

Current trends in the diagnosis and treatment of pyloric stenosis

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Abstract

Aim We hypothesized that recent trends towards earlier diagnosis of hypertrophic pyloric stenosis continued throughout the early part of the 21st century.

Methods We reviewed the medical records of patients with HPS at a single institution during two periods: 1/03–12/05 and 4/09–7/13.

Results A total of 433 patients with hypertrophic pyloric stenosis who underwent pyloromyotomy were included (modern cohort = 259; historic = 174). The two cohorts did not differ in terms of age, weight, or median time from symptom onset to physician (5 vs 6.5 days; $p = 0.3$) or surgeon (7 days for both) evaluation. The percentage of patients who presented late (>7 days of symptoms) (27 % modern vs 25 % historic; $p = 0.15$) or with an elevated serum bicarbonate (22 % for both; $p = 0.8$) did not change over time. There was a shift to laparoscopic procedures: 99 % modern vs 57 % historic ($p < 0.0001$) with no associated change in operative length (28 vs. 27 min; $p = 0.06$), or operative (3 % for both, $p = 0.8$) or respiratory (4 vs 2 %, $p = 0.4$) complications.

Conclusion Most infants with hypertrophic pyloric stenosis are diagnosed early, prior to significant electrolyte

abnormalities; however, continued improvement in awareness is necessary given that a fourth of patients are diagnosed after over 1 week of symptoms.

Keywords Early diagnosis · Hypertrophic pyloric stenosis · Metabolic abnormalities

Introduction

Recent data have demonstrated a trend towards earlier diagnosis and treatment of hypertrophic pyloric stenosis (HPS) [1–4]. Previous authors have shown that infants are presenting earlier, with fewer severe metabolic derangements, leading to decreased rates of surgical complications and shorter hospital length of stay [1, 3, 4]. The majority of these reports were published in the 1990s, and demonstrate that infants with HPS treated in the 1990s presented earlier in the disease course with fewer severe metabolic derangements than those infants treated in the 1970s and 1980s [1–4]. Furthermore, previous data have demonstrated that approximately one-third of infants present after 7 days or more of symptoms [3]. We hypothesized that trends toward earlier presentation with fewer severe metabolic derangements, leading to improved surgical outcomes, would continue into the 2000s and 2010s. We aimed to compare two cohorts of infants with HPS, an historic cohort and a modern cohort, to determine if these previously documented trends have continued.

Materials and methods

Following approval of the Colorado Multiple Institutional Review Board, we reviewed the medical records of all

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patients with HPS who underwent pyloromyotomy at Children's Hospital Colorado (CHCO) during two distinct time periods: 1/03–12/05 and 4/09–7/13. A list of all patients who underwent pyloromyotomy as well as date of operation was obtained from the operative database at CHCO. Further data were obtained via retrospective review of the electronic medical record. Data collected include demographic information, details of clinical presentation including all laboratory and radiologic studies obtained at presentation, surgical evaluation and operative treatment, as well as details of the postoperative course.

For analysis, statistical comparisons were made between the historic cohort (1/03–12/05) and the modern cohort (4/09–7/13). Statistical analysis was conducted in Prism 6.0b (by GraphPad Software, Inc. La Jolla, CA, USA). Variables were compared between the groups using either a Mann–Whitney test or an unpaired *t* test where appropriate. Statistical analysis was performed based on available data. Differences were considered significant when $p < 0.05$.

Results

A total of 433 patients with HPS were identified and included in analysis (contemporary cohort 259; historic 174). The two cohorts were well-matched with no differences seen between the two with regard to age (median 34 days for both; $p = 0.97$), percentage of female patients (13.5 % modern vs. 17.2 % historic; $p = 0.3$), or weight (3.9 kg for both; $p = 0.96$). Demographic characteristics are presented in Table 1.

There was no difference in the median time from symptom onset to evaluation by a physician (median 5 days modern vs. 6.5 days historic; $p = 0.3$), whether that be a primary care physician or in the emergency department. The percentage of patients, who presented late for initial evaluation, after 7 or more days of symptoms, did not differ between the groups (27 % modern vs. 25 % historic; $p = 0.15$). Additionally, there was no difference in time from symptom onset to evaluation by a surgeon (median 7 days for both; $p = 0.08$, Table 2).

Also shown in Table 2 are laboratory studies obtained at the time of presentation. No clinically significant differences were demonstrated between the two cohorts in terms of serum sodium, potassium, chloride, or bicarbonate on presentation or the percentage of patients with a serum bicarbonate level of greater than 29 mmol/L or serum chloride less than 85 mmol/L.

Table 3 compares details of the operative care and complication rates between the two cohorts. There was no difference in time from surgical evaluation to operating room (17.8 h modern vs 13.8 h historic; $p = 0.73$), or postoperative length of stay (median 1 day for both; $p = 0.17$) between the two groups. There was a significant shift to laparoscopic procedures in the modern cohort with 258 of 259 procedures performed laparoscopically (99.6 %), 6 of which were converted to open procedures (2.3 %) while only 99 of 174 procedures in the historic cohort were performed laparoscopically (56.9 %), one of which was converted to open (1.0 %). Despite the increase in laparoscopy use, there was no associated change in operative length (median 28 min modern vs. 27 min historic; $p = 0.06$) or rate of intraoperative perforation (2 modern vs. 1 historic; $p = 1$). Rate of all operative complications including perforations, postoperative hernia, or wound infection also remained constant (3.5 % modern vs. 2.9 % historic; $p = 0.79$). Additionally, rates of postoperative respiratory complications, including episodes of apnea and hypoxia, did not change over time.

Discussion

We found that the clinical presentation of HPS has changed little over the last 10 years. Despite several reports from the 1990s that demonstrated trends towards earlier diagnosis with fewer severe metabolic derangements at presentation, as well as shorter postoperative length of stay [1–3], we did not show a similar trend from 2004 to 2013. Overall, we found very few differences between two well-matched cohorts of infants with HPS treated at the same institution during these two time periods. Over one-fourth of patients in each cohort did not present for physician

Table 1 Demographic characteristics of children with HPS

	Historic cohort ($n = 174$)	Modern cohort ($n = 259$)	<i>p</i> value
Age, days mean (SD)	38.2 (18.3)	38.0 (17.6)	0.97
Weight kg, mean (SD)	3.9 (0.9)	3.9 (0.7)	0.96
Male, n (%)	144 (82.7 %)	224 (86.4 %)	0.34
Presence of congenital anomalies n (%)	9 (5.2 %)	12 (4.6 %)	0.82

SD standard deviation

Table 2 Characteristics of clinical presentation and treatment of children with HPS

	Historic cohort (n = 174)	Modern cohort (n = 259)	p value
Time from symptom onset to clinician evaluation, days, median (IQR)	6.5 (1–14)	5 (3–10)	0.37
Time from symptom onset to surgeon evaluation	7 (4–14)	7 (4–14)	0.0815
Time from surgeon evaluation to OR	7.5 (3–15)	6.5 (3.5–12.5)	0.68
Late presentation, n (%)	43 (24.7 %)	71 (27.4 %)	0.15
Laboratory studies on presentation, mmol/L, median (IQR)			
Na	136 (135–138)	137 (135–139)	0.0015
K	4.7 (4.2–5.2)	4.8 (4.4–5.3)	0.11
Cl	101 (96–103)	103 (98–105)	0.0005
Bicarbonate	26 (23–29)	26 (24–29)	0.35
Cl <85 mmol/L, n (%)	9 (5.2 %)	6 (2.3 %)	0.18
Bicarbonate >29 mmol/L, n (%)	39 (22.4 %)	57 (22.0 %)	0.81

Late presentation defined by >7 days of symptoms at time of initial physician evaluation

SD standard deviation, IQR interquartile range, HPS hypertrophic pyloric stenosis

Table 3 Details of surgical treatment and complications

	Historic cohort (n = 174)	Modern cohort (n = 259)	p value
Laparoscopic pyloromyotomy, n (%)	99 (56.9 %)	258 (99.6 %)	<0.0001
Length of operation, min, median (IQR)	28 (23–37)	27 (22–32)	0.06
Postoperative length of stay, days, median (IQR)	1 (1–2)	1 (1–2)	0.17
Intraoperative perforation, n (%)	1 (0.6 %)	2 (0.8 %)	1
Conversion to open procedure, n (%)	1 (1.0 %)	6 (2.3 %)	0.68
Postoperative complications, n (%)	5 (2.9 %)	9 (3.5 %)	0.79
Respiratory complications, n (%)	4 (2.3 %)	10 (3.9 %)	0.42

IQR interquartile range

evaluation until they had been symptomatic for over 1 week. We did not find a delay in referral for surgical evaluation and there was no difference between our historical versus modern cohort. Previous groups who reported an improvement in early diagnosis of HPS during 1990s hypothesized that increased utilization of imaging studies to assist with diagnosis contributed to the improvement in early diagnosis [1, 2]. We hypothesize that uniform utilization of ultra sound was already in place in 2004, thus further improvements in early diagnosis were not seen between our two cohorts.

The percentage of patients with severe metabolic derangement in our series is smaller than what has been reported previously [1, 2] with only 5.2 % in the historic cohort and 2.3 % in the modern cohort presenting with a serum chloride <85 mmol/L. In their report, Poon et al. suggested that reductions in hospital stay could potentially be achieved by operation on the day of admission among infants who present with normal electrolytes followed by discharge the next day [1]. Our data reflect that this has become standard practice in our institution. When compared to previous data demonstrating a median

postoperative length of stay of 10 days in 1996 [4], the changes reported here are significant. Our data demonstrate that over the past 20 years, we have seen significant improvements in early diagnosis and treatment of HPS, however, the majority of these improvements seem to have occurred in the first half of this time period, with little change over the past 10 years.

Our data also demonstrate that nearly one-third of patients did not present for physician evaluation until after a week of symptoms. This finding highlights the key area for improvement with regards to HPS, as improvements in post admission care have plateaued. Further improvement will rely on increased awareness of the signs and symptoms of HPS, in particular at initial well-child visits and at time of discharge from the nursery. Looking to the non-surgical data, previous groups have shown that resources should be focused on distributing data to pediatricians to make them aware of the problem utilizing existing educational structures [5]. A second area for potential modification includes telephone triage protocols, which are frequently utilized in the pediatric population [6–9]. The nurses in these call centers facilitate triage by the use of symptom-specific

guidelines and protocols [9]. It is unknown how many of the patient's parents in the current study first sought advice through a telephone nurse prior to physician evaluation or how many were seen and diagnosed with gastroesophageal reflux, a common differential diagnosis. However, this may offer an opportunity for surgeons to provide input to the symptom-specific triage protocols used at their facility.

There was a transition to uniform use of laparoscopy during this time period with no change in overall complication rates or even a prolonged operative time, confirming the safety and efficacy of the laparoscopic approach which has been demonstrated previously [10–12]. Laparoscopic pyloromyotomy is currently accepted as a suitable treatment modality for HPS [13]. The current data provide further evidence that laparoscopic pyloromyotomy is a safe procedure with equivalent operative time and complication rates to open pyloromyotomy. We have previously demonstrated that the hiring of junior faculty members with extensive training in minimally invasive surgical (MIS) techniques is associated with uniform utilization of MIS by all surgeons in the group [14] and hypothesize that this accounts for the trend demonstrated with the current data.

As with all data collected retrospectively, our data have limitations. Our data demonstrate some trends toward continued improvement in early diagnosis and treatment of HPS during our 10-year study period, however, given the relatively small improvements and relatively small sample size, these differences did not reach statistical significance. Despite these limitations, these data remain valuable as they highlight many patients who still present with over a week of symptoms, despite other improvements. Our data confirm that the majority of infants with HPS are diagnosed early, prior to significant electrolyte abnormalities. However, continued improvement in education of both pediatricians and new parents, with potential changes to nursing call center triage protocols, is necessary considering a fourth of patients diagnosed with over a week of symptoms and this number has not changed throughout the most recent decade.

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Conflict of interest None.

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