



Implementation of Pulse Inversion Harmonic Imaging on 2d Convex Transducer on Anatomical Information of first-trimester Pregnancy Ultrasound Image

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KEYWORDS	ABSTRACT
Pulse Inversion, Harmonic Imaging, Convex Transducer, Anatomical Information, Pregnancy, Ultrasound Image.	This study aims to compare the imaging results of Pulse Inversion Harmonic Imaging (PIHI) on transabdominal ultrasound with convex 2D transducer with and without PIHI on transvaginal ultrasound in providing anatomical information on first-trimester pregnancies. Involving 30 pregnant women meeting inclusion and exclusion criteria, the research was conducted at Swamedika Clinic Jakarta in August 2023. A quasi-experimental method was employed with evaluation performed by ultrasound experts and assessment by a radiologist unaware of PIHI use. The findings indicate that the use of PIHI on transabdominal ultrasound yields clear images of the boundary walls, fetal objects, and yolk sac boundary with appropriate frequency, gain, and depth settings. However, the comparative analysis between images with PIHI on transabdominal and without PIHI on transvaginal did not show significant differences. This study highlights the potential of PIHI in enhancing the quality of ultrasound images in the first trimester of pregnancy, although the results did not significantly differ from transvaginal technique without PIHI.

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INTRODUCTION

The health of the fetus and mother in the first trimester of pregnancy is crucial, considering that time is the beginning of fetal life development. Nutrition and health provided by the mother must be considered, and maintaining a diet and exercising as recommended by a doctor will facilitate the course of labour in the future (1). In terms of health, it also needs to be considered not only from the outside but can be added with an ultrasound examination that can clearly describe the shape, location and size of the fetus because it is expected that the pregnancy will run normally (2). The use of first-trimester ultrasound has benefits for determining age, ensuring the fetus lives in good condition and congenital abnormalities in early fetal development (3).

Ultrasound in the first trimester generally uses a transvaginal transducer because high-quality images are obtained from the position of the intrauterine transducer closer to the uterus and gestational sac than abdominal ultrasound. Transvaginal ultrasound in the first trimester of pregnancy examination is done with preparation. Namely, the patient is asked to urinate before the examination so that there are no artefacts from urine. Transvaginal ultrasound has the disadvantage that discomfort is given during the examination by inserting a transvaginal transducer into the vagina, before examination the surface of the transducer is given a gel; then the transducer is coated with a condom to see the gestational sac, yolk sac and fetal position. The existence of transvaginal probes is also very limited in the field due to the limited number of users who can use them and the need to purchase additional probes (4).

Transabdominal ultrasound in pregnant patients does not need to be inserted transducer, which can stress the patient, and does not require special attention to be coated with additional gel condoms; nal gel condoms, the convex 2D transducer is the main package that is included in the budget purchase package of ultrasound equipment. There are convex transducers that are 4D and 2D, for 4D transducers can be used for 2D as well. Because the frequency of the 4D probe is higher, the resolution of the 2D convex transducer is smoother than the 2D resolution in the 2D convex transducer, therefore utilizing Pulse Inversion Harmonic Imaging can help refine the resolution of the 2D convex transducer (5).

Transabdominal ultrasound in the first trimester of pregnancy examination is done with preparation. Namely, the patient is expected to drink a glass of water one hour before the examination and hold urination as acoustic shadow (6). When applied evenly in the abdominal area, the function of the gel is to reduce acoustic impedance from the surrounding air; an ultrasound is performed to see the gestational sac, yolk sac, and fetal position (7) (8).

Pregnancy examination in the first trimester can be done with a 2D convex transducer by adjusting the parameters of ultrasound images to maximize image results, including adjusting frequency, gain, depth and Pulse Inversion Harmonic Imaging (9).

The application of Pulse Inversion Harmonic Imaging limits the linear echo provided by Conventional Ultrasound and Tissue Harmonic Imaging so that the image obtained is much smoother and more detailed (10). So, its use is very beneficial for the use of transabdominal ultrasound in terms of comfort and a good image that can improve the first-trimester pregnancy examination and make patients comfortable.

In ultrasound, frequency, gain, and depth are used in ultrasound imaging because the setting can increase the resolution of the ultrasound image which is affected by the weight of the object under study. Therefore, this study is limited to objects with normal weight. Pulse Inversion Harmonic Imaging parameters, Frequency 2 MHz, Depth 8 cm and Gain 55 on 2D convex transducers. Pulse Inversion Harmonic Imaging parameters, Frequency 5 MHz, Depth 5 cm and Gain 48 on transducer transducers. This parameter number is set and determined when researchers implement it on sample objects with normal body weight to get good image image results.

METHOD

This study used a quasi-experimental method to compare the results of Pulse Inversion Harmonic Imaging (PIHI) images on 2D transabdominal transducer convex ultrasound with and without PIHI on transvaginal ultrasound. The object of study is anatomical information of the first-trimester pregnancy ultrasound image, which includes gestational sac, fetus, and yolk sac images. Data were obtained from 30 pregnant women with normal weights and pregnancies, selected through purposive sampling techniques. Inclusion and exclusion criteria have been established to select samples suitable for the study's purpose. The study was conducted at Swamedika Clinic Jakarta in August 2023.

The research procedure involved evaluating first-trimester pregnancies using two different ultrasound techniques, namely transabdominal with PIHI on a 2D convex transducer and transvaginal. An ultrasound expert carries out the examination with certain settings on the ultrasound device. Ultrasound results are evaluated by radiologists who are not aware of the use of PIHI. Assessment is carried out by questionnaires that measure the clarity of the picture ordinally.

The data processing method involves univariate analysis to describe the variables studied and bivariate analysis to compare the results of the picture between the two ultrasound techniques. Bivariate

analysis used the Mann-Whitney statistical test to determine significant differences between the two groups.

The tools and materials used in data processing include ultrasound tools, transducers, and examination support materials such as ultrasound gel. Special preparations are made for transvaginal and transabdominal examinations. Arrangements on ultrasound devices include the use of PIHI in the transabdominal and without PIHI in the transvaginal. After that, the data was analyzed to see the difference in the picture results between the two ultrasound techniques.

This study aims to determine whether the use of PIHI in the transabdominal can provide better anatomical information of first-trimester pregnancy ultrasound images compared to techniques without PIHI in the transvaginal.

RESULTS AND DISCUSSION

Image Results Characteristics

The research data collection was carried out in August 2023 at the BNI Jakarta Swamedica Clinic. The patient is a pregnant woman with a normal weight during the first trimester of pregnancy.

Then the first-trimester pregnancy ultrasound examination was carried out, with the results of anatomical information of the first-trimester pregnancy ultrasound image, namely gestational sac, fetus, and yolk sac, by applying the Pulse Inversion Harmonic Imaging upgrade method on the 2D convex and without Pulse Inversion Harmonic Imaging on transvaginal.

A study was conducted with 30 patients, as many as 30 women, with the number of research objects, namely anatomical information of first-trimester pregnancy ultrasound images in the gestational sac, fetus and yolk sac using Pulse Inversion Harmonic Imaging upgrade on 2D convex as many as 30 images and without Pulse Inversion Harmonic Imaging on transvaginal ultrasound as many as 30 images.

Table 1. Questionnaire Results from 1 Radiology Doctor.

Score	Information	<i>Pulse Inversion Harmonic Imaging upgrade with convex 2D</i>	<i>No Pulse Inversion Harmonic Imaging with 2D transvaginal</i>
1	Unclear	0%	0%
2	Clear	30%	23,33%
3	Very clear	70%	76,67%

Based on **table 1.** which is the questionnaire data obtained from 1 Radiology Doctor in conditions using Pulse Inversion Harmonic Imaging upgrade on the 2D convex which has a score of 1 as much as 0 which is 0%, score of 2 as much as 9 which is 30% and score 3 as much as 21 which is 70%. Without Pulse Inversion Harmonic Imaging in transvaginal which has a score of 1, as much as 0 which is 0%, a score of 2, as much as 7, which is 23.33%; and a score of 3, as much as 23, which is 76.67, %.



Picture 1. Pulse Inversion Harmonic Imaging Upgrade on *Convex* 2D with Frequency 2 MHz, Depth 8 cm and *Gain* 55.



Figure 2. No *Pulse Inversion Harmonic Imaging* in *transvaginal* with Frequency 5 MHz, Depth 5 cm and *Gain* 48.

Descriptive Test

Table 2. Descriptive Test Table.

Descriptive Variables of Statistical Analysis		
Pulse Inversion Harmonic Upgrade with <i>convex</i> 2D	Mean	2.7
	Median	3
	Std. Deviation	0.46609
	Minimum	2
	Maximum	3
	Std Error	0,0851
Without Pulse Inversion Harmonic with <i>Transvaginal</i>	Mean	2.7667
	Median	3
	Std. Deviation	0.43018
	Minimum	2

Maximum	3
Std Error	0,07854

In this data analysis, we compared two groups of measurements, namely "*Pulse Inversion Harmonic Upgrade with convex 2D*" and "*Without Pulse Inversion Harmonic with transvaginal*". For the first group, the average measurement was 2.7, with most of the data centered around a value of 3, as indicated by a median that was also 3. However, a relatively high standard deviation of 0.46609 indicates a significant variation from the mean.

On the other hand, the second group, "*Without Pulse Inversion Harmonic with transvaginal*", had a slightly higher average measurement of 2.7667. A median returning 3 indicates a symmetrical distribution of data, and a slightly lower standard deviation, which is 0.43018, indicates a smaller variation in measurements.

Although there are small differences between the averages of the two groups, these differences may not be clinically significant. Meanwhile, a larger standard deviation in the first group showed greater variation in measurements. In conclusion, both groups had similar data distributions, but further attention may be needed regarding variations within the first group.

In the context of this study, these results should be viewed taking into account measurement methodology and design. Further interpretation may be needed to explore the clinical implications of the observed differences.

Table 3. Whitney Mann Test Table

Ranks	Method	N	Mean Rank	Sum of Ranks
Test Results	Pulse Inversion Harmonic Upgrade with <i>convex 2D</i>	30	29.5	885
	Without Pulse Inversion Harmonic with <i>Transvaginal</i>	30	31.5	945
	Total	60		

Table 4. Test Statistics

Test Statistics	Test Results
Mann-Whitney U	420
a Grouping Variable:	
Method	

Table 5. Test Results

Test Results	Mann-Whitney U
Hypothesis	H0: There was no median difference between the two groups
U value	420
Alpha	0.05
Conclusion	Insignificant

In conducting a comparative analysis between the two groups, "Pulse Inversion" and "Without Pulse Inversion," the Mann-Whitney test is involved as the primary statistical tool for assessing median differences. The null (H0) hypothesis proposed is that the two groups have no significant median difference. The Mann-Whitney U Statistic, with a score of 420, shows a comparison of rankings between the two groups.

These results provide an in-depth understanding of the characteristics of the variable distribution measured in the context of the methods "Pulse Inversion" and "Without Pulse Inversion." Although ranking differences were found, statistical values did not support a significant median difference between the two groups. This interpretation is important in the context of further research regarding the influence of the method used on the observed variables. Thus, these findings can make a meaningful contribution to scientific understanding in related fields and become the basis for further development of knowledge.

Discussion

Analysis Based on Statistical Test Data

Statistical analysis data is processed based on questionnaire data filled out by 1 expert, namely a radiology specialist. The next stage of data processing is using SPSS statistical software, where the first stage of data processing will be carried out using the descriptive test (Appendix 10) and the Mann-Whitney test (Appendix 11). The data compared consisted of two groups of measurements, namely "Pulse Inversion Harmonic Upgrade with convex 2D" as the first group and "Without Pulse Inversion Harmonic with transvaginal" as the second group in first trimester pregnant women with normal weight and normal pregnancy.

In the Descriptive Test data analysis, the conclusion of the descriptive test, both groups have a similar distribution of data, but further attention may be needed regarding variations within the first group.

In data analysis, the Mann-Whitney Test is the main statistical tool for assessing median differences. Although ranking differences were found, statistical values did not support a significant median difference between the two groups.

Analysis of Anatomical Information of First Trimester Pregnancy Ultrasound Image with implementation of Pulse Inversion Harmonic Imaging Upgrade on 2D Convex Transducer and Without Pulse Inversion Harmonic Imaging on Transvaginal Transducer.

In the results of this research discussion, the results of first-trimester pregnancy ultrasound images have been applied with the implementation of Pulse Inversion Harmonic Imaging upgrade on a 2D convex transducer and without Pulse Inversion Harmonic Imaging on the transvaginal transducer.

Pregnancy examination in the first trimester can be done with transducer convex 2D ultrasound image parameters using Pulse Inversion Harmonic Imaging and maximize image results, including frequency, gain and depth parameters. In ultrasound, Pulse Inversion Harmonic Imaging is used in ultrasound imaging because it has better spatial resolution and contrast as well as fewer artefacts than conventional ultrasound (CUS) and makes it easier for patients who are difficulty doing ultrasound examination because it uses pure harmonic signals and is known to provide good spatial resolution.

From the results of the analysis, there was no significant difference in imaging results between the groups "Without Pulse Inversion Harmonic with transvaginal" and "Pulse Inversion Harmonic upgrade with convex 2D" against the implementation of Pulse Inversion Imaging upgrade on transducer convex 2D anatomical information of first trimester pregnancy ultrasound images. So that the image of

the 2D convex probe with Pulse Inversion Harmonic Imaging upgrade is clear on the wall barrier, clearly visible on fetal objects, and clearly visible on the yolk sac wall barrier.

CONCLUSION

The implementation of Pulse Inversion Harmonic Imaging on 2D convex transducers for gestational ultrasound imaging, specifically targeting anatomical details of the sac, fetus, and yolk sac during the first trimester, has undergone investigation. It is evident that employing Pulse Inversion Harmonic Imaging with appropriate frequency, gain, and depth settings enhances the visibility of images obtained through 2D convex transducers. The upgrade significantly improves the clarity of images, particularly highlighting details such as the wall barrier, fetal objects, and the yolk sac wall barrier. Comparative analysis between images captured with the upgraded Pulse Inversion Harmonic Imaging on 2D convex transducers and those obtained using transvaginal transducers without such enhancement reveals no significant disparities.

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