Seasonal Effect on the Development of Infantile Hypertrophic Pyloric Stenosis

İnfantil Hipertrofik Pilor Stenozu Gelişiminde Mevsimsel Etki

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ABSTRACT Objective: The aim of this report was to determine if seasonal variation exists in the incidence of pyloric stenosis and to review the management of infantile hypertrophic pyloric stenosis (IHPS) in a single tertiary pediatric hospital over a seven-year period. **Material and Methods:** We conducted a retrospective chart review of all patients who underwent pyloromyotomy between October 2004 and October 2011. Patient data and laboratory results on admission were recorded from medical charts. The total and postoperative length of stay was calculated from the date of admission, surgery and discharge. Patients were divided into four groups according to seasons as winter, spring, summer and autumn. **Results:** A total of 55 pyloromyotomies were performed. Forty-seven patients were male (85.5%) and 8 were female (14.5%). The age distribution of the patients varied from 3 weeks to 13 weeks (median 6 weeks). There was no perioperative mortality. Oral feeding was achieved by 24 hours in 78.2% of infants and there was persistent vomiting in only 30.9%. There was no significant difference between the groups in terms of age, gender, weight, plasma pH, HCO3, Cl-, and K+ values; in addition, ultrasonographic findings were similar in each group. The highest rate of pyloromyotomy was in spring and the lowest in winter and summer; this difference was statistically significant (p=0.0049). **Conclusion:** In conclusion, seasonal variation of the hypertrophic pyloric stenosis suggests a possible etiological role for environmental factors and pyloromyotomy is the best treatment of IHPS that can be undertaken safely in specialized pediatric centers.

Key Words: Alkalosis; pyloric stenosis, hypertrophic; hypokalemia; infant; seasons

ÖZET Amaç: Bu çalışmanın amacı, pilor stenozu insidansının mevsimsel ilişkisi olup olmadığını saptamak ve üçüncü basamak bir çocuk hastanesinin yedi yıllık bir süre boyunca infantil hipertrofik pilor stenozunun tedavisindeki deneyimini gözden geçirmektir. **Gereç ve Yöntemler:** Ekim 2004-Ekim 2011 tarihleri arasında hastanemizde piloromiyotomi ameliyatı geçiren tüm hastaların dosya kayıtları gözden geçirildi. Dosya kayıtlarından hastaların demografik verileri, başvuru sırasındaki laboratuar sonuçları, ameliyat sonrası yatış süreleri ve hastanedeki toplam yatış süreleri kaydedildi. Hastalar başvurdukları mevsimlere göre kış, ilkbahar, yaz ve sonbahar olarak dört gruba ayrıldı. **Bulgular:** Kayıtlardan elde edilen bilgilere göre toplam 55 hastada piloromiyotomi yapılmıştı. Hastaların 47 (%85,5)'si erkek ve 8 (%14,5)'i kızdı. Hastaların yaş dağılımları 3 hafta ile 13 hafta arasında değişiyordu (ortanca 6 hafta). Perioperatif dönemde hasta kaybı gözlenmedi. Hastaların %78,2'sinde oral beslenmeye 24 saat içinde başlandı; %30,9 hastada uzamış kusma görüldü. Gruplar arasında yaş, cinsiyet, ağırlık, plazma pH, HCO3, Cl-, ve K+, değerleri açısından anlamlı bir farklılık bulunmadı. Ayrıca her bir grupta ultrasonografi bulguları benzer bulundu. En fazla piloromiyotomi ilkbahar aylarında, en az ise yaz ve kış aylarında yapılmıştı; bu durum istatistiksel olarak anlamlı bulundu (p=0,0049). **Sonuç:** Sonuç olarak, infantil hipertrofik pilor stenozunun mevsimsel farklılık göstermesinde çevresel faktörlerin etiyolojik rolü olabileceği ileri sürülebilir. Piloromiyotomi, özelleşmiş çocuk hastanelerinde güvenli bir şekilde yapılabilir.

Anahtar Kelimeler: Alkaloz; pilor stenozu,hipertrofik; hipokalemi; bebek; mevsimler

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Infantile hypertrophic pyloric stenosis (IHPS) is the most common surgical cause of vomiting in infants. This disorder is characterized by hypertrophy and hyperplasia of the circular muscle layer of the pylorus,

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with stenosis of the pylorus channel causing gastric outlet obstruction, gastric distension, and retrograde peristalsis in stomach, which can be detected by inspection after feeding. As a consequence, dehydration and hypochloremic metabolic alkalosis will occur.[1] The cause remains unknown with a sporadic hereditary pattern and evidence to suggest that the failure of muscle relaxation may be due to inadequate innervations, nitric oxide synthase, resistance to vasoactive intestinal peptide or a combination of these.[2-4] Seasonal variation in the incidence of IHPS has been long debated.[5] Some experts have tried to shed light on the cause of IHPS by carrying out epidemiological studies.[5] The variation in incidence throughout the year hints that environmental or infectious factors may play important roles in the pathogenesis of IHPS.[6] Seasonal variation in incidence has been found in Ireland and the UK with higher incidence in winter.[6,7]

Since the advent of sonography, IHPS can be easily diagnosed and confirmed by abdominal sonography.[8] Surgical correction by the Ramstedt procedure under general anesthesia, initially reported in 1911, remains the standard treatment for this condition and is considered a "relatively simple procedure with an excellent outcome".[8,9]

The aim of this report was to determine if seasonal variation exists in the incidence of pyloric stenosis and to review the management of IHPS in a tertiary pediatric hospital over a seven-year period.

MATERIAL AND METHODS

A retrospective chart review was conducted for all consecutive patients who underwent pyloromyotomy between October 2004 and October 2011. Data extraction included demographic information, history of illness, physical findings, baseline laboratory values, and results of ultrasound imaging if performed. The total and postoperative lengths of stay were recorded.

Age at presentation was calculated as time from birth to admission to the hospital. We defined alkalosis as pH ≥7.45 on arterial blood sample, elevated bicarbonate as bicarbonate >25mmol/L on arterial or venous sample, hypochloremia as chloride <95 mEq/L on venous sample and hypokalemia as potassium <4 mEq/L on venous sample. The sonographic criteria used to diagnose IHPS were a pyloric muscle thickness of ≥4 mm and a pyloric length of ≥14 mm. Full oral feeding was defined as 150 mL/kg body weight daily.

The hospitalized child was not allowed oral feeding and received intravenous hydration. Nasogastric drainage was established in all cases. Infants who had electrolyte and metabolic disturbances required preoperative correction by intravenous fluid replacement. In all cases in which there was metabolic derangement, surgery was postponed until the biochemical parameters had been corrected. No routine antibiotics were used. Only prophylactic antibiotics were used for 24 hours for the prevention of surgical site infection. Ramstedt pyloromyotomy was performed through a right upper quadrant muscle splitting incision. The special pyloric spreader was used. No minimal invasive approach was performed. Feeding was started 12 hours after the operation with low-volume dextrose solution initially and rapidly to full feeds of formula. Patients were discharged once two full-strength full volume feeds had been tolerated and the surgical team was satisfied that the infant was stable.

DEFINITION OF SEASONS

Patients were divided into four groups according to the season. Seasons were defined based on calendar months as follows: winter (December, January, February), spring (March, April, and May), summer (June, July, and August), and autumn (September, October, November).

STATISTICAL ANALYSIS

Statistical analyses were performed by SPSS software for Windows (Version 15.0, Chicago, IL, US). Categorical data analysis was performed using the Pearson's Chi-square or Fisher's Exact test, where applicable. The statistical significance of differences among groups for continuous data was analyzed with the Kruskal Wallis test. A $p<0.05$ was considered statistically significant for all analyses.

TABLE 1: Patient data and laboratory results according to seasons [median (min-max)]

	Spring	Summer	Autumn	Winter	P
Age (median)	5 weeks (3-12)	5 weeks (3-13)	6 weeks (3-13)	4 weeks (3-9)	0.894
Gender (male/female)	18/2	6/2	15/3	9/0	Spr-Sum : 0.555 Spr-Aut :0.653 Spr-Win :1.000 Sum-Aut :0.628 Sum-Win :0.206 Aut-Win :0.529
Body weight (g)	3460 (2400-4800)	3000 (1810-4000)	3680 (2200-4720)	3775 (2770-5300)	0.309
pH	7.57 (7.00-7.68)	7.47 (7.43-7.50)	7.55 (7.31-7.66)	7.53 (7.26-7.65)	0.136
HCO3 (mmol/L)	27.1 (17.4-47.8)	26 (14-28.4)	28.2 (17.2-47.5)	24.8 (17.8-33)	0.815
Cl- (mEq/L)	95.5 (73.7-107)	98.9 (78.6-106.8)	97.4 (63-109.6)	99.7 (84.4-106.4)	0.670
K+ (mEq/L)	3.90 (3-6)	4.54 (3-5)	3.95 (3-6)	4.3 (3-6)	0.367
Longitudinal diameter (mm)	20 (15-29)	21 (16-26)	20 (13-28)	20 (14-32)	0.909
Muscle thickness (mm)	4.6 (3-9)	4.0 (3-5)	5.0 (3-7)	5.0 (4-6)	0.175

RESULTS

A total of 55 cases were included in this study group including 47 boys (85.5%) and 8 girls (14.5%). The male:female ratio of the infants studied was 47:8 (5.8:1). The age distribution of the patients ranged between 3 weeks and 13 weeks (median 6 weeks). Most of our patients presented after 3 weeks of life, with only 5 patients (9.1%) presenting earlier. Median time from diagnosis to surgery was 3 days (min-max 1-8 days).

In 46 cases (83.6%) the diagnosis was based on a history of projectile vomiting and the typical findings of visible peristalsis after a "test meal" and a palpable pyloric tumor. The diagnosis was confirmed by ultrasonography in 51 (92.7%) patients. The median body weight at presentation was 3500 g (min-max 1810-5300).

The age, gender, weight, plasma pH, HCO_3, Cl^- and K^+ values, and US findings of patients were similar in all seasons groups (p>0.05) (Table 1). IHPS was most common in the spring (n=20, 36.3%), followed by autumn (n=18, 32.7%), winter (n=9, 16.3%) and summer (n=8, 14.5%), respectively. The difference between seasons of presentation was statistically significant (p=0.042) (Figure 1).

Metabolic alkalosis was present in most of the patients. The pH was elevated (>7.45) in 42 patients (76.4%) and 32 patients (58.1%) had elevated HCO_3^-. Hypochloremia was detected in 18 patients (32.7%) and hypokalemia was present in 30 patients (54.5%). In all cases where there was metabolic derangement, surgery was postponed until the biochemical parameters had been corrected. Twenty-six patients (47.2%) had jaundice (Table 2).

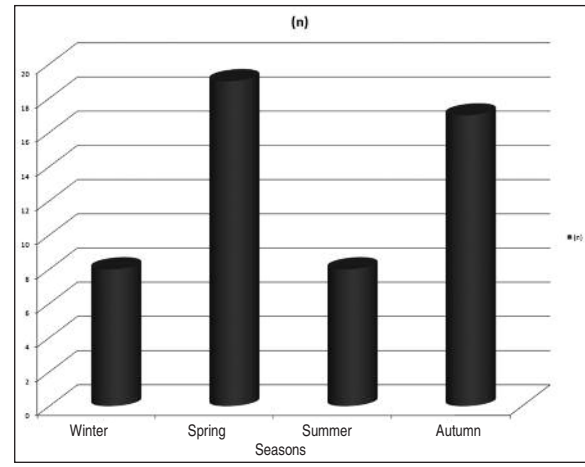

FIGURE 1: Seasonal variation of patients.

Oral feeding was started successfully by 24 hours in 43 infants (78.2%). Twelve children (21.8%) were discharged from the hospital after 3 days. Seventeen infants (30.9%) vomited once or more in the early postoperative phase, although only 5 (9%) had vomiting lasting more than 72

TABLE 2: Patient data and laboratory results on admission (n=55)

Age at operation (median)	6 weeks (min-max; 3-13)
Body weight at admission (median)	3500 g (min-max; 1810-5300)
Muscle thickness of pylorus (median)	5.0 mm (min-max; 3-9)
Longitudinal diameter of pylorus (median)	20.0 mm (min-max; 13-32)
Sex (male/female)	47/8
Diagnosed by ultrasound	51 (92.7%)
Palpable olive mass	46 (83.6%)
Jaundice	26 (47.2%)
Alkalosis as pH ≥7.45	42 (76.4%)
Hypochloremia as chloride <95 mEq/L	18 (32.7%)
Hypokalemia as potassium <4 mEq/L	30 (54.5%)
Elevated HCO3- as bicarbonate >25	32 (58.1%)

hours. All of those cases settled spontaneously within 1 week. The median duration of hospital stay was 6 days (range, 2 to 18 days). There was no intraoperative complication and no perioperative and postoperative mortality.

DISCUSSION

IHPS is a common surgical condition in infancy with a reported incidence of 1 to 4 per 1000 live births.[10] This condition results from a hypertrophied pyloric muscle that can usually be diagnosed by palpation of the "olive" in the mid-epigastrium. Physical examination by an experienced examiner is very accurate, but requires the infant to be relaxed.[8,11]

Our demographic data were similar to that previously reported with a predominance of male patients and presentation at approximately 5 weeks of age.[8,10-12] Vomiting of gastric contents leads to the depletion of sodium, potassium and hydrochloric acid with resultant hypokalemic, hyponatremic, hypochloremic metabolic alkalosis.[8,12] In our study, bicarbonate was higher than 25 mmol/L in 58.1% and a pH >7.45 was present in 76.4% of patients. Hypochloremia was noted in 32.7% of patients.

Seasonal variation in incidence has been reported in other studies but the times of maximum and minimum incidence do not coincide in any of these suggesting that where seasonal variation does exist it is caused by local factors that are yet biologically unexplained.[13] According to Webb et al. seasonal variation in incidence of IHPS was more common in winter months with a peak incidence in March.[13] However, in our series, spring and autumn were the seasons with the highest incidence of IHPS. Kwok et al. were the first to report a seasonal variation in IHPS and they reported that the incidence of IHPS was the highest in April-May and in October-November, similar to our findings.[14] According to other previous studies, the seasonal variation found by some authors was confirmed.[15,16] Overall, there was a higher incidence in children born in September and October although the increases in later years were not confined to infants born in those months. The incidence of IHPS in our study seems to show seasonal variation in accordanve with previous reports. The peak spring and autumn incidence suggests that some seasonally fluctuant environmental factor may play a role in the pathophysiology of IHPS. This most likely would be an infectious agent; however, it is unclear when infection with such an agent might occur.[5]

The diagnosis can be suspected by the primary care physician based on the history; however, vomiting is also very common in infancy. The surgical literature suggests that in most cases an experienced surgeon can palpate the olive and this obviates the need for imaging.[8,17,18] The diagnosis in the majority of our cases was based on clinical findings, although ultrasonography also was used to confirm the diagnosis in most cases.

We found a good correlation between ultrasonographic width and length of the pylorus and the intraoperative findings.

Many studies have investigated the incidence and changing patterns of IHPS methods of surgical correction, and the impact of volume of surgical cases on complications.[12,19] Intra-operative complications such as duodenal perforation occur in 4% of patients operated on for IHPS and in 6% of the patients the post-operative period is complicated with one or more of the following unfavorable con-

ditions like wound infections, incisional hernia, incomplete pyloromyotomy, and persistent vomiting.[19,20] Other large series have varied widely in reported complication rates such as 3% to 60% for postoperative vomiting.[19,21]

There was no inadvertent mucosal perforation in our series. This nonaggressive approach may reflect the higher incidence of persistent postoperative vomiting observed (30.9%) compared with that described by other investigators. In our study, the median postoperative stay was 6 days, which compares well with the 3 to 7 days reported in other series.[12,20]

The major limitation of our study was the retrospectivenature of the study. In addition, a large prospective study allowed us to demonstrate all possible etiological factors, which may yield a new research topic for the etiology of the IHPS.

In conclusion, etiology of IHPS is still controversial. We suggest that some seasonal environmental factor may play a role in the pathophysiology of IHPS.

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