.) in 2D General Measurements
Thyroid Mass1~10	/	
Testicular Mass1~10	/	

Tools	Descriptions	Methods or formulae
THY Mass1~3 Strain Ratio	Thyroid Mass Strain Ratio	Strain Ratio in 2D General measurements
THY Nodule1~3 Strain Ratio	Thyroid Nodule Strain Ratio	
Breast Mass1~10 Strain Ratio	/	
THY Mass1~3 Elas. Ratio	Thyroid Mass Elastography Ratio	Elastography Ratio in 2D General Measurements
THY Nodule1~3 Elas. Ratio	Thyroid Nodule Elastography Ratio	
Breast Mass1~10 Elas. Ratio	Breast Mass Elastography Ratio	
Thyroid(Superior)	/	Distance in 2D General Measurements
Thyroid(Mid)	/	
Thyroid(Inferior)	/	
Parathyroid 1-2	/	
Parotid	/	
Lymph Node 1-6	/	
Isthmus Finding 1-3	/	

9.2.2 Doppler Mode

Measurement

Tools	Descriptions	Methods or formulae
STA	Superior Thyroid Artery	D trace in General D measurements
ITA	Inferior Thyroid Artery	
Isthmus	/	
Parathyroid 1-2	/	
Testicular A	Testicular Aorta	
Testicular V	Testicular Vein	
Testis V(Valsalva)	/	
Epididymis A	Epididymis Aorta	
Epididymis V	Epididymis Vein	

9.3 References

Thyroid Vol (k= 0.479)

Volumetrie der Schilddruesenlappn mittels Realtime-Sonographie; J Brunn, U. Block, G. Ruf, et al.; Dtsch.med. Wschr.106 (1981), 1338-1340.

Thyroid Vol (k=0.523)

Gomez JM, Gomea N, et al. Determinants of thyroid volume as measured by ultrasonography in healthy adults randomly selected. Clin Endocrinol(Oxf), 2000;53:629-634

10 Pediatrics

The HIP (Hip Joint Angle) measurement is used in pediatric Pediatrics. Such measurement provides early diagnosis for infant hip joint dislocation.

10.1 Basic Measurement Procedures

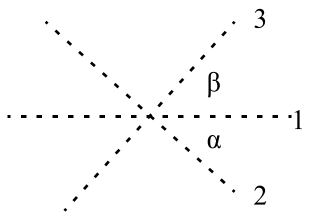
1. Press <Patient> on the control panel and enter the patient information.
2. Perform the scanning to acquire the desired image.
3. Press <Measure> to enter the Application Measurement.
4. Select the measurement tool from the measurement menu to start the measurement.
   - For measurement tools, see "10.2 Pediatrics Measurement Tools".
   - For measurement methods, see "2 General Measurement".

   The system calculates and displays the results after the measurement tools have been completed.

10.2 Pediatrics Measurement Tools

10.2.1 HIP

The HIP calculation assists in assessing the development of the infant hip. In this calculation, three straight lines are superimposed on the image and aligned with the anatomical features. The two angles are calculated and displayed.



Line	1	The baseline (BL), connecting the osseous acetabular convexity to the point where the joint capsule and the perichondrium unite with the ilium.
	2	The roof line (RL), connecting the lower edge of the ilium to the osseous acetabular convexity.
	3	The inclination line (IL), connecting the osseous acetabular convexity to the acetabular labrum.
Angle	α (Alpha)	The angle between BL and RL.
	β (Beta)	The angle between BL and IL

Dislocation type can be determined using the Graf method, as described in the following table.

Tpye		α	Bony roof	Superior bony rim	β	Cartilaginous roof	Age (Weeks)
I	Ia	≥60°	good	angular/slightly rounded (“blunt”)	≤55°	covers the femoral head	any age
	Ib	≥60°	good	angular/slightly rounded (“blunt”)	>55°	covers the femoral head	any age
II	IIa	[50°,60°)	adequate (satisfactory)	rounded	any angle	covers the femoral head	[0,6]
	IIa(+)	[55°,60°)	adequate (satisfactory)	rounded	any angle	covers the femoral head	(6,12]
	IIa(-)	[50°,55°)	deficient	rounded	any angle	covers the femoral head	(6,12]
	IIb	[50°,60°)	deficient	rounded	any angle	covers the femoral head	>12
	IIc	[43°,50°)	severely deficient	rounded to flattened	≤77°	covers the femoral head	any age
D		[43°,50°)	severely deficient	rounded to flattened	>77°	pressed shift	any age
III	IIIa	≤42°	poor	flattened	no measure	pressed upwards-without structural alteration (devoid of echoes) proximal perichondrium goes up to the contour of the iliac wall	any age
	IIIb	≤42°	poor	flattened	no measure	pressed upwards-with structural alteration (they are echogenic) proximal perichondrium goes up to the contour of the iliac wall	any age
IV		≤42°	poor	flattened	no measure	pressed downwards (horizontal or mulded proximal perichondrium	any age

Perform the following procedure:

1. In B mode, select [HIP] from the measurement menu.

   A line appears, and there is a fulcrum on the line.
2. Use the trackball/touchpad to move the line to the position of the hip joint. Then rotate the <Angle> knob to fix the baseline.
3. Press <Set> to confirm and the second line displays.
4. Use the method for adjusting the first line to anchor the RL and press <Set> to fix the RL.
5. Use the same method to fix the third line IL. The angles of α and β come out.

   If the patient's age is entered, the dislocation type is also displayed.

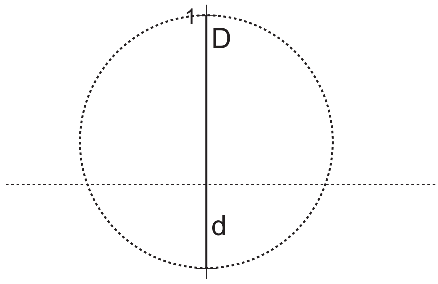
   Measure the angles of α and β separately: click [HIP (α)] or [HIP (β)] to measure.

10.2.2 HIP-Graf

The measurement items, results and procedures, see “10.2.1 HIP”.

10.2.3 d/D

Measures the distance between the baseline and bottom line of the osseous acetabular and the maximum width of the hip to estimate the hip osseous acetabular coverage.



Perform the following procedure:

1. Select [d/D] in the measurement menu.
2. Use the Distance tool in the 2D General Measurement to measure the maximum width of the hip (D), and the distance between the osseous acetabular roof and bottom (d).

   The system calculates the d/D.

10.3 References

Graf R., “Sonographic diagnosis of hip dysplasia. Principles, sources of error and consequences” Ultraschall Med. 1987 Feb;8(1):2-8

Schuler P., “Principles of sonographic examination of the hip” Ultraschall Med. 1987 Feb;8(1):9-1

Graf, R. “Fundamentals of Sonographic Diagnosis of Infant Hop Dysplasia.” Journal Pediatric Orthopedics, Vol. 4, No. 6:735-740,1984.

Graf, R. Guide to Sonography of the Infant Hip. Georg Thieme Verlag, Stuttgart and New York, 1987.

Morin, C., Harcke, H., MacEwen, G. “The Infant Hip: Real-Time US Assessment of Acetabular Development.” Radiology, 177:673-677, December 1985.

R. Graf. “Hip Sonography Diagnosis and Management of Infant Hip Dysplasia” With the collaboration of S. Scott, K. Lercher, F. Baumgartner, A. Benaroya

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11 Nerve

11.1 Basic Measurement Procedures

1. TPress <Patient> on the control panel and enter the patient information.
2. Perform the scanning to acquire the desired image.
3. Press <Measure> to enter the Application Measurement.
4. Select the measurement tool from the measurement menu to start the measurement.
   - For measurement tools, see “11.2 Nerve Measurement Tools”.
   - For measurement methods, see “2 General Measurement”.

   The system calculates and displays the results after the measurement tools have been completed.

11.2 Nerve Measurement Tools

There are no specific tools for Nerve by default, however, you can preset measurement tools for Nerve using tools from other packages. For details, see *Basic Volume*.

NOTE:

Measurement tools in each application package depend on the specific measurement data preset for each ultrasound system.

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12 Emergency&Critical

12.1 Basic Measurement Procedures

1. Press <Patient> on the control panel and enter the patient information.
2. Perform the scanning to acquire the desired image.
3. Press <Measure> to enter the Application Measurement.
4. Select the measurement tool from the measurement menu to start the measurement.
   – For measurement tools, see "12.2 EM Measurement Tools".
   – For measurement methods, see "2 General Measurement".

   The system calculates and displays the results after the measurement tools have been completed.

12.2 EM Measurement Tools

The following optional emergency exam modes are available in the current system:

- EM ABD
- EM FAST
- EM OB
- EM Vascular
- EM Superficial
- EM Cardiology

The commonly used measurement tools are contained in the EM package corresponding to each EM exam mode.

NOTE:

- Measurement tools in each EM package depend on the specific measurement data preset for each ultrasound system.
- For detailed descriptions of the measurement items, see the corresponding application chapter.
- For more information about package preset, see *Basic Volume*.

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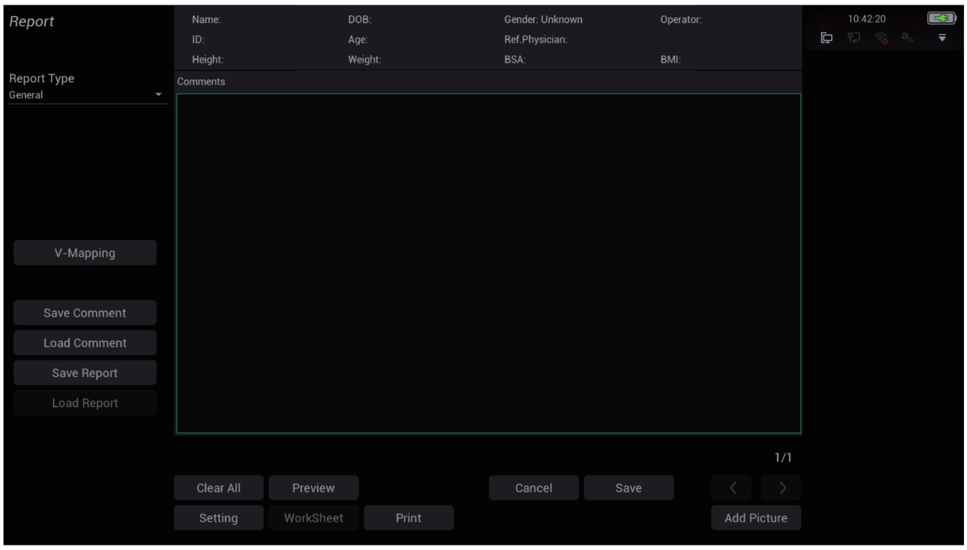
13 Report

The report records measurement results, which are automatically saved by the system after each measurement.

13.1 Viewing Reports

13.1.1 To View Current Reports

Press <Report> on the control panel to enter the report dialog box. The default report of the current exam appears.



- Each measurement contains the three latest values and a final value.
- The report only displays results of tools that are displayed in the report template by default and are completed.
- Select [Prev Page] or [Next Page] to switch between pages if the report has more than one page.
- When using Obstetric template, if LMP has already been entered, select [Trend] to view Fetal Growth Curve after measurement.
- After viewing, press <Freeze>, or select [Cancel] or [OK] to exit the report page.

Editing Measurement Data

⚠**CAUTION**

Input appropriate data when editing the measurement values, otherwise misdiagnosis may occur.

NOTE:

- Only measurement values are editable while calculation values are not.
- After a measurement value is modified, the average value of the tool and the corresponding calculation value will be updated automatically.

The measurement values in the text boxes are editable. Move the cursor to the text box and press <Set>.

The modified value(s) is/are underlined.

The final value displays in the [Value] column. Select an option ([Last], [Avg], [Max] or [Min]) from [Method] to determine the method in which the final value is calculated.

For result values used to calculate GA (Gestational Age) and SD (Standard Deviation), the formula used in this calculation can be selected from [Formula]. The GA and SD values update with the formula change.

Entering Ultrasound Remarks

In the [Comments] box, enter the corresponding information.

You can also save or load the comments.

- Save comment: enter information in the Comments box and then select [Save Comment] to save current information in the report comment database.
- Load comment: select [Load Comment] to open the dialog box to check history saved comment information. You can select related information to add to current report comment or select the location of the comments.

Selecting Images

Images saved for the current exam can be added to the report.

Perform the following procedure:

1. Click [Add Picture] on the report page.
   – Left Column: Images saved for the current exam.
   – Right Column: Images selected to add to the report.
2. Select the image.
   – Add/Remove the image by using [>], [>>], [<] and [<<].
   – Select an image in the right column and select [Move Up] or [Move Down] to adjust the sequence in which the images are arranged in the report.

V-Mapping

The V-Mapping function is used to display various types of vascular anatomical graphics under the image scanning status. You can draw graphics, mark lesion position and types, and print graphics.

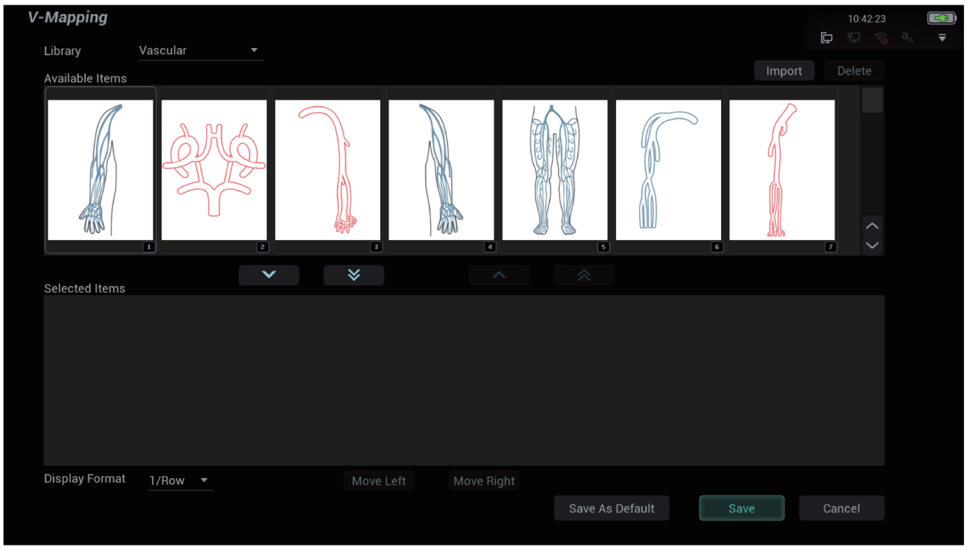
NOTE:

OB, EM OB, IVF, Stress Echo and LV analysis reports do not support this function.

Perform the following procedure:

1. Select [V-Mapping].

   The dialog box appears.



– Available items: the graphic saved in the current exam can be added to the report.

– Selected items: the selected graphic will be added to the report.

2. Select the graphic

   – Adding/ Removing the image with [∨], [︾], [∧], [︽].

   – Select a graphic from the selected items. Click [Move Left] or [Move Right] to adjust the graphic sequence in the list.

     The sequence of the graphic in the bottom column is that of the graphics in the report.

   You may customize the anatomical graphic and import it to the report. Display effect of 480*640 works best.

3. When measuring the results of the anatomical curve, the measurements appear on the curve.

4. Select the painter color, and draw on the anatomical area manually.

5. Select [Save] to add anatomical picture.

NOTE:

Entering V-Mapping directly through the touch screen:

- In both real-time and freeze modes, you can directly tap [V-Mapping] on the touch screen in B/Color/Power imaging modes. In this case, the main screen remains the same as the imaging screen, and the touch screen enters the anatomical editing status.
- The operation of the touch screen is the same as that of the V-Mapping entered under report status.

Analyzing Report Data

You can preset and edit anatomy information in the report.

Perform the following procedure:

1. Select [Analyze].

2. Select or enter anatomy descriptions.

   NOTE:

   Descriptions of [Fetus Score] can only be selected from the drop-down list.

   Use the [Previous]/[Next] buttons to switch between pages.

3. Select [OK] to confirm. Analysis information displays after the measurement values in the report.

13.1.2 To View History Reports

NOTE:

History reports can be viewed, but cannot be edited.

If more than one exam is performed for a patient, an [Exam] drop-down list appears in the top-right part on the report.

Perform the following procedure:

1. Select previous exams from the [Exam] drop-down list.
2. According to the exam mode, select a proper template from the [Report Type].

   Make sure the template matches the exam mode, otherwise the measurement result will not display correctly. E.g. An abdomen measurement result will not display in an OB report template preset without any abdomen measurement items.
3. View the history report.

13.2 Obstetric Exam Report

13.2.1 Fetal Biophysical Profile

Fetal Biophysical Profile means to first obtain a few indices related to fetal growth through experiment or measurement and then evaluate the hazardous situation that the fetus is facing by grading these indices respectively.

Under OB report status, select [Analyze], the fetus Score is listed after the fetal analysis.

The scoring criteria the system provides are based on the Vintzileos formula.

<table>
<tr><th>Fetal growth index</th><th>Score 0</th><th>Score 2</th><th>Observation time</th><th></th></tr>
<tr><td>FHR</td><td><2, or Reactive FHR ≤15 bpm</td><td>Reactive FHR ≥ 15 bpm, duration ≥ 15 s, ≥ 2 times</td><td>30 minutes</td><td rowspan="4">The score(s) can be manually entered into the system.</td></tr>
<tr><td>FM</td><td>≥ 2 fetal movements</td><td>FM ≥ 3 times (continuous movement is deemed as 1 time)</td><td>30 minutes</td></tr>
<tr><td>FBM</td><td>No FBM or duration ≤ 30 s</td><td>FBM ≥ 1 times; duration ≥ 30 s</td><td>30 minutes</td></tr>
<tr><td>FT</td><td>Limbs stretch, no bend, fingers loose</td><td>Limbs and spine stretch/bend ≥ 1 times</td><td>/</td></tr>
<tr><td>AF</td><td>No AF, or AF volume < 2 × 2 cm</td><td>One or more AF volumes > 2 × 2 cm</td><td>/</td><td></td></tr>
</table>

The scores of each index as well as the total score will be appended to the report.

Fetal scoring results criteria:

Total scores	Growth condition
8-10	Normal, chronic asphyxia risk low
4-6	Chronic asphyxia risk suspicious
0-2	Chronic asphyxia risk high

13.2.2 Comparison Bar

This function compares the clinical GA, the ultrasound GA obtained from OB measurements and the AUA (CUA).

1. Under report status, select [Compare Bar].
2. Select the [Print] checkbox to determine whether to include the bar in the printed report or not.

13.2.3 Z-Score

NOTE:

The Z-Score study is effective for fetuses aged 15-40 weeks.

As the FL, BPD and GA are most relevant to the fetus cardiac structure and the Z-Score regression equation is related to the natural logarithm value of the FL, BPD and GA variables, the Z-Score of cardiac structures can be obtained by looking at the Z-Score table, which is important in fetus cardiac growth evaluation and intrauterine interventional therapy.

$$\text{In (predicted cardiac dimension)} = m \times \text{In(FL, GA or BPD)} + c$$

$$\text{Z-Score} = (\text{In(actual)} - \text{In(predicted cardiac dimension)})/\text{root MSE}$$

Where the unit of FL and BPD is cm, GA is week, m is multiplier, c is intercept and root MSE is root-mean-square error, which can be obtained from the table.

Perform the following procedure:

1. Measure the BPD and FL.
2. Select Z-Score parameters (with Z-Score tag in the name) from the measurement menu.
3. Open the report to check the Z-Score result.

13.2.4 Fetal Growth Curve

NOTE:

If the patient ID is blank, the clinical GA is not calculated or the measurement value is not valid, the measurement values will not be displayed on the curve.

The fetus growth curve compares the measured data of the fetus with the normal growth curve to judge whether the fetus is in normal growth state. The growth curve data is sourced from the Fetal Growth Table.

Perform the following procedure:

1. Select [Trend] to display the Obstetric Growth Curve dialog box. The dialog box displays the growth curve and the position of the measurement value.
   – Two drop-down lists above the curve display the measurement item/tool and the formula of the curve, which can be changed.

- Different symbols are used on the growth curves to identify measurement data of different fetuses.
- Current and historic data of a fetus are displayed in the same symbols, with the historic data appearing in smaller symbols.
- Select the [Print] checkbox to determine whether to include the growth curve in the printed report or not.
- The green dotted line indicates the clinical GA on the X-axis.
- Select the number and layout of the curves from [Display Layout].

  1*1: one curve displays in the screen.

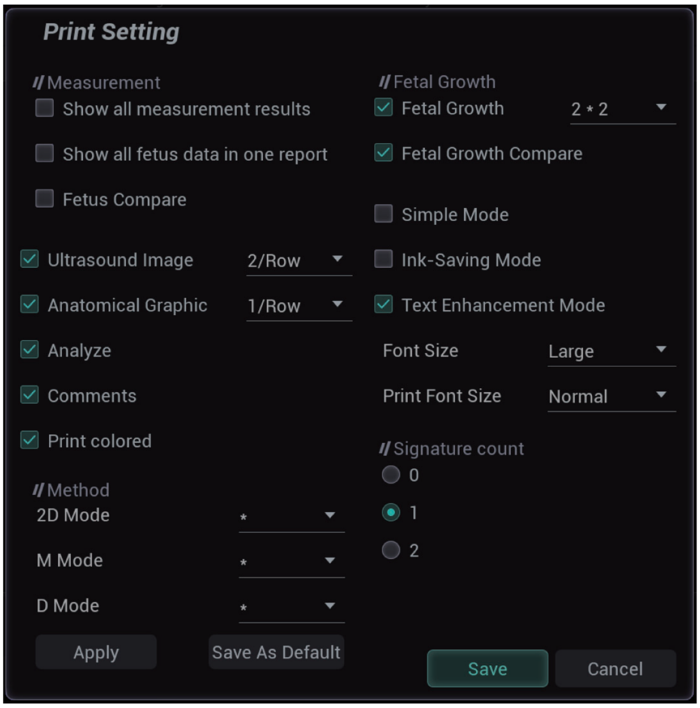
  2*1: two curves (up/down) display in the screen.

  2*2: four curves display in the screen.
- Select [Previous]/[Next] to turn the growth curve pages.

2. Select [OK] to confirm the setting and exit the page.

13.3 Report Setting

Select [Setting] to generally change the report display.



Type	Description	
Print information and layout	Choose the item (s) to be displayed on the report: ultrasound image, anatomical graphic, analysis and comments. Set the layout for ultrasound image and anatomical graphic for printing.	
	Ultrasound Image	Select the ultrasound image to be printed. Then, set the image layout for printing. If checking “Ink-Saving Mode”, the ultrasound image is printed in white background.
	Anatomical Graphic	Select the anatomical graphic to be printed. Then, set the graphic layout for printing.
	Analyze	Select to print the added analysis.
	Comments	Select to print the comment column.
	Print colored	After checking it, WMS score mode of stress echo is displayed in color. If not checking it, WMS score mode is displayed in numeric.
	Ink-Saving Mode	If it is selected, the printing background color is white. If it is deselected, the printing background color is black.
	Simple Mode	If it is selected, the report will be displayed in a compact layout.
	Text Enhancement Mode	If it is selected, characters on probe parameter area, patient information area and image parameter area will be printed in bold.
	Font Size	Set the font size for report viewing screen.
	Print Font Size	Set the font size for report preview screen and for printed report.

Type	Description	
Measurement	Show all measurement results	Display all measurement results of each item for printing.
	Show all fetus data in one report	After clicking it, the report chooses and prints the multi-fetus data simultaneously.
	Fetus compare	Select the fetus comparison to be printed.
Fetal Growth	Fetal growth	Select to print fetal growth result. Then set the layout in the report.
	Fetal growth compare	Select the result of fetal growth comparison to be printed.
Method	2D/M/D Mode	Select the method in which the final value is calculated for 2D/M/D mode. The sign "*" means methods for the same mode are not the same.
Signature Count	Signature Count	Select the signature number: 0, 1, 2.

13.4 Printing Reports

Select [Print] to print the report.

Or select [Preview] to preview the report. On the preview page, you can:

- Select [Print].
- Select [Prev Page] or [Next Page] to view the previous or next page.
- Select a zoom ratio from the drop-down list.
- Select [Close] to exit preview.

13.5 Save/Load Report

After the report template is edited, the history report archived in the system will change at the same time. The user may print or export the current report to make a copy in advance.

NOTE:

- The function is disenabled for anonymous patient.
- For report sending and backup, see *Basic Volume*.

13.5.1 Save report

Reports can be exported as RTF or PDF documents, which can be viewed and edited on a PC.

Perform the following procedure:

1. Under report status, select [Save Report].
2. Select the drive and directory.
3. Enter the filename for the report to export and select the file type.
4. Select the file type.
5. Select [OK] to confirm.

13.5.2 Load Report

Select [Load Report] to bring up the history report dialog box, click to select a report to export or print.

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