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The Diagnostic Utility and Clinical Implications of Wrist MRI in the Pediatric Population

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Abstract

Background: Unexplained wrist pain is a common presentation in children. To our knowledge, no studies have explored the clinical utility of magnetic resonance imaging (MRI) in the diagnostic workup of pediatric patients. **Methods:** We retrospectively reviewed 307 consecutive wrist MRIs ordered at a tertiary-care pediatric hospital. Demographic data and the indication for imaging were recorded and grouped into admitting categories. The final impression of each MRI was scored with regard to potential impact on future treatment (0 = normal, 1 = minimal, 2 = moderate, 3 = high). Patients who went on to wrist surgery within 1 year were noted. **Results:** In our cohort, 27% of all studies were normal, including 34% of those with pain. Although pain was the most common category, MRI was most useful in the delineation of a mass/cyst, evaluating for infection and evaluating arthropathy. Compared with all other categories, patients with pain were 3.6 times more likely to have a normal study and 4.6 times more likely to have a clinical score less than or equal to 1. Given an admitting diagnosis of pain, females were 1.7 times more likely to present for an MRI and 2.4 times more likely to have a normal MRI. The Spearman correlation revealed no linear relationship between age and MRI outcome. In all, 13% of patients went on to have surgery within 1 year of MRI. **Conclusions:** At our pediatric institution, the majority of wrist MRIs were ordered for wrist pain. Given our data, wrist MRI is not an ideal screening tool in children, particularly in those with wrist pain, and should only be used to exclude or confirm a specific diagnosis.

Keywords: wrist, MRI, pediatric, pain, diagnosis, utility, outcomes

Introduction

Wrist pain is a common presentation for pediatric patients. Although a thorough history, physical examination, and series of diagnostic radiographs are often sufficient to identify the etiology, radiographs may miss up to 30% of wrist fractures.[34] Although the majority of wrist injuries with negative radiograph have a good prognosis, these "wrist sprains" can lead to long-term pain and/or impaired function.[4,29] In the setting of negative radiographs but persistent pain, cross-sectional magnetic resonance imaging (MRI) enables improved identification of occult injuries to osseous and/or soft tissue structures such as cartilage, ligaments, and tendons.[4,14,24,27,30,32] However, MRI is a time-intensive and resource-intensive imaging modality that may require sedation for young children. It also frequently identifies asymptomatic pathology, raising the possibility of positive findings that do not affect treatment.[8,28] Moreover, the majority of pediatric hand and wrist injuries heal spontaneously without complications or further intervention.[19,33]

Some authors have questioned the negative predictive value of MRI in patients with chronic pain,[2,25] in turn suggesting diagnostic arthroscopy for any patient with a high clinical suspicion for underlying injury.[1,12] Nevertheless, further evaluation via advanced imaging remains appropriate for all patients with persistent wrist pain who have failed conservative management.[7,9,10] The purpose of this study was to describe the clinical utility of wrist MRI in the diagnostic workup of a large, consecutive cohort of pediatric patients. Particularly, we were most interested in those with wrist pain.

Methods

Institutional review board approval was obtained prior to the commencement of this study. The authors' institution is

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a large, level I pediatric trauma center and academic tertiary referral center. Radiographic software (iSite) was used to query the radiology department's records for all consecutive wrist MRIs ordered over a 5-year time span (2007-2012). Exclusion criteria were age more than 18 years at the time of MRI, an MRI ordered for research purposes, and wrist arthrograms. Baseline and demographic data were recorded. Patient history, the department of the referring physician, prior diagnostic studies, and the indicating reason for referral (eg, evaluate for scaphoid fracture), when available, were noted from the referral. The radiographic findings and final impression were recorded.

The indication for MRI was copied from the original prescription, and then patient records were retrospectively reviewed to confirm the indicating reason for MRI from the referring provider's immediately preceding clinic note when documentation was available and/or clear. This included a review of the note's assessment/plan for clear indications for MRI as well as a review of relevant physical exam findings (eg, an MRI ordered for "pain" in a patient with an exam notably only for snuffbox tenderness was interpreted to be an MRI to "rule out scaphoid fracture"). Patients who went on to wrist arthroscopy and/or surgery within 1 year of the MRI were noted, and procedural details were recorded. Referring departments were grouped into the following categories: hand surgery, orthopedic surgery, nonoperative sports medicine, rheumatology, and primary care/other. MRIs were then grouped into admitting categories: pain, evaluation of a known fracture, infection/abscess/osteomyelitis, arthropathy, evaluation of a mass/cyst, growth plate evaluation, and other. Pain was classified as "chronic" or "acute/not-otherwise-specified," with chronic pain defined as greater than or equal to 3 months or specifically described as "chronic."

To evaluate each MRI's potential impact on future decision making, each report was independently reviewed by 2 fellowship-trained pediatric hand surgeons (RBC, ICL) provided with only the radiology referral order (age, gender, indication, and prior studies) and results (findings and impression). Each report was then scored on a scale from 0 to 3 based on each reviewer's subjective interpretation of the MRI's likely impact on therapeutic treatment, where 0 = normal result, 1 = mild clinical significance, 2 = moderate clinical significance, and 3 = high/definitive clinical significance. The following are examples of findings included for each clinical score: 1 = bone contusion/edema but no other findings; 3 = nondisplaced, occult fracture of the scaphoid or physeal bar greater than 50% of the physeal area. The mean clinical score between the 2 independent raters was then used for all further analyses to further reduce variation.

Statistical Analysis

Shapiro-Wilk tests were used to assess continuous variables for fit with a normal distribution. Comparative analyses were performed using the Fisher exact/chi-square tests, Student *t* tests/Mann-Whitney *U* test, or analysis of variance, as indicated. Bivariate correlations were calculated using Spearman tests. Interrater reliability was assessed using a weighted kappa coefficient.[6,13,26] Categorical variables are reported as frequency and percentage; continuous variables are presented with a measure of central tendency (mean or median) and spread (SD or range). Effect size (relative risk or mean difference) and its associated 95% confidence interval [CI]) was calculated, where applicable, based on the expectation of equality between the genders. All comparative analyses were 2-tailed with alpha set at 0.05. Statistical analysis was performed using Stata (StataCorp, College Station, Texas).

Results

There were 307 wrist MRIs in the final cohort, including 182 females (59%) and 125 males (41%). The median age at the time of MRI was 14 years (range, 1-19). Fifty-five percent of patients had a previous imaging study within 1 month. There were no differences in terms of median age (P = .075), laterality (P = .144), or percent with a prior study (P = .456) between the genders. When evaluating the clinical score, the interobserver chance-corrected agreement using a weighted kappa statistic was 0.66 ("substantial" per Landis-Koch standard).[20]

Overall, 84 studies (27%) were normal (Table 1). Assuming equality between the genders, females were 1.5 times more likely to present for wrist MRI and 2.7 times more likely to have a normal study. The mean clinical score was higher in males ($P < .001$), with a greater proportion of scores higher than 1 (70% vs 48%; $P < .001$). Hand surgeons ordered 55% of all studies as compared with orthopedic surgeons (14%), nonoperative sports medicine (16%), primary care/other (16%), and rheumatology (4%). There were no differences between the referring departments in terms of percent normal studies (P = .990) or mean clinical score (P = .982). The Spearman correlation revealed no linear relationship between age and MRI outcome (P = .404).

Pain was the most common admitting diagnostic category (n = 222; 72%; Table 2). MRI was most useful in the delineation of a mass/cyst (0% normal; mean score, 2.4), evaluating for infection (11% normal; mean score, 2.1) and evaluating arthropathy (21% normal; mean score, 1.4). It was least useful in diagnosing patients categorized with "wrist pain" (34% normal; mean score, 1.2). Compared with all other admitting categories, patients ascribed to the pain category with pain were 3.6 times more likely to have a normal study (95% CI, 1.8-7.2; $P \leq .001$) and 4.6 times more likely to have a clinical score less than or equal to 1 (95% CI, 2.6-8.4; $P < .001$). They also had a lower mean score (1.2 vs 2.1; $P < .001$).

Given an admitting diagnosis of pain, females were 1.7 times more likely to present for an MRI and 2.4 times more

Table 1. MRI Outcomes by Gender.

	Total	Female	Male	Relative risk or mean difference (95% CI)[a]	*P* value[b]
No. (%)[c]	307 (100)	182 (59)	125 (41)	1.5 (1.2-1.7)	.001
Normal studies, no. (%)[d]	84 (27)	67 (37)	17 (14)	2.71 (1.7-4.4)	<.001
Clinical score					
• Mean score (±SD)	1.5 (1.1)	1.2 (1.1)	1.8 (1.0)	−0.6 (−0.9-−0.4)	<.001
• Category[d]					<.001
○ Scores ≤1, no. (%)	131 (43)	94 (52)	37 (30)	1.7 (1.3-2.4)	
○ Scores >1, no. (%)	176 (57)	88 (48)	88 (70)	0.7 (0.6-0.8)	
With normal studies excluded					
Mean clinical score (±SD)	2.0 (0.7)	1.9 (0.7)	2.1 (0.8)	−0.2 (−0.4-−0.01)	.036

Note. All values are presented as frequency (percentage) or mean (±SD), as indicated. MRI = magnetic resonance imaging; CI = confidence interval; SD = standard deviation.
[a]Relative risk and mean difference presented for females as compared with males, along with corresponding 95% CIs for each.
[b]*P* values correspond to intergender differences based on the chi-square/Fisher exact test or the Student *t* test/Wilcoxin rank-sum test, as appropriate.
[c]% calculated as a within-row relative frequency for a given variable.
[d]% calculated as a within-column relative frequency for a given variable.

Table 2. MRI Outcome by Admitting Category.

	Total	Pain	Mass/cyst	Infection/abscess/ osteomyelitis	Arthropathy	Growth plate evaluation	Evaluation of fracture	Other	*P* value[a]
No. (%)[b]	307 (100)	222 (72)	28 (9)	19 (6)	19 (6)	9 (3)	7 (2)	3 (1)	
Normal studies, no. (%)[c]	84 (27)	76 (34)	0 (0)	2 (11)	4 (21)	0 (0)	1 (14)	1 (33)	<.001
Clinical score									
• Mean score (±SD)	1.5 (1.1)	1.2 (1.1)	2.4 (0.5)	2.1 (0.9)	1.5 (0.9)	2.3 (0.5)	2.5 (1.1)	1.7 (1.5)	<.001
• Category									<.001
○ Scores ≤1, no. (%)	131 (43)	121 (55)	0 (0)	2 (11)	6 (32)	0 (0)	1 (14)	1 (33)	
○ Scores >1, no. (%)	176 (57)	101 (46)	28 (100)	17 (89)	13 (68)	9 (100)	6 (86)	2 (67)	

Note. All values are presented as frequency (percentage) or mean (±SD), as indicated. MRI = magnetic resonance imaging; CI = confidence interval; SD = standard deviation; ANOVA = analysis of variance.
[a]*P* values correspond to intergender differences based on the chi-square/Fisher exact or ANOVA, as appropriate.
[b]% calculated as a within-row relative frequency for a given variable.
[c]% calculated as a within-column relative frequency for a given variable.

likely to have a normal MRI than males (Table 3). There were no differences in percent normal studies ($P = .611$) or mean clinical scores ($P = .950$) when stratifying by chronicity of pain. The most common specific indications within the pain category were to evaluate for scaphoid fracture (33%; 34% normal), evaluate for TFCC injury (11%; 29% normal), evaluate for occult fracture (7%, 27% normal), and evaluate for ganglion cyst (5%; 0% normal). Sixty-seven studies (30%) had no indication.

Forty patients (13%) were advanced to wrist surgery within 1 year following MRI (Table 4), including only 1 of 84 (1%) of those with a "normal study." Specific procedures are listed in Table 5. The mean clinical score of those undergoing future surgery was 2.3, with 98% having a clinical score higher than 1. Patients for whom at least 1 surgeon rater ascribed a clinical score of "3" had a 4.1-times higher risk of future surgery within 1 year following MRI than those for whom both scores were less than or equal to 2 (95% CI, 2.2-7.7; $P < .001$).

Discussion

The wrist is one of the most commonly injured body parts in children. Chronic, activity-related wrist pain is also prevalent, particularly among adolescent girls.[7,33] Previous work has highlighted the potentially low correlation between wrist MRI results and gold-standard diagnostic arthroscopy for certain findings, which may limit its utility as a diagnostic adjuvant to initial radiographs.[1,2,12,25] To the authors' knowledge, however, no previous studies have explored the clinical utility of wrist MRI across a broad, heterogeneous cohort of pediatric patients.

One notable finding in this study was the statistically significant gender disparity. Assuming equality between the

Table 3. Pain as an Admitting Diagnosis.

	Total	Female	Male	Relative risk or mean difference (95% CI)[a]	*P* value[b]
No.[c]	222 (100)	139 (63)	83 (37)	1.7 (1.4-2.0)	<.001
Normal studies, no. (%)[d]	76 (34)	61 (44)	15 (18)	2.4 (1.5-4.0)	<.001
Clinical score					
• Mean clinical score (±SD)	1.2 (1.1)	1.0 (1.1)	1.5 (1.0)	−0.5 (−0.8-−0.2)	<.001
• Category[d]					.004
○ No. of scores ≤1 (%)	121 (55)	86 (62)	35 (42)	1.5 (1.1-2.0)	
○ No. of scores >1 (%)	101 (46)	53 (38)	48 (58)	0.7 (0.5-0.9)	
Normal studies excluded					
Mean score (±SD)	1.8 (0.7)	1.8 (0.7)	1.8 (0.7)	−0.03 (−0.3-0.2)	.804

Note. All values are presented as frequency (percentage) or mean (±SD), as indicated. CI = confidence interval; SD = standard deviation.
[a]Relative risks and mean differences are presented for females as compared with males, along with corresponding 95% CIs for each.
[b]*P* values correspond to intergender differences based on the chi-square/Fisher exact test or the Student *t* test/Wilcoxin rank-sum test, as appropriate.
[c]% calculated as a within-row relative frequency for a given variable.
[d]% calculated as a within-column relative frequency for a given variable.

Table 4. Patients With Future Wrist Surgery.

	Total	Future surgery	No future surgery	Relative risk or mean difference (95% CI)[a]	*P* value[e]
No.[b]	307 (100)	40 (13)	267 (87)		
Normal studies, no. (%)[c]	84 (27)	1 (3)[d]	83 (31)	0.1 (0.01-0.6)	<.001
Clinical score					
• Mean clinical score (±SD)	1.5 (1.1)	2.3 (0.7)	1.3 (1.1)	0.9 (0.7-1.1)	<.001
• Category[c]					<.001
○ Scores ≤1, no. (%)	131 (43)	1 (3)	130 (49)	0.1 (0.01-0.4)	
○ Scores >1, no. (%)	176 (57)	39 (98)	137 (51)	1.9 (1.7-2.2)	
• At least 1 score = 3	112 (36)	28 (70)	84 (31)	2.2 (1.7-2.9)	<.001
Pain of any type	222 (72)	15 (38)	207 (78)	0.5 (0.3-0.7)	<.001
Normal studies excluded					
• Mean score (±SD)	2.0 (0.7)	2.3 (0.6)	1.9 (0.7)	0.4 (0.1-0.6)	.0019

Note. All values are presented as frequency (percentage) or mean (±SD), as indicated. CI = confidence interval; SD = standard deviation.
[a]Relative risks and mean differences are presented for females as compared with males, along with corresponding 95% CIs for each.
[b]% calculated as a within-row relative frequency for a given variable.
[c]% calculated as a within-column relative frequency for a given variable.
[d]Among those undergoing future surgery, the single "normal" study per radiologist impression was interpreted by the attending surgeon as a 6 × 5 mm osteophyte increased in size from previous MRI in the setting of more than 5 years of chronic, localized pain. The patient subsequently underwent osteophyte excision.
[e]*P* values correspond to intergender differences based on the chi-square/Fisher exact test or the Student *t* test/Wilcoxin rank-sum test, as appropriate.

genders, girls in our cohort were 1.7 times more likely to present with wrist pain. Earp noted a gender distribution of 3:1 (female:male) in kids with chronic wrist pain caused primarily by scapholunate tears,[10] and Bracken described a female predominance of 2:1 when evaluating ganglion cysts in children.[5] Similarly, Farr reported a distribution of 4.6:1 for their series of children/adolescents advanced to wrist arthroscopy for therapy-refractory pain, although they also note that their results were likely affected by a higher incidence of girls with upper extremity malformation.[12] Beyond the baseline differences at initial presentation, our results also showed that the female predominance increased even further to 2.4:1 when quantifying the frequency of a normal MRI in those presenting with wrist pain.

Previous work has highlighted the low sensitivity of plain radiographs for wrist injury. In 155 patients following acute trauma, Bergh and colleagues[4] used MRI to identify pathologic findings in 80% of wrists with previously normal radiographs—a median of 2 findings per wrist. Other studies report an incidence between 62% and 97% for occult bony and soft tissue injuries in patients with a strong clinical suspicion for underlying injury and negative radiographs.[14,27,30,32] Most of these patients, however, were adults following acute trauma. Looking at specific injuries, MRI is the imaging

Table 5. Types of Future Wrist Surgery.

Procedure	Count
Ganglion cyst excision	9 (23)
Biopsy, curettage and/or excision of soft tissue mass	8 (20)
Epiphyseodesis, physeal bar resection and/or surgery for Madelung's deformity, including associated procedures	6 (15)
Arthrotomy, biopsy and/or I&D for suspected Infection	5 (12)
Diagnostic arthroscopy for SL and/or other ligament injury, including associated procedures, as indicated	4 (10)
ORIF with bone graft (scaphoid)	4 (10)
Osteophyte and/or exostoses excision	2 (5)
Diagnostic arthroscopy, TFCC debridement vs repair, ulnar shortening	2 (5)
Total	40 (100)

Note. All values are presented as frequency and percentage.
I&D = irrigation and debridement; SL = scapholunate; ORIF = open reduction and internal fixation; TFCC = triangular fibrocartlige complex.

modality of choice for radiographically occult scaphoid fractures, which represented 33% of all indications in this study.[3,18,21,24] In children, MRI is also useful in the workup of a variety of other radiographically occult findings, including ganglion cysts,[5] Madelung's deformity,[15] and physeal injuries, among others.[11] Here, in a pediatric-only cohort, 73% of all wrists had at least 1 abnormal finding. Consistent with our initial hypotheses, categories with physical exam findings, laboratory values, and/or previous imaging studies that could potentially corroborate MRI findings had the highest rate of abnormal pathology.

As a tool to guide clinical decision making, MRI may have therapeutic consequences for 33% to 66% of patients.[4,16,23] Particularly, radiographic results and positive MRI findings are the most significant predictors of future need for treatment following acute wrist injury; negative MRI is not predictive.[25] Our study supports this assessment, as patients with at least 1 clinical score of "3" had a 4.1-times higher risk of surgical intervention within 1 year, whereas only 1 patient with a negative MRI required surgery. Nevertheless, a potentially impactful finding on MRI does not inevitably lead to intervention, as only 25% of our patients with at least one "3" were advanced to surgery within 1 year.

In this study, 27% of all MRIs were normal, including 34% of those with wrist pain. Previous studies have reported a frequency of normal MRIs following acute trauma of 46% in children[12] and between 3% and 57% in adults.[14,25,27,30,32] It is important to note, however, that positive findings might be asymptomatic,[8,22] and other findings might not necessarily affect treatment. Although our study used a scoring system to determine that 55% of all studies with an admitting category of pain had an MRI with minimal clinical impact, we did not definitively determine the incidence of therapeutic change through postimaging documentation review.

At the same time, wrist pathology may be present despite a normal MRI. Huellner noted that MRI has a sensitivity of 65% and a diagnostic accuracy of 56% when compared with single photon emission computed tomography (SPECT)/CT, CT, bone scan, and radiographs.[17] They also described poor agreement between experienced and inexperienced readers. A level II systematic review by Andersson concluded that "a negative result from MRI is unable to rule out the possibility of a clinically relevant injury to the TFCC, SL ligament, or the LT ligament of the wrist,"[2] whereas Smith noted that low MR field strength and/or partial tears may even further limit MRIs already low sensitivity for TFCC injury.[31] In comparing MRI with gold-standard wrist arthroscopy, Adolfsson noted that arthroscopy demonstrated pathology in 41 of 43 wrists, of which 17 would have benefited from acute intervention, although 5 of 7 prearthroscopy MRIs were normal.[1] In a cohort of children with chronic wrist pain, Farr found TFCC tears in 81% of wrists, with 76% also showing other pathomorphological findings.[12] Interestingly, MRI had been normal in 46% of these wrists, including 56% of those later shown to have a TFCC tear.

This study may offer additional insights into how to evaluate children with persistent wrist pain. On one hand, we do not mean to imply that a normal MRI has no clinical value. Such a result may provide valuable and highly accurate information to guide therapeutic decision making (eg, ruling out an underlying scaphoid fracture). As highlighted above, however, a negative MRI also does not definitively mean relevant pathology is not present. In considering a diagnostic approach for children with wrist pain, Earp recommends nonoperative management followed by MRI and arthroscopy for injuries that fail to heal.[10] Farr goes further, noting "MRI alone might not be an adequate tool to indicate or decline surgery" and that "chronic wrist pain in children and adolescents should not be ignored because of unsuspicious imaging findings but should be followed by diagnostic wrist arthroscopy."[12] Still, not all patients warrant prompt arthroscopy, as the majority of adolescent wrist pain can be managed nonoperatively.[7] Furthermore, "failure" of nonoperative management in the setting of generalized wrist pain and a "negative" MRI may warrant either a referral to rheumatology for inflammatory workup and/or consideration of secondary gain/malingering. Taken together, it becomes imperative to consider the entire clinical picture, including physical exam, before proceeding with either diagnostic arthroscopy or continued conservative management, and wrist MRI is merely one potential step in the clinical decision-making algorithm.

In this study, MRI was most useful for a variety of common pediatric conditions in which other supporting and/or suggestive clinical and/or exam information is frequently available, including evaluation of mass/cysts, infection, arthropathy, and physeal injuries. Therefore, our data suggest that wrist MRI is not an ideal screening tool in children, particularly in those with wrist pain, and should only be used to exclude or confirm a specific diagnosis. When used in such a guided fashion, MRI can serve as a valuable diagnostic tool without delaying arthroscopy when necessary.

This study has a number of limitations. First, indications for MRI and admitting category were determined retrospectively from the MRI referral, which introduced the possibility for error and inaccurate classification due to limited and/or missing information. Although each indication was confirmed when possible from the immediately preceding clinic note, clinical documentation is not always clear, and many patients were referred from outside institutions without correlating documentation. Second, our single institution may not be representative of the broader pediatric population. To minimize this drawback, as well as selection bias, we included all consecutive patients aged 18 years or younger over a 5-year interval, which yielded a robust and heterogeneous cohort. Third, MRI findings were not correlated with gold-standard arthroscopy. Nevertheless, the purpose of this study was to investigate the clinical utility of a wrist MRI for all possible indications, the majority of which are not advanced to arthroscopy. Fourth, MR arthrograms were excluded, which may have biased our results given the potential that such studies were ordered for more specific reasons, and that positive results may have been more likely to lead to operative intervention. Instead, we included only wrist MRIs as a means to reduce variability and focus primarily on studies that are prescribed far more frequently, particularly among non-hand surgeons. Fifth, as opposed to the reevaluation of the original MRI by the senior authors, only the final report was reviewed and scored. Although an expert review may have confirmed and/or clarified a particular study's findings, it was felt that any variability in the reading applied retrospectively would not accurately reflect the MRI's real-time clinical impact when originally released, as many studies were ordered by primary care providers, rheumatologists, and/or community orthopedists who likely relied exclusively on the final radiology report for relevant clinical decision making. Finally, clinical documentation was not retrospectively reviewed to definitively determine the therapeutic impact or the ultimate outcome (besides progression to surgery) of those with normal MRIs. Relatedly, a review of pertinent clinical information regarding preceding/concurrent treatment (eg, occupational therapy, injections, etc) was also not conducted, which might have affected the prescribing physician's relevant clinical decision making regarding the clinical utility of MRI. Given the frequency of referrals from outside institutions, the inconsistency of electronic medical records during the early years of this study, and the inaccuracy inherent in retrospectively interpreting other provider's clinical documentation, it was felt such a review would not be efficient. Furthermore, it is reasonable to expect that many patients with MRIs that were "normal" and/or of low potential clinical impact (score of "1") would be lost to follow-up as their wrist pain spontaneously improved in the absence of serious structural injury, thus limiting the value of a retrospective review for ultimate clinical outcome. Instead, a blinded clinical scoring system was implemented to gauge therapeutic impact, and the assigned score from 2 hand surgeons was averaged to minimize subjective bias.

In conclusion, this study sought to describe the clinical utility of wrist MRI in the diagnostic workup of pediatric patients, particularly those with wrist pain. Compared with all other admitting categories, patients with pain were 3.6 times more likely to have a normal study, 4.6 times more likely to have a clinical score less than or equal to 1, and roughly half as likely to proceed to wrist surgery within 1 year. Therefore, given our data, wrist MRI is not an ideal broad-based screening tool in children, particularly in those with wrist pain, and should only be used to exclude or confirm a specific diagnosis. Finally, this research highlights a potentially high-yield area for streamlining diagnostic efficiency and improving patient care with regard to a common pediatric injury, with a particular need for studies that include a thorough review of relevant clinical information at the time of MRI prescription/indications for MRI as well as the MRI's broader impact on future therapeutic decision making.

Ethical Approval

This study was approved by our institutional review board.

Statement of Human and Animal Rights

Institutional review board approval was obtained prior to commencement of this study via our institution's (The Children's Hospital of Philadelphia) Committee for the Protection of Human Subjects (IRB 12-009444). All procedures were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2007.

Statement of Informed Consent

Given the limited, retrospective nature of this study's chart review, a waiver of informed consent was granted by the authors' institutional review board.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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