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Detection of crossing vessels in pediatric ureteropelvic junction obstruction: Clinical patterns and imaging findings

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Summary

Background
Pediatric ureteropelvic junction obstruction (UPJO) is caused by congenital intrinsic narrowing and/or a lower pole-crossing renal artery. When a crossing renal vessel (CRV) is missed at the time of pyeloplasty, a redo-pyeloplasty is often required.

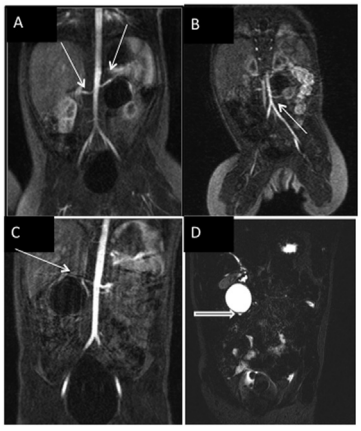
Objectives
The aims were to analyze clinical predictors for the presence of a CRV in UPJO and the utility of functional magnetic resonance urography (fMRU) in preoperative identification of a crossing vessel.

Methods
Using an Institutional Review Board approved registry database, we identified 166 patients from July of 2007 until January of 2014 who had undergone open, laparoscopic, or robotic assisted laparoscopic pyeloplasty at our institution. We abstracted data including age at surgery, preoperative symptoms, preoperative imaging findings, and whether or not a CRV was identified intraoperatively. Statistical analysis was performed on SPSS using the Mann–Whitney U test.

Results
Of the 166 patients identified, 78 were found to have a CRV at the time of surgery and 88 did not. The surgical approach was distributed as 104 robotic assisted laparoscopic, 51 open, and 11 pure laparoscopic. On univariate analysis, older age at presentation and pain at presentation predicted the presence of a CRV; antenatal hydronephrosis was a negative predictor, though 20 of 68 (25.6%) infants diagnosed with UPJO antenatally did have a CRV. Subgroup analysis of patients undergoing preoperative MRU showed a sensitivity of 88.2% and specificity of 91.7% for the detection of CRVs.

Discussion
This study confirmed the importance of looking for a crossing vessel in all cases, with the knowledge that increased age and pain at presentation were more likely to be associated with a crossing vessel. In addition, fMRU is a valuable source of information in the preoperative identification of the presence of a crossing vessel. The study has limitations including being retrospective in nature, and that the sensitivity of fMRU to identify CRVs was based on the read of an experienced uroradiologist who specializes in MRU, so may not correlate with the standard clinical read of an fMRU.

Conclusion
This study confirms the need to maintain a high index of suspicion for the presence of a CRV when intervening in a clinically symptomatic older child, although 25% of infants with antenatally detected UPJO did have one too. Our subset analysis demonstrated that MRU is a reliable method of detecting crossing vessels.



E

		Crossing Vessel seen at Surgery N=17	No Crossing Vessel seen at Surgery N=24	Sensitivity / Specificity
fMRU : CRV Present	Yes	15	2	88.2%/ 91.7%
	No	2	22	
fMRU: Obstruction present	Yes	9	0	52.9%/ 100%
	No	8	24	

Figure (A) Normal bilateral renal arteries (arrows) on post-contrast T1-weighted fat-saturated scan. On the left side there is ureteropelvic junction obstruction and clearly the left renal artery enters into the kidney above the dilated renal pelvis. (B) Left crossing vessel detected on post-contrast T1-weighted fat-saturated scan (thin arrow) without additional signs of obstruction on fMRU (not shown) and, no crossing found intraoperatively. (C) A post-contrast T1-weighted fat-saturated scan demonstrating a right crossing vessel (arrow) arising as a branch from the main renal artery and wrapping around the dilated renal pelvis to enter the kidney at the ureteropelvic junction. (D) Obstruction of the proximal ureter is noted (arrow) on the non-contrast 3D T2-weighted fat-saturated scan. The obstructing right crossing vessel was identified intraoperatively. (E) Sensitivity and specificity of fMRU for identification of the presence of crossing renal vessels and for ureteral obstruction.

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Introduction

Ureteropelvic junction obstruction (UPJO) in children is commonly caused by an intrinsic narrowing of the proximal ureter, with or without impingement of a lower pole-crossing renal vessel (CRV). The ability to preoperatively predict the proximate cause of an obstructive process may, in some cases, alter the surgical approach, preferring a lateral approach to dorsal lumbotomy in open cases, or carrying out a more distal mobilization of the ureter during a laparoscopic approach. The consequences of missing a crossing vessel during repair are significant, and can lead to failed surgery requiring a redo pyeloplasty [1,2].

Pelvicaliectasis may be detected on antenatal sonography leading to a postnatal diagnosis of UPJO, or later diagnosis occurs after a work-up of symptoms such as flank pain, nausea and emesis, or urinary tract infections. Previous published experience indicates that infants typically present with an intrinsic ureteric obstruction, older children with a late presentation have a greater likelihood of having a CRV, and that CRV are seen in 6—11% of the pediatric population [3—5].

In nearly all cases, renal bladder ultrasound (RBUS) is the primary imaging obtained, as it is non-invasive, does not require sedation, and does not expose the child to radiation. Once hydronephrosis is identified, or if there is the suspicion of UPJO, further imaging studies may be obtained with a nuclear medicine diuretic renogram or functional magnetic resonance urography (fMRU). While diuretic renograms provide relative function and drainage, fMRU offers the advantage of vertical integration of the anatomy with functional information. Anatomic imaging may help to identify CRVs prior to surgery, which may be helpful in planning the surgical approach. fMRU, however, unlike magnetic resonance angiography (MRA), is not specifically protocoled to identify the renal vasculature [6]. Indeed, the contrast dose, injection speed, and timing of imaging are geared for functional evaluation of the renal parenchyma, which disadvantages the depiction of vascular structures. Computer tomography angiography (CTA) is another imaging modality that is designed to identify CRV. However, due to the high radiation exposure and lesser comprehensive renal morphologic and functional information than fMRU, CTA is overall a less desirable imaging study [7].

Our aim in this study was to identify clinical and imaging predictors for identifying a CRV as cause of a UPJO. In addition, we sought to determine whether cross-sectional imaging with fMRU was a valuable adjunct to the identification of CRV.

Materials and methods

Using an Institutional Review Board approved urology registry, we identified 166 patients who had undergone open, laparoscopic, and robotic assisted laparoscopic pyeloplasties at our institution from July of 2007 until January of 2014. Patients ranged from 6 months to 20 years at the time of surgery. Data were abstracted from the electronic medical record to identify features including age at first surgery, antenatal detection of hydronephrosis, history of urinary tract infection (UTI), history of stone disease, whether there were signs or symptoms associated with UPJO (pain, nausea or emesis, and UTI), preoperative imaging studies, and whether or not a CRV was detected at the time of surgery. The presence of a CRV intraoperatively was determined by the operative report. If no mention was made about any CRV, then the report was recorded as presuming absence of a CRV.

Statistical analysis for correlation between demographics and the presence of a crossing vessel was performed on Stata using Wilcoxon rank sum tests.

For the secondary analysis, all patients who had undergone fMRU preoperatively were selected. The list of these patients was then given to a pediatric uroradiologist (K.D.) to explicitly review for the presence of accessory renal vessels and for signs of ureteral obstruction by the vessels. The fMRU evaluation for CRV primarily focused on the single series of the post-contrast coronal three-dimensional (3D) T1-weighted fat-saturated dynamic scan without additional multiplanar reconstructions. For detection of proximal ureteric obstruction by a CRV the pre-contrast coronal 3D T2-weighted fat-saturated and sagittal T2-weighted scans were reviewed. The pediatric radiologist was blinded to the intraoperative findings. For the review, a CRV was defined as an accessory artery emanating from the aorta or from the main renal artery, that crosses over the area of the UPJ, independent of additional findings of ureteral obstruction. Ureteral obstruction was defined as a vascular impression or linear filling defect of the proximal ureter, or a kinking of the proximal ureter with or without a small segment of ureteral filling (nipple sign). In addition, we recorded whether the fMRU report in the electronic medical record was evaluated for mention of the presence of a CRV (Fig. 1).

Results

A total of 166 pediatric patients with UPJO made up the cohort for this study. A total of 78 patients were identified as having a CRV intraoperatively, while 88 did not have a CRV. Median age at surgery was 8.27 years for those with a CRV, and 0.95 years for those without a CRV. Characteristics of antenatal diagnosis, pain at presentation, history of UTI, history of stone disease, and grade of hydronephrosis are shown in Table 1. In addition, patients were stratified according to function on mercapto-acetyltriglycine (MAG) 3 diuretic renogram, also shown in Table 1. Of those patients who had MAG 3 data available, 61.5% had $<$40% function of the affected side when there was no CRV, whereas only 28.8% had $<$40% function in association with a CRV. This difference was not statistically significant. Univariate analysis showed that older age and pain at presentation were indicative of a CRV, while antenatal hydronephrosis was a negative predictor (Table 1). However, 20 of 68 (25.6%) infants diagnosed with UPJO antenatally did have a CRV.

On subgroup analysis, we identified 45 patients who had undergone fMRU prior to surgery. Of these, one was omitted for a horseshoe kidney, and three were deemed to have inadequate study quality due to motion degradation of the post-contrast dynamic scan, limiting the evaluation