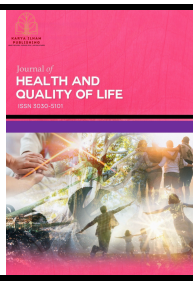
KARYA ILHAM PUBLISHING
CONNECTING MINDS, BRIDGING IDEAS, INSPIRING READERS

Journal of Health and Quality of Life

Journal homepage:
https://karyailham.com.my/index.php/jhqol/index
ISSN: 3030-5101



The Efficacy of Pineapple Juice as a Negative Oral Contrast Agent in Magnetic Resonance Cholangiopancreatography (MRCP)

Soh Jie Wei[1], Nik Nadia Hazwani Nek Kamal[1,*], Mohammad Fadhlul Hadi Abd Gani[2]

[1] Department of Medical Imaging, Faculty of Health Sciences, Nursing and Education, MAHSA University, Selangor, Malaysia
[2] Radiology Department, Hospital Sultanah Bahiyah, Kedah, Malaysia

ARTICLE INFO

Article history:
Received 13 September 2024
Received in revised form 11 November 2024
Accepted 29 November 2024
Available online 15 December 2024

Keywords:
Magnetic Resonance Cholangiopancreatography; pineapple juice; common bile duct; pancreatic duct

ABSTRACT

Strong signals from the gastrointestinal tract (GIT) often degrade the quality of MRCP images due to overlapping static fluids from the GIT and pancreaticobiliary system, obscuring the common bile duct (CBD) and pancreatic duct. This study aimed to investigate the efficacy of pineapple juice as a negative oral contrast agent in magnetic resonance cholangiopancreatography (MRCP) to improve visualization of the CBD and pancreatic duct in T2-weighted images. An analytical and observational study was conducted on 17 patients from April 2024 to June 2024. MRCP was performed before and 5 minutes after the ingestion of pineapple juice. Three independent radiologists evaluated the images using a 4-point Likert scale. Signal intensity data for the CBD and pancreatic duct were recorded by measuring the mean and standard deviation using a region of interest (ROI) circle of 20mm² for CBD and 10mm² for the pancreatic duct. A statistically significant improvement was observed in the visibility and detectability of the CBD and pancreatic duct following pineapple juice ingestion ($p < 0.001$). Pre-ingestion scores for visibility and detectability ranged from 1.33 to 3.33, while post-ingestion scores improved to 2.67 to 4.00. Significant differences in signal intensity for the CBD ($p < 0.001$) and pancreatic duct ($p < 0.001$) were also noted. Pineapple juice is an effective negative oral contrast agent for enhancing the visualization of the CBD and pancreatic duct in T2-weighted MRCP images.

1. Introduction

Magnetic Resonance Cholangiopancreatography (MRCP) is a specialized MRI technique used to visualize the biliary and pancreatic systems, along with surrounding organs like the liver, pancreas, and gallbladder. MRCP has evolved significantly over the past two decades, improving in spatial resolution and acquisition speed, and is widely recognized as a reliable, non-invasive method for diagnosing conditions such as choledocholithiasis and acute gallstone pancreatitis [1]. Compared to Endoscopic Retrograde Cholangiopancreatography (ERCP), MRCP offers similar diagnostic accuracy while being non-invasive, radiation-free, and less operator-dependent, reducing associated risks [2]. MRCP relies on T2-weighted pulse sequences with long echo times to effectively visualize the

* *Corresponding author.*
E-mail address: niknadiahazwani@mahsa.edu.my

https://doi.org/10.37934/jhqol.4.1.1117

common bile duct (CBD) and pancreatic duct. These ducts have high water content and appear bright on T2-weighted images, providing optimal contrast against darker surrounding tissues [3]. However, strong signals from fluids in the gastrointestinal tract (GIT) can overlap with those from the ducts, degrading image quality [4]. Although a 6-hour fasting period is recommended to minimize bowel movement and reduce fluid secretion, this alone often does not sufficiently suppress unwanted signals [5]. Negative oral contrast agents containing paramagnetic substances, which shorten T2 relaxation times, are used to reduce high signal intensity from GIT fluids. Recent studies suggest that pineapple juice, due to its high manganese content, can serve as an effective negative oral contrast agent for MRCP. It significantly enhances the visualization of the CBD and pancreatic duct by suppressing signals from GIT fluids, particularly in 3D MRCP sequences [6]. Pineapple juice offers a cost-effective, natural alternative to conventional contrast agents, potentially improving diagnostic accuracy by enhancing image quality in MRCP procedures [7].

2. Methodology

2.1 Research Design

The study design is an analytical and observational study to investigate the effectiveness of pineapple juice as a negative oral contrast agent for MRCP in enhancing the visualization of CBD and pancreatic duct in T2-weighted images. It involved both qualitative evaluation of the visibility and detectability CBD and pancreatic duct as well as quantitative measurements of signal intensity of CBD and pancreatic duct during pre- and post-ingestion of pineapple juice. The T2 weighted images collected before and after the ingestion of pineapple juice were evaluated by three independent radiologists by using a 4-point Likert scale. The evaluation involved a blind assessment of the visibility and detectability of the CBD and pancreatic duct before and after the ingestion of pineapple juice. Additionally, the signal intensity of CBD and pancreatic duct before and after ingestion of pineapple juice were also measured and collected.

2.2 Research Materials

The materials used in this study include a 1.5 Tesla MRI machine (GE SIGNA ™ Artist), body coil, 240ml of pineapple juice, paper cup, and straw.

2.3 Data Collection

A total of 17 patients underwent MRCP scanning in two phases, which are before and after the ingestion of pineapple juice. Prior to the ingestion of pineapple juice as a negative oral contrast agent, patients will first proceed with standard MRCP protocol. Subsequently, after the ingestion of pineapple juice, patient was required to wait for 5 minutes before proceed with the second scanning. The second scanning process focusing solely on the coronal 3D hypersense sequence, which is also a heavily T2-weighted sequence. This is because, this specific sequence able to provide a better visualization of the CBD and pancreatic duct. The coronal 3D hypersense sequence will undergo post-processing to produce one MRCP rotate image for each patient. The MRCP rotate images are then recorded and evaluated by three different radiologists. The 4-point Likert scale used in this study for the visibility and detectability of CBD and pancreatic duct during pre- and post-ingestion of pineapple juice are adapted from Mohabir *et al*., [8]. The 4-point Likert scale used is consisting of 4 scoring, which are: a) Score 1 = Poor visibility (not detected) b) Score 2 = Fair (difficult to detect the anatomy) c) Score 3 = Good (the anatomy is visible but with some difficulty) d) Score 4 = Excellent (completely

visible). Besides, the signal intensity of CBD and pancreatic duct were measured by placing a region of interest (ROI) circle on the 3D coronal hypersense image to obtain the value of mean and standard deviation. The size of the ROI used were 20mm² for CBD and 10mm² for pancreatic duct.

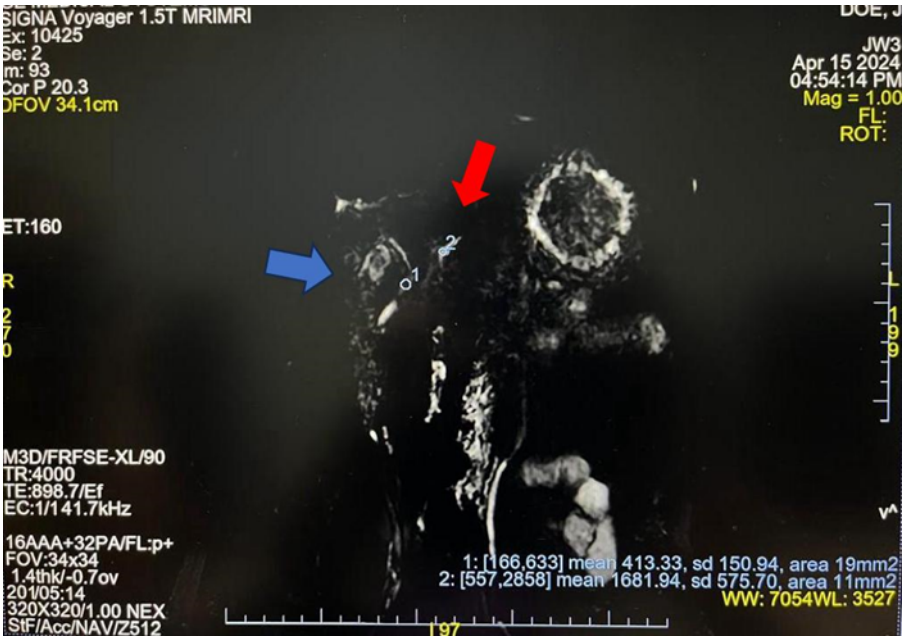


Fig. 1. Region of interest (ROI) circle placed on CBD (blue arrow) and pancreatic duct (red arrow) to measure the signal intensity

2.4 Data Analysis

IBM SPSS Statistics version 29.0.2.0 was used to analyse the data collected during the study. Since the data for the visibility and detectability of CBD and pancreatic duct were not normally distributed, Wilcoxon-signed rank test was used to compare these variables during pre- and post-ingestion of pineapple juice. Besides, paired T-test was used to compare the differences in signal intensity of CBD and pancreatic duct in T2-weighted images before and after ingestion of pineapple juice. All the data collected were assessed for normality. Furthermore, inter-rater reliability among three independent radiologists was assessed using Kendall's coefficient of concordance.

3. Results

Since the normality tests for visibility and detectability of CBD and pancreatic duct during pre- and post-ingestion of pineapple juice did not shows a normal distribution, a non-parametric test, which is Wilcoxon signed-rank test was conducted (Figure 2). Wilcoxon signed-rank test was conducted to compare the difference in the visibility and detectability of CBD and pancreatic duct before and after ingestion of pineapple juice. The result showed a Z-value of -3.452 and p-value of <0.001. The p-value is less than the significance level of 0.05, indicating that there is a significance different in visibility and detectability of CBD and pancreatic between the two conditions.

Wilcoxon Signed Ranks Test

Ranks

		N	Mean Rank	Sum of Ranks
Post_Ingestion - Pre_Ingestion	Negative Ranks	1[a]	4.00	4.00
	Positive Ranks	16[b]	9.31	149.00
	Ties	0[c]		
	Total	17		

a. Post_Ingestion < Pre_Ingestion
b. Post_Ingestion > Pre_Ingestion
c. Post_Ingestion = Pre_Ingestion

Test Statistics[a]

	Post_Ingestion - Pre_Ingestion
Z	-3.452[b]
Asymp. Sig. (2-tailed)	<.001

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.

Fig. 2. Wilcoxon signed-rank test for visibility and detectability of CBD and pancreatic duct before and after the ingestion of pineapple juice

Figure 3 and Figure 4 show the result of the paired t-test for signal intensity of CBD and pancreatic duct during pre- and post-ingestion of pineapple juice. Paired t-test was conducted to compare the differences in signal intensity of CBD and pancreatic duct in T2-weighted images before and after the ingestion of pineapple juice.

Paired Samples Test

		Paired Differences					t	df	Significance	
					95% Confidence Interval of the Difference					
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			One-Sided p	Two-Sided p
Pair 1	Pre_Ingestion_CBD - Post_Ingestion_CBD	-1401.37176	530.60716	128.69114	-1674.18479	-1128.55874	-10.889	16	<.001	<.001

Fig. 3. Paired t-test for signal intensity of CBD during pre- and post-ingestion of pineapple juice

Paired Samples Test

		Paired Differences					t	df	Significance	
					95% Confidence Interval of the Difference					
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			One-Sided p	Two-Sided p
Pair 1	Pre_Ingestion_Pancreatic_duct - Post_Ingestion_Pancreatic_duct	-473.05235	212.60730	51.56484	-582.36494	-363.73977	-9.174	16	<.001	<.001

Fig. 4. Paired t-test for signal intensity of pancreatic duct during pre- and post-ingestion of pineapple juice

In Figure 5, the result of signal intensity of CBD showed a t-value of 10.889 and p-value of <0.001. Meanwhile, in Figure 6, the result of signal intensity of pancreatic duct showed a t-value of 9.174, and p-value of <0.001. The critical value at the significance level of 0.05 with a degree of freedom (df) of 16 is 2.120. Since both t-values are greater than the critical value of 2.120 and p-values are less than the significance level of 0.05, null hypothesis is rejected. This indicating that there is a significance difference in signal intensity between CBD and pancreatic duct in T2-weighted images before and after the ingestion of pineapple juice as a negative oral contrast agent in MRCP.

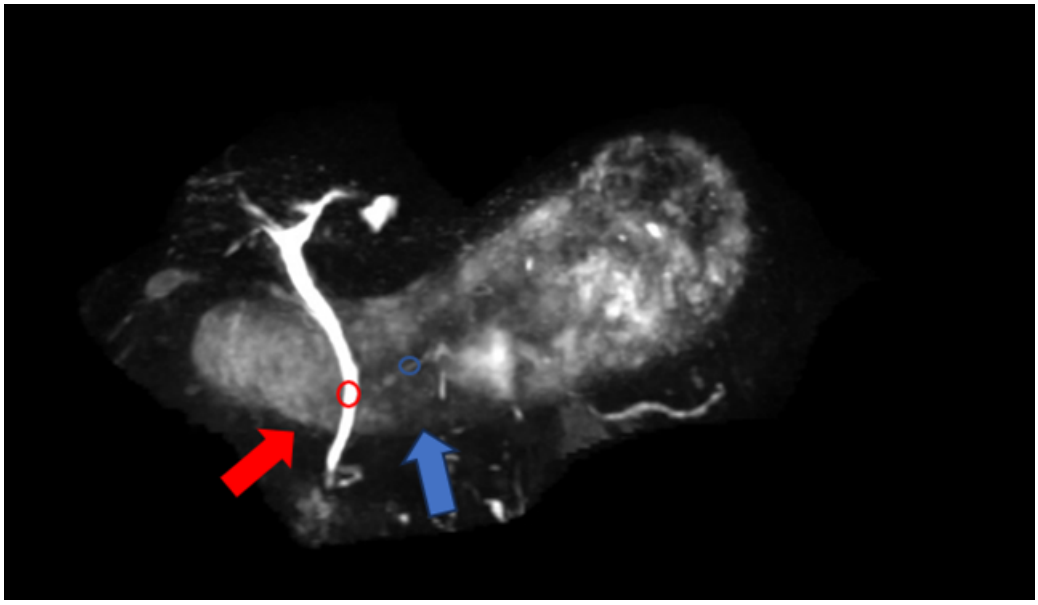


Fig. 5. MRCP rotate image during pre-ingestion of pineapple juice, CBD (red arrow), pancreatic duct (blue arrow)

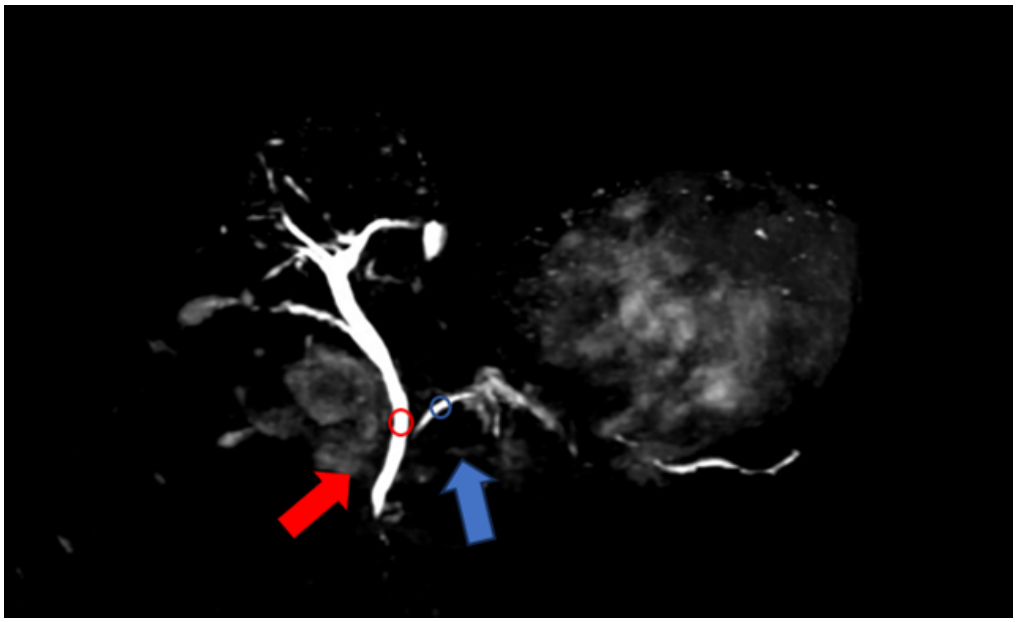


Fig. 6. MRCP rotate image during post-ingestion of pineapple juice, CBD (red arrow), pancreatic duct (blue arrow)

4. Discussion

This study assessed the efficacy of pineapple juice as a negative oral contrast agent for MRCP, particularly in improving the visualization of the common bile duct (CBD) and pancreatic duct in T2-weighted images. Both qualitative and quantitative evaluations showed significant enhancement in the visibility and detectability of these ducts following pineapple juice ingestion. The 4-point Likert scale scores, assessed by three independent radiologists, demonstrated marked improvements from pre- to post-ingestion, with a statistically significant difference ($p < 0.001$). These results are consistent with previous studies showing that pineapple juice effectively suppresses high-intensity signals from the gastrointestinal tract (GIT), enhancing the visualization of pancreaticobiliary structures [8].

Pineapple juice's efficacy is attributed to its high manganese content, which shortens T2 relaxation time and reduces signal intensity, similar to pharmaceutical contrast agents like ferumoxsil [9]. Unlike synthetic agents, pineapple juice is more palatable and well-tolerated, reducing the risk of adverse reactions [10]. It also minimizes ghost artifacts caused by bowel motion, enhancing the clarity of the pancreaticobiliary tree [11]. However, the study observed considerable variability in signal intensity improvements among patients, likely due to patient-related factors such as individual metabolism, dietary habits, fasting duration, and overall health conditions, which affect the absorption and distribution of manganese in the body [12]. For instance, differences in metabolic rates can influence how effectively the manganese in pineapple juice suppresses unwanted signals, leading to variations in imaging outcomes. Besides, this study utilized a 240ml dose of pineapple juice but did not establish the optimal manganese concentration or volume needed for the best visualization. Previous studies suggest that manganese concentrations above 15 mg/L can achieve effective signal suppression comparable to synthetic agents [13].

5. Conclusion

In conclusion, this study demonstrated that pineapple juice is an effective negative oral contrast agent for MRCP, consistent with previous findings. Pineapple juice significantly improved the visibility, detectability, and signal intensity of the common bile duct (CBD) and pancreatic duct, as assessed by three independent radiologists. This enhancement aids radiologists in recognizing anatomical variations and reducing imaging artifacts, thereby improving diagnostic accuracy [14]. Pineapple juice enhances the depiction of the pancreaticobiliary system by suppressing strong signals from the gastrointestinal tract, likely due to its high manganese content [15]. This decreases the T2 relaxation time of fluids in the stomach and duodenum [16]. As a naturally occurring, affordable, widely available, and well-accepted agent, pineapple juice is recommended as an alternative negative oral contrast agent for MRCP in clinical settings in Malaysia.

Acknowledgement

The authors would like to express their gratitude to all individuals and organizations who contributed to this study.

References

[1] Sevensma, Karlin, Miranda Allen, Rebecca Harden, and William Corser. "The Use of Magnetic Resonance Cholangiopancreatography (MRCP) in the Setting of Acute Pancreatitis: When is it Most Useful?." *Spartan Medical Research Journal* 2, no. 1 (2017). https://doi.org/10.51894/001c.5963

[2] Jagtap, Nitin, J. Kiran Kumar, Radhika Chavan, Jahangeer Basha, Manu Tandan, Sundeep Lakhtakia, Rakesh Kalapala et al. "EUS versus MRCP to perform ERCP in patients with intermediate likelihood of choledocholithiasis: a randomised controlled trial." *Gut* 71, no. 10 (2022): 2005-2010. https://doi.org/10.1136/gutjnl-2021-325080

[3] Vidal, Bruno PC, Daniel Lahan-Martins, Thiago J. Penachim, Marco Alexandre M. Rodstein, Patrícia P. Cardia, and Adilson Prando. "MR cholangiopancreatography: What every radiology resident must know." *Radiographics* 40, no. 5 (2020): 1263-1264. https://doi.org/10.1148/rg.2020200030

[4] Renzulli, Matteo, Daniele Caretti, Irene Pettinari, Maurizio Biselli, Stefano Brocchi, Alessandro Sergenti, Nicolò Brandi, and Rita Golfieri. "Optimization of pineapple juice amount used as a negative oral contrast agent in magnetic resonance cholangiopancreatography." *Scientific Reports* 12, no. 1 (2022): 531. https://doi.org/10.1038/s41598-021-04609-6

[5] Griffin, Nyree, Geoff Charles-Edwards, and Lee Alexander Grant. "Magnetic resonance cholangiopancreatography: the ABC of MRCP." *Insights into imaging* 3 (2012): 11-21. https://doi.org/10.1007/s13244-011-0129-9

[6] Bittman, Mark E., and Michael J. Callahan. "The effective use of acai juice, blueberry juice and pineapple juice as negative contrast agents for magnetic resonance cholangiopancreatography in children." *Pediatric radiology* 44 (2014): 883-887. https://doi.org/10.1007/s00247-014-2884-5

[7] Sasmithae, Lia, Tisha Patricia, and Indra Perdana. "Effect of Parigi Pineapple (Ananas Sp.) Juice Consumption on LDL Cholesterol Level in Students of Medical Faculty, University of Palangka Raya." *Nutrición Clínica y Dietética Hospitalaria* 43, no. 3 (2023).

[8] Mohabir, Sheryl, Richard D. Pitcher, Rubeshan Perumal, and Matthew Goodier. "The eficacy of pineapple juice as a negative oral contrast agent in magnetic resonance cholangiopancreatography." *SA Journal of Radiology* 24, no. 1 (2020): 1-6. https://doi.org/10.4102/sajr.v24i1.1875

[9] Welle, Christopher L., Frank H. Miller, and Benjamin M. Yeh. "Advances in MR imaging of the biliary tract." *Magnetic Resonance Imaging Clinics* 28, no. 3 (2020): 341-352. https://doi.org/10.1016/j.mric.2020.03.002

[10] Sharip , H., Azmi, N. N., & Supar , R. Different Types of Commercial Fruit Juices in Malaysia as Alternative Negative Oral Contrast Agent on Phantom Image Quality in Magnetic Resonance Cholangiopancreatography (MRCP). *International Journal of Health Sciences and Research* (2016).

[11] Papanikolaou, Nikolaos, Apostolos Karantanas, Thomas Maris, and Nickolas Gourtsoyiannis. "MR cholangiopancreatography before and after oral blueberry juice administration." *Journal of computer assisted tomography* 24, no. 2 (2000): 229-234. https://doi.org/10.1097/00004728-200003000-00008

[12] Renzulli, M., M. Biselli, E. Fabbri, D. Caretti, A. Sergenti, F. Modestino, F. A. Giannone, M. Storchi, L. Pierotti, and R. Golfieri. "What is the best fruit juice to use as a negative oral contrast agent in magnetic resonance cholangiopancreatography?." *Clinical Radiology* 74, no. 3 (2019): 220-227. https://doi.org/10.1016/j.crad.2018.11.005

[13] Arrivé, L., C. Coudray, L. Azizi, M. Lewin, C. Hoeffel, L. Monnier-Cholley, C. Lacombe, S. Vautier, J. Poupon, and J. M. Tubiana. "Pineapple juice as a negative oral contrast agent in magnetic resonance cholangiopancreatography." *Journal de radiologie* 88, no. 11 Pt 1 (2007): 1689-1694. https://doi.org/10.1016/S0221-0363(07)74047-7

[14] Rizzo, Domenico, Enrico Ravera, Marco Fragai, Giacomo Parigi, and Claudio Luchinat. "Origin of the MRI contrast in natural and hydrogel formulation of pineapple juice." *Bioinorganic chemistry and applications* 2021, no. 1 (2021): 6666018. https://doi.org/10.1155/2021/6666018

[15] Wahsner, Jessica, Eric M. Gale, Aurora Rodríguez-Rodríguez, and Peter Caravan. "Chemistry of MRI contrast agents: current challenges and new frontiers." *Chemical reviews* 119, no. 2 (2018): 957-1057. https://doi.org/10.1021/acs.chemrev.8b00363

[16] Frisch, Anne, Thula C. Walter, Bernd Hamm, and Timm Denecke. "Efficacy of oral contrast agents for upper gastrointestinal signal suppression in MRCP: A systematic review of the literature." *Acta Radiologica Open* 6, no. 9 (2017): 2058460117727315. https://doi.org/10.1177/2058460117727315