



DEPARTMENT OF THE AIR FORCE
59TH MEDICAL WING (AETC)
JOINT BASE SAN ANTONIO - LACKLAND TEXAS



15 MAR 2017

MEMORANDUM FOR 959 CSPS

ATTN: MAJ JAMES D COVELLI

FROM: 59 MDW/SGVU

SUBJECT: Professional Presentation Approval

1. Your paper, entitled **Diagnosis of Pediatric Appendicitis: Is MR Imaging More Appropriate than CT?** presented at/published to **Should Non-Contrast Rapid MRE Evaluation of Clinically Suspected Pediatric Appendicitis Trump CT after Equivocal Ultrasound? (No Publication Journal Assigned Yet) & American Roentgen Ray Society (ARRS), New Orleans, LA, 1-6 April 2017** in accordance with MDWI 41-108, has been approved and assigned local file #**17059**.
2. Pertinent biographic information (name of author(s), title, etc.) has been entered into our computer file. Please advise us (by phone or mail) that your presentation was given. At that time, we will need the date (month, day and year) along with the location of your presentation. It is important to update this information so that we can provide quality support for you, your department, and the Medical Center commander. This information is used to document the scholarly activities of our professional staff and students, which is an essential component of Wilford Hall Ambulatory Surgical Center (WHASC) internship and residency programs.
3. Please know that if you are a Graduate Health Sciences Education student and your department has told you they cannot fund your publication, the 59th Clinical Research Division may pay for your basic journal publishing charges (to include costs for tables and black and white photos). We cannot pay for reprints. If you are a 59 MDW staff member, we can forward your request for funds to the designated Wing POC at the Chief Scientist's Office, Ms. Alice Houy, office phone: 210-292-8029; email address: alice.houy.civ@mail.mil.
4. Congratulations, and thank you for your efforts and time. Your contributions are vital to the medical mission. We look forward to assisting you in your future publication/presentation efforts.

LINDA STEEL-GOODWIN, Col, USAF, BSC
Director, Clinical Investigations & Research Support

PROCESSING OF PROFESSIONAL MEDICAL RESEARCH/TECHNICAL PUBLICATIONS/PRESENTATIONS

INSTRUCTIONS

USE ONLY THE MOST CURRENT 59 MDW FORM 3039 LOCATED ON AF E-PUBLISHING

1. The author must complete page two of this form:
 - a. In Section 2, add the funding source for your study [e.g., 59 MDW CRD Graduate Health Sciences Education (GHSE) (SG5 O&M); SG5 R&D; Tri-Service Nursing Research Program (TSNRP); Defense Medical Research & Development Program (DMRDP); NIH; Congressionally Directed Medical Research Program (CDMRP) ; Grants; etc.]
 - b. In Section 2, there may be funding available for journal costs, if your department is not paying for figures, tables or photographs for your publication. Please state "YES" or "NO" in Section 2 of the form, if you need publication funding support.
2. Print your name, rank/grade, sign and date the form in the author's signature block or use an electronic signature.
3. Attach a copy of the 59 MDW IRB or IACUC approval letter for the research related study. If this is a technical publication/presentation, state the type (e.g. case report, QA/QI study, program evaluation study, informational report/briefing, etc.) in the "Protocol Title" box.
4. Attach a copy of your abstract, paper, poster and other supporting documentation.
5. Save and forward, via email, the processing form and all supporting documentation to your unit commander, program director or immediate supervisor for review/approval.
6. On page 2, have either your unit commander, program director or immediate supervisor:
 - a. Print their name, rank/grade, title; sign and date the form in the approving authority's signature block or use an electronic signature.
7. Submit your completed form and all supporting documentation to the CRD for processing (59crdpubspres@us.af.mil). **This should be accomplished no later than 30 days before final clearance is required to publish/present your materials.** If you have any questions or concerns, please contact the 59 CRD/Publications and Presentations Section at 292-7141 for assistance.
8. The 59 CRD/Publications and Presentations Section will route the request form to clinical investigations, 502 ISG/JAC (Ethics Review) and Public Affairs (59 MDW/PA) for review and then forward you a final letter of approval or disapproval.
9. Once your manuscript, poster or presentation has been approved for a one-time public release, you may proceed with your publication or presentation submission activities, as stated on this form. **Note:** For each new release of medical research or technical information as a publication/presentation, a new 59 MDW Form 3039 must be submitted for review and approval.
10. If your manuscript is accepted for scientific publication, please contact the 59 CRD/Publications and Presentations Section at 292-7141. This information is reported to the 59 MDW/CC. All medical research or technical information publications/presentations must be reported to the Defense Technical Information Center (DITC). See 59 MDWI 41-108, *Presentation and Publication of Medical and Technical Papers*, for additional information.
11. The Joint Ethics Regulation (JER) DoD 5500.07-R, *Standards of Conduct*, provides standards of ethical conduct for all DoD personnel and their interactions with other non-DoD entities, organizations, societies, conferences, etc. Part of the Form 3039 review and approval process includes a legal ethics review to address any potential conflicts related to DoD personnel participating in non-DoD sponsored conferences, professional meetings, publication/presentation disclosures to domestic and foreign audiences, DoD personnel accepting non-DoD contributions, awards, honoraria, gifts, etc. The specific circumstances for your presentation will determine whether a legal review is necessary. **If you (as the author) or your supervisor check "NO" in block 17 of the Form 3039, your research or technical documents will not be forwarded to the 502 ISG/JAC legal office for an ethics review.** To assist you in making this decision about whether to request a legal review, the following examples are provided as a guideline:

For presentations before professional societies and like organizations, the 59 MDW Public Affairs Office (PAO) will provide the needed review to ensure proper disclaimers are included and the subject matter of the presentation does not create any cause for DoD concern.

If the sponsor of a conference or meeting is a DoD entity, an ethics review of your presentation is not required, since the DoD entity is responsible to obtain all approvals for the event.

If the sponsor of a conference or meeting is a non-DoD commercial entity or an entity seeking to do business with the government, then your presentation should have an ethics review.

If your travel is being paid for (in whole or in part) by a non-Federal entity (someone other than the government), a legal ethics review is needed. These requests for legal review should come through the 59 MDW Gifts and Grants Office to 502 ISG/JAC.

If you are receiving an honorarium or payment for speaking, a legal ethics review is required.

If you (as the author) or your supervisor check "YES" in block 17 of the Form 3039, your research or technical documents will be forwarded simultaneously to the 502 ISG/JAC legal office and PAO for review to help reduce turn-around time. If you have any questions regarding legal reviews, please contact the legal office at (210) 671-5795/3365, DSN 473.

NOTE: All abstracts, papers, posters, etc., should contain the following disclaimer statement:

"The views expressed are those of the [author(s)] [presenter(s)] and do not reflect the official views or policy of the Department of Defense or its Components"

NOTE: All abstracts, papers, posters, etc., should contain the following disclaimer statement for research involving humans:

"The voluntary, fully informed consent of the subjects used in this research was obtained as required by 32 CFR 219 and DODI 3216.02_AFI 40-402."

NOTE: All abstracts, papers, posters, etc., should contain the following disclaimer statement for research involving animals, as required by AFMAN 40-401_IP :

"The experiments reported herein were conducted according to the principles set forth in the National Institute of Health Publication No. 80-23, Guide for the Care and Use of Laboratory Animals and the Animal Welfare Act of 1966, as amended."

PROCESSING OF PROFESSIONAL MEDICAL RESEARCH/TECHNICAL PUBLICATIONS/PRESENTATIONS			
1. TO: CLINICAL RESEARCH	2. FROM: (Author's Name, Rank, Grade, Office Symbol) James D Covelli, Maj, O4, 959 CSPA	3. GME/GHSE STUDENT: ☒ YES ☐ NO	4. PROTOCOL NUMBER: C.2016.080d
5. PROTOCOL TITLE: (NOTE: For each new release of medical research or technical information as a publication/presentation, a new 59 MDW Form 3039 must be submitted for review and approval.) Should Non-Contrast Rapid MRI Evaluation of Clinically Suspected Pediatric Appendicitis Trump CT after Equivocal Ultrasound?			
6. TITLE OF MATERIAL TO BE PUBLISHED OR PRESENTED: Electronic Poster: Diagnosis of Pediatric Appendicitis: Is MR Imaging More Appropriate than CT?			
7. FUNDING RECEIVED FOR THIS STUDY? ☐ YES ☒ NO FUNDING SOURCE:			
8. DO YOU NEED FUNDING SUPPORT FOR PUBLICATION PURPOSES: ☐ YES ☒ NO			
9. IS THIS MATERIAL CLASSIFIED? ☐ YES ☒ NO			
10. IS THIS MATERIAL SUBJECT TO ANY LEGAL RESTRICTIONS FOR PUBLICATION OR PRESENTATION THROUGH A COLLABORATIVE RESEARCH AND DEVELOPMENT AGREEMENT (CRADA), MATERIAL TRANSFER AGREEMENT (MTA), INTELLECTUAL PROPERTY RIGHTS AGREEMENT ETC.? ☐ YES ☒ NO NOTE: If the answer is YES then attach a copy of the Agreement to the Publications/Presentations Request Form.			
11. MATERIAL IS FOR: ☒ DOMESTIC RELEASE ☐ FOREIGN RELEASE CHECK APPROPRIATE BOX OR BOXES FOR APPROVAL WITH THIS REQUEST. ATTACH COPY OF MATERIAL TO BE PUBLISHED/PRESENTED.			
☐ 11a. PUBLICATION/JOURNAL (List intended publication/journal.)			
☒ 11b. PUBLISHED ABSTRACT (List intended journal.) Should Non-Contrast Rapid MRI Evaluation of Clinically Suspected Pediatric Appendicitis Trump CT after Equivocal Ultrasound? (N ⁺)			
☒ 11c. POSTER (To be demonstrated at meeting: name of meeting, city, state, and date of meeting.) Electronic Poster to be demonstrated at American Roentgen Ray Society (ARRS), New Orleans, LA, 1 Apr 2017-6 Apr 2017			
☐ 11d. PLATFORM PRESENTATION (At civilian institutions: name of meeting, state, and date of meeting.)			
☐ 11e. OTHER (Describe: name of meeting, city, state, and date of meeting.)			
12. HAVE YOUR ATTACHED RESEARCH/TECHNICAL MATERIALS BEEN PREVIOUSLY APPROVED TO BE PUBLISHED/PRESENTED? ☐ YES ☒ NO ASSIGNED FILE # _____ DATE _____			
13. EXPECTED DATE WHEN YOU WILL NEED THE CRD TO SUBMIT YOUR CLEARED PRESENTATION/PUBLICATION TO DTIC NOTE: All publications/presentations are required to be placed in the Defense Technical Information Center (DTIC).			
DATE 1 March 2016			
14. 59 MDW PRIMARY POINT OF CONTACT (Last Name, First Name, M.I., email) Quintero, Susan, J. susan.j.quintero.civ@mail.mil			15. DUTY PHONE/PAGER NUMBER 210-292-5290
16. AUTHORSHIP AND CO-AUTHOR(S) List in the order they will appear in the manuscript.			
LAST NAME, FIRST NAME AND M.I.	GRADE/RANK	SQUADRON/GROUP/OFFICE SYMBOL	INSTITUTION (If not 59 MDW)
a. Primary/Corresponding Author Covelli, James D	Major/O4	959 CSPA	
b.			
c.			
d.			
e.			
17. IS A 502 ISG/JAC ETHICS REVIEW REQUIRED (JER DOD 5500.07-R)? ☐ YES ☒ NO			
I CERTIFY ANY HUMAN OR ANIMAL RESEARCH RELATED STUDIES WERE APPROVED AND PERFORMED IN STRICT ACCORDANCE WITH 32 CFR 219, AFMAN 40-401_IP, AND 59 MDWI 41-108. I HAVE READ THE FINAL VERSION OF THE ATTACHED MATERIAL AND CERTIFY THAT IT IS AN ACCURATE MANUSCRIPT FOR PUBLICATION AND/OR PRESENTATION.			
18. AUTHOR'S PRINTED NAME, RANK, GRADE James D Covelli, Maj, O4	19. AUTHOR'S SIGNATURE COVELLI.JAMES.D.1109129077		20. DATE January 10, 2017
21. APPROVING AUTHORITY'S PRINTED NAME, RANK, TITLE Robert M DeWitt, Maj, O4, Associate Program Director, Dept of Radiology	22. APPROVING AUTHORITY'S SIGNATURE DEWITT.ROBERT.MICHAEL.1257534584		23. DATE January 18, 2017

PROCESSING OF PROFESSIONAL MEDICAL RESEARCH/TECHNICAL PUBLICATIONS/PRESENTATIONS		
1st ENDORSEMENT (59 MDW/SGVU Use Only)		
TO: Clinical Research Division 59 MDW/CRD Contact 292-7141 for email instructions.	24. DATE RECEIVED March 08, 2017	25. ASSIGNED PROCESSING REQUEST FILE NUMBER 17059
26. DATE REVIEWED 8 Mar 2017		27. DATE FORWARDED TO 502 ISG/JAC
28. AUTHOR CONTACTED FOR RECOMMENDED OR NECESSARY CHANGES: ☒ NO ☐ YES If yes, give date. _____ ☐ N/A		
29. COMMENTS ☒ APPROVED ☐ DISAPPROVED The abstract and slide presentation are approved.		
30. PRINTED NAME, RANK/GRADE, TITLE OF REVIEWER Rocky Calcote, PhD, Clinical Research Administrator	31. REVIEWER SIGNATURE CALCOTE.ROCKY.D.1178245844 Digitally signed by CALCOTE.ROCKY.D.1178245844 DN: cn=US, ou=US Government, ou=502, ou=PMI, ou=USAF email=CALCOTE.ROCKY.D.1178245844 Date: 2017.03.08 08:32:27 -0500	
2nd ENDORSEMENT (502 ISG/JAC Use Only)		32. DATE
33. DATE RECEIVED	34. DATE FORWARDED TO 59 MDW/PA	
35. COMMENTS ☐ APPROVED (In compliance with security and policy review directives.) ☐ DISAPPROVED		
36. PRINTED NAME, RANK/GRADE, TITLE OF REVIEWER	37. REVIEWER SIGNATURE	
3rd ENDORSEMENT (59 MDW/PA Use Only)		38. DATE
39. DATE RECEIVED March 09, 2017	40. DATE FORWARDED TO 59 MDW/SGVU March 14, 2017	
41. COMMENTS ☒ APPROVED (In compliance with security and policy review directives.) ☐ DISAPPROVED		
42. PRINTED NAME, RANK/GRADE, TITLE OF REVIEWER Kevin Iinuma, SSgt/E-5, 59 MDW Public Affairs	43. REVIEWER SIGNATURE IINUMA KEVIN MITSUGU 1296227 613 Digitally signed by IINUMA KEVIN MITSUGU 1296227613 DN: cn=US, ou=US Government, ou=502, ou=PMI, ou=USAF email=IINUMA KEVIN MITSUGU 1296227613 Date: 2017.03.14 14:45:24 -0500	
4th ENDORSEMENT (59 MDW/SGVU Use Only)		44. DATE March 14, 2017
45. DATE RECEIVED	46. SENIOR AUTHOR NOTIFIED BY PHONE OF APPROVAL OR DISAPPROVAL ☐ YES ☐ NO ☐ COULD NOT BE REACHED ☐ LEFT MESSAGE	
47. COMMENTS ☐ APPROVED ☐ DISAPPROVED		
48. PRINTED NAME, RANK/GRADE, TITLE OF REVIEWER	49. REVIEWER SIGNATURE	
5th ENDORSEMENT (59 MDW/SGVU Use Only)		50. DATE

Abstract No:

16-077

ePoster_16-077

Author(s):

James Covelli¹, Justin Costello¹, Christian Carlson¹

Institutions:

¹San Antonio Military Medical Center, San Antonio, TX

Purpose:

In lieu of potential radiation risks associated with CT, MR imaging has become much more prevalent in the evaluation of children with suspected appendicitis. While several studies have demonstrated its efficacy at dedicated stand-alone pediatric hospitals, the goal of this study is to determine if implementation of a MR pediatric appendicitis protocol is feasible in the non-subspecialty pediatric setting, where non-pediatric radiologists routinely perform interpretation.

Materials/Methods Used:

Pediatric appendicitis work-up algorithm was implemented at the San Antonio Military Medical Center emergency department in 2012 (diagram 1). Non-sedated MR imaging was obtained in patients with equivocal ultrasound findings and persistent clinical concern for appendicitis. MR protocols consisted of three whole abdomen T2 sequences through the abdomen (average scan time 11 minutes). No intravenous contrast was administered. Between 2012 and 2015, 415 pediatric patients (mean age 9.8 years old) underwent MRI of the abdomen after equivocal ultrasound evaluation. Non-pediatric radiologists interpreted the vast majority of MR exams.

Results:

Over the three year period of data acquisition, 10.2% (44/432) of patients were found to have appendicitis after surgery. Of those patients with pathologically proven appendicitis, 42 were true positives and 2 were false negatives by MRI, resulting in sensitivity and specificity of 95% and 99%, respectively. Additionally, negative and positive predictive values by MRI were 99% and 89%, respectively. Both false negative exams were surgically confirmed early appendicitis without inflammatory changes by MR imaging. Several non-appendiceal abnormalities were also found by MRI, including ovarian pathology (7/432), pyelonephritis (5/432) and terminal ileitis (3/432).

Conclusions:

MRI is an effective imaging modality for the evaluation of pediatric appendicitis and can be accurately interpreted by non-pediatric radiologists. Because of the lack of ionizing radiation and IV contrast, non-sedated, rapid MRI may be considered more appropriate than CT in the pediatric population, which is at higher risk for radiation-induced malignancies and also has less tolerance for IV placement.

Primary Track/Category:

Quality and Safety

Secondary Track/Category:

Clinical Education

Area of Focus:

Diagnostic Radiology

Disclaimer: The views expressed are those of the author(s)/presenter(s) and do not reflect the official views or policy of the Department of Defense or its Components.

SAMMC

SAN ANTONIO MILITARY MEDICAL CENTER

Diagnosis of Pediatric Appendicitis: Is MR Imaging More Appropriate than CT?

San Antonio Military Medical Center
San Antonio, Texas

James D Covelli, MD
Justin E Costello, MD
Sunthosh P Madireddi, MD
Christian L Carlson, MD

DISCLOSURE

L

Neither the authors nor their immediate family members have a financial relationship with a commercial organization that may have a direct or indirect interest in the content of this exhibit.

The contents of this presentation are not the official views of, or are endorsed by, the U.S. Government, Department of the Air Force, Department of the Army, or any other governmental agency.

INTRODUCTION

MATERIALS AND METHODS

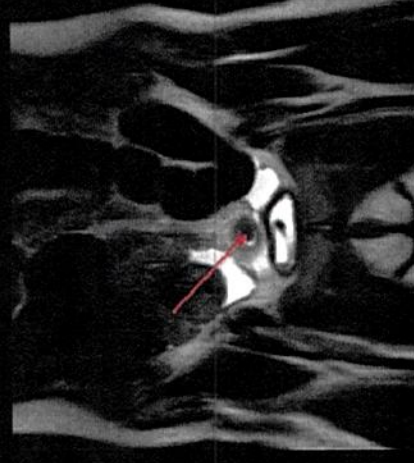
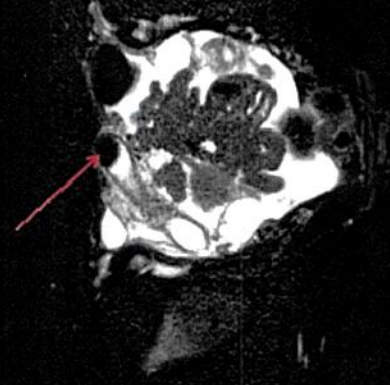
RESULTS

CONCLUSIONS

Purpose

- Prospective and retrospective studies have shown sensitivity and specificity of MRI to be comparable to CT.
- In lieu of potential radiation risks associated with CT, MRI has increased in children with suspected appendicitis.
- Several studies have demonstrated MRI efficacy at stand-alone pediatric hospitals.

The purpose of our study is to determine if implementation of an MRI pediatric appendicitis protocol is feasible in the non-specialty pediatric setting where non-pediatric radiologists and residents routinely perform interpretation



10 year old female with perforated appendicitis
T2 Axial Fat Saturated image (left) and a coronal HASTE image (right) demonstrate a dilated fluid filled appendix with an appendicolith (arrow) and T2 hyperintense pelvic free fluid.

Suspected Appendicitis?

- In 2012, a pediatric appendicitis work-up algorithm was established for children aged 0-17 with suspected appendicitis in collaboration with SAMMC Radiology, Emergency Room, Pediatric Surgery, General Surgery and Pediatrics staff.
- Modifications were made to the algorithm to improve efficiency including:
 - Immediate ultrasound (US) review by radiologist
 - Orders for US and MRI were placed at the same time by the ER. If US was positive or clearly negative, the MRI order was cancelled
 - If equivocal US findings or non-visualization of the appendix, the patient was transported directly from US to MRI (instead of returning to the ER)
 - MRI scan time was reduced from 21 minutes to 11 minutes from 2012 to 2015 after determining the optimal sequences to arrive at diagnosis
- The latest algorithm (Figure 1) was implemented in 2015

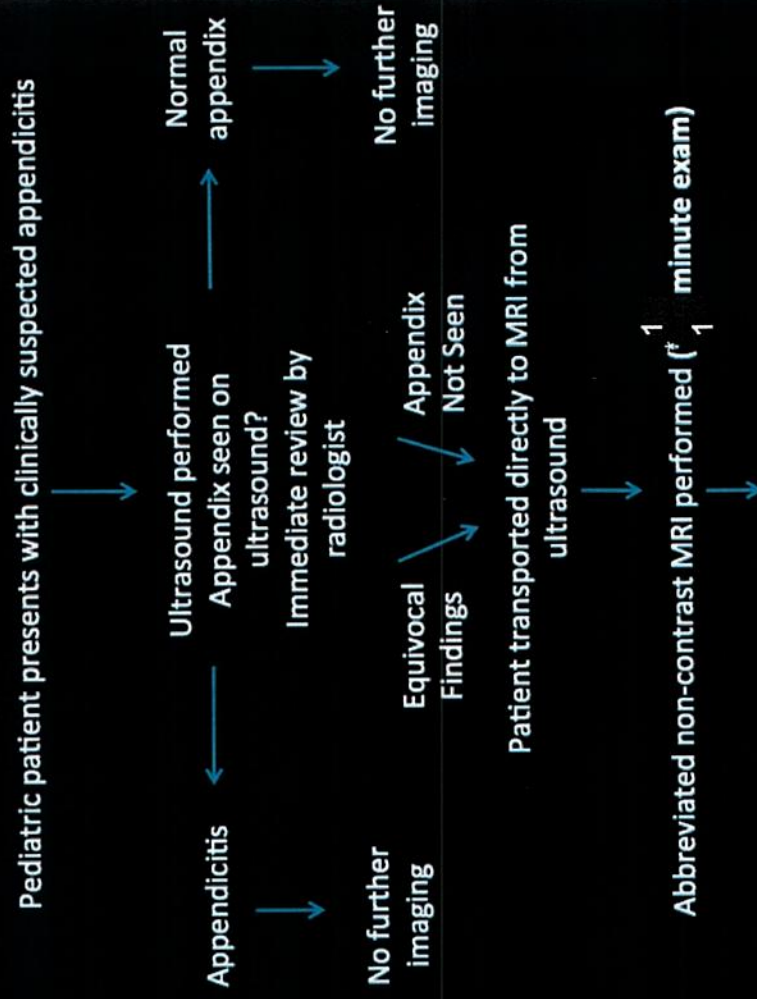


Figure 1. Current SAMMC algorithm for all children 0-17 years of age with suspected appendicitis.

* This time was reduced from 21 minutes (in 2012) to 16 minutes in 2015 after reducing the total number of MRI sequences. Exams that did not include restricted diffusion took 11 minutes)

INTRODUCTION

MATERIALS AND METHODS

RESULTS

CONCLUSIONS

Rapid MRI Protocol

- A non-sedation MRI protocol was established using either 1.5T or 3T scanners and exams were worked in-between inpatient and scheduled outpatient exams.
- Multichannel torso coil was used
- Patient urinates prior to exam
- Technique for children ≥ 12 years
 - Breath hold
 - 4 mm slice thickness with 10% gap
- Technique for children < 12 years old
 - Free breathing
 - 3 mm slice thickness with 10% gap
- Trial sequences were found to have limited utility or did not add to or improve interpretation and were removed from our protocol:
 - In and out of Phase T1-weighted imaging
 - Sagittal and Coronal fat-saturation HASTE
 - VIBE
 - Diffusion-weighted MRI (DW-MRI)
 - TruFisp
 - SPARE

Current SAMMC Rapid Appendicitis Protocol (protocol finalized in 2015)

Axial T2-weighted fat saturated images

Axial half-Fourier acquisition single shot turbo spin echo
(HASTE)

Coronal half-Fourier acquisition turbo spin echo (HASTE)

Coronal HASTE FOV: Entire abdomen and pelvis
Axial HASTE and T2 FS FOV: Inferior endplate of L3
through the pubic floor

256 x 256 matrix

Figure 2. Current SAMMC rapid MRI appendix protocol

INTRODUCTION

MATERIALS AND METHODS

RESULTS

CONCLUSIONS

Radiologist and Clinician Education

- Between 2012 and 2015, 506 patients under the age of 18 (mean age 9.8 years) with clinically suspected appendicitis, and equivocal findings or non-visualization of the appendix on ultrasound, underwent MRI of the abdomen using our rapid MRI appendix protocol
- The majority of exams were performed during overnight and weekend hours when a pediatric radiologist was unavailable
- Approximately 40 residents (PGY2-PGY5) and 40 non-pediatric subspecialty attending radiologists interpreted >90% of the examinations
- The primary focus was to identify key findings of appendicitis and alternative explanations for the patient's symptoms on MRI
- A key component of instituting the protocol was training non-expert radiologists and residents

- Many methods (figure 3) were also employed in 2012-2013 to educate surgeons, pediatricians and emergency physicians who were well experienced in CT and not as comfortable with MRI
- As a result, in the initial phases of our protocol, many patient's underwent CT after MRI for confirmation

Methods to Educate Clinicians

Grand Rounds	Departments of Radiology, Emergency Medicine, General and Pediatric Surgery and Pediatrics
Literature	Sharing literature documenting similar accuracy of MRI compared to CT
ALARA Campaign	Robust Image Gently Campaign, fliers, posters, patient education pamphlets
Workstation teaching	Included radiology residents and staff, general surgery residents and pediatricians
Correlation	Interdepartmental radiologic-surgical-pathologic correlation

Figure 3. Methods used at SAMMC to educate other physicians

INTRODUCTION

MATERIALS AND METHODS

RESULTS

CONCLUSIONS

Physician Education

In addition to didactic teaching, direct feedback was also highly effective. We maintained a database of over 500 cases at SAMMC for radiologist review with direct feedback provided to the interpreting radiologist when possible:

- MRI technique (motion, spatial resolution, etc)
- Pathology and surgical reports
- 1 month clinical follow up
- Alternative explanations for patient symptoms
- Good examples of positive and negative cases
- False positives, false negatives



17 year old male with a normal appendix

Coronal HASTE demonstrates a tubular hypodense structure originating from the cecum, measuring 5 mm in diameter. No peri-appendiceal fluid or inflammation.



8 year old male with appendicitis

Axial T2 FS demonstrates a dilated appendix measuring 8 mm with thickened appendiceal wall, intraluminal fluid and peri-appendiceal fluid.

Important concepts used in our exam interpretation

Visualization of the appendix	A normal appendix does not need to be identified to exclude appendicitis. I.e appendix is not seen and there is no free fluid or inflammation = no appendicitis.
Peri-appendiceal inflammation	Present in nearly all cases of acute appendicitis
Appendiceal wall thickening	Circumferential wall thickening >2 mm was nearly always present in acute appendicitis
Small amount of free-fluid and appendix is not visualized	Appendicitis unlikely. May be physiologic or secondary to alternative pathology (ovarian, gastroenteritis, etc)
Appendiceal tip	If RLQ fluid or inflammation, should visualize full appendiceal length to exclude tip appendicitis
Size	Appendix was considered dilated when >6mm; however, size is not a standalone criteria as the appendix may be enlarged without inflammatory changes
Alternative pathology	Assessing for alternative pathology is critical

Figure 4. MR Findings that support or disfavor the diagnosis of appendicitis

Protocol Efficiency

- We compared the time parameters of the first 50 and last 50 rapid MRI exams performed at SAMMC for suspected appendicitis
- Interval changes between first and last exam
 - Abdominal radiograph removed from initial protocol
 - Radiologist reviews US images and determines immediately if MRI is warranted. If so, the patient is sent directly to the MRI Suite
 - Female patient no longer required to fill their bladder (for ovarian evaluation) resulting in decreased ER wait time
 - Decreased number of MR sequences from 7 to 3



8 year old male with appendicitis

Left: Coronal HASTE image demonstrating a dilated fluid filled appendix.

Right: Axial T2 FS image demonstrating a thickened T2 hyper intense edematous appendiceal wall (arrows) with intraluminal T2 hyper intense fluid

Time Parameter Comparison Between the First 50 and Last 50 Rapid Appendicitis MRI Exams

	First 50 Exams	Last 50 Exams
Average number of sequences	7	3
Average repeated sequences	1.2	<1
US Duration	22 Minutes	12 minutes
MRI scanning duration	21 minutes	11 minutes
US Start to MRI Finish	420 minutes	65 minutes

Figure 5. MRI Time Considerations

INTRODUCTION

MATERIALS AND METHODS

RESULTS

CONCLUSIONS

Statistical Analysis

506 patients* clinically suspected of having appendicitis aged 17 years or younger with equivocal ultrasound (or non-visualization of the appendix) underwent rapid MRI appendicitis imaging at SAMMC between April 2012 and Dec 2015.

* 6 cases were equivocal on MRI and were not included in the statistical analysis. These patients were admitted for observation and all were discharged without acute appendicitis

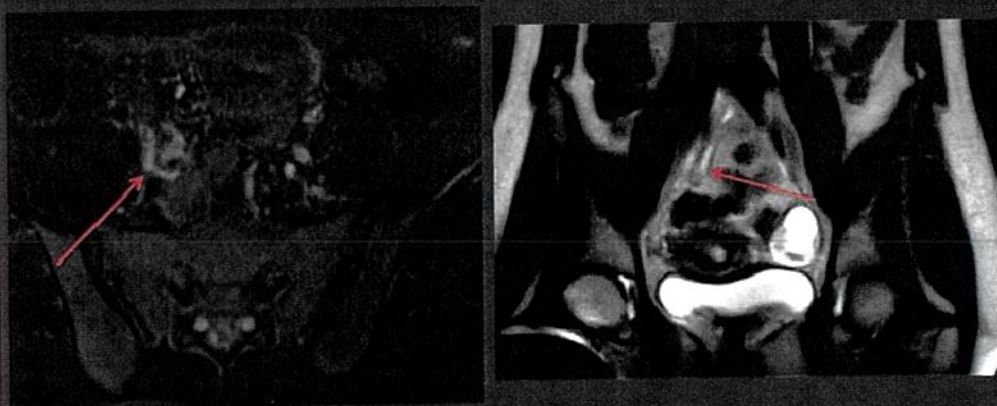
MRI was classified as either positive or negative

Positive

- MRI findings consistent with appendicitis
- MRI secondary signs of appendicitis (e.g. free fluid with right lower quadrant, inflammation and no appendix visualized)

Negative

- Normal MRI appearance of the appendix
- Appendix not visualized but no secondary signs of appendicitis (inflammation or free fluid)



16 year old female with tip appendicitis.

Left: Axial T2 FS images demonstrate a dilated appendiceal tip with appendicolith and inflammation (arrow)

Right: Coronal HASTE demonstrating a dilated appendiceal tip (arrow)

11 % of all patient's suspected of having appendicitis were true positives (confirmed by surgery or pathology).

		95% CONFIDENCE INTERVAL
Sensitivity by MRI	96%	87.02-99.54
Specificity by MRI	98%	96.21-99.08
Positive Predictive Value	85%	73.43-92.90
Negative Predictive Value	100%	98.37-99.94

Figure 6. Statistical Analysis

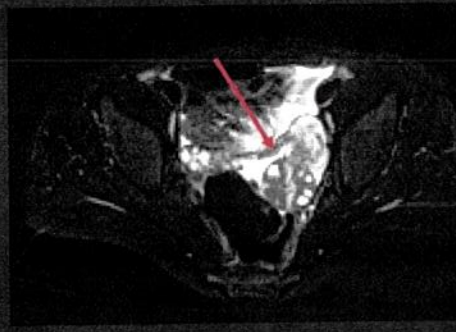
Alternative Diagnoses

- Our exams proved useful in assessing alternative causes for the patients' clinical presentation. And many abnormalities would be more difficult to interpret on ultrasound or CT
- Several non-appendiceal abnormalities were found to likely explain the patients' symptoms
- All patients' records were reviewed for 1 month following discharge to determine if any patients returned with appendicitis



7 year old female with terminal ileitis

Axial T2 FS demonstrates circumferential thickening of the terminal ileum (arrow)



5 year old female with ovarian torsion

Axial T2 FS demonstrates an enlarged left ovary with peripheralization of the follicles and pelvic free fluid

Non-appendiceal abnormalities

Ovarian Pathology	3%
Pyelonephritis	2%
Rectus Abdominus Edema/Tear	1%
Terminal Ileitis	3%
Pneumonia	1%
Other findings (mesenteric adenitis, cholelithiasis, large stool burden, UTI, Right hip osteonecrosis, right inguinal hernia)	11%

Figure 7. *Alternative diagnoses.*

INTRODUCTION

MATERIALS AND METHODS

RESULTS

CONCLUSIONS

Conclusions

1. MRI is an effective imaging modality for the evaluation of pediatric appendicitis and can be accurately interpreted by non-pediatric radiologists.
2. Because of the lack of ionizing radiation and IV contrast, non-sedated, rapid MRI may be considered more appropriate than CT in the pediatric population, which is at higher risk for radiation-induced malignancies and also has less tolerance for IV placement.

3. Clear communication with training of radiology residents, non-pediatric radiologists, clinicians and pediatric radiologists is paramount in guaranteeing the success of MRI in a predominantly adult medical center.

James D Covelli, MD
Justin E Costello, MD
Sunthosh P Madireddi, MD
Christian L Carlson, MD

INTRODUCTION

MATERIALS AND METHODS

RESULTS

CONCLUSIONS

References

1. Orth RD, Guilleman RP, Zang W, et al. Prospective Comparison of MR Imaging and US for the Diagnosis of Pediatric Appendicitis. *Radiology* 2014;272(1):233-240.
2. Baldisserotto M, Marchiori E. Accuracy of noncompressive sonography of children with appendicitis according to the potential positions of the appendix. *Am J Roentgenol* 2000;175(5):1387-1392.
3. Strouse PJ. Pediatric Appendicitis: An Argument for US. *Radiology* 2010;255(1):8-13.
4. Hernanz-Schulman M. CT and US in the Diagnosis of Appendicitis: An Argument for CT. *Radiology* 2010;255(1):3-7.
5. Rosines LA, Chow DS, Lampl BS, et al. Value of Gadolinium-Enhanced MRI in Detection of Acute Appendicitis in Children and Adolescents. *AJR* 2014;203:543-548.
6. Koning JL, Naheedy JH, Kruk PG. Diagnostic performance of contrast-enhanced MR for acute appendicitis and alternative causes of abdominal pain in children. *Pediatr Radiol* 2014;44:948-955.
7. Avcu S, Çetin FA, Arslan H et al. The value of diffusion-weighted imaging and apparent diffusion coefficient quantification in the diagnosis of perforated and nonperforated appendicitis. *Diagn Interv Radiol* 2013;19:106-110.
8. İnci E, Kılıkmez O, Elif H, et al. Utility of diffusion-weighted imaging in the diagnosis of acute appendicitis. *Eur Radiol* 2011;21:768-775.
9. Leeuwenburgh MM, Jensch S, Gratama JW, et al. MRI features associated with acute appendicitis. *Eur Radiol* 2014;24:214-222.
10. Moore MM, Brian JM, Mehratia ST, et al. MRI for clinically suspected pediatric appendicitis: case interpretation. *Pediatr Radiol* 2014;44:605-612.
11. Leeuwenburgh MM, Wiarda BM, Bipat S, et al. Acute Appendicitis on Abdominal MR Images: Training Readers to Improve Diagnostic Accuracy. *Radiology* 2012;264(2):455-463.
12. Leeuwenburgh MM, Wiarda BM, Jensch et al. Accuracy and interobserver agreement between MR-non-expert radiologists and MR-experts in reading MRI for suspected appendicitis. *Eur Radiol* 2014;83:103-110.
13. Dillman JR, Gadepalli S, et al. Equivocal Pediatric Appendicitis: Unenhanced MR Imaging Protocol for Nonsedated Children-A Clinical Effectiveness Study. *Radiology* 2015 Oct 9:150941.
14. Kulaylat AN, Moore MM, et al. An implemented MRI program to eliminate radiation from the evaluation of pediatric appendicitis. *Clin Radiol J Pediatr Surg*. 2015 Aug;50(8):1359-63.



Contact: James D Covelli, MD
James.d.covelli.mil@mail.mil