

Original Research Article

Different Types of Commercial Fruit Juices in Malaysia as Alternative Negative Oral Contrast Agent on Phantom Image Quality in Magnetic Resonance Cholangiopancreatography (MRCP)

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ABSTRACT

The usage of negative oral contrast agent in magnetic resonance cholangiopancreatography (MRCP) is capable to improve image of pancreatobiliary system by suppressing unnecessary signal from undesired area. However, problems arise when ideal characteristics of contrast agent such as palatable, easily prepared, swallow with good acceptance by patient and acceptable in cost are difficult to achieve. Thus, positive contrast agent and fruit juices are some alternatives to overcome it. The purpose of this study is to evaluate the effect of different types of commercially available fruit juices in Malaysia as alternative negative oral contrast agent on phantom image quality in MRCP procedure. This study was conducted at Clinical Training Centre, UiTM Sungai Buloh. Phantom image quality was used in order to get images of Omniscan contrast media and different alternative fruit juices on two different MRI sequences, which are T1-FL2D (T1 FLASH) and T2-SPC (T2 SPACE) sequence. Signal intensity of contrast agents tested was also analyzed. Pineapple juice-1 shows to be an excellent oral contrast agent and is suggested to be used as an alternative negative oral contrast agent for MRCP. It is hoped that this study can contribute to the improvement on the usage of contrast media in clinical practice of Radiology Department in Malaysia.

Keywords: Magnetic Resonance Cholangiopancreatography (MRCP), negative oral contrast agent, T1-FL2D, T2-SPC, signal to noise (SNR), image quality score.

INTRODUCTION

Magnetic Resonance Cholangiopancreatography (MRCP) is one of non-invasive magnetic resonance imaging (MRI) procedure used to image pancreatic duct and biliary tree. This technique uses heavily T2-weighted MRI sequence to eliminate soft tissue signal, thus improving fluid signal arises from duct. [1] MRCP gives more benefits compared to Endoscopic Retrograde Cholangiopancreatography (ERCP), as it is capable of displaying diagnostic information equally as

ERCP, other than no radiation received by patient. [2]

Depiction of pancreaticobiliary system in MRCP procedure could be improved by using negative oral contrast agent. This agent is capable of removing fluid bright signal intensity arises from nearby area. [3] In order for a contrast agent to be an ideal type for MRI procedure, it has to be sensitive and specific in diagnosis, good patient acceptance, suitable cost, and no toxicity and unchanged of contrast when diluted throughout the gastrointestinal (GI) tract. [4] Other characteristics are better GI

tract toleration, providing a homogenous signal and no effect of collateral with less stimulation of peristaltic. [5]

However, these ideal characteristics are difficult to achieve. Ferumoxsil, manganese chloride, barium sulphate and ferric particle are some of negative oral contrast agents that are not well accepted by patient due to higher price and unpalatable even though they produce a better dark image in T2 weighted images. [6] While the usage of superparamagnetic iron oxide (SPIOs) and other available contrast agents might cause either adverse reaction, expensive or becoming too diluted or changing when applied. [5]

Due to these limitations and possibility of side effect, the usage of artificial negative oral contrast agent is not widely used in medical imaging department. [4] Although it is not necessary to be used in MRCP, but the usage of negative oral contrast media is significant as it is capable in improving the visualization of pancreaticobiliary system. [5]

In finding alternative to this problem, positive oral contrast media was tested. Ferric ammonium citrate (FAC) has becomes widely used in Japan due to its ability in giving high T2-shortening effect with high concentration dose. [7] However, due to its characteristic as positive contrast agent, the quality of image produced is not the same as negative contrast agent. This is because positive contrast agents are primarily function to improve signal intensity in T1 sequence, while negative contrast agents are primarily function to create low signal in T1 and especially in T2 sequence. [7]

Some radiologists use tap water as oral contrast agent to substitute these artificial types of contrast. [8] However, in term of removing fluid signal from MRCP images, negative oral contrast media is still the most preferred type. [8]

Many studies have successfully proved the use of fruit juice as alternative oral contrast agent. While some of them also have tested fruit juice according to the

commercially available fruit juices in their area. Fruit juices in Malaysia are not yet fully tested, making it reasonable to be studied in term of the appearance and capability to act as alternative oral contrast agent. Thus, this study aims to evaluate the effect of different types of fruit juices which are commercially available in Malaysia as alternative oral negative contrast agent on phantom image quality for MRCP procedure.

MATERIALS AND METHODS

This is an experimental study done to investigate the effect of different types of natural fruit juices which are commercially available in Malaysia as alternative negative oral contrast agents on image quality phantom for MRCP procedure. The phantom consists of 6 plastic bottles of the same size and a plastic box. [9] Due to fat rich content in margarine, it was placed around plastic bottle inside the plastic box to mimic human fat which is soft tissue. [9] Each bottle was filled with 70 milliliters (ml) volume of various types of contrast agents.

Alternative fruit juices selected for this study are two different types of pineapple juice from different manufactures, orange juice, apple juice, Omniscan contrast media and also water. Omniscan and water were the types of negative contrast agents which are mainly used in hospital around Selangor area in Malaysia.

Data was obtained by using Magnetom Aera 1.5 Tesla (T) MRI (Siemens). During experiment, phantom made up of plastic bottle and box was positioned inside the gantry. The orientation of the phantom bottle inside MRI gantry is side by side on MRI couch. Each of them was arranged in a Tupperware plastic box to prevent spill of contrast media during procedure, forming coordinates of 3 columns and 2 rows. Each plastic was labeled A to F according to the types of contrast media used starting with pineapple juice-1, apple juice, water, pineapple juice-2, orange juice and lastly artificial contrast

agent which is Omniscan. The phantom then was covered by abdominal coil. Seven sequences have been tested based on common MRCP sequences used in CTC UiTM Sungai Buloh. All sequences tested were performed in a coronal plane. Based on the image appearances and signal intensity values of image produced, T1-FL2D (T1 FLASH) and T2-SPC (T2 SPACE) sequences were further selected for image quality assessment. Qualitative image quality assessment was then done by two MRI senior radiographers based on Image Quality Score Evaluation. [7] Signal to noise (SNR) ratio was calculated for quantitative image quality assessment.

Statistical analysis

Data was analyzed by using statistical software for social science (SPSS) version 20.0. Statistical test used were One-way ANOVA and Pearson Correlation.

Ethical approval

Ethical approval was obtained from the ethical committee of Faculty of Health Sciences, University Technology MARA (UiTM). The reference number for ethical approval is 600-FSK (PT.5/2).

RESULTS

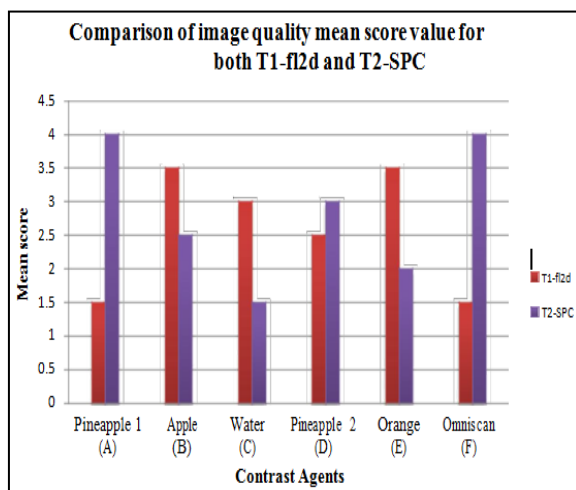


Figure 1: SNR value of each contrast agents for both T1-FL2D and T2-SPC.

With reference to Figure 1, Omniscan gives the highest value of SNR in T1-FL2D and the lowest SNR value in T2-SPC. In contrast, water gives the highest

value of SNR in T2-SPC and the lowest SNR value in T1-FL2D. In order to test the significance difference in SNR between different types of contrast agent, one way ANOVA was performed. The result shows that there are significant differences between all pairs of contrast media used in this study in term of its SNR values ($p < 0.05$).

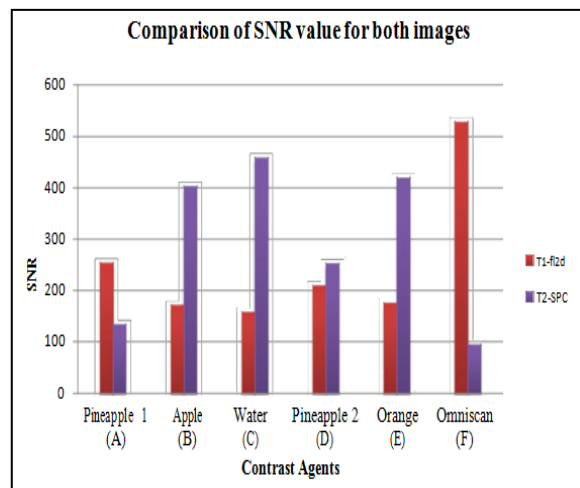


Figure 2: Image quality score of each contrast agents for both T1 FL2D and T2 SPC.

For qualitative image quality assessment, it is shown that in T1-FL2D sequence, Omniscan and pineapple juice-1 give the lowest score while apple and orange give the highest score. In contrast, in T2-SPC sequence, Omniscan and pineapple juice-1 give the highest score while water gives the lowest image score.

One way ANOVA then performed to test the significant different in image score between different types of contrast agents used. There is no significant different in image score between different contrast agents used in T1-FL2D ($p = 0.059$) but, the significant different in image score exists between all pairs of contrast agents used in T2-SPC sequence ($p < 0.05$). Omniscan and pineapple juice-1 give the best image quality, followed by pineapple juice-2, apple juice, orange juice and lastly, water.

Pearson correlation was used to test the relationship between SNR and image quality score. In T1-FL2D sequence, there is a significant ($p < 0.005$), negative good correlation ($r = -0.745$) between SNR and

image quality score. While in T2-SPC, there is a significant ($p < 0.001$), negative excellent correlation ($r = -0.976$) between SNR and image quality score. It is shown that as SNR is higher, the image quality score will become lower.

DISCUSSION

Omniscan gives the highest value of SNR in T1-FL2D and the lowest SNR value in T2-SPC sequence. For image quality assessment, Omniscan gives the lowest score in T1-FL2D and the highest score in T2-SPC. As SNR value increases, image quality score is significantly decreases. This is because signal intensity from the used of contrast agents is suppressed in T2 relaxation time which then lead to decrease of signal in T2 images. [8] Less signal intensity is needed in T2 weighted image in MRCP to suppress undesired area and improve appearance of desired area. As a result, area with negative contrast agents will appear dark due to signal loss.

Among different fruit juices tested, pineapple juice-1 shows a comparable result next to omniscan as it gives a good image quality score, significantly the same as Omniscan in T2-SPC sequence. For SNR value, pineapple juice-1 gives the second highest value after Omniscan in T1-FL2D and the second lowest after Omniscan in T2-FPC.

Pineapple juice-2 is the second best alternative after pineapple juice-1 in term of its SNR and image score in both T1-FL2D and T2-SPC sequence. The different between pineapple juice-1 and pineapple juice-2 in this study are different manufacturer and different manganese concentration. Pineapple juice-1 contains mostly pure pineapple with sugar while Pineapple juice-2 is manufactured with mixture of juice, water, sugar and some other chemical.

Manganese is the substance that affects the signal in MRI images, which commonly found in contrast agents. [10] When contrast agents are in adequate concentration of manganese content, it can

affect T1 and T2 by decreasing it recovery times. Pineapple juice has the highest manganese content compared to other fruit juices. [11] In T2 images, pineapple juice is capable to produce a small signal value giving an appearance almost dark. [11]

In this study, pineapple juice appears to be the lowest in signal intensity which is hypointense in T2 image compared to other fruit juices examined. Many studies have also found that pineapple juice appears to be darker and low in signal intensity with slightly remaining intensity compared to other fruit juice examined. [12,13]

An image with high signal intensity in T1 will create a poor image quality where in return produce a hyperintense signal. Although pineapple juice gives higher signal intensity in T1 weighted images, it can still be used as alternative oral contrast agent for MRCP procedure as long as T1 images are not desire during procedure [12] Even though orange juice and apple juice give lower signal intensities in T1-FL2D, it cannot be used as alternative contrast agent due to its bright appearance in T2-SPC. [12] Water is not preferable to be used as alternative contrast agent as it gives high T2 weighted image and low T1 weighted image signal intensities. [14] In this study, water gives the lowest image quality score in T2-SPC. Thus, it is not preferred to be used an alternative to Omniscan.

Pineapple juice-1 is chosen in this study to be an ideal alternative to the commonly used artificial contrast media which is Omniscan. Furthermore, the usage of pineapple juice as negative contrast agent has no side effect on human subject. [15]

CONCLUSION

In conclusion, performance of pineapple juice-1 as negative oral contrast media in MRCP is better compared to other fruit juices. Pineapple juice-1 yields better image quality and act similar to Omniscan. It is cheap, easily available and good patient acceptance, thus it is suggested to be used as an alternative negative oral contrast agent for MRCP in clinical area in Malaysia.

Since this study was conducted by using a phantom, image quality and signal intensity obtained only effective on phantom. Thus, future study could be done with the same setting by using real human body system for more precise result.

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