A Rapid MRI Protocol for Acute Pediatric Musculoskeletal Infection Increases Access to Imaging while Eliminating Contrast and Decreasing Sedation, Scan Time, Interpretation Time, and Hospital Length of Stay without Missing Actionable Diagnoses

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INTRODUCTION: Acute musculoskeletal infections (MSK) affect more than 1 in 6000 children in the United States annually, with most cases comprised of osteomyelitis, septic arthritis, and/or pyomyositis. Sequela of these infections ranges from joint damage to chronic infection, to limb deformities, and even death. Expedited management is essential to good outcomes from these infections. MRI is the gold standard for diagnosis, but traditionally requires contrast and often depends on anesthesia, leading to significant delays in acquisition and results, which slow treatment decision making. We implemented a limited-sequence Rapid MRI protocol for acute pediatric MSK infection and investigated impact on access and treatment.

METHODS:

This was a single-center retrospective study. The two cohorts were comprised of patients in the emergency department and inpatient setting undergoing workup for MSK infection; 1) before ("Traditional cohort") and 2) after implementation of the Rapid MRI protocol ("Rapid cohort"). In the Rapid cohort, patients underwent unsedated MRIs as defined by the new protocol which consists of a limited number of non-contrast sequences optimized for detection of fluid and bone marrow signal abnormalities. This includes a large field-of-view sequence to localize abnormalities in young children that are difficult to examine, and diffusion-weighted images to help identify abscesses. Data collection of demographic and clinical outcomes, including MRI delays, scan times, time of treatment onset, and hospital length of stay, was performed for both cohorts. Analyses were performed to compare groups via student's T-test and Mann-Whitney U analyses.

RESULTS:

Data collection was performed for a Traditional cohort of 72 patients and for the Rapid cohort of 55 patients. The demographics, diagnoses, and interventions were similar among the two cohorts, while the rate of sedation and contrast administration were 53% and 89% in the Traditional cohort compared to 6% and 0% in the Rapid cohort. The time to MRI acquisition after ordering was 9.6 hours (IQR = 9.1 hours) and 4.5 hours (IQR = 3.4 hours) respectively ($P<0.001$). The average duration of MRI in the Traditional cohort was 72.2 minutes (IQR = 31.0 minutes), versus 29.1 minutes (IQR = 23.6 minutes) in the Rapid cohort ($P<0.001$). The average duration of hospital stay was 7.4 days (IQR = 5.3 days) versus 5.2 days (IQR= 5.1 days) ($P = 0.006$), respectively. The average delay between ordering and receiving the final interpretation of an MRI was 14.8 hours (IQR = 13.0 hours) for the Traditional cohort, and 8.4 hours (IQR = 7.0 hours) in the Rapid cohort ($P<0.001$). Eight out of 50 (16%) of ordered Rapid MRIs were canceled or ended early due to patient motion, but only 3/50 required repeat with sedated MRI. No infections were missed by the Rapid protocol.

DISCUSSION AND CONCLUSION: Data collection is ongoing, however a significant improvement in prompt access to MRI imaging and a decrease in hospital length of stay has been shown thus far. We observed significant decreases in time to MRI, scan time, and interpretation time. Future steps include continuing data collection, charge comparisons between the two cohorts, interobserver reliability between the Traditional and Rapid protocols, and multicenter program expansion. Our Rapid MRI protocol improved pediatric patient access to imaging while nearly eliminating sedation and contrast.

Characteristic	Traditional MRI (n=72)	Rapid MRI (n=55)	
Age (years)	8.6	7.7	
Sex, male (%)	44 (61)	36 (65)	
# received OR intervention (%)	21 (29)	16 (29)	
# received IR intervention (%)	24 (33)	4 (7)	
# received antibiotics (%)	53 (74)	33 (60)	
# anesthetized for MRI (%)	**38 (53)**	**3 (5)**	***p* <.00001**
# received contrast (%)	**64 (89)**	**0 (0)**	***p* <.00001**
Average time between MRI order and MRI Start (hours)	**9.6**	**4.5**	***p* <.001**
Average duration of MRI Exam (minutes)	**72.2**	**29.1**	***p* <.001**
Average time arrival to discharge (days)	**7.4**	**5.2**	***p* <.006**