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Analysis of differences in anatomical information in magnetic resonance cholangiopancreatography (MRCP) examinations between the use of the mouth breath hold technique and trigger technique

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ARTICLE INFO	ABSTRACT
<i>Article history:</i> Received Apr 17, 2025 Revised Apr 30, 2025 Accepted May 5, 2025 <i>Keywords:</i> MBH MRCP Trigger	MRCP is a non-invasive imaging method used to visualize the biliary system and detect abnormalities in the bile ducts or gall bladder. In taking images, there are two techniques, namely the mouth breath hold (MBH) technique and the trigger technique, where the MBH technique is carried out by the radiographer giving instructions directly related to the patient's respiratory movements, while the trigger technique uses respiratory gating to detect breathing patterns and minimize image blur due to organ movement. At Department of Radiology SMC Telogorejo Semarang both techniques are used in MRCP examinations by looking at the condition of each patient. So the author is interested in comparing the results of anatomical information from the two techniques. Methods: This research uses a quantitative design with an experimental approach. Data was collected from 10 patients who underwent MRCP examinations at the Department of Radiology SMC Telogorejo Semarang in August-September 2024. The scanning procedure was carried out using a T2 HASTE coronal section sequence twice for each patient using the MBH and trigger technique. Anatomical information was assessed by means of visual grading analysis by 3 radiologists on the structure of the cystic duct, intra-hepatic duct, common hepatic duct, common bile duct, pancreatic duct, and gallbladder (gallbladder) using a questionnaire with a scale (1-4). Then the data was analyzed using SPSS to determine whether there were differences in image information from the two techniques using the Wilcoxon difference test. This research has passed the ethical test number: KEPK/UMP/170/I2025. Results: Based on the results of the Wilcoxon test, both for the entire anatomy and for each anatomy, it shows a p-value < 0.05. This indicates that there are significant differences in the anatomical information produced by the two techniques. Based on the mean rank value, the most optimal technique for displaying anatomical information is MBH. This advantage is due to its ability to reduce movement artifacts through the breath-hold method, resulting in clearer and more detailed anatomical images compared to the trigger technique. The MBH technique is more effective in improving MRCP anatomical information, especially in patients with respiratory instability. It is hoped that these results can be a reference in determining the optimal method for MRCP examination. <i>This is an open access article under the CC BY-NC license.</i>



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INTRODUCTION

Magnetic resonance cholangiopancreatography (MRCP) is a commonly used non-invasive technique (Ghaffar & Batool, 2025), to evaluate the biliary system, with the aim of visualizing abnormalities in the human bile duct or gallbladder (Lintjewas et al., 2024). To obtain high-quality images in MRCP examination, accurate parameter settings are essential (Malik et al., 2022). This is important because the parameters used directly affect the image quality. Some factors that contribute to the quality of MRI images include Signal-to-Noise Ratio (SNR), Contrast-to-Noise Ratio (CNR) where good image quality is characterized by high Signal to Noise Ratio (SNR) and high Contrast to Noise Ratio (CNR) (Shetewi et al., 2020; Ugwuanyi et al., 2020). SNR is the ratio between the magnitude of the signal amplitude and the amplitude of the noise (Diana Ega Rani, 2016; Salim, 2023). The higher the SNR value, the better the quality of the resulting image. While CNR is the difference between the SNR values on two adjacent networks (Westbrook, C., & Talbot, 2018). One of the main disadvantages of MRCP is its sensitivity to respiratory motion and respiratory conditions exerted a significant impact on MRCP image quality (Wang et al., 2023). It can reduce anatomical information.

MRCP is limited by susceptibility to motion artifacts (Feng & Chandarana, n.d.; Hasse et al., 2021). Physiological movements such as breathing, heart activity, blood vessel pulsations, and intestinal peristaltic movements are the main factors that trigger the emergence of artifacts in MRI imaging (Kolokythas & Amin, 2022). MRI examinations of moving organs tend to be difficult to perform because they can cause blurring of the resulting image. MRI scans around moving organs also often produce artifacts that can interfere with the image. Because MRCP is a type of MRI examination of moving organs, special techniques are required to prevent or minimize image blurring due to organ movement.

In MRCP examination, there are two main techniques in the image acquisition process, namely the mouth breath hold and trigger techniques. In the mouth breath hold technique, the image is taken when the patient holds his breath. This breath holding aims to prevent movement of the abdominal organs which can cause image blur. This technique is performed if the patient is able to hold his breath for about 20 seconds. The level of cooperation between the officer and the patient greatly determines the quality of the resulting image, so that blur can be avoided.

Meanwhile, the acquisition process with the trigger technique uses a respiratory gating device attached to the patient's diaphragm to detect breathing patterns. This technique is applied to patients who are less cooperative or to children who cannot hold their breath well. Data is acquired during the transition between the inspiratory and expiratory phases, where there is a time lag of several seconds that allows image acquisition to be carried out (Tokoro et al., 2020).

High-speed acquisition sequences, such as single-shot techniques or single-shot sequences, can be used to reduce image interference due to motion artifacts. The SS-FSE/HASTE technique is very effective in uncooperative patients. The HASTE technique in the trigger method provides a more detailed image anatomy analysis compared to the breath hold technique. With the high acquisition speed of the HASTE technique, it is expected that the image formation process in MRCP examination will be faster and can minimize motion artifacts (Rochmayanti et al., 2022).

Previous research has been conducted in two main studies. The first study entitled "Comparative Evaluation of Image Quality in Breath Hold Technique (SSTSE) and Respiratory Triggering (TSE) in Magnetic Resonance Imaging Cholangiopancreatography (MRCP) Examination" was conducted in 2016.(SUROIYAH, 2016). The results of this study indicate that a high Signal to Noise Ratio (SNR) value indicates the anatomical structure of the pancreatic duct

(Tajuddin et al., 2022). It was concluded that the respiratory trigger technique produced high SNR, especially in the anatomical structure of the pancreatic duct, while the mbh technique showed a higher Contrast to Noise Ratio (CNR) value. The recommended technique to produce good images is the mouth breath hold (MBH) technique.

The second study entitled "Differences in Coronal Magnetic Resonance Cholangiopancreatography (MRCP) Anatomical Image Information on T2 FRESE (Fast Recovery Fast Spin Echo) Sequences between Using ARC and Without ARC", which was conducted in 2021. This study found significant differences in the anatomical image information of the coronal T2 FRESE MRCP sequence between using ARC and without ARC, with a significance value of <0.05 . Based on the mean rank results, the coronal MRCP T2 FRESE sequence with ARC has a mean rank value of 4.50, while without ARC the value is 0.00. This means that the T2 FRESE sequence with ARC produces better images than without ARC (Kartikasari et al., n.d.).

Based on the two studies, the author is interested in further researching the MRCP image acquisition technique with the research title. "Analysis of Differences in Anatomical Information in Magnetic Resonance Cholangiopancreatography (MRCP) Examination between the Use of Breath Hold Technique and Trigger Technique.

RESEARCH METHOD

This study is a quantitative research with an experimental approach. The study was conducted from August to September 2024 at the Department of Radiology SMC Telogorejo Semarang. The study population included all patients who underwent MRCP examination at the the Department of Radiology SMC Telogorejo Semarang, with a sample of 10 patients who underwent MRCP examination for various clinical indications.

The research process involved MRCP scans using the T2 HASTE sequence. Each patient underwent two scans, namely with the MBH technique and the trigger technique. The image results from both techniques were then assessed using visual grading analysis by three radiologists. The assessment included the structure of the intra-hepatic duct, cystic duct, common hepatic duct, common bile duct, pancreatic duct, and gallbladder, using a questionnaire with a scoring scale consisting of: value 1 for structures that are unclear and cannot be assessed, value 2 for structures that are quite visible but the contour boundaries are less clear, value 3 for structures that can be visualized but the contour boundaries are not sharp, and value 4 for structures that are clearly visible with sharp contours.

Data processing was performed using SPSS software with the Wilcoxon test, which is suitable for non-parametric data analysis with two paired samples. This study has passed the ethical test with the number: KEPK / UMP / 170 / I2025.

RESULTS AND DISCUSSIONS

This study involved 10 patients with the following details: 8 male patients and 2 female patients with the age category of 20-25 years as many as 2 patients, 26-30 years as many as 2 patients, 31-35 years as many as 3 patients and 36-45 years as many as 3 patients. Furthermore, the results of the radiology assessment were processed using the kappa test to determine the level of agreement between observers.

Table 1. Kappa test results kappa test

Radiologist	P-Value
Radiologist 1-2	0.967
Radiologist 1-3	0.950
Radiologist 2-3	0.983

The results of the kappa test showed that there was a similarity in the assessment between the 3 radiologists, with a coefficient value between radiologist 1 and radiologist 2 of p-value 0.967, then for radiologist 1 and radiologist 3 of p-value 0.950, then radiologist 2 and radiologist 3 of p-value 0.983, which means that the level of agreement between the three observers is high.

Next, a test was conducted to determine the overall difference in anatomical information between the MBH technique and the Trigger technique using the Wilcoxon test.

Table 2. Overall anatomical difference test results

TECHNIQUE	P-Value
MBH	0.001
TRIGGER	

The overall difference test above shows a significant difference in anatomical information between the MBH technique and the Trigger technique in MRCP examination at SMC Telogorejo Semarang with a p-value of 0.001. Furthermore, a difference test was carried out for each anatomy assessed between the MBH technique and Trigger technique MRCP examination.

Table 3. Test results different for each anatomy

Anatomy	P-Value
Intrahepatic duct	0.020
Pancreatic Duct	0.008
Gall Blader	0.036
Cystic Duct	0.011
Common Hepatic Duct	0.020
Common Bile Duct	0.034

The results of the difference test analysis showed significant differences in anatomical information based on the p-value obtained in several structures. The Intra Hepatic Duct has a p-value of 0.020, the Pancreatic Duct is 0.008, the Gall Bladder is 0.036, the Cystic Duct is 0.011, the Common Hepatic Duct is 0.020, and the Common Bile Duct is 0.034. Based on the p-value, it can be concluded that each anatomical structure has a statistically significant level of difference.

To determine the most optimal technique in producing anatomical information, a comparison was made between the MBH and trigger techniques. Determination of the best technique is based on the analysis of the mean rank value obtained from the analyzed data. This value describes the average rank that shows the extent to which each technique is able to provide the best quality anatomical information with the table below.

Table 4. Mean Rank Result for Each Anatomy

Anatomy	Technique	Mean Rank
Intrahepatic Duct	MBH	40.00
	Trigger	5.00
Pancreatic Duct	MBH	30.00
	Trigger	15.00
Gall Blader	MBH	35.00
	Trigger	10.00
Cystic Duct	MBH	31.50
	Trigger	4.50
Common Hepatic Duct	MBH	40.00
	Trigger	5.00
Common Bile Duct	MBH	31.50
	Trigger	4.50

The results of the test analysis showed that the MBH technique has a superior ability to produce better information compared to the Trigger technique. This superiority is seen in all anatomical structures analyzed, including the intrahepatic duct, cystic duct, common hepatic duct, common bile duct, gall bladder, and pancreatic duct. These findings indicate that the MBH technique provides clearer and more detailed anatomical information on all of these structures, so it has the potential to be a more effective choice in diagnostic examinations as shown in Figure 1 MRCP anatomy.

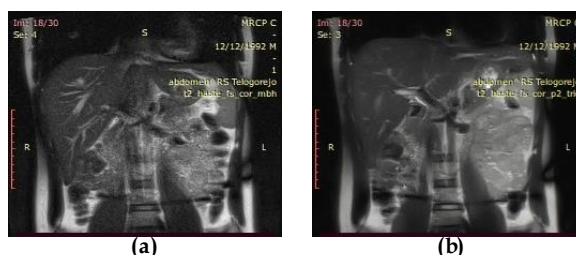


Figure 1. Anatomical Images of MRCP Sequence T2 Haste (a) MBH Technique (b) Trigger Technique

Discussion

In this study, a P value <0.05 was resulted in both the overall anatomical statistical test and the statistical test of each anatomy. This indicates that there is a significant difference in anatomical information in magnetic resonance cholangiopancreatography (MRCP) examination between the use of the mouth breath-hold technique and the trigger technique. The mean rank results of the statistical test of each anatomy showed that the MBH technique was better at displaying anatomy in each of those anatomical information.

Magnetic Resonance Cholangiopancreatography (MRCP) technique with the breath-hold (MBH) method is preferred in clinical practice because it produces optimal anatomical information and in previous study shows that breath hold technique has shorter acquisition time (Chevallier et al., 2021). This technique require patients to hold their breath (Goo & Kim, 2022). In this technique, the patient is asked to hold his breath for 15–20 seconds, which significantly reduces respiratory artifacts and minimizes abdominal organ movement. This technique is very effective in cooperative patients, because it does not require additional equipment such as respiratory gating or synchronization with the respiratory cycle, making the process simpler and faster. The present study shows that the CS-BH-MRCP sequence provides overall better image quality and bile and pancreatic ducts visualization compared to the conventional RT-MRCP sequence at 3T, with the advantage of a much shorter acquisition time in addition, MBH allows images of organs such as the bile duct, hepatic duct, and pancreas to be recorded in a stable position, providing excellent visualization quality (Westbrook & Roth, 2019).

However, Magnetic resonance cholangiopancreatography (MRCP) may exhibit ghosting and blurring artifacts due to irregular breathing cycles (Ihara et al., 2023), so that for patients who are unable to hold their breath, such as children or individuals with respiratory disorders, using trigger techniques may be more reasonable (Kim et al., 2023). The choice of examination technique depends on the patient's condition and clinical goals to ensure accurate results. This technique is very useful for minimizing artifacts due to respiratory movements and ensuring optimal image quality even in less cooperative patients (Edelman & Hesselink, 2013).

The trigger technique in Magnetic Resonance Cholangiopancreatography (MRCP) examinations has several significant drawbacks, especially when compared to the simpler and faster breath-hold technique. One of the main drawbacks is the longer examination duration, because imaging is performed at a specific phase in the patient's respiratory cycle. This process requires a longer acquisition time that are often associated with poorer image quality (Yoon et al., 2017) and can cause discomfort for patients, especially those with certain medical conditions such as pain or difficulty lying down for long periods. In addition, this technique relies heavily on synchronization with the patient's breathing pattern, meaning that image quality can be compromised if the patient has an unstable breathing pattern, as is common in patients with chronic respiratory disorders or lung disease (Westbrook & Roth, 2019).

Another disadvantage of the trigger technique is its higher level of technical complexity. Additional equipment is required to accurately monitor the patient's respiratory cycle, such as special sensors or detectors, which not only increases the cost but also requires more preparation time before imaging. This can slow down the clinical workflow, especially in healthcare facilities with high patient volumes. While this technique remains useful in certain circumstances, especially for patients who cannot hold their breath, these disadvantages make it less than ideal for most cases. It is therefore essential for healthcare providers to consider factors such as the patient's

physical condition, ability to cooperate during the examination, and diagnostic needs, in order to choose the most effective and comfortable method for the patient (Sutton, 2003).

T2 HASTE (Half-Fourier Acquisition Single-shot Turbo Spin-Echo) sequences are excellent for imaging Magnetic Resonance Cholangiopancreatography (MRCP) examinations because of their ability to produce high contrast between fluid and surrounding tissue. This technique is designed to enhance the signal from fluids, such as bile and pancreatic fluid, so that the bile ducts and pancreas can be clearly visualized. In addition, T2 HASTE allows for very fast acquisition times, minimizing motion artifacts due to breathing or patient movement. Another advantage is its high sensitivity to fluid-filled structures, making it ideal for detecting obstructions, strictures, or anatomical anomalies in the bile ducts and pancreas. However, although effective, this technique can be limited in patients with metal artifacts or inability to hold their breath (Kraitchman et al, 2020).

The T2 HASTE (Half-Fourier Acquisition Single-shot Turbo Spin Echo) sequence is very effective in Magnetic Resonance Cholangiopancreatography (MRCP) examinations because of its ability to produce high contrast between fluid-filled structures, such as the bile ducts and pancreas, and the surrounding tissue. This technique allows for rapid acquisition times, often requiring only a single breath hold, making it very effective in reducing motion artifacts due to respiration or peristalsis. T2 HASTE has high sensitivity in detecting abnormalities in the bile duct, such as strictures, stones, or anatomical anomalies, as well as in visualizing the pancreatic duct. Its use is also very useful in preoperative mapping of the biliary tract in cases of liver transplantation or evaluation of biliary disease (Westbrook & Roth, 2019).

However, despite its high accuracy, this technique can be limited in patients with metal artifacts or who are unable to hold their breath steadily. This limits the effectiveness of T2 HASTE in some cases, especially if the patient has respiratory disorders or metal implants that can interfere with image quality (Edelman & Hesselink, 2013).

In addition, The previous study shows that the breath hold technique provides overall better image quality and bile and pancreatic ducts visualization compared to the conventional respiratory trigger technique, with the advantage of a much shorter acquisition time (Chevallier et al., 2021).

This study is also supported by interviews conducted by researchers with radiologists from several hospitals, namely SMC Telogorejo Semarang and RS dr. Oen Kandang Sapi Solo. Radiologists from both facilities stated that the mouth breath hold (MBH) technique is considered more optimal and efficient in capturing images during MRCP examinations. This is due to the manual nature of the technique, where the radiographer provides direct instructions to the patient regarding breathing regulation, such as the right time for inspiration and holding the breath. With this method, the accuracy in capturing images during a stable respiratory phase can be significantly improved, resulting in clearer visualization and free from motion artifacts. This approach is very helpful in maximizing the quality of imaging results, especially when the patient is able to follow instructions well during the examination process.

CONCLUSION

Based on the results of the study, it is recommended that Magnetic Resonance Cholangiopancreatography (MRCP) examination with the mouth breath-hold (MBH) technique be used as the main technique in the examination, especially in patients who are able to hold their breath well, because this technique has been proven to provide more optimal anatomical information and minimal movement artifacts. For patients with respiratory disorders or certain conditions that inhibit the ability to hold their breath, the trigger technique can be used as an alternative even though it takes longer. The suggestion from the results of this study is to conduct socialization to radiographers regarding the results of the image information produced by the two techniques and then continue with training to provide effective breathing instructions to patients is also important to ensure maximum image quality. In addition, further research with a larger

sample size can help strengthen these findings and explore the efficiency of both techniques in various patient conditions.

The study supports the use of MBH as the primary technique for MRCP due to its ability to produce optimal anatomical images with minimal motion artifacts, particularly in patients who can comply with breath-holding instructions. In resource-limited facilities, this finding is highly valuable for standardizing imaging protocols without relying on advanced triggering systems or additional hardware.

The widespread use of the MBH technique can improve efficiency in radiology by shortening scan times, increasing patient throughput, and reducing the need for repeat imaging due to fewer motion artifacts. Faster and more predictable exams allow for better scheduling and resource use. However, its success depends on effective breath-hold instruction, making radiographer training essential even in resource-limited settings.

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