Clinical findings versus imaging studies in the diagnosis of infantile hypertrophic pyloric stenosis

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Background **Infantile hypertrophic pyloric stenosis is the most common surgical cause of vomiting in early infancy and can be diagnosed clinically or by imaging studies.**

Objectives **The aim of this study was to assess the accuracy of clinical examination compared with ultrasound and upper gastrointestinal contrast imaging in the diagnosis of infantile hypertrophic pyloric stenosis.**

Patients and methods **A prospective analysis was carried out of 60 patients referred to the Pediatric Surgical Department with a proven diagnosis of infantile hypertrophic pyloric stenosis on surgical exploration in the period from January 2010 to January 2014. All patients underwent clinical, radiological, and sonographic evaluations.**

Results **The male to female ratio was 3.28 : 1. The mean age at onset was 29.5 days. The mean age at presentation was 48 days. Projectile vomiting was present in all infants (100%). A pyloric mass was palpable in 31 (51.66%) infants, visible peristaltic waves were noted in 24 (40%) infants, and 54 (90%) patients had gastric aspirate of more than 10 ml. Ultrasound examination was confirmatory in all patients (100%). Barium study was positive in 55 (91.66%) cases.**

Conclusion **A palpable pyloric mass with a suggestive history is a sufficient indication for proceeding to surgical treatment without confirming diagnostic imaging studies. However, when physical findings alone are inconclusive, an abdominal ultrasound examination should be performed because of their high accuracy in identifying the underlying problems.** ***Ann Pediatr Surg*** **14:13–15 © 2018 Annals of Pediatric Surgery.**

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Introduction

Infantile hypertrophic pyloric stenosis (IHPS) is the most common surgical cause of vomiting in early infancy and it occurs in about 3/1000 live births [1–4].

The diagnosis can be made clinically by the presence of projectile vomiting in an infant aged between 2 and 8 weeks with associated weight loss [1,3,5,6]. Visible gastric peristalsis is a supportive finding, whereas palpation of an olive-shaped mass in the right upper quadrant of the abdomen is diagnostic [5–10]. The availability of ultrasonography and barium studies, however, has raised a question on the best method of diagnosis. Different studies suggested that diagnosis by means of clinical methods is possible in more than 80% of cases [11,12]. Such patients should be operated on without undergoing imaging studies [1–5,7,8]. Hulka *et al.* [13] noted that 61% of patients in the earliest group of their study and 96% of patients in the latest group underwent an imaging study and, in 86%, it was ordered by the referring physician, whereas Breaux *et al.* [12] reported a 34% increase in the use of imaging techniques. The increased reliance on imaging studies to diagnose IHPS has been ascribed to inexperienced examiners not palpating pyloric tumors and subsequently proceeding with further evaluation [6].

Patients and methods

A prospective study of sixty patients with infantile hypertrophic pyloric stenosis was carried out at the Pediatric Surgery Department in Pediatric Teaching Hospital in Duhok from January 2010 to January 2014.

All patients in this study underwent clinical, laboratory, radiological, and sonographic evaluations. The clinical diagnosis depends on the following:

(1) Presence of projectile vomiting at the typical age.
(2) Palpable pyloric mass.
(3) Visible gastric peristalsis.
(4) Residual gastric aspirate of more than 10 ml.

If the pyloric mass could not be palpated in the beginning, the following steps were adopted:

(1) Ensure that the infant is relaxed; thus, we allow the child to suck a pacifier.
(2) Examine with the knees and hips flexed to relax the abdominal wall musculature.
(3) Decompress the stomach with a nasogastric tube because if the stomach is full, the distended antrum will obscure the pylorus.
(4) If the infant proves difficult to relax, we hand the infant over to the mother to be breast fed, provided that the stomach is empty at the commencement of the feed; the relaxation afforded by the breast feeding may enable the tumor to be felt before the stomach refills and to observe for visible gastric contraction after feeding.
(5) Re-examine the infant after an interval of time and while he/she is sleeping.

In our study, volumetric measurements of nasogastric aspirate were performed in patients after fasting of at least 1 h. A size 8 Fr nasogastric feeding tube was placed

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in the child's stomach. An aspirate of more than 10 ml of milky fluid implicated gastric outlet obstruction, whereas an aspirate of less than 10 ml suggested a medical cause for the emesis.

The sonographic features of IHPS were evaluated in all patients and the following three pyloric parameters were measured and evaluated: (i) thickness of the pyloric muscle, (ii) diameter, and (iii) length. For the sonographic examination, a linear scanner with a 7 MHz transducer was used.

A barium study was carried out in all patients with the collaboration of the radiological department in our hospital. The stomach was emptied by a nasogastric tube before and at the end of the study to eliminate the risk of aspiration. Different signs of pyloric stenosis were recorded.

Results

A total of sixty patients with IHPS were included in the study and, in all cases, this was confirmed at operation.

The male to female ratio was 3.28 : 1. The mean age at the onset of vomiting was 29.5 days, with the youngest patient 7 days old and the oldest patient 91 days old. The mean age at presentation was 48 days, with a range of 24–112 days. The single most common presenting symptoms were bile-free projectile emesis that was present in all cases (100%); six (10%) of them had coffee ground vomiting. The average duration of symptoms at presentation was about 18 days, with the shortest period being 10 days and the longest period being 28 days. A firm spherical mass was noted on palpation of the abdomen in 31 (51.66%) infants. Visible peristaltic waves were noted in only 24 (40%) infants. Overall, 54 (90%) patients were subjected to volume measurement of residual gastric aspirate of more than 10 ml after 1 h of fasting.

Ultrasound (US) examination was confirmatory in all patients (100%). There was increased muscle thickness of more than 4 mm in all (100%) patients, increased pyloric channel length of more than 16 mm in 25 (83.3%) patients, and increased muscle diameter of more than 14 mm in 54 (90%) patients with both longitudinal and transverse images.

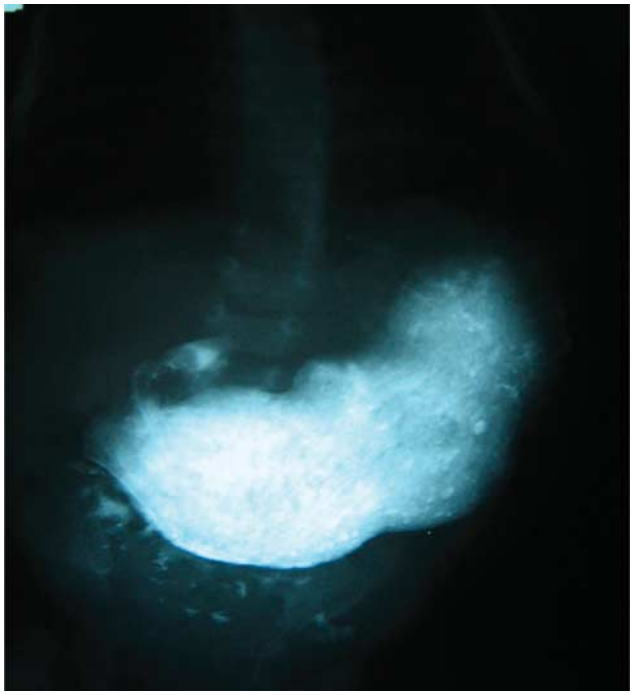
A barium study was performed in all patients and different signs were noted (Fig. 1). Distended stomach and delayed gastric emptying were found in 55 (91.66%) cases, elongated pyloric channel in 48 (80%) infants, string sign in 44 (73.3%) infants, double-track sign in 10 (16.6%) infants, caterpillar sign in 10 (16.6%) infants, and shoulder sign in eight (13.3%) infants.

Discussion

Infantile hypertrophic pyloric stenosis is a common surgical condition encountered in neonates and during early infancy. The clinical features of bile-free progressive projectile vomiting, visible gastric peristaltic waves, and an olive-shaped palpable abdominal mass in the right upper quadrant are frequently diagnostic [6,14–16].

The typical clinical presentation in all (100%) of our patients was non bilious projectile vomiting; this is similar to a study by Gruber and colleagues in which the projectile vomiting occurred in all cases in their study [17]. Six patients had a coffee ground appearance presumably from associated gastritis or esophagitis; these patients had persistent vomiting for more than 2 weeks. The detection of a pyloric mass depends on the experience and patience of the examiner. In this study, it was palpable in 31 (51.66%) patients and it is similar to a study of Mark *et al*, in which a pyloric tumor was palpable in 48% of patients [13], whereas Godbole *et al.* [11] found a palpable pyloric mass in 72% of their cases. Also, according to Blumhagen and Noble [18], the pyloric muscle tumor could be palpated in about 80% of IHPS patients by experienced clinicians. The presence of a palpable pyloric mass was highly specific and sensitive for IHPS. A positive feeding test with visible gastric peristalsis was positive in 24 (40%) patients; this is similar to a study carried out by Macdessi and Oates [6], who reported it in 47% of their cases. Measurements of nasogastric aspirate were positive in 54 (90%) patients after 1 h of fasting; the other six patients had false-negative findings. Although most patients develop vomiting after feeding, residual gastric aspirates were present. Finkelstein *et al.* [15] have already shown that IHPS was present in 91.7% of patients with 10 ml or more nasogastric aspirate and gastroesophageal reflux was present in 85.7% of patients with less than 10 ml nasogastric aspirate in a group of 38 infants. In the study by Mandell *et al.* [19], a volumetric measurement of 5 ml was used as the criterion to differentiate IHPS from non obstructive causes of vomiting and the study could diagnose 91% of IHPS cases.

Fig. 1



Upper gastrointestinal contrast study in an infant with infantile hypertrophic pyloric stenosis shows caterpillar sign, shoulder sign, and double-track sign.

Table 1 Comparison between palpable masses with imaging studies

	US		Barium study	
Palpable olive				
Result	+	−	+	−
+	31	0	29	2
−	29	0	26	3
Total	60	0	55	5

US, ultrasonography.

In addition to the history and clinical examination, confirmation of the diagnosis has traditionally been provided by a barium study of the upper gastrointestinal tract. A barium study is very useful when the hypertrophied pylorus is not observed on US to assess other causes of vomiting. Barium meal was performed in all cases and different radiological signs were found. Although the most common finding in 54 (90%) patients was a distended stomach with delayed gastric emptying, it is the least reliable indicator of IHPS and can be observed with pylorospasm, gastric hypotonia, sepsis, and ileus [14]. Other signs were an elongated pyloric canal, string sign, double-track or triple-track sign, caterpillar sign, and shoulder sign, which were positive in 80, 73.3, 16.6,16.6, and 13.3%, respectively. There were five patients with a negative barium meal; two of them had a palpable pyloric mass and this provides the rational for an alternative technique in diagnosing IHPS (Table 1). Freund and colleagues found the incidence of radiological error to be 4.5–11% [20], whereas Shuman and colleagues reported an incidence of radiological error to be about 5% [21]. However, radiological examinations involve exposure to ionizing radiation and the ingestion of contrast medium.

In our study, an ultrasonographic examination was performed in all patients, and it showed typical increased muscle thickness in all patients, increased pyloric channel length in 50 (83.3%) patients, and increased muscle diameter in 54 (90%) patients. Blumhagen and Coombs [22] were the first to point out that pyloric muscle thickness is the most important sonographic parameter in the diagnosis of HPS. Blumhagen and Noble [18] reported the degree of canal elongation to be considerably greater in patients with IHPS. Of the three parameters diameter, thickness, and length, muscular wall thickness is considered to be the most precise in sonography [23]. In equivocal cases, however, diameter and length may be useful in confirming the diagnosis [23]. In our study, US examination was confirmatory in all patients and this is similar to the studies of Godbole *et al.* [11] and Gibbs *et al.* [17] in which the diagnosis of HPS was confirmed by US in 97%. Although it is non invasive and easy to perform, with direct visualization of the hypertrophied muscle and no risk of radiation or aspiration, it is more operator dependent [23] and in six patients, the initial US were negative, but they were positive on the second US performed by an experienced ultrasonographer.

Conclusion

A clinical examination should be performed by an experienced surgeon or clinician and the infant should be calm with an empty stomach. US is recommended as the standard investigation, whereas Barium meal in this clinical setting is not always specific in addition to the risk of radiation and aspiration.

Conflicts of interest

There are no conflicts of interest.

References

1 Gilchrist BF, Lessin MS. Pyloric stenosis. In: Ashcraft KW, Holcomb GW, Murphy JP, editors. *Pediatric surgery*. Philadelphia, PA: Elsevier Saunders; 2005. pp. 407–410.
2 Beasley SW. Pyloric stenosis. In: Beasley SW, Hutson JM, Auldist AW, editors. *Essential pediatric surgery*. London: Arnold; 1996. pp. 39–44.
3 Barksdale EM. Pyloric stenosis. In: Ziegler MM, Azizkhan RG, Weber TR, editors. *Operative pediatric surgery*. New York, PA: McGraw-Hill; 2003. pp. 583–588.
4 Fujimoto T. Hypertrophic pyloric stenosis. In: Puri P, Hollwarth M, editors. *Springer surgery atlas series: pediatric surgery*. Heidelberg: Springer; 2006. pp. 171–180.
5 Sato TT, Oldham KT. Infantile hypertrophic pyloric stenosis. In: Greenfield LJ, Mulholland MW, Oldham KT, Gerald B, *et al*, editors. *Essentials of surgery: scientific principles and practice*. Baltimore: Lippincott William and Wilkins; 1997. pp. 1293–1296.
6 Macdessi J, Oates RK. Clinical diagnosis of pyloric stenosis: a declining art. *BMJ* 1993; **306**:553–555.
7 Stringer MD. Infantile hypertrophic pyloric stenosis: principles of pediatric surgery. In: Russell RCG, Williams NS, Bulstrode CJK, editors. *Baley and love's short practice of surgery*. London: Arnold; 2004. pp. 1425–1426.
8 Moront ML. Hypertrophic pyloric stenosis. In: Arensman RM, Bambini DA, Stephen Almond P, editors. *Pediatric surgery*. Georgetown: Landes Bioscience; 2000. pp. 85–88.
9 Griffiths DM. Infantile hypertrophic pyloric stenosis. In: Morris PJ, Wood WC, editors. *Oxford textbook of surgery*. Oxford: oxford university press; 2000. pp. 2039–2041.
10 Irish M. Pediatric Hypertrophic Pyloric Stenosis Surgery. Available at: *http://www.emedicine.medscape.com*. [Accessed 25 March 2016].
11 Godbole P, Sprigg A, Dickson JA, Lin PC. Ultrasound compared with clinical examination in infantile hypertrophic pyloric stenosis. *Arch Dis Child* 1996; **75**:335–337.
12 Breaux CW, Georgeson KE, Royal SA, Curnow AJ. Changing patterns in the diagnosis of hypertrophic pyloric stenosis. *Pediatrics* 1988; **18**:213–217.
13 Hulka F, Timothy J, John R, Marvin W. Evolution in the recognition of infantile hypertrophic pyloric stenosis. *Pediatrics* 1997; **100**:1–9.
14 Frkovic M, Seronja M, Perhoc Z, Barbaric V, Molhar M, Vukovic J. Diagnostic imaging of hypertrophic pyloric stenosis. *Radiol Oncol* 2001; **35**:11–16.
15 Finkelstein MS, Mandell GA, Tarbell KV. Hypertrophic pyloric stenosis: volumetric measurement of nasogastric aspirate to determine the imaging modality. *Radiology* 1990; **177**:759–761.
16 Owens MP, Beljan JR. Congenital hypertrophic pyloric stenosis. *California Med J* 1973; **118**:33–37.
17 Gibbs MK, Van Herrden JA, Lynn HB. Congenital hypertrophic pyloric stenosis: surgical experience. *Mayo Clin Proc* 1975; **50**:312–316.
18 Blumhagen JD, Noble HGS. Muscle thickness in hypertrophic pyloric stenosis: sonographic determination. *Am J Roentgenol* 1983; **140**: 221–223.
19 Mandell GA, Wolfson PJ, Adkins ES, Caro PA, Cassell I, Finkelstein MS, *et al*. Costeffective imaging approach to the nonbilious vomiting infant. *Pediatrics* 1999; **103**:1198–1202.
20 Shuman FI, Darling DB, Fisher JH. The radiographic diagnosis of congenital hypertrophic pyloric stenosis. *J Pediatr* 1967; **71**:70–74.
21 Freund H, Berlatzky Y, Katzenleson R, Schiller. M. Diagnosis of pyloric stenosis. *Lancet* 1976; **22**:473–476.
22 Blumhagen JD, Coombs JB. Ultrasound in the diagnosis of hypertrophic pyloric stenosis. *J Clin Ultrasound* 1981; **9**:289–292.
23 GruBner R, Pistor G, Abon-Touk B, Alzen G. Significance of ultrasound for the diagnosis of hypertrophic pyloric stenosis. *Pediatr Surg Int* 1986; I:130–134.