

# Rapid Sequence MRI Analysis of Acute Abdominal Pain

Ali Haydar Baykan<sup>1</sup>, Sukru Sahin<sup>1</sup>, Ibrahim Inan<sup>2</sup>, Safiye Kafadar<sup>1</sup>, Mustafa Goksu<sup>3</sup>, Sukru Mehmet Erturk<sup>1</sup>

<sup>1</sup>Department of Radiology, Adiyaman University Faculty of Medicine, Adiyaman, Turkey

<sup>2</sup>Department of Radiology, Biruni University Hospital, Istanbul, Turkey

<sup>3</sup>Department of General Surgery, Adiyaman University Faculty of Medicine, Adiyaman, Turkey

## Abstract

**Aim:** The aim of this study was to evaluate the diagnosis performance of non-contrast rapid sequences MRI (RAMRI) visualization on cases who have been clinically diagnosed as acute abdominal pain (AAP).

**Materials and Methods:** 46 were chosen from 2850 patients who have applied to the emergency service between January 2016-January 2019 because of sudden onset of abdominal pain and could not get a CT analysis. 1.5 Tesla MR device (GE Signa Hi-Speed, Milwaukee) was used for analysis. Coronal and axial T2-weighted SS FSE series were used as scan protocol. No intravenous, oral or rectal contrast material were used. The cases identified as positively (+) and negatively (-) by MRI. The cases who have symptoms, related with AAP, considered as positive (+), normal or symptoms which are not related with AAP, considered as negative (-).

**Results:** 26 of the cases were female (56.5 %), 20 of them were male (43.5%) and the median age was calculated as 38.65 (18-86). The treatment methodology was surgery for 25 cases (54 %) and conservative for 21 (46 %) cases. The operative group (surgically treated) includes 24 MR (+) and 1 MR (-) cases. There is a harmony between the clinic and MRI data of all members of non-surgical group. The accuracy of the study was calculated as 95.6 % (44/46). The sensitivity and specificity of RAMRI was detected 96 % for operative group and 100 % for non-operative group

**Conclusion:** A successful diagnostic performance has been applied to the AAP cases by non-contrast RAMRI.

## Introduction

Acute abdominal pain (AAP) is one of the most common reasons for emergency service applications [1]. Only a few of emergency cases can be diagnosed by physical and laboratory tests [2] because the differential diagnoses of AAP are wide and the most frequently encountered reasons are acute appendicitis (AA), biliary colic, cholecystitis, diverticulitis, ileus, gastrointestinal lumen perforation, pancreatitis and renal colic [3]. Thus, radiological visualization is one of the most used methods for the diagnosis of the reason for AAP [4]. According to the conformity criteria of American College of Radiology (ACR) for the cases which have fever, delocalized stomach pain and lack of surgical background, the abdomen computerized tomography (CT) is the most suitable analysis [4]. However, this methodology is rarely preferred for

children and pregnant women because of the ionized radiation and contrast material usage which has nephrotoxic effects [5-7]. Ultrasonography (US) can be preferred because it is easily accessible, cheap and safe [5]. But need of an operator and the prevent of stomach-intestine gas superposition for high quality visualization are the disadvantages of the method [7,8]. Besides CT is more sensitive than US for delocalized AAP [4].

Magnetic Resonance Imaging (MRI) is not frequently used for AAP. Lack of ionized radiation and high soft tissue contrast are the advantages of MRI [5]. MRI methodology is limited for intense stomach pains because of long analysis duration and possible movement artefacts. But diagnostic images can be handled for these cases by rapid sequence abdominal MRI (RAMRI) [9]. The main purpose of RAMRI analysis is to keep the patient in MR

**Corresponding Author:** Department of Radiology, Adiyaman University Faculty of Medicine, Adiyaman, Turkey  
**Phone:** ++90 505 351 93 07 **E-mail:** drbaykan@yahoo.com **ORCID ID:** orcid.org/0000-0002-9281-652X

**Received:** 08.05.2019

**Accepted:** 07.08.2019

device as short as possible and handle the diagnostic images by preventing movement artefacts. Single shot sequences can be used for this purpose.

Single shot fast spin echo (SSFSE) sequence was used in this study to evaluate the performance of non-contrast RAMRI visualization on the cases who have AAP clinic diagnosis.

## Materials and Methods

The study has a retrospective design, the local ethics committee approval was obtained (2017/6-10) and carried out with the approval of the and the working principles of the Helsinki Declaration.

### Patients

46 were chosen from 2850 patients for this study who have applied to the emergency service because of sudden onset of abdominal pain and could not get a CT analysis because of pregnancy, kidney dysfunction, history of contrast material reaction or do not have enough radiological data by US. The images were saved and evaluated retrospectively from University Hospital radiology archive. Patients who have low quality images, more than 72 hours analysis duration with RAMRI and renal colic diagnosis excluded from study.

### MRI Protocol

1.5 Tesla MR device (GE Signa Hi-Speed, Milwaukee) was used for analysis. Coronal and axial T2-weighted SS FSE series were used as scan protocol (TR/TE/NEX: 634/101/1). Thickness and gap were determined as 5 mm and 0.1 mm respectively. Additionally, axial fat-suppressed axial T2-weighted SS FSE and T2 gradient echo (GRE) were used when essential. No intravenous, oral or rectal contrast material were used. The analysis duration was shorter than 2 min. for most of the cases.

### Image Analysis

The images were evaluated by two radiologists who have abdomen MR experience. The operation data for surgically cured patients and clinic final diagnosis for conservatively cured patients were saved. The cases identified as positively (+) and negatively (-) by MRI. The cases who have symptoms (swelling and an inflame appendix, enlarged ovarian torsion, pericholecystic fluid and accompanier biliary gallstone, existence of free fluid, inflame intestinal wall) related with AAP considered as positive (+), normal or symptoms (simple renal cortical cyst, liver hemangioma) not related with AAP considered as negative (-).

### Statistical Method

SPSS 22.0 was used for statistical analysis. All data were managed, processed, and compiled in Microsoft Office Excel.

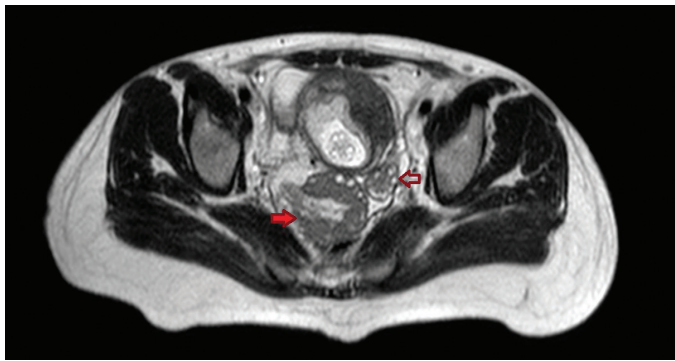
## Results

26 of the cases were female (56.5 %), 20 of them were male (43.5 %) and the median age was calculated as 38.65 (18-86). Additionally, 6 cases were pregnant. The treatment methodology was surgery for 25 cases (54 %) and conservative for 21 (46 %) cases. The operative group (surgically treated) includes 24 MR (+) and 1 MR (-) cases. 15 of these cases were AA, 3 were acute cholecystitis, 1 was stomach perforation, 2 were over torsion, 2 were small bowel obstruction and 1 was colon tumor. One of the cases which was reported as MR (-) was diagnosed as AA surgically. One of the cases which was reported as MR (+) and considered as AA identified as normal appendix after surgical diagnosis and pathology results. The surgical and pathologic diagnosis of other members of operative group and MRI diagnosis of these cases were in harmony. Two of the cases considered as perforation because of periappendicular fluid and this phenomenon was proved by surgically. Acute cholecystitis was evaluated for three of the cases and cholecystectomy was applied for each one. Impacted cystic duct stone was accompanied to one of them, cholelithiasis and choledocholithiasis were accompanied to other ones. Perforation was considered for one of the cases because of discontinuity at the stomach wall and free air at abdomen and this phenomenon was proved surgically (Table 1).

Three acute pancreatitis, one terminal ileitis, one colitis, one omental infarct, one pelvic inflammatory disease (PID), one Crohn disease reported in the non-surgical group (MR (+)) which have been clinically followed up and 13 cases were evaluated

**Table 1. Classification of the MRI findings**

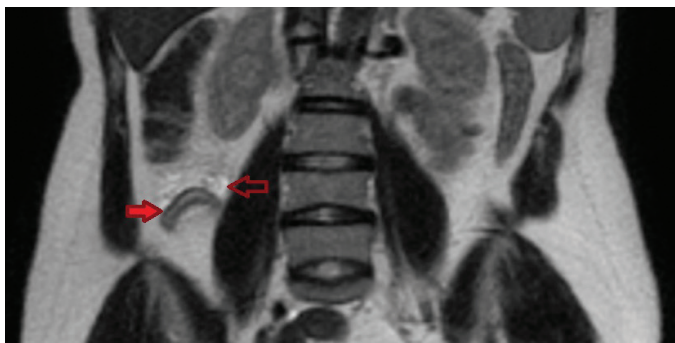
Cases	Surgery group (n =25)		Non-surgery group (n =21)	
	MR (+) (n=24)	MR (-) (n=1)	MR (+) (n=8)	MR (-) (n=13)
Appendicite	15	1		
Cholecystitis	3			
Over torsion	2			
Intestinal obstruction	2			
Colon tumor	1			
Stomach perforation	1			
Pancreatitis			3	
Terminal ileitis			1	
Colitis			1	
Omental infarct			1	
PID			1	
Crohn			1	



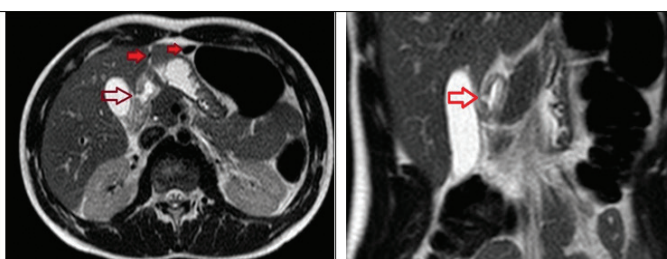
**Figure 1:** Increased right ovary dimensions (filled red arrow), peripherally displaced follicles and normal left ovary dimensions (empty red arrow). Right ovarian torsion.



**Figure 2:** Inflammation at mass like fatty tissue of omental infarct case which is at the neighbor of cecum anterior.



**Figure 3:** Dilated appendix (filled arrow) and periappendicular fluid (empty arrow) at acute appendicitis case.



**Figure 4:** Free air (filled arrow) and perforation area (empty arrow) at stomach perforation case.

as non-pathologic and marked as MR (-) (Table 1). Duodenal diverticulum was diagnosed for one and gallbladder stone was detected additionally for two of the three patients who were diagnosed as acute pancreatitis. There is a harmony between the clinic and MRI data of all members of non-surgical group. Torsion was evaluated for one of the pregnant cases because of the increase of asymmetric ovarian volume and detorsioned surgically. AA was diagnosed for two of the pregnant cases. No pathology was detected for the rest of the pregnant cases and the patients were discharged from hospital when the symptoms were decreased. The radiological findings of some cases are shown in figures 1 to 4.

The sensitivity and specificity of RAMRI was detected 96 % for operative group and 100 % for non-operative group.

## Discussion

MRI is sensitive for the visualization of inflammatory changes at liver, biliary system, pancreas, urinary system, intestinal anes and pelvic organs [10]. There are studies in literature which emphasize the activity of abdominal MRI on AA [11,12], acute diverticulitis [13], acute pancreatitis [14] and acute cholecystitis [15]. Nevertheless, there is a lack of literature about the MRI application in AAP [2]. Besides there is no study on the cost analysis [2]. MRI is generally applied to the pregnant cases where the US is not an option. However, the CT is the first option for AAP, MRI is generally considered as an alternative. It has been considered as a good alternative, especially for the pregnant and children, to prevent patients from ionized radiation [16].

AA is still the most common reason for AAP and the ratio of AA for AAP cases is between 11-23 % [17]. The ratio of AA for this study is 32 % (15 case from 45) which is higher than literature. CT analysis has not been applied to the patients and this may be a reason for the high ratio. In one case, reactive fluid increase and mild enlargement has been detected by RAMRI at appendix lumen radius and periappendicular area respectively and reported as AA. But after the surgery it has been concluded that there is no AA and the appendix symptoms are normal. One of the other cases has been reported as MR (-) by RAMRI but surgical evidences showed that the diagnosis is AA. For both cases the duration between the RAMRI analysis and surgery is more than 24 hours. There are still blur parts in visualization data for AA which is an inflammatory disease. New studies should be organized with higher number of patients group.

The images should be handled quickly, and they should be diagnostic in AAP cases. The sequences like fast spin echo (single shot fast spin echo), which have short analysis duration, can be used for this purpose. The analysis duration was shorter than 2

min. for most of the cases. Soft tissue resolution is considerably high and the inflammatory changes, like edema and fluid, can be diagnosed easily. It has been reported that the detection sensitivity of air at gradient echo (GRE) and inflammatory changes at T2A sequences were increased [10]. These two sequences were applied in current study when they are necessary. It has been concluded that the RAMRI is significant and hopeful because the radiological analysis duration is shorter and provides enough information.

There are some disadvantages of the method; the patients who have claustrophobia and hearth battery are not allowed for MRI [17]. Despite short analysis duration, diagnostic images may not be handled because of pain. The radiologist may not be familiar to the images of acute abdomen. This disadvantage can be eliminated by reputation of MRI on AA.

It has been proved that it is possible to have highly sensitive diagnosis for most of the AA pathologies by rapid sequence MR. Retrospective design of study, low case number, absence of case under 18 and short follow up duration for the conservatively watched patients.

## Conclusion

Rapid sequence MR is an important diagnostic tool for AA cases when US can not provide enough data and CT is not possible. RAMRI has important properties; it has high resolution for soft tissue, does not include radiation and does not need contrast material. Radiologists may not be familiar to AAP pathologies because it is not a routine methodology. Frequently application of rapid sequence MRI on AAP patients may improve the radiologists.

## References

- Kilicaslan I., et al., Demographic properties of patients presenting to the emergency department in Turkey. *Turkiye Acil Tıp Dergisi*, 2005. 5(1): p. 5-13.
- Stoker J., et al., Imaging patients with acute abdominal pain. *Radiology*, 2009. 253(1): p. 31-46.
- Abdullah M. and Firmansyah MA., Diagnostic approach and management of acute abdominal pain. *Acta Med Indones*, 2012. 44(4): p. 344-50.
- Scheirey CD, et al., ACR Appropriateness Criteria® Acute Nonlocalized Abdominal Pain. *Journal of the American College of Radiology*, 2018. 15(11): p. S217-S231.
- Ditkofsky NG, et al., The role of emergency MRI in the setting of acute abdominal pain. *Emerg Radiol*, 2014. 21(6): p. 615-24.
- Tkacz JN, Anderson SA, and Soto J, MR imaging in gastrointestinal emergencies. *Radiographics*, 2009. 29(6): p. 1767-80.
- LeBedis CA, et al., Current applications of MRI in emergent gastrointestinal diseases. *Applied Radiology*, 2012. 41(11): p. 9.
- Corson-Knowles D and Russell FM, Clinical Ultrasound Is Safe and Highly Specific for Acute Appendicitis in Moderate to High Pre-test Probability Patients. *West J Emerg Med*, 2018. 19(3): p. 460-464.
- Byott S and Harris I, Rapid acquisition axial and coronal T2 HASTE MR in the evaluation of acute abdominal pain. *Eur J Radiol*, 2016. 85(1): p. 286-290.
- Lubarsky M, et al., MR imaging for acute nontraumatic abdominopelvic pain: rationale and practical considerations. *Radiographics*, 2013. 33(2): p. 313-37.
- Spalluto LB, et al., MR imaging evaluation of abdominal pain during pregnancy: appendicitis and other nonobstetric causes. *Radiographics*, 2012. 32(2): p. 317-34.
- Cobben L, et al., A simple MRI protocol in patients with clinically suspected appendicitis: results in 138 patients and effect on outcome of appendectomy. *Eur Radiol*, 2009. 19(5): p. 1175-83.
- Heverhagen JT, et al., Prospective evaluation of the value of magnetic resonance imaging in suspected acute sigmoid diverticulitis. *Dis Colon Rectum*, 2008. 51(12): p. 1810-5.
- Viremouneix L, et al., Prospective evaluation of nonenhanced MR imaging in acute pancreatitis. *J Magn Reson Imaging*, 2007. 26(2): p. 331-8.
- Tonolini M, et al., Urgent MRI with MR cholangiopancreatography (MRCP) of acute cholecystitis and related complications: diagnostic role and spectrum of imaging findings. *Emerg Radiol*, 2012. 19(4): p. 341-8.
- Oto A, et al., Right-lower-quadrant pain and suspected appendicitis in pregnant women: evaluation with MR imaging--initial experience. *Radiology*, 2005. 234(2): p. 445-51.
- Fagerström A, Paajanen P, Saarelainen H, Ahonen-Siirtola M, Ukkonen M, Miettinen P, & Paajanen H. Non-specific abdominal pain remains as the most common reason for acute abdomen: 26-year retrospective audit in one emergency unit. *Scandinavian journal of gastroenterology*, 2017, 52(10), 1072-1077.