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A review of postoperative feeding regimens in infantile hypertrophic pyloric stenosis

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Abstract Infantile hypertrophic pyloric stenosis is a condition well known to pediatric surgeons. Postoperative length of hospital stay is a financial concern and remains a potential target for reduction in hospital costs. Ultimately, these costs are directly affected by the ability to effectively advance postoperative enteral nutrition. This review will serve to: 1) identify clinically relevant postoperative feeding patterns following pyloromyotomy, 2) review the relevant literature to determine an optimal feeding pattern, and 3) identify possible preoperative predictors that may determine the success of postoperative feeding regiments.

Infantile hypertrophic pyloric stenosis is a condition well known to pediatric surgeons, and has been deemed "the most common cause for surgery in the first 6 months of life" [1]. This condition affects a large group of children annually with an incidence of 1.8 per 1000 births [2]. Postoperative length of hospital stay is a financial concern and remains a potential target for reduction in hospital costs. Ultimately, these costs are directly affected by the ability to effectively advance postoperative enteral nutrition [3,4]. Some experts calculated the potential savings to be $392.00 per patient [5] while others estimate an impressive $1290 saved per patient [6]. Therefore, the purpose of this review is to: 1) identify clinically relevant postoperative feeding patterns following pyloromyotomy, 2) review the relevant literature to determine an optimal feeding pattern, and 3) identify possible preoperative predictors that may determine the success of postoperative feeding regimens. The major studies cited in this review and the associated levels of scientific evidence considered are listed in Table 1 [7,8].

1. Postoperative feeding regimens

There are several choices to consider when determining the timing of initiation of enteral feeds following a pyloromyotomy. Some practice patterns have initiated feedings as soon as the infant awakens from anesthesia [6,9]. Some authors have suggested a period of withholding feedings for several hours postoperatively [10], while others have recommended a significantly longer period of starvation, up to 18 h, before initiating feedings [11]. The ongoing debate arises over whether a physician chooses a standardized, incremental feeding regimen versus an ad libitum feeding schedule which allows the infant to decide when and

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Table 1 Level of evidence for major studies cited.

Study	Level of Evidence [7,8]
Leinwand et al. [3]	II
Carpenter et al. [4]	III
Adibe et al. [9]	II
Puapong et al. [6]	II
van der Bilt et al. [10]	II
Turnock et al. [11]	I
Georgeson et al. [12]	III
Lee et al. [13]	III
Leahy et al. [14]	II
Foster et al. [15]	II
Gollin et al. [16]	III
Wheeler et al. [18]	I
Garza et al. [5]	II
St. Peter et al. [19]	I

Level I: Prospective randomized controlled trials or meta-analyses.
Level II: Prospective studies without randomization, retrospective case–control studies, or cohort studies.
Level III: Uncontrolled studies using retrospective data (ie, case reviews, clinical series, expert opinion).

how much to eat. Thus, physicians are presented with four broad feeding regimens: immediate ad lib, delayed ad lib, immediate standardized, and delayed standardized. Of course, there exist numerous variations when considering exactly how many hours postoperatively to initiate feeding, as well as how aggressively the standardized regimen reaches full feeds.

1.1. Immediate versus delayed feeding

When considering immediate versus delayed feeding regimens, the total number of postoperative emeses has been a primary factor used to evaluate patient progress. It is important to note that many studies have slightly different definitions of "immediate" and "delayed" feeds, which can range from initiation of feeds immediately upon awakening from anesthesia to 1, 4, 6, or 8 h postoperatively (Table 2). The general consensus in literature indicates that feedings initiated earlier than 6 h postoperatively are considered "immediate", and any time after that is considered a "delayed" feed. At least four studies comparing immediate versus delayed feeding reported that the incidence of emesis is increased with immediate feeding [10,12–14], while several other studies determined that emesis will occur regardless of feeding regimen, and that immediate feeding does not increase incidence of postoperative emesis [15–18].

Table 2 Variation in definition of immediate versus delayed feeding demonstrated by time to initial feeding.

Study	Time to Immediate Feeding	Time to Delayed Feeding
van der Bilt et al. [10]	0 h	≥ 4 h
Turnock and Rangecroft [11]	4 h	18 h
Georgeson et al. [12]	6 h	>10 h
Lee et al. [13]	<8 h	13–20 h
Leahy et al. [14]	4 h	24 h
Foster and Lewis [15]	3–6 h	>6 h
Gollin et al. [16]	1 h	6 h
Wheeler et al. [18]	4 h	24 h

The ultimate goal of initiating early feedings is to achieve full feeds more quickly, and therefore safely decrease total length of hospital stay. Turnock and Rangecroft [11] found that there was no difference in the percentage of infants who vomited with immediate versus delayed feeding, but the frequency of emesis was higher in the immediate group, thus suggesting a longer period of postoperative starvation [9]. Wheeler et al. advocated for a 24 h period of starvation following surgery in an attempt to decrease postoperative emesis [16]. These recommendations come in spite of their conclusion that vomiting is self-limited and independent of the timing and composition of the designated feeding regimen. The mere incidence of emesis may not correlate with a worse prognosis or an increased postoperative hospital stay. Several studies have confirmed that while an immediate feeding regimen may increase the incidence of emesis, this increase did not impact ad lib feeding tolerance, lengthen hospital stay, or increase postoperative complications [10,12].

Many concerns surrounding immediate feeding regimens take into account the degree of postoperative gastroparesis. Studies analyzing radiographic and manometric functional variables suggest that gastric peristalsis completely ceases for 4–6 h postoperatively and is profoundly depressed for 12–18 h postoperatively [17]. Interestingly, despite these functional results, the same study found no difference in the frequency of emesis between infants fed at 1–2 h postoperatively versus those fed greater than 12 h postoperatively. Other studies suggest waiting to restart feedings until the 4–6 h window postoperatively when peristalsis was shown to resume [10,12]. Gollin et al. found no difference in the frequency or number of emeses when comparing infants who initiated feeding one hour postoperatively versus six hours postoperatively, therefore advocating for a rapid and early feeding regimen due to an earlier discharge of 20–24 h [16].

Despite convincing postoperative gastroparesis data, other studies advocate for an immediate ad lib feeding regimen upon awakening from anesthesia [5,6,9]. These studies found a significantly shorter time to full feeds with no statistical difference in frequency of emesis (Table 3). Only one study specifically compared the time to initiation of feedings while keeping the feeding regimen identical between cohorts [10]. They concluded that clinical outcome and time to discharge were not adversely affected by early feeding (within 4 h after surgery versus after 4 h). However, they advocate waiting 4 h due to an increased incidence of severe vomiting that modified the feeding regimen in the early group (23%) versus the late group (6%, $p=0.003$).