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ORIGINAL ARTICLE

Does secretin add value in pediatric magnetic resonance cholangiopancreatography?

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Abstract
Background Secretin—a hormone that stimulates pancreatic exocrine secretion—is described to improve visualization of the pancreatic duct by magnetic resonance cholangiopancreatography (MRCP). In our pediatric practice, however, we have not observed substantial benefit with the use of secretin.
Objective To determine whether secretin dilates and improves visualization of the pancreatic duct in pediatric MRCP.
Materials and methods Retrospective evaluation of secretin-enhanced MRCPs performed over a 15-month period. One reviewer measured the pancreatic duct pre- and post-secretin and two reviewers, blinded to the administration of secretin, assessed image quality and subjective duct visibility. Similar assessments of the biliary tree served as internal controls.
Results We reviewed 20 MRCPs in 17 children. Following secretin administration, there was a small (0.3 mm) but statistically significant increase in pancreatic duct diameter (P=0.002) and small (<0.2 mm) but significant increase in intrahepatic bile duct diameter (P=0.0104). On subjective review, there was no significant difference in image quality or duct visibility based on the administration of secretin.
Conclusion Secretin induces dilatation of the pancreatic duct but the value of that effect in pediatric MRCP is suspect given the small change in duct diameter and the lack of improvement in image quality and duct visibility.

Keywords MRCP · Cholangiopancreatography · Secretin · Pediatrics

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Introduction

Magnetic resonance cholangiopancreatography (MRCP) has gained favor as a non-invasive means of evaluating the pancreatic and biliary systems in both adults and children [1]. These heavily T2-weighted images allow visualization of small-caliber fluid-filled ductal structures of the liver and pancreas. The addition of secretin-enhanced MRCP sequences has been shown to improve visualization of the pancreatic duct and associated anatomic variation and pathology and also aids in the assessment of pancreatic exocrine function [2–9]. Although most of these data are based on studies in adults, studies in children have shown similar results [2, 6, 10].

Despite these reports, we have anecdotally noted that, in routine clinical use, secretin has little observable effect on pancreatic ductal diameter in our pediatric population and thus appears to add little incremental diagnostic value. Given that the administration of secretin adds approximately US $500 to the charge billed to the patient for a routine MRCP examination at our institution, adds logistical complexity (requiring nursing and pharmacy support) and has a potential risk of allergic or other adverse reaction, we set out to assess the effect of secretin administration on the pancreatic duct during MRCP.

We hypothesized that there would be no observable effect of secretin on the pancreatic duct in children. Specifically, there would be no objectively measurable dilatation of the pancreatic duct or subjectively improved visibility of the pancreatic duct following administration of secretin.

Materials and methods

Following approval by the Institutional Review Board at our tertiary care children's hospital, we performed a HIPAA-compliant retrospective review of all secretin-enhanced MRCP examinations performed at our institution over a 15-month period (March 2010–June 2011). Eligible examinations were identified through a query of the hospital electronic medical record system. Patient examinations were included in this study if images were acquired according to our standard protocol (detailed below) with both pre- and post-secretin images. MRCP examinations in which secretin was not administered or in which only post-secretin images were acquired were excluded.

Imaging technique

All MR images were acquired on a 1.5-T HDx scanner equipped with eight receiver channels with a gradient performance of 50 mT/m (GE Healthcare, Waukesha, WI) using an eight-channel cardiac array coil. Children were sedated as needed, depending on the expected ability of the child to remain still and tolerate approximately 30 min of imaging. The field of view was adjusted to best fit the child's size and stay within the minimum coil parameters. The imaging sequences were prescribed as shown (Table 1). Intravenous contrast was administered only when clinically indicated such as in the assessment of cholangitis or vascular anatomy. No oral contrast material was administered.

Secretin administration and post-secretin imaging

Secretin is administered in cases where it is requested by the referring physician and in cases where, after discussion between the referring physician and interpreting radiologist, either believes that the addition of secretin might improve detectability of pancreatic ductal anatomy or pathology.

After completing the pre-secretin sequences, a 0.2-μgm/kg IV dose of secretin (ChiRhoStim®; ChiRhoClin, Burtonsville, MD) up to a maximum of 16 μgm was administered slowly over approximately 1 min. Post-secretin images were then acquired immediately following secretin administration.

Dynamic post-secretin images were not obtained, as the referring clinicians at our institution use MRCP for assessment of duct structural anatomy and pathology and not as a means to assess pancreatic exocrine function.

Objective image review

All MRCP examinations were reviewed in their clinical form by a single reviewer (A.T.T.) with direct comparison

Table 1 Magnetic resonance cholangiopancreatography (MRCP) imaging parameters. *TR* repetition time, *TE* echo time, *bSSFP* balanced steady-state free precession, *FSE* fast spin-echo, *SSFSE* single-shot fast spin-echo

Sequence	Plane	Approximate scan time (s)	TR (ms)	TE (ms)	Bandwidth (kHz)	Matrix size	Slice thickness (mm)	Gap (mm)	Protocol
T1-W 2-D	Coronal	165	350	Min	15.63	256×192	5	1	High-resolution T1-W
bSSFP 2-D	Axial	60	Min	Min	83.33	256×192	5	1	Fat-suppressed balanced weighting
T2-W 2-D	Axial	320	5,000	90	62.5	256×192	5	1	Fat-suppressed T2-W
bSSFP 2-D	Coronal	60	Min	Min	83.33	256×192	5	1	Fat-suppressed balanced weighting
FSE 3-D	Axial	400	3,500	Min	31.25	256×256	1.5	0	3-D pre-secretin
SSFSE 2-D	Radial[a]	30	6,000	180	62.5	256×256	4	NA	Radial slices 10° covering the pancreas
SSFSE 2-D	Coronal	10	5,000	385	31.25	256×256	2	NA	2-mm thin slab angled to the pancreas
SSFSE 2-D	Coronal	10	6,000	180	62.5	256×256	3	NA	3-mm thin slab angled to the pancreas
Secretin administered									
FSE 3-D	Axial	400	3,500	Min	31.25	256×256	1.5	0	3-D post-secretin
SSFSE 2-D	Radial[a]	30	6,000	180	62.5	256×256	4	NA	Radial slices 10° covering the pancreas
SSFSE 2-D	Coronal	10	5,000	385	31.25	256×256	2	NA	2-mm thin slab angled to the pancreas
SSFSE 2-D	Coronal	10	6,000	180	62.5	256×256	3	NA	3-mm thin slab angled to the pancreas

[a] Radial pre- and post-secretin single-shot images were centered over the pancreatic head on an axial view and five or six images were obtained with 10° radial spacing

of the pre- and post-secretin MRCP images. Duct diameters were measured in the axial plane perpendicular to the long axis of the duct at the same location on the pre- and post-secretin 3-D fast spin-echo images (Fig. 1). Duct measurements were obtained at the following locations: pancreatic head, pancreatic body, pancreatic tail, common bile duct just above the level of the pancreatic head, and right and left intrahepatic ducts within 1 cm of their confluence. Spatial resolution was calculated based on imaging parameters employed in the 3-D fast spin-echo images. Duodenal fluid content was also quantified prior to and following secretin administration according to the system described by Matos et al. [7]. This system grades duodenal fluid content relative to anatomical landmarks, assigning a grade of 0 to no fluid in the duodenum, grade 1 to fluid confined to the duodenal bulb, grade 2 to fluid within the bulb and partially filling the duodenum to the level of the genu inferius, and grade 3 to filling of the duodenum beyond the level of the genu inferius [7].

Subjective image review

Following objective review, all images were de-identified and the T1, T2 and balanced steady-state free-precession (bSSFP) images were discarded. The remaining pre- and post-secretin MRCP images for each case were separated into two distinct studies and the separated image files were ordered randomly. Two additional reviewers (A.J.T. and D.J.P., both pediatric abdominal imagers) independently reviewed the de-identified, randomized images blinded to patient information, imaging data, and secretin administration status. They subjectively assessed the overall image quality and the visibility of the same duct segments as measured in the objective portion of the study. Overall image quality was graded as poor, sufficient, good, or excellent. All ducts were classified as not visible, partially visible or visible. The impact of secretin administration on overall image interpretation was not assessed.

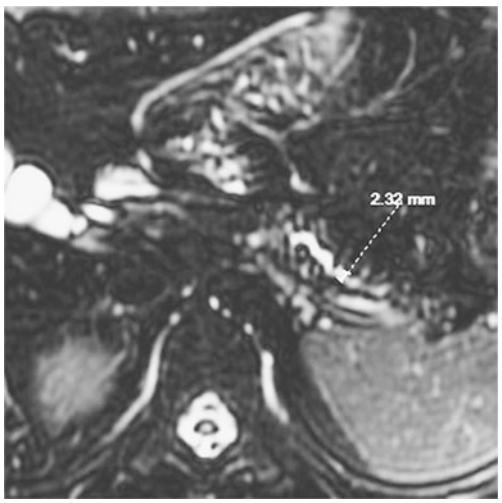

Fig. 1 Magnetic resonance cholangiopancreatography (MRCP) in a 10-year-old boy with familial pancreatitis. Coned down image from axial 3-D FSE MRCP sequence shows measurement of the pancreatic duct at the level of the pancreatic tail. Prominent side branch ducts are present in the pancreatic tail, consistent with the history of a chronic form of pancreatitis

Table 2 Clinical indications for secretin-enhanced MRCP in the reviewed population

Indication	*n*
Recurrent pancreatitis, evaluate anatomy	10[a]
History of single episode of pancreatitis	2
Familial pancreatitis, evaluate anatomy	2[a]
Abdominal pain	2
Abdominal pain, dilated common bile duct on US	1
Abdominal pain, fatty infiltration of pancreas on CT	1
History of liver transplant, evaluate anatomy	1
Crohn disease	1

[a] Patients/exams included in the subanalysis of cases of possible chronic pancreatitis

Clinical review

Patient medical records were reviewed for demographic information and clinical history. Records were also reviewed to identify children with histories or imaging indications suggestive of chronic pancreatitis, because chronic pancreatitis is known to dampen the dilatory effect of secretin on the pancreatic ductal system and to be associated with decreased exocrine function of the pancreas [11].

Statistical analysis

Changes in pancreatic duct segments (both objective and subjective) were evaluated individually for each segment and as a

Table 3 Mean absolute and percentage increase in pancreatic duct diameter following administration of secretin. For the purpose of statistical analysis, the three discrete pancreatic duct segments were evaluated both individually and as a composite ("composite pancreatic duct")

Duct segment	Mean diameter increase (mm)	Mean percentage diameter increase	*P*-value
Composite pancreatic duct	NA[a]	NA[a]	0.0020
Head	0.315±0.097	18.4%	0.0071
Body	0.322±0.148	17.1%	0.0610
Tail	0.2±0.094	11.4%	0.0667

[a] Not applicable because "composite pancreatic duct" represents a sum of the individual segments

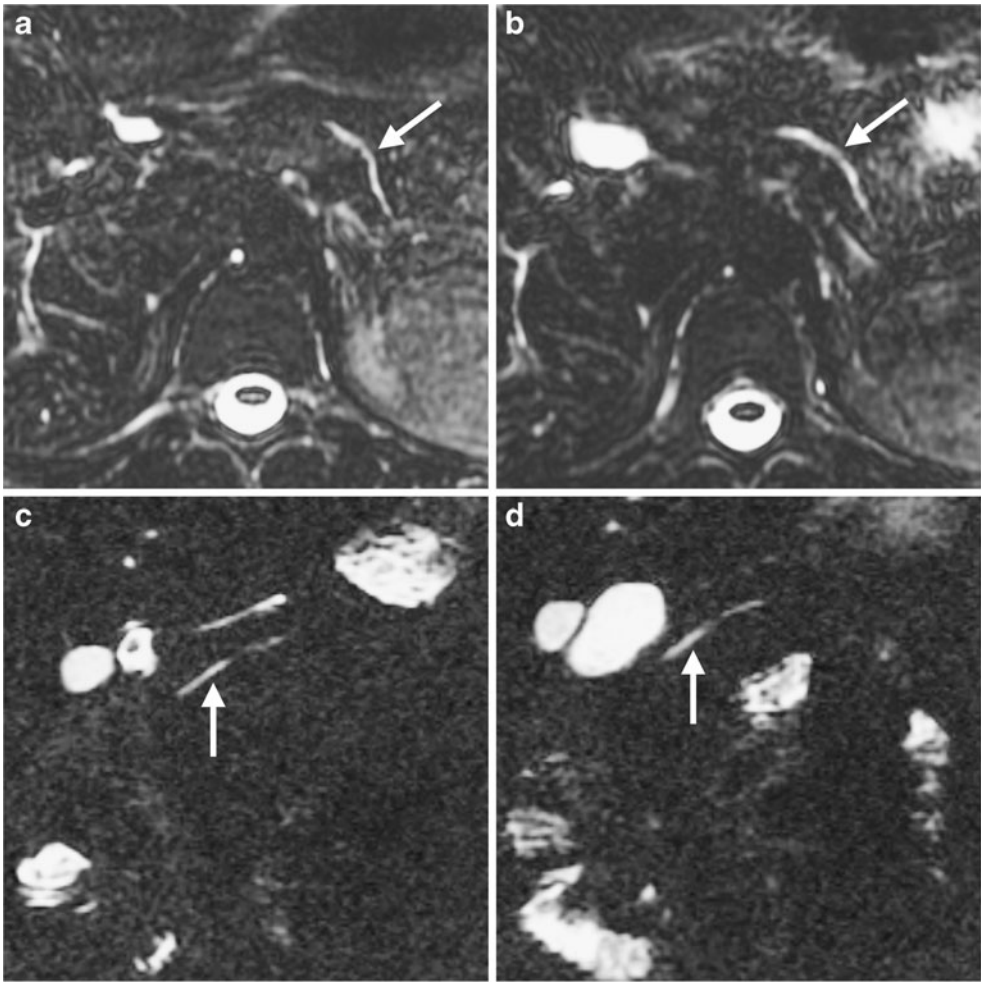

Fig. 2 MRCP images in a 17-year-old girl with Crohn disease. **a** Coned down image from axial 3-D FSE MRCP sequence prior to secretin administration. Pancreatic duct (*arrow*) measured 2.1 mm. **b** Coned down image from axial 3-D FSE MRCP sequence after secretin administration. Pancreatic duct (*arrow*) measured 2.4 mm. **c**, **d** Coned down images from coronal 2-D SSFSE sequence prior to (**c**) and following (**d**) secretin administration with *arrows* indicating approximately the same duct segment seen in (**a**) and (**b**). Note that, although the duct is larger in caliber on the post-secretin image in both the coronal and axial planes, the same duct segment is visible both pre- and post-secretin

composite of the segments. Analysis of the intrahepatic biliary ducts was based on a composite of the right and left ducts (diameter of right intrahepatic duct + diameter of left intrahepatic duct). Subanalyses of children with histories suggestive or diagnostic of chronic pancreatitis were performed to assess for a confounding effect by disease. Comparison of pre- and post-values for each duct segment and composite segments were examined using a paired *t*-test for normally distributed outcomes and signed rank test for skewed outcomes. Agreement between raters on image quality was assessed using kappa statistics. Results were considered statistically significant if $P<0.05$.

Table 4 Mean image quality pre- and post-secretin. Image quality is scored 0–4 (poor, sufficient, good, excellent) by two reviewers blinded to the administration of secretin

Reviewer	Mean quality pre-secretin	Mean quality post-secretin	*P*-value (within observer)
1	2.7±0.164	2.6±0.245	1.0000
2	2.75±0.16	2.85±0.264	0.2734

Results

A total of 20 secretin-enhanced MRCP examinations in 17 children were reviewed with indications for the examinations detailed in Table 2. The mean (± SD) patient age at the time of the examination was 13.3±5.3 years and ten of the children were boys. Twelve (12/20; 60%) examinations were performed in children who carried a clinical diagnosis of recurrent pancreatitis, chronic pancreatitis or hereditary pancreatitis. Pathological proof of chronic pancreatitis was not available in any of these cases.

Objective image review

After the administration of secretin, there was a small (0.3-mm maximum, <20% duct diameter) but statistically significant increase in pancreatic duct diameter ($P=0.002$ for composite pancreatic duct) (Table 3). Example pre- and post-secretin images are shown in Fig. 2. There was no significant increase in diameter of the common bile duct ($P=0.3661$) after secretin administration but there was a significant increase in the composite diameter of the

Table 5 Visibility of individual duct segments pre- and post-secretin for reviewers 1 and 2. "Composite pancreatic duct" includes the three assessed duct segments (pancreatic head, body and tail). Statistically there was no significant difference in duct visibility for either reviewer following secretin administration

Duct segment	Secretin	Reviewer	Visible	Partially visible	Not visible
Composite pancreatic duct (n=60)	Pre	R1	26 (43.3%)	9 (15%)	25 (41.7%)
		R2	24 (40%)	9 (15%)	27 (45%)
	Post	R1	31 (51.7%)	11 (18.3%)	18 (30%)
		R2	28 (46.7%)	18 (30%)	14 (23.3%)
Common bile duct (n=20)	Pre	R1	17 (85%)	2 (10%)	1 (5%)
		R2	16 (80%)	3 (15%)	1 (5%)
	Post	R1	18 (90%)	2 (10%)	0
		R2	15 (75%)	4 (20%)	1 (5%)
Intrahepatic ducts (n=20)	Pre	R1	19 (95%)	0	1 (5%)
		R2	14 (70%)	5 (20%)	1 (5%)
	Post	R1	19 (95%)	1 (5%)	0
		R2	14 (70%)	5 (20%)	1 (5%)

intrahepatic ducts (mean summed increase=0.355±0.129 mm, P=0.0104).

Calculated spatial resolution for the 3-D fast spin-echo images range 0.94–1.4 mm with a mean of 1.2 mm.

Duodenal fluid content increased significantly following secretin administration (P=0.0001) with median filling scores of 1 (interquartile range=0.5–2) pre-secretin and 2 (interquartile range=2–3) post-secretin [7].

Among the subgroup of children with chronic pancreatitis, a significant increase in duodenal fluid content was observed (P=0.0078) similar to the overall population. Ductal changes were also similar in this subgroup of children, with a significant increase in composite pancreatic duct diameter (P=0.0214) and in composite intrahepatic duct diameter (P=0.0039) following secretin administration. The mean change in pancreatic and biliary duct diameter following secretin administration was not significantly different between the subgroups of children with and without chronic pancreatitis (P=0.9229 pancreatic, P=0.5805 biliary).

Subjective image review

Inter-rater agreement on image quality was limited with poor agreement (κ=0.0345) on the quality of the pre-secretin MRCP images and only fair agreement (κ=0.2131) on the quality of the post-secretin images. However, within each observer, there was no significant difference in image quality based on the administration of secretin (Table 4).

Inter-rater agreement on the subjective visibility of duct segments was slightly better. Specifically, there was moderate agreement on the visibility of pancreatic duct segments both pre- and post-secretin (κ=0.4576 and κ=0.5302 respectively), substantial agreement on visibility of the common bile duct pre-secretin (κ=0.6694), moderate agreement on common bile duct visibility post-secretin (κ=0.5082),

Table 6 Mean visibility of duct segments pre- and post-secretin. Visibility is scored 0–2 (not visible, partially visible, visible) by two reviewers blinded to the administration of secretin. Composite pancreatic duct visibility represents the sum of visibility scores for the three pancreatic duct segments (pancreatic head, body, tail)

Duct segment	Mean visibility pre-secretin	Mean visibility post-secretin	P-value (within observer)
Reviewer 1			
Composite pancreatic duct	3.05±0.591	3.65±0.559	0.3320
Pancreatic head	1±0.218	1.1±0.216	0.8125
Pancreatic body	0.95±0.211	1.3±0.193	0.1127
Pancreatic tail	1.1±0.204	1.25±0.19	0.4492
Common bile duct	1.8±0.117	1.9±0.069	0.5000
Intrahepatic ducts	1.9±0.1	1.95±0.05	1.0000
Reviewer 2:			
Composite pancreatic duct	2.85±0.595	3.7±0.534	0.0522
Pancreatic head	0.95±0.223	1.2±0.186	0.2344
Pancreatic body	1.05±0.211	1.3±0.179	0.1797
Pancreatic tail	0.85±0.196	1.2±0.186	0.0654
Common bile duct	1.75±0.123	1.7±0.128	1.0000
Intrahepatic ducts	1.65±0.131	1.65±0.131	1.0000

and perfect agreement (κ=1 for both) on visibility of the intrahepatic ducts pre- and post-secretin. Although more duct segments were visible following secretin administration (Table 5), overall subjective segmental duct visibility was not significantly different based on the administration of secretin (Table 6).

Discussion

Magnetic resonance cholangiopancreatography is a technique that has many potential advantages in the pediatric population. This non-invasive modality allows assessment of pancreatic and biliary ductal anatomy without direct instrumentation and the associated technical challenges, cost and risks. The addition of secretin to pediatric MRCP imaging protocols can theoretically improve the diagnostic value of this technique by increasing visibility of the pancreatic ducts. The mechanism by which secretin is stated to have this effect is through ductal dilatation resulting from a combination of increased exocrine secretion by the pancreas and changes in tone at the sphincter of Oddi [12–15].

Studies in adults have demonstrated both objective and subjective improvements in evaluation of the pancreatic duct following secretin administration. Objective increases in the diameter of the pancreatic duct are reported to be in the range of 0.5–1.2 mm following secretin administration [7, 12, 16]. Reported subjective improvements following secretin administration have included improvements in overall image quality as well as improved visualization of the pancreatic duct either in its entirety or at specific segments [4, 7–9, 16]. This improved visualization of the pancreatic duct has been described to enhance detection of duct pathology and anatomic variation including duct disruption, duct stricture, pancreas divisum and anomalous pancreaticobiliary junction [5, 8].

Based upon the reported benefit in adults, secretin has also been used in MRCP in children. To date, three studies have looked specifically at the diagnostic value of secretin in pediatric MRCP. The first study prospectively evaluated three secretin-enhanced MRCP examinations as part of a larger series and described a subjective improvement in the conspicuity of the pancreatic duct in 2/3 of the patients following secretin administration [2]. The second study of 15 children reported a similar subjective improvement in visualization of the pancreatic duct as well as an objective increase in the mean ductal diameter of the pancreatic duct at three locations: pancreatic head (1.2-mm increase), pancreatic body (1-mm increase) and pancreatic tail (0.9-mm increase) [6]. In the most recent pediatric secretin MRCP study, Delaney et al. [10] reviewed 41 secretin-enhanced MRCPs and reported a significant improvement in the visibility of the pancreatic duct as well as an increase in the mean duct diameter of 0.6 mm in the pancreatic head, 0.4 mm in the pancreatic body, and 0.5 mm in the pancreatic tail following secretin administration.

Our data differ from the findings of these studies. In the 20 MRCP examinations we reviewed, neither image quality nor subjective visibility of the pancreatic duct (or duct segments) was improved significantly with the administration of secretin. Objectively, there was a statistically significant increase in pancreatic duct diameter, but the actual increase in duct diameter was only 0.3 mm throughout the length of the pancreatic duct, less than the changes described in other papers.

There are several possible reasons for our discrepant results. First, at our institution, post-secretin MRCP imaging consists primarily of static 3-D slab FSE images oriented in the axial plane with an image acquisition time of approximately 400 seconds. These are acquired immediately following secretin administration. We do not perform dynamic imaging of the pancreatic duct as described in previous studies in the pediatric literature [2, 6, 10]. It is possible that by imaging in this manner we are temporally missing the maximal effect of secretin on the pancreatic duct or that the time required to acquire this sequence results in signal averaging that partly masks the duct dilatation. Unfortunately because of the retrospective nature of this study and the limited data available in the medical record we cannot assess this temporal question. That being said, the plasma half-life of secretin is in the range of 3–5 min, which means that the effect of the drug on the pancreatic duct should persist through the time required to acquire this sequence. Moreover, the significant increase in duodenal fluid content observed on the post-secretin images in our population suggests that the drug is having its desired effect and that we are imaging during that effect and should be seeing changes in the pancreatic duct diameter.

Heterogeneity in patient population might also influence the results of our study. In adults, data in the literature suggest that ductal dilatation might not be seen following secretin administration in patients with chronic pancreatitis because of decreased exocrine function of the gland and fibrosis of the duct [11]. If this effect were at play in the substantial proportion of our population with clinically diagnosed chronic pancreatitis, then that might explain the lack of observed effect on ductal diameter. However, this does not appear to be the case in our study because subanalysis of children with clinically diagnosed chronic pancreatitis showed no significant difference in ductal change following secretin administration from the other study patients. Moreover, the observed increase in duodenal fluid after secretin administration in these children suggests a lack of substantial exocrine insufficiency related to pancreatitis that might mask the medication effect and skew the study findings. The importance of these results is in demonstrating that an abnormal response to secretin in patients with chronic pancreatitis is not masking the effect of

secretin in the remainder of the population but these results also raise the question of the severity of chronic pancreatitis in these children.

Differences in study design might be the most important possible explanation for our findings. Our study represents the first reported blinded assessment of the effect of secretin on pancreatic duct visibility in pediatric MRCP. In our study, the subjective reviews were performed in a blinded, randomized fashion without direct side-by-side comparison of pre- and post-secretin images. Previous studies have looked at the pre- and post-secretin images together, perhaps introducing bias, a possibility recognized in those publications [10]. This effect is apparent when one reviews the paired pre- and post-secretin images in Fig. 2. In addition to the objective dilatation of the pancreatic duct, the duct is clearly larger in caliber and more easily seen on the post-secretin images. However, the duct over this segment was fully visible on the pre-secretin images and both images would have been scored equally (duct = visible) when reviewed in a blinded fashion.

Whatever the reason(s) for our findings, they raise questions about the added diagnostic value of secretin in pediatric MRCP, particularly given its added cost. It is entirely possible that children are different from adults in some way that limits the effect/value of secretin. Previous studies have acknowledged that pediatric MRCP as a whole is more difficult than adult MRCP because of the small caliber of pediatric pancreatic and biliary ductal structures [1].

In addition to enlargement of the pancreatic duct, there was a statistically significant increase in diameter of the main right and left intrahepatic ducts. Most reports of secretin-enhanced MRCP have not reported a change in bile duct diameter following secretin administration. There are two ways to look at this finding: first, it is possible that the less-than-0.2-mm dilatation of the right and left biliary ducts reflects measurement error. If this is the case, it casts doubt on the significance of the 0.3-mm dilatation of the pancreatic duct. The other possible explanation is that this effect reflects pathology or a normal physiological process. Some authors view biliary duct dilation or increased fluid signal in the biliary tree following secretin administration as a pathological finding related to reflux of pancreatic secretions into the biliary tree [17]. However, secretin is known to stimulate secretion of bicarbonate-rich fluid from the biliary epithelium, perhaps accounting for the observed biliary ductal dilatation [18, 19]. Whatever the explanation for this finding, it is clear that further research into secretin-enhanced MRCP in children is needed.

This study has several limitations, the most important of which is its retrospective design. A well-designed, blinded prospective study is needed to adequately evaluate the diagnostic value of secretin in children. One effect of the retrospective design of this study is that we are limited to evaluating images obtained according to our clinical protocol, which might not adequately capture the peak effect of secretin on the pancreatic duct. If assessing the maximal effect of secretin on the pancreatic duct is of diagnostic value, dynamic post-secretin imaging might better serve this purpose. To this point, however, clinicians at our institution are more interested in ductal anatomy, which is better defined by high-resolution 3-D images than in dynamic exocrine functional information. Small sample size is also a limitation of this study. It is possible that the observed lack of statistical significance for some of the analyses is a function of the small number of children in the population (limited statistical power). Measurement constraints are a further limitation that applies not only to this study but also to those previously reported in the literature. Measurements are limited by pixel size, which is determined by the image matrix. Differences in the range of 0.3 mm, as seen in our study, are below the resolution of the acquired images (mean resolution=1.2 mm) and therefore within the range of measurement error. Additionally, although duct measurements were obtained in a consistent fashion throughout the study, the measurements were performed in the axial plane rather than in the true short axis and might not represent the true cross-sectional diameter of the duct. Finally, this study focused on the effect of secretin on duct diameter and visibility. We did not assess whether there was value related to secretin administration in terms of assessing pathology or providing a clinical diagnosis. While changes in visibility of the pancreatic duct would be expected to be correlated with or predictive of interpretive benefit, this was not assessed directly.

Conclusion

Based upon the results of this study, we conclude that, although secretin does result in minimal dilatation of the pancreatic duct when used in pediatric MRCP, the effect that dilatation has on visualization and assessment of the pancreatic duct is suspect. The observed dilatation is small (mean of 0.3 mm, <20% duct diameter) and there is no significant corresponding improvement in overall image quality or subjective visibility of the pancreatic duct. We acknowledge that these findings differ from those of prior studies and that further research is needed to assess the possible clinical value of secretin-enhanced MRCP. As a result of this study we are carefully assessing the clinical indications for use of secretin at our institution. In future cases where secretin is administered we might alter our imaging protocol to include dynamic post-secretin imaging of the pancreatic duct and plan to continue to assess the effect of secretin on duct diameter and visibility.

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Conflicts of interest None

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