Computed Tomography (CT) meal: A useful radiological tool in the diagnosis of upper intestinal obstruction in children

Presentation of five cases

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Abstract:

Background: This study was aimed to highlight the usefulness of the computed tomography (CT) meal technique used in our hospital in identification of the causes of upper intestinal obstruction in children.

Methods: Five child cases complaining mainly of recurrent vomiting and suspected to had an element of gastrointestinal obstruction were involved in the study. CT meal was performed by inserting a nasogastric tube in each child's stomach, and a concentrated oral contrast media (Iohexol 300) was injected via the tube on CT table. Then a helical pre-intravenous-contrast CT scanning was performed for the whole abdomen and pelvis with collimation of 3 mm. After that, intravenous contrast was injected via an automated injector as 2ml/kg, and a second post-contrast CT scanning run was performed. Images were then evaluated by a qualified radiologist.

Results: The first case was a ten months infant boy diagnosed as superior mesenteric artery syndrome. Second case was six years boy diagnosed as duodenal stricture. Third case was twenty five years neonate boy diagnosed also as duodenal stricture. Fourth case was a three years boy with gross abdominal lymphomatous masses diagnosed as lymphoma. Fifth case was a twelve days newborn girl diagnosed as intestinal duplication cyst.

Conclusion: CT meal technique was a useful technique in CT scanning evaluation of the children abdomen in suspected upper intestinal obstruction.

Keywords: Intestinal obstruction, computed tomography (CT), Superior mesenteric artery syndrome, Duplication cyst, children.

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وجبة التصوير المقطعي المحوسب: طريقة إشعاعية مفيدة في تشخيص الانسداد المعوي العلوي لدى الأطفال

عرض لخمس حالات

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الهدف: هدفت هذه الدراسة إلى تسليط الضوء على فائدة تقنية وجبة التصوير المقطعي المحوسب التي استخدمناها في مستشفانا في تحديد أسباب الانسداد العلوي للأمعاء لدى الأطفال.

الطريقة: خمس حالات أطفال تشكو أساسا من القيء المتكرر ويشتبه في وجود انسداد في الجهاز الهضمي عندهم تم اشراكهم في الدراسة. تم إجراء طريقة الوجبة مع التصوير المقطعي عن طريق إدخال أنبوب أنفي معدي الى معدة كل طفل، وتم حقن الصبغة المركزة الفمية (ايوهيكسول 300) عن طريق الأنبوب على طاولة جهاز الأشعة المقطعية. ثم تم اجراء مسح تصويري حلزوني ما قبل الصبغة الوريدية للبطن والحوض. بعد ذلك، تم حقن الصبغة الوريدية عن طريق الحاقن الآلي بمعدل 2مل/ كغ، وتم اجراء المسح التصويري الثاني ما بعد الصبغة الوريدية. ثم تم تقييم الصور من قبل أخصائي أشعة مؤهل.

النتائج: كانت الحالة الأولى طفل رضيع عمره عشرة أشهر تم تشخيصه كمتلازمة الشريان المساريقي العلوي. الحالة الثانية كانت صبي عمره ست سنوات شخص كتضيق في الاثني عشر. الحالة الثالثة كانت صبي عمره 25 يوم شخص ايضا كتضيق في الاثني عشر. الحالة الرابعة كانت صبي عمره ثلاث سنوات عنده اورام بطنية لمفاوية كبيرة تم تشخيصها على أنها سرطان الغدد الليمفاوية. الحالة الخامسة كانت فتاة حديثة الولادة عمرها اثني عشر يوما تم تشخيصها ككيس امعائي ازدواجي.

الخلاصة: دكانت تقنية وجبة التصوير المقطعي تقنية مفيدة في التصوير المقطعي المحوسب لتقييم بطن الأطفال الذين يشتبه في وجود انسداد معوي علوي عندهم.

الكلمات المفتاحية: انسداد معوي، التصوير المقطعي المحوسب، متلازمة الشريان المساريقي العلوي، الكيس الازدواجي، الأطفال.

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Introduction:

In general, small bowel obstruction is the commonest surgical emergency encountered in childhood whose etiologies vary mainly with patient age [1,2]. Congenital, and in some instances acquired, abnormalities involving the small bowel or colon in children are detected only when they are the direct cause of obstruction. Early and accurate diagnosis of intestinal obstruction is paramount for proper patient management, and in neonates, such abnormalities must be rectified surgically if the patient is to survive [3]. Clinical signs and symptoms including abdominal distention, vomiting and constipation prompt the clinician to consult the radiologist, who must determine the presence, location, and cause of an obstruction [4].

In complete congenital obstruction encountered in neonates, radiograph is the most valuable means of determining whether obstruction is present, or may help determine the next most useful diagnostic procedure [5]. However, congenital anomalies causing incomplete obstruction (eg, stenoses, webs, duplications, malrotations, peritoneal bands, aganglionosis) may not manifest until later in life, and other types of examinations (eg, barium studies, ultrasonography, computed tomography, magnetic resonance imaging) are generally needed for diagnosis [6].

In older children, the causes of bowel obstruction are more extensive and varied [7,8], and a more diverse list of diagnoses should be entertained. So understanding the proper selection of imaging modalities and developing familiarity with the characteristic appearances of common causes of bowel obstruction are needed [9].

In the routine gastrointestinal barium or gastrografin contrast studies, only the lumen of the small intestine is seen and evaluated, while the intramural and external compressive causes of intestinal obstruction are not seen, so information about the causative agent and associated complications are not usually obtained. Good ultrasonography (USG) machines can provide high-resolution images and can be used for evaluation of intestinal obstruction in infants and children with good results [10], but still there is a limited evidence for the imaging diagnosis of some conditions [11], specially if there is no clinical suspicious, and in children with large body habitus, excessive bowel gas, and postoperative patients in whom the anatomy may be distorted [12].

Magnetic resonance imaging (MRI) is also suited for evaluation of gastrointestinal tract disorders in children, and could be a good replacement of ionizing techniques specially in chronic diseases and in younger children [13]. As a noninvasive imaging tool, it has the capabilities of multiplanar imaging and superior soft tissue contrast, which are very important in delineating the pathologies of the abdomen's solid and hollow organs [14]. But it still not established well in children, and is expensive, not always available and imaging takes long time that is not suitable in acute cases.

CT is reported to have sensitivity for diagnosis of small bowel obstruction at over 90% for complete or high grade obstruction, and to detect causes of obstruction in 70-95% of cases [15]. The value of CT in the evaluation of bowel obstruction is based on its capability to provide information that aids in answering relevant questions like where is the transition point, what is the cause of the obstruction, and if there is coexistent complications [16,17]. CT also allows extramural areas that would not be visible on contrast studies to be assessed, and the multiplanar reformation views and the 3D imaging may help identify the site, level, and cause of obstruction when axial findings are indeterminate [18,19].

So, this study was conducted to show the value of the additional CT technique used by us in our hospital, which we called CT meal because resembles barium meal in filling the stomach and duodenum by contrast, in the detection and determination of the causative pathology responsible for the child upper intestinal obstruction, specially in incomplete obstructive cases that may not fulfilly identified by usual barium series, ultrasound or routine CT scan

Patients and Method:

The study was carried out in Ibn-seena general hospital including five child cases complaining mainly of recurrent vomiting and suspected to had an element of gastrointestinal obstruction. The children were send firstly for ultrasound evaluation which revealed distended stomach by fluid and food contents suggestive of upper gastrointestinal obstruction. Patients then referred for abdominal computed tomography (CT) scanning for more evaluation.

Computed tomography scanning (CT) of abdomen was done according to the routine local protocol in a16-section multi–detector row CT (Brilliance 16, Phillips). Helical scan of the whole abdomen and pelvis was done, including lower chest, with collimation of 3 mm, and multi-planar reconstruction at 0.6 mm

thickness. Interpretation and evaluation of the CT scan images were done by one qualified radiologist.

Iohexol 300mg/ml (Omnipaque 300®), bottle of 50 ml, was used as an iodinated contrast media for both oral and intravenous administration. The amount of intravenous (I.V) contrast media was calculated according to the weight of the child as 2ml/kg, and given via the automated injector, while the rest of the contrast in the bottle was used for oral administration according to child age and stomach capacity.

Before scanning, nasogastric tube was inserted into the child's stomach by pediatric department team, then on the CT machine table, a concentrated contrast media (without dilution by water) was injected via the tube into stomach, as the fluid collection within the distended stomach will dilute the contrast material inside it, so internally serve as a routine enteric contrast (which usually diluted by water for routine abdominal CT scanning) and prevent artifacts that could be resulted from the concentrated dye.

Scanning was performed after oral contrast injection and regarded as a pre-I.V contrast series, in which, the amount of gastric contrast was evaluated under radiologist supervision, to see if it was sufficient or needed additional amount. Then I.V contrast was injected and another scanning run was performed as a post-contrast series, then the two series were evaluated and reported by the radiologist.

Results:

The first case was a 10 months infant boy with frequent bilious vomiting. His CT scan revealed distended stomach, first and second duodenal portions, and proximal segment of the third part of the duodenum, with severe narrowing at the third duodenal part as it emerged between aorta and the proximal part of the superior mesenteric artery (SMA). Sagittal reconstruction images showed narrowed aorto-mesenteric angle < 22° and shortened aortomesenteric distance < 8 mm, that causing compression on the duodenal segment that passed between them (Fig.1). Diagnosis of superior mesenteric artery syndrome (SMAS) was made.

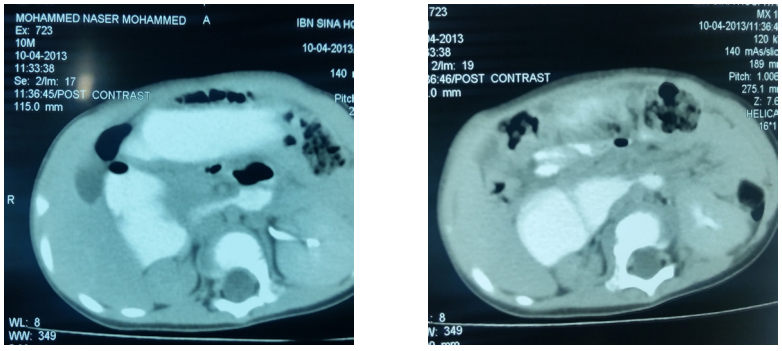

Fig. 1: CT images at upper abdominal level of a 10 months infant boy, showed severe compression of the 3rd part of the duodenum, where it passed between aorta and SMA (SMAS).

The second case was six years boy with recurrent vomiting. CT images revealed severe narrowing at the second part of the duodenum with mildly thickened duodenal wall at that site, and distention of the proximal part of the duodenum and stomach (Fig.2). Diagnosis of duodenal stricture was made for that case.

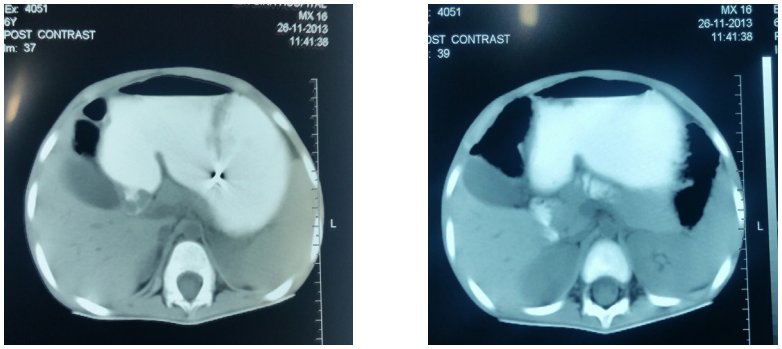

Fig. 2: 6 years boy with severe duodenal stricture at 2nd part with thickened duodenal wall at strictured area. Note passage of contrast beyond the narrowed segment.

Third case was a 25 days neonate with recurrent vomiting. His CT showed severe narrowing at the second part of duodenum, with gross distention of the first part of duodenum and stomach, without visible wall thickening or extrinsic compressive lesion, while contrast passes to the jejunum and ileum excluding atresia or complete obstruction (Fig.3). Severe congenital duodenal stricture was the diagnosis.

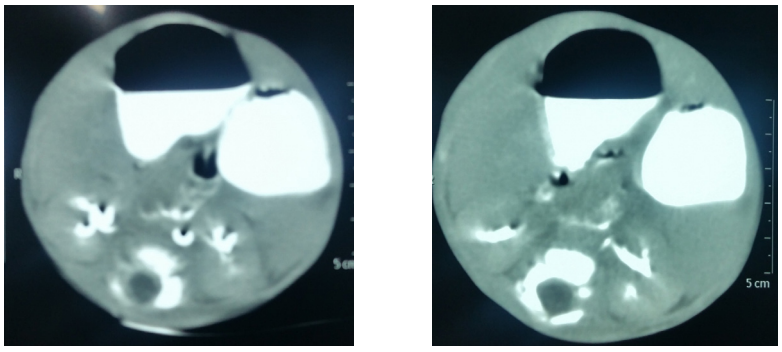

Fig. 3: Newborn with severe 2nd part duodenal stricture, resulting in gross dilatation of the 1st part of the duodenum and stomach.

Fourth case was a three years old boy complained of abdominal distention and vomiting. CT images showed multiple mesenteric and retroperitoneal nodal masses formed by matted enlarged lymph nodes, one of them located at the epigastric area compressing the first part of duodenum and resulting in distention of the stomach, along with encasement of the aorta and its branches by the matted retroperitoneal lymphadenopathy (Fig. 4). Abdominal lymphadenopathy highly suggestive of lymphoma was the diagnosis, resulting in upper duodenal obstruction.

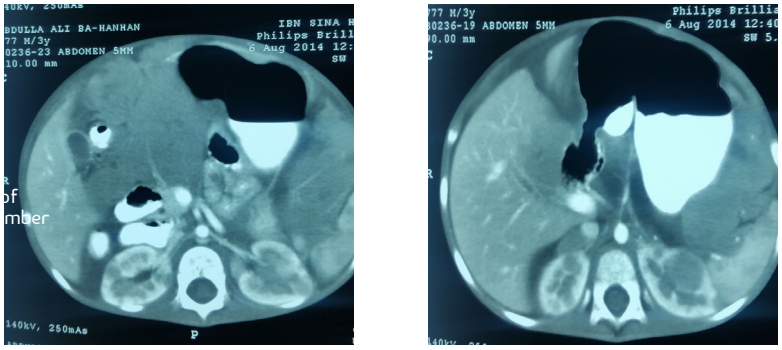

Fig. 4: 3 years boy with lymphomatous masses at epigastric area, compressing and obstructing the duodenum and causing distension of the stomach.

Fifth case was 12 days neonate female presented with vomiting and constipation. Images showed distended stomach and upper small intestine but contrast was passed freely through them, and a rounded cystic mass lesion seen at the left lower abdomen, measures about 4X4 cm compressing and displacing the intestine centrally and to the right side (Fig 5). Intestinal duplication cyst was the diagnosis for that case, and its compressive effect resulting in partial upper intestinal obstruction and hence gastric dilatation.

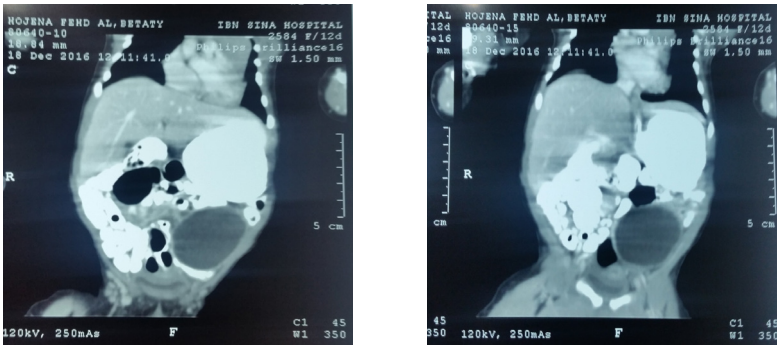

Fig. 5: Neonate female had cystic mass lesion at the Lt. lower abdomen, compressing the small intestinal loops and resulting in partial obstruction with distension of the stomach.

Discussion:

In acute intestinal obstruction, oral contrast material usually does not required for CT examination because the retained intraluminal fluid serves as a natural negative contrast agent [20]. Also, the routine CT scanning of the abdomen including oral administration of either 1.2% barium or 2% iodinated water-soluble contrast material 30–120 minutes before scanning, and this was also preferred by some authors in case of intestinal obstruction [21].

In our technique, we used concentrated iodinated contrast material (Iohexol 300) as an oral contrast media, because in such cases, the stomach and upper small intestine above the site of obstruction were distended and filled by fluid, which acts as a diluted media causing some degree of contrast dilution less than the usual routinely used diluted contrast, so the contrast can reaches the transitional zone with a good hyperdense luminal enhancement that allows better visualization of the bowel structural pattern, and at the same time prevents imaging artifacts that may be resulted from the purely concentrated contrast media. In the other hand, nasogastric intubation ensures better and forceful filling of the upper small intestinal segment above the obstructive point and hence better continuous and early filling of the transitional zone and passage of the contrast through the strictured area that allows identification of its nature and degree of compression from extrinsic causes.

In our study, local duodenal stricture was seen only in two cases as a cause of obstruction, while in the other three cases, the cause was outside the bowel and the obstruction was resulted from its compressive effect, not due to a local intestinal pathology. In such cases, the value of CT scan becomes obvious, as those external causes can't be detected by routine upper gastrointestinal barium or gastrografin studies, which can reveal the site of obstruction, but can't determine the causative process. Also, the added concentrated oral contrast to the CT technique will replace the value of the barium and gastrografin series, and give more determinant of the bowel lumen at the transition zone that enable the radiologist to correlate the compressive external pathology with the true site of obstruction and linked it as a cause.

In the first case, the obstructive cause was superior mesenteric artery syndrome (SMAS), which called also Wilkie's syndrome [22]. It is a rare cause of upper gastrointestinal obstruction, which results from compression of the third part of the duodenum between aorta and the proximal part of the superior mesenteric artery, could be congenital or acquired in nature [23]. In infancy, like our case, SMAS is extremely rare, therefor. other duodenal obstructive diseases including congenital duodenal stenosis and intestinal malrotation must be ruled out prior to diagnosis [24], which achieved by CT scan in our case. CT scan is useful in the diagnosis of SMA syndrome, showing an aortomesenteric angle of < 22° and an aortomesenteric distance of < 8-10 mm, and also for identification of other associated problems that may require surgical intervention [25]. CT is advantageous over upper gastrointestinal barium study because it has a greater patient comfort and relative noninvasiveness. On the other hand, the advantage of CT over ultrasonography is its ability to demonstrate additional pathologies [26].

Duodenal stricture was the cause in the second and third cases. Duodenum is a common site of obstruction in pediatric age group [27], and accounting for nearly half of all cases of neonatal intestinal obstruction [28]. There are several causes of congenital duodenal obstruction including atresia, stenosis, annular pancreas and malrotation with bands, most of which require elective surgical corrections [27,29]. Acquired causes of duodenal obstruction in children is also well known [30], among them, the external compression of the duodenum by the lymphomatous masses in lymphoma cases, like the fourth case in our study [31,32].

In the fifth case, congenital intestinal duplication cyst was the obstructive cause, and hence presented early (at 12 days of age). Gastrointestinal duplications are uncommon congenital abnormalities that may occur anywhere along the mesenteric side of the gastrointestinal tract, and manifest before the age of 2 years in 80% of cases, but occasionally manifested later in adult life [33]. They may be asymptomatic, presents with vague symptoms or signs of obstruction [34]. There are two general types of gastrointestinal duplication cyst: cystic duplication (in 80% of cases) is spherical in shape and has no communication with the bowel lumen, and tubular duplication (in 20% of cases) which communicates directly with the bowel lumen [35]. In small bower duplication cysts, Jejunal duplications are the most common, followed by ileal and duodenal duplications [36,37].

Conclusion:

Of different radiological methods used for evaluation of intestinal obstruction in children, computed tomography (CT) plays a major rule, for its capability to identify luminal, mural and extrinsic obstructive causes, and any associated findings or complications. We found also that CT meal technique used in our hospital for the five children in the study was a useful technique that lead to definite diagnosis and identification of the cause of obstruction in each involved child. So, can be applied as a routine method in the CT scanning evaluation of children with suspected upper intestinal obstruction, specially in cases of incomplete obstruction.

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