Hypertrophic pyloric stenosis (HPS) is considered one of the most common causes of gastric outlet obstruction (GOO) in infants, affecting 2 per 1000 live births. Prompt diagnosis and resuscitation play an important role in preventing possible morbidities from the associated dehydration and metabolic disturbances. Other diseases in newborns that are associated with longer duration of GOO, such as duodenal and pyloric atresias, are usually complicated by gastric, pyloric, or duodenal atony, which can delay the infants’ ability to tolerate oral intake postoperatively and prolong their overall recovery time. A similar phenomenon could possibly occur in GOO caused by HPS and might be responsible for the variation in the recovery of gastric motility after pyloromyotomy, which has a direct impact on postoperative hospital stay. Several authors have highlighted the advantages of early surgical intervention and rapid institution of oral feeding, particularly in the presence of well-designed clinical pathways, in reducing postoperative recovery period and duration of hospitalization. In this study, we examined the effects of the duration of vomiting as a symptom of GOO caused by HPS on the severity of the presenting metabolic disturbances. We also examined whether prolonged vomiting correlates with or predicts the timing of postoperative feeding and the duration of hospital stay.

**Patients and Methods**

After obtaining an institutional review board approval, the medical records of all patients who underwent pyloromyotomy between February 1997 and February 2009 were reviewed. All premature infants as well as infants...
with significant comorbidities not related to HPS were excluded. Diagnosis was initially established by either an ultrasound or by barium meals followed by intraoperative confirmation. Open or laparoscopic pyloromyotomy was performed once the patient was adequately resuscitated and the associated metabolic derangements were corrected. Feeding was started 6 hours post surgery and advanced gradually according to patient tolerance. Patients were discharged once they tolerated full enteral feeding without vomiting. Records were examined for postoperative morbidities, including wound infections, hernias, the need for redo pyloromyotomies, and readmission within 30 days from the time of operation.

Duration of vomiting at presentation was calculated (in days) from the onset of repeated vomiting to the day of presentation to our institution; it was then correlated with the presenting chloride, pH, and bicarbonate levels. To compensate for the variability in the preoperative stay, the preoperative duration of vomiting was calculated by adding the number of preoperative in-hospital days to the duration of vomiting at presentation. This was then correlated with the time to tolerate full feeding (in hours) and postoperative hospitalization (in days) after excluding patients who developed morbidities as a direct result of surgical technical error. The impact of pyloromyotomy technique was studied by comparing the time to tolerate full feeding and postoperative hospitalization between open and laparoscopic techniques. The Pearson correlation coefficient was used for comparative analysis of continuous variables, and the t test was used to compare the means of two categories, with P<.05 indicating the presence of a significant correlation.

**RESULTS**

During the study period, 47 pyloromyotomies were performed in our institution. The male-to-female ratio was 33:14 (2.4:1), and the mean (SD) age at presentation was 42 (17.3) days. In addition to ultrasound, barium meal was performed in 11 (23.4%) patients to confirm the diagnosis. The median and mean duration of vomiting at presentation were 14 (3-60) and 16.6 (13.3) days, respectively, with 9 (19%) of our patients having been symptomatic for more than 4 weeks. Patient metabolic parameters at presentation showed a mean chloride level of 93.9 (8.8) mEq/L; pH 7.5 (0.9); and bicarbonate, 27.8 (6.4). However, no significant correlation was detected between these parameters and the duration of vomiting at presentation (Table 1).

Pyloromyotomy was performed at a mean of 1.9 (1.2) days following admission. After excluding 1 patient, who developed significant postoperative wound infection because of technical difficulties during his surgery, the mean duration of vomiting at operation was 16.5 (13.4) days. The mean time to tolerate feeding after pyloromyotomy was 31 (15.1) hours, and total duration of postoperative hospitalization was 5.1 (2.2) days. Again, neither the time to tolerate full feeding nor the duration of hospitalization had any significant correlation with the preoperative duration of vomiting of the study population (Table 2). Twenty-nine patients had open pyloromyotomy, and 18 had laparoscopic pyloromyotomy. The use of different techniques did not have a significant impact on the time to tolerate full feeding (P=.3) or hospitalization days (P=.7) (Table 3).

**DISCUSSION**

Many authors have demonstrated that the implementation of standardized protocols in managing HPS reflects positively on its outcome, leading to shorter

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**Table 1.** Preoperative data correlated with the preoperative duration of vomiting.

|   | Mean (SD) | r  | P value |
|---|-----------|----|---------|
| Total/male | 47/33 |   |         |
| Age (days) | 42 (17.3) |   |         |
| Duration of vomiting at presentation | 16.6 (13.3) |   |         |
| Admission to surgery (days) | 1.9 (1.2) | .13 | .39     |
| Chloride | 93.9 (8.8) | .13 | .39     |
| pH | 7.5 (0.9) | .42 | .12     |
| HCO₃⁻ | 27.8 (6.4) | -.21 | .17     |

r, coefficient of correlation with the duration of vomiting.

**Table 2.** Postoperative outcome data correlated with duration of vomiting.

|   | Mean (SD) | r  | P value |
|---|-----------|----|---------|
| Total | 46 |   |         |
| Duration of vomiting at surgery (days) | 16.5 (13.4) | -.94 | .53     |
| Time to full feeding (hours) | 31 (15.1) | -.022 | .09     |
| Total hospitalization (days) | 5.1 (2.2) | -.022 | .09     |

r, coefficient of correlation with duration of vomiting at surgery until the time of surgery.
hospitalization and cost savings,7-9 emphasizing the role of early and rapid advancement of postoperative oral feeding.7,10 Our data are clearly different from what have been reported by others. For instance, there was a noticeable delay in the presentation or diagnosis of HPS in our population, as is evident from the prolonged duration of projectile vomiting before presentation, with a median of 14 (3-60) days and a mean of 16.6 (13.3) days, compared with a reported median of 5 (1-35) days by some11 and a mean of 5.5 (5.1) days reported by others in a general hospital12 and 9.9 (9.7) days reported by another specialized pediatric surgery unit.13 Moreover, 19% of our patients did not present until their duration of vomiting had exceeded 4 weeks. Another difference is the frequent use of barium meals in addition to ultrasound for confirming the presence of HPS. Despite these differences, our patients had a comparable time before tolerating full feeding and a number of hospitalization days like that reported in other studies.2,7,11,12 These two observations are likely attributable to the low incidence of HPS cases encountered by our physicians and radiologists (personal communication, Dr. M. Zamakhshary, with permission). This could have negatively impacted on their ability to suspect the disease and diagnose it early. In addition, the limited availability of specialized pediatric care, which could have contributed to the delay in making the diagnosis and consequently in the provision of appropriate management. Unfortunately, we still lack the appropriate epidemiological data to support this inference.

Only 1 (2.1%) patient developed a significant postoperative complication, and none needed redo pyloromyotomy. Unlike in other series,10-12 we did not include persistent postoperative vomiting in our outcome data, as it can be indirectly predicted by the other measured outcomes, such as time to tolerate full feeding and postoperative hospital stay. Unlike recently published reports,13,14 we did not find an impact on the time to tolerate feeding or total hospitalization from a minimal invasive technique. This is probably attributable to the retrospective nature of our study, which might have lacked sufficient numbers of patients compared to other studies.13,14 A similar finding was demonstrated in an earlier prospective trial.15

In theory, the delayed presentation or longer duration of vomiting in HPS could worsen the associated metabolic derangements and subsequently delay the operative intervention as the resulting derangements might require a longer time after admission to correct. It has also been reported that after pyloromyotomy the stomach will take 12 to 18 hours to regain its activity,3 so it is possible that the longer duration of the associated GOO would cause a slow postoperative regain of gastric motility and therefore delay the infant's ability to tolerate full feeding and thus prolong hospitalization. However, contrary to this belief, our study did not demonstrate any correlation between the duration of symptomatic GOO and any of the expected outcomes.

It is possible that metabolic derangements are better correlated with the severity of the pyloric stenosis or the frequency of vomiting rather than its duration. Based on this, the longer duration of less tight stenosis, which allows the passage of some fluid, might not result in worse electrolytes and acid-base disturbances. The lack of significant correlation between the duration of symptoms and the postoperative recovery time or hospitalization can be explained in a similar fashion. In fact, the pyloric thickness or length as an indicator of severity of stenosis could have better correlated with our outcomes rather than the duration of symptoms, but unfortunately these measures were not reliably documented by our radiologists because of their frequent reliance on contrast studies.

In conclusion, our study shows that patients who had pyloromyotomy after a longer duration of vomiting can still be fed early and enjoy a recovery period similar to the others who presented earlier. Existing protocols for managing HPS may still be applicable for this group of patients without any modification in the postoperative feeding or discharge instructions. Future studies with a larger sample could help in identifying the role of pyloric ultrasound measurements in the disease outcome.

| Table 3. Impact compared between laparoscopic pyloromyotomy (Lap) and open pyloromyotomy. |
| Open mean (SD) | Lap mean (SD) | P value |
|----------------|---------------|---------|
| Number         | 29            | 18      |        |
| Time to full feed (days) | 32.8 (14.2) | 27.5 (16.2) | .3      |
| Total hospitalization (days) | 5.1 (2.2) | -0.022 | .7      |
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