ROLE OF MRI IN DIFFERENTIATING OSTEOMYELITIS FROM OSTEONECROSIS IN CHILDREN WITH SICKLE CELL DISEASE:
A CROSS-SECTIONAL STUDY FROM A TERTIARY CARE HOSPITAL IN RIYADH, SAUDI ARABIA

Authors:

L. Alfahad - Diagnostic Radiology PGY-4 – KKUH

A. Alboukai - Pediatric and Musculoskeletal Radiology Consultant – KKUH

K. Attia - Pediatric Radiology Consultant – KKUH

DECLARATION OF INTEREST

- None to disclose

INTRODUCTION

- Up to 27% of Saudi Arabian population carry sickle cell disease (SCD) trait.

- Vaso-occlusive crisis (VOC) lead to various end-organ ischemia/infarction.

- Skeletal system problems:

1) Chronic: red marrow hyperplasia.

2) Acute: osteonecrosis and osteomyelitis.

- Medullary osteonecrosis and osteomyelitis are not easily distinguished.

- Distinction between these two entities is important to guide management.

PURPOSE

To evaluate the role of multi-sequential MRI in differentiating medullary osteonecrosis from osteomyelitis in children with sickle cell disease.

MATERIALS AND METHODS

Patient Selection:

- Ages 0-13 years
- Presenting with an episode of acute bone pain
- Between 2015-2021

50 radiological observations in total
- 8 were excluded

MRI Protocols:

- Magnet strength
  - 1.5 Tesla (n = 17) and 3 Tesla (n = 25)

Sequence	Performed	Not Performed
Nonfat-saturated T1WI	42	0
STIR/T2WI	42	0
Fat-saturated T1WI	40	2
Contrast-enhanced T1 fat-saturated WI	40	2
T2*WI	41	1

MATERIALS AND METHODS

Image Interpretation:

- Two radiologists with 3 and 20+ years experience in pediatric and musculoskeletal imaging.
- Originally blinded to
  - Radiological reports
  - Clinical presentation
  - Laboratory findings

MATERIALS AND METHODS

MRI Parameters			
NonFat-sat T1WI bone marrow signal intensity	High	Intermediate	Low
Fluid Sen. sequence bone marrow signal intensity	High	Intermediate	Low
Enhancement pattern	Peripheral	Geographic homogenous	Geographic heterogenous
Bone marrow fluid collection	Present	Absent	
Sequestrum	Present	Absent	
Cortical defect	Present	Absent	
Periostitis	Present	Absent	
Sub-periosteal collection	Present	Absent	
Extent of soft tissue inflammation	Proportional or disproportional		
Adjacent joint effusion	Present	Absent	

Radiological diagnosis:
- ➤ Osteomyelitis
- ➤ Osteonecrosis
- ➤ Indeterminate

Disagreement ➡ 9 out of 42 observations

To resolve disagreement ➡ Censuses was reached in 8 out of the 9 observations

Clinical Diagnosis (Electronic medical records):

➤Osteomyelitis
➤Osteonecrosis

> Censuses of pediatric hematology service, pediatric infectious diseases services, and orthopedic surgery.

- Bone biopsies
- Joint space aspiration
- Blood culture results
- Days from onset of symptoms to MRI

Statistical analysis

- Statistical analysis was done using IBM SPSS statistics 25.
- Descriptive statistics were used for basic clinical and radiological percentages and mean values.
- Kappa test was used to determine the clinical/radiological agreement.
- Fisher's exact test to evaluate statistically significant MRI parameters in relation to radiological diagnosis of osteomyelitis or osteonecrosis (statistical significance defined at $P < 0.05$).

RESULTS

Observations n=50

Excluded n=8

lack of imaging findings or diagnosis of epiphyseal AVN
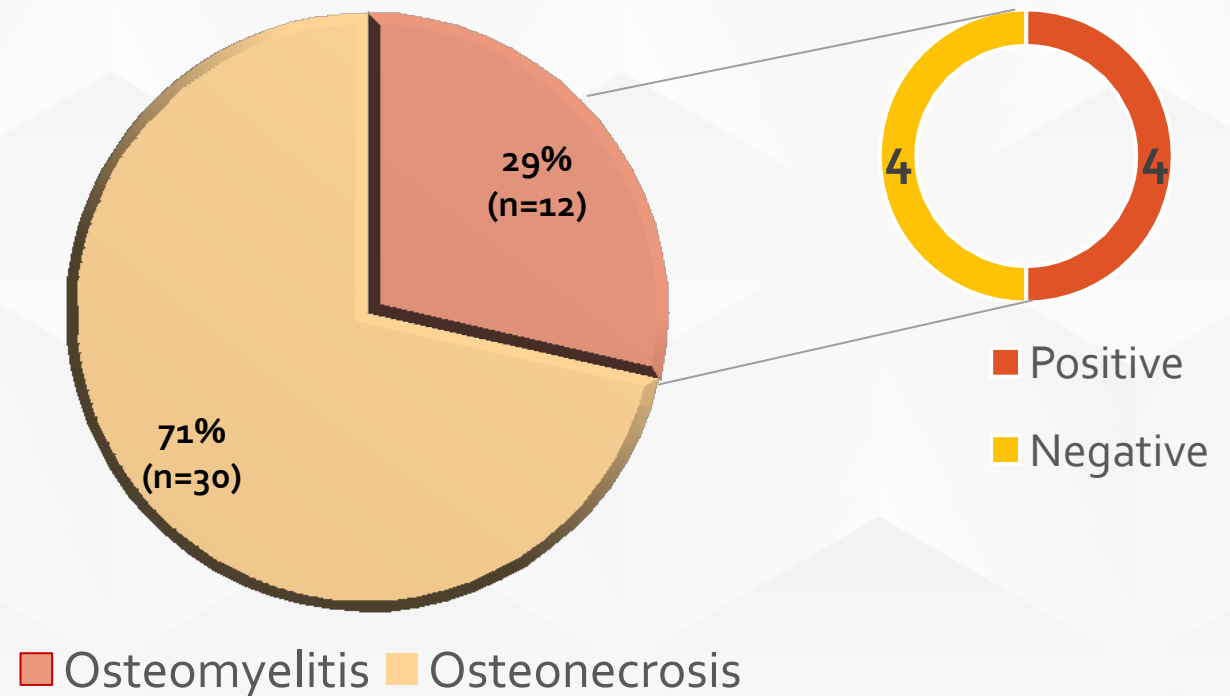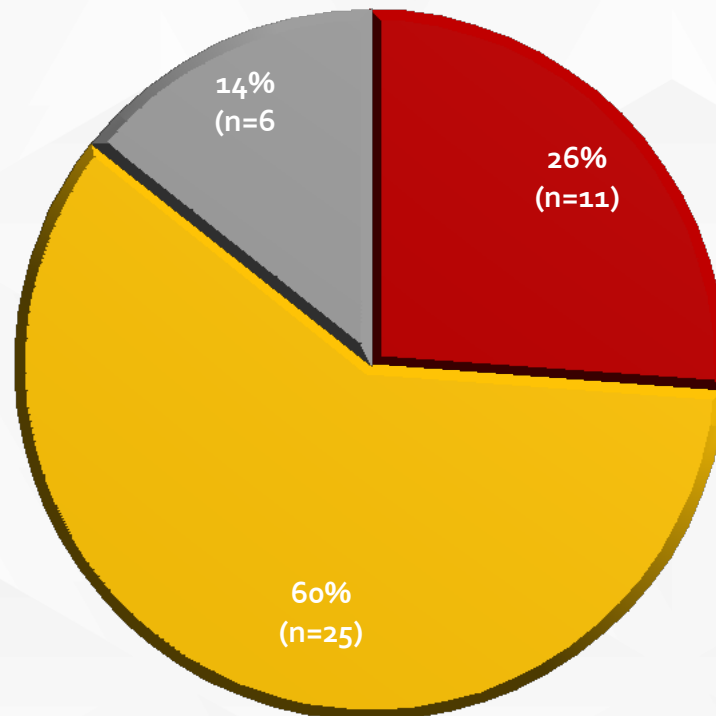
RESULTS : RADIOLOGICAL OBSERVATIONS

Radiological Diagnosis

■ Osteomyelitis ■ Osteonecrosis
■ Indeterminate

26% (n=11)

14% (n=6)

60% (n=25)

Agreement between clinical and radiological diagnoses was moderate (Kappa = 0.52)

MRI parameter		MRI Dx			Clinical Dx		
		Osteomyelitis/Indeter.	Osteonecrosis	P-value	Osteomyelitis	Osteonecrosis	P-value
NonFS T1WI	High	8 (3+5)	19	0.1053	4	18	0.0286
	Low/Intermediate	8	6		8	6	
Enhancement pattern	Peripheral	7 (3+4)	3	0.0598	4	7	1.0000
	Geographic*	9 (8+1)	20		8	16	
BM fluid collection	Present	3 (3+0)	0	0.0525	3	0	0.0308
	Absent	13 (8+5)	25		9	24	
Cortical defect	Present	6 (6+0)	1	0.0094	7	0	0.0001
	Absent	10 (5+5)	24		5	24	
Subperiosteal collection	Present	12 (8+4)	4	0.0003	8	8	0.0815
	Absent	4 (3+1)	21		4	16	
SPC thickness	SPC >=4 mm	13 (8+5)	4	1.0000	8	8	1.0000
	SPC <4 mm	0	0		0	0	
	SPC >=10 mm	12 (8+4)	1	0.0071	5	7	0.5692
	SPC <10 mm	0	3		3	1	
STI	Present	16 (11+5)	8	0.0000	11	12	0.0253
	Absent	0 (0+0)	17		1	12	
STI extent	STI diffuse	4 (3+1)	8	0.0013	7	5	0.4136
	STI localized	12 (8+4)	0		4	7	
STI to bone changes	Proportional/less	10 (6+4)/0	9 (8/1)	0.0571	5	11	0.0272
	More	6 (5+1)	0		6	1	
Adjacent joint effusion	Present	8 (4+4)	5	0.0982	6	8	0.4587
	Absent	8 (7+1)	17		5	14	
Sequestrum	Present	1 (1+0)	0	0.3902	1	0	0.3514
	Absent	15 (10+5)	25		12	24	
Periostitis	Present	16 (11+5)	21	0.1429	11	21	1.0000
	Absent	0	4		1	3	
		16	25		12	24	

*Homogenous and heterogenous. Indeter.: Indeterminate. NonFS: nonfat-saturated. BM: bone marrow. SPC: subperiosteal collection. STI: soft tissue inflammation.
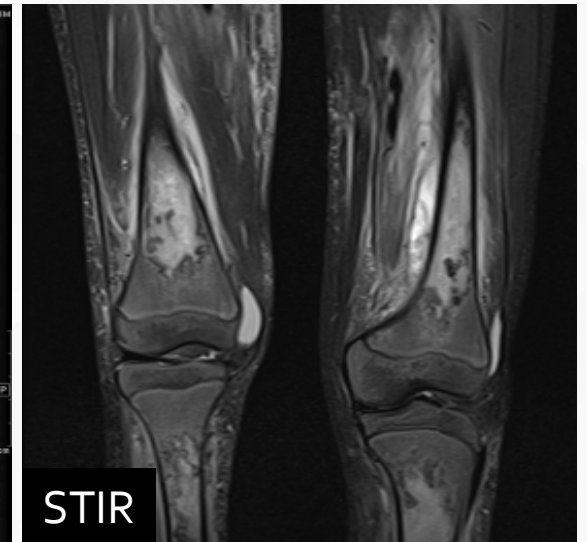
Osteonecrosis

1
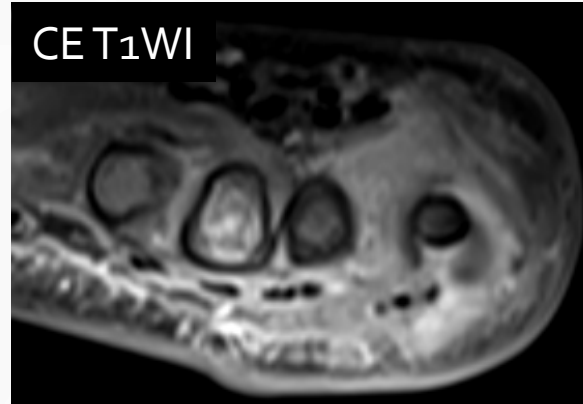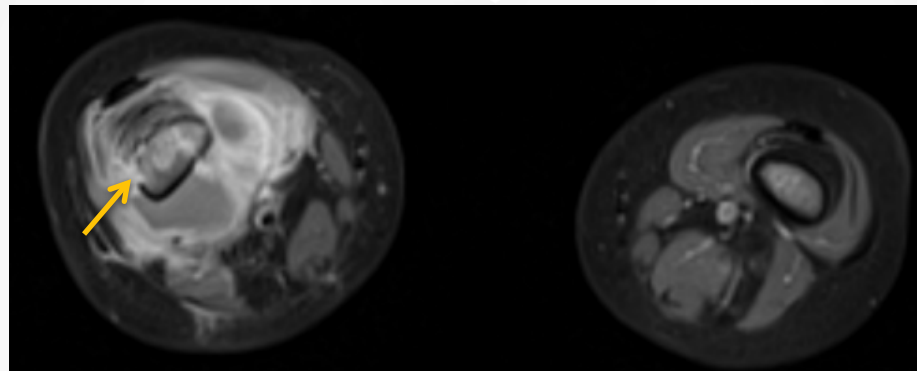
FS T₂WI

CE T₁WI

2

STIR

STIR

CASES

Osteomyelitis

King Saud University
جامعة الملك سعود
1957
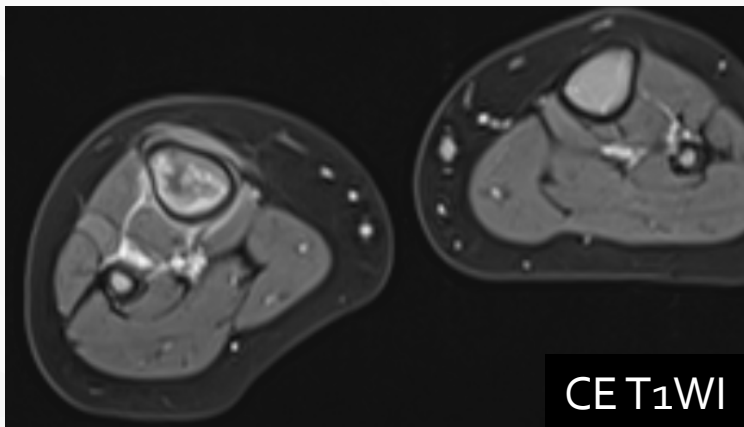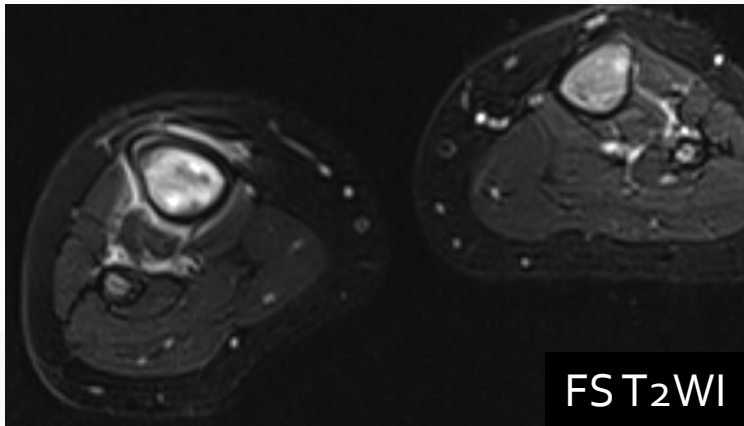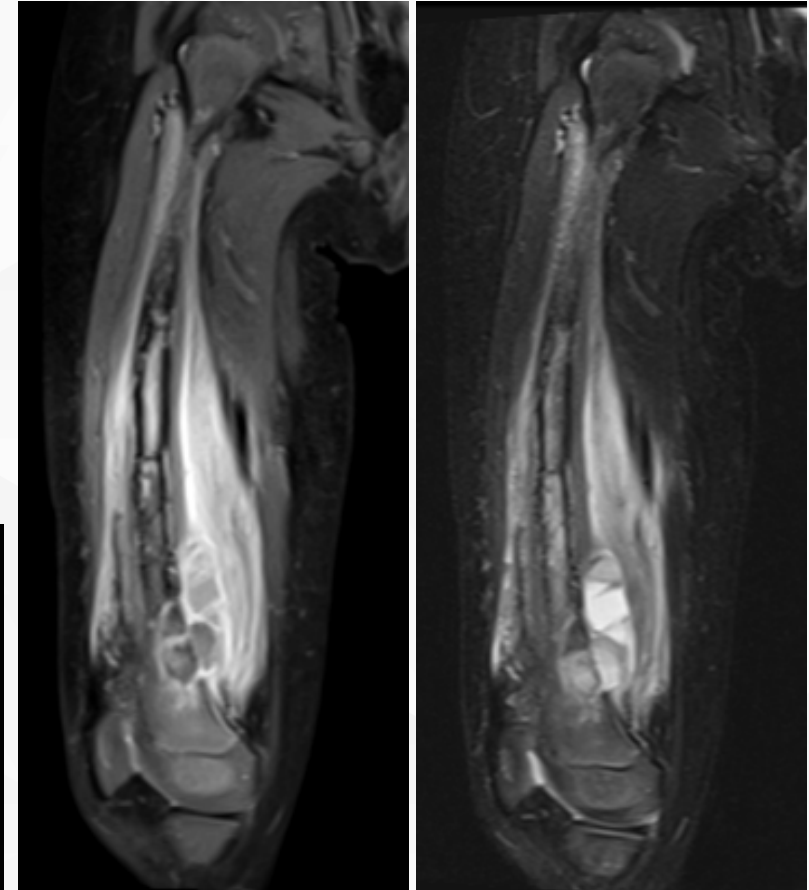
CONCLUSION

MRI can reliably differentiate osteomyelitis from medullary osteonecrosis in children with SCD, based on the presence of:

· Cortical defects

· Soft tissue inflammation.

Other parameters, including enhancement pattern, can be of supplemental value, but are not reliable.

LIMITATIONS

- Retrospective study
  - Confounding
  - Misclassification bias
  - Missing information

- Uncertain diagnoses / lack of follow-up

- Sample Size

Thank you

FINAL RESULTS

In support of Osteomyelitis

MRI parameter		Radiological Diagnosis				Clinical Diagnosis		
		Osteomyelitis	Osteonecrosis	Indeterminate	P-value	Osteomyelitis	Osteonecrosis	P-value
NonFS T1WI	High	3 (7.1%)	20 (47.6%)	5 (11.9%)	0.021	4 (9.5%)	24 (57.1%)	0.014
	Low	6 (14.3%)	5 (11.9%)	0		6 (14.3%)	5 (11.9%)	
	Intermediate	2 (4.8%)	1 (2.4%)	0		2 (4.8%)	1 (2.4%)	
Enhancement pattern	Peripheral	3 (7.1%)	5 (11.9%)	4 (9.5%)	0.026	4 (9.5%)	8 (19%)	0.51
	Geographic homogenous	0	2 (4.8%)	1 (2.4%)		0	3 (7.1%)	
	Geographic heterogenous	8 (19%)	19 (45.2%)	0		8 (19%)	19 (45.2%)	
BM fluid collection	Present	3 (7.1%)	0	0	0.011	3 (7.1%)	0	0.004
	Absent	8 (19%)	26 (61.9%)	5		9 (21.4%)	30 (71.4%)	
Cortical defect	Present	6 (14.3%)	1 (2.4%)	0	0.001	7 (16.7%)	0	0.001
	Absent	5 (11.9%)	25 (59.5%)	5 (11.9%)		5 (11.9%)	30 (71.4%)	
Subperiosteal collection	Present	8 (19%)	5 (11.9%)	4 (9.5%)	0.002	8 (19%)	9 (21.4%)	0.029
	Absent	3 (7.1%)	21 (50%)	1 (2.4%)		4 (9.5%)	21 (50%)	
STI	Present	11 (26.2%)	9 (21.4%)	5 (11.9%)	0.001	11 (26.2%)	14 (33.3%)	0.007
	Absent	0	17 (40.5%)	0		1 (2.4%)	16 (38.1%)	
STI extent	Diffuse	8 (19%)	5 (11.9%)	4 (9.5%)	0.002	7 (16.7%)	10 (23.8%)	0.136
	Localized	3 (7.1%)	21 (50%)	1 (2.4%)		5 (11.9%)	20 (47.6%)	
STI to bone changes	Less	0	8 (19%)	0	0.001	2 (4.8%)	6 (14.3%)	0.001
	Proportional	6 (14.3%)	7 (16.7%)	4 (9.5%)		4 (9.5%)	13 (31%)	
	More	5 (11.9%)	11 (26.2%)	1 (2.4%)		6 (14.3%)	11 (26.2%)	
Adjacent joint effusion	Present	5 (11.9%)	7 (16.7%)	4 (9.5%)	0.069	6 (14.3%)	10 (23.8%)	0.315
	Absent	6 (14.3%)	19 (45.2%)	1 (2.4%)		6 (14.3%)	20 (47.6%)	
Sequestrum	Present	1 (2.4%)	0	0	0.236	1 (2.4%)	0	0.11
	Absent	10 (23.8%)	26 (61.9%)	5 (11.9%)		11 (26.2%)	30 (71.4%)	
Periostitis	Present	11 (26.2%)	22 (52.4%)	0	0.257	11 (26.2%)	27 (64.3%)	0.868
	Absent	0	4 (9.5%)	5 (11.9%)		1 (2.4%)	3 (7.1%)	
Total		11	26	5		12	30	

NonFS: non-fat saturated. BM: bone marrow. SPC: subperiosteal collection. STI: soft tissue inflammation.

In support of Osteonecrosis

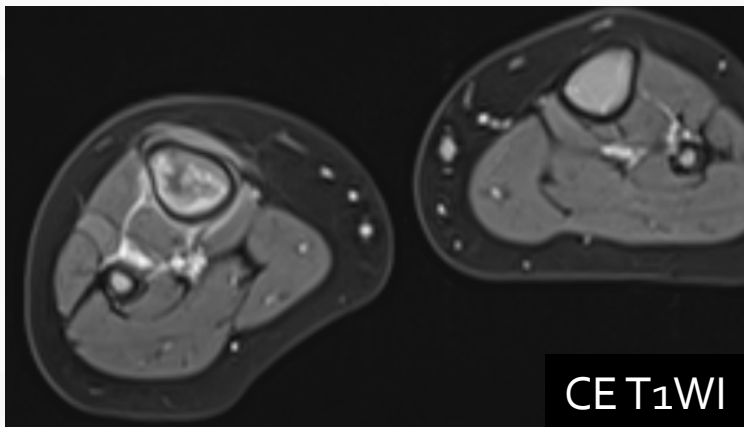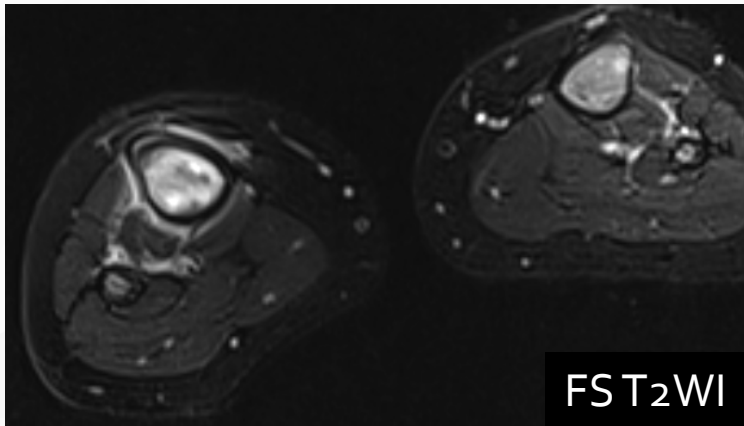| MRI parameter		Radiological Diagnosis				Clinical Diagnosis		
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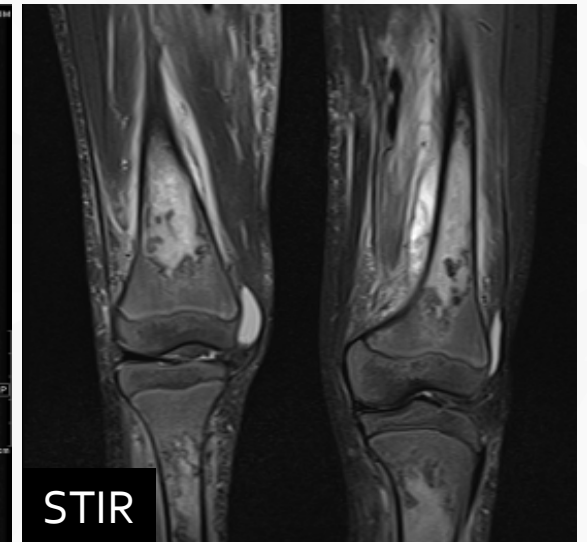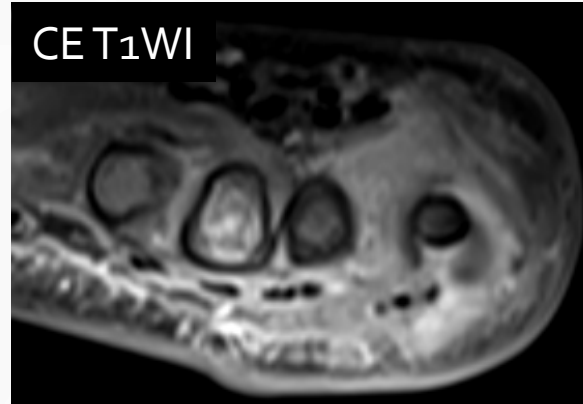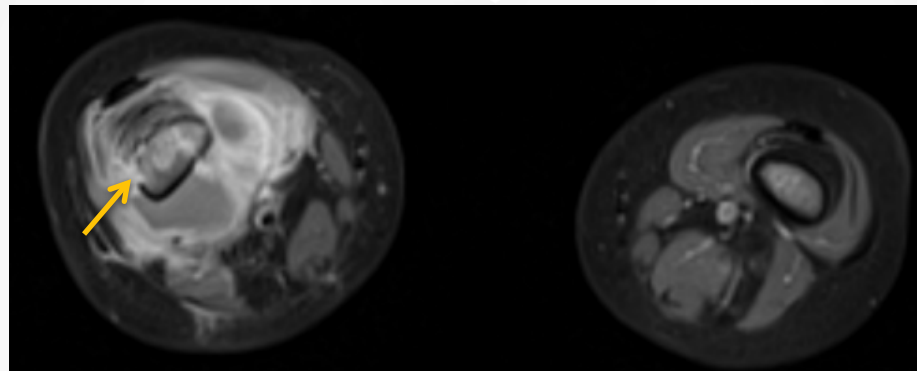
CASES — Osteonecrosis — King Saud University

1 — FS T2WI / CE T1WI

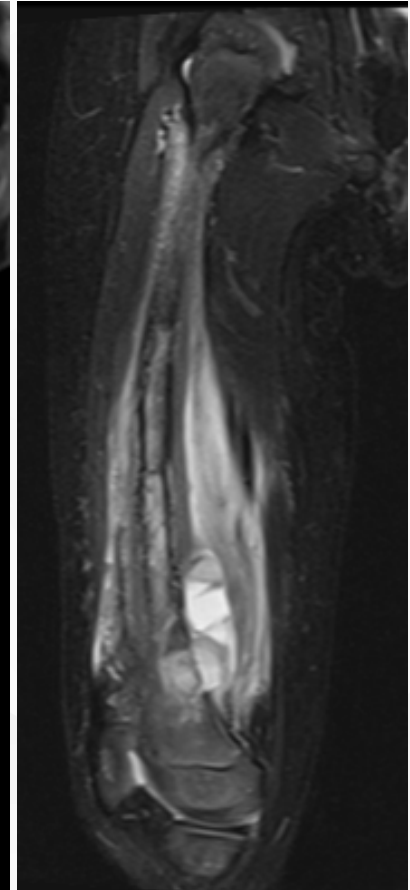2 — STIR / STIR

CASES

Osteomyelitis

King Saud University
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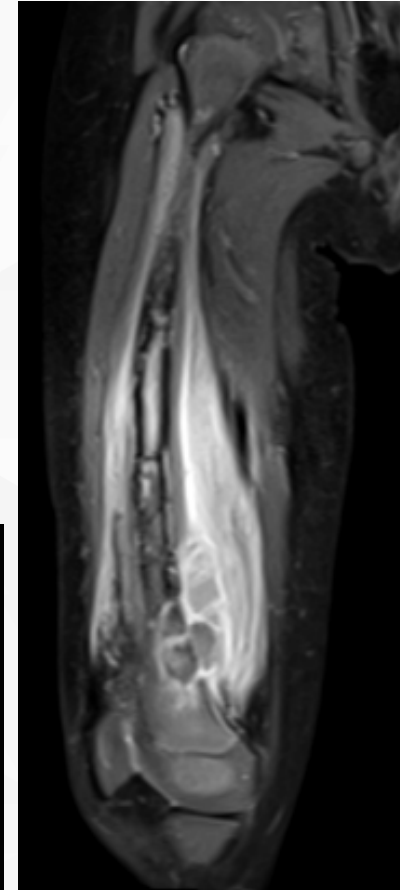
CONCLUSION

Multi-sequential MRI can reliably differentiate osteomyelitis from medullary osteonecrosis in children with SCD.

Findings that can aid in the diagnosis of osteomyelitis:
- Presence of cortical defects
- Extensive soft tissue inflammation relative to bony changes
- Presence of bone marrow fluid collection.

Osteonecrosis is highly suggested with:
- high bone marrow signal intensity on non-fat saturated T1WI
- Presence of relatively less extensive soft tissue inflammation
- The absence of subperiosteal fluid collection.

LIMITATIONS

- Retrospective study
  - Confounding
  - Misclassification bias
  - Missing information

- Uncertain diagnoses / lack of follow-up

- Sample Size

Thank you