

Transpyloric feeding with artificial lung ventilation in premature with pneumonia: an observational study

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Abstract

INTRODUCTION: Feeding critically ill patients on mechanical ventilation through a gastric tube can be challenging. Parenteral nutrition is often preferred when enteral feeding is problematic. Transpyloric feeding has been identified as an optimal method of nutrition for seriously ill premature infants. **OBJECTIVE:** This study aims to evaluate the advantages of transpyloric feeding combined with artificial ventilation compared to gastric feeding in premature neonatal patients. **MATERIALS AND METHODS:** The study included 64 patients with low tolerance to enteral feeding who required mechanical ventilation. The gestational age of the patients did not exceed 34 (32–35) weeks. Enteral feeding using a NAN® mixture was administered through a feeding tube placed outside the pylorus with an anti-reflux mechanism. The volume of enteral feeding was determined based on the requirement of 120 kcal/kg/day. **RESULTS:** The results of the study demonstrated that the group receiving transpyloric feeding had a significantly shorter hospital stay of 54 (41–67) days compared to the group receiving gastric feeding with 86 (64–94) days, $p < 0.05$. The weight gain in the group receiving gastric feeding was significantly lower at 89 (55–200) g compared to the group receiving transpyloric feeding with 161.5 (110–218) g. Similar findings were observed regarding a decrease in total protein levels on the 10th day of the study in the gastric feeding group with 36.5 (32–40) g/l compared to the transpyloric feeding group with 47 (42–50) g/l, $p < 0.05$. **CONCLUSIONS:** Transpyloric nutrition in premature infants on mechanical ventilation is a more efficient method compared to gastric feeding. The findings suggest positive effects including reduced hospitalization duration, prevention of hypoproteinemia, and significant increase in body weight.

Транспилорическое кормление при искусственной вентиляции легких у недоношенных детей с пневмонией: наблюдательное исследование

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Реферат

АКТУАЛЬНОСТЬ: Как известно, питание через гастральный зонд не всегда хорошо переносится тяжелобольными пациентами на искусственной вентиляции легких (ИВЛ). При возникновении проблем с усвоением энтерального кормления врачи отдают предпочтение парентеральному питанию. Транспилорический метод кормления является оптимальным методом для тяжелобольных недоношенных детей. **ЦЕЛЬ ИССЛЕДОВАНИЯ:** Оценить преимущества использования транспилорического метода кормления у недоношенных детей, находящихся на ИВЛ, в сравнении с гастральным кормлением (ГК). **МАТЕРИАЛЫ И МЕТОДЫ:** В исследование были включены 64 пациента, которые имели низкую толерантность к энтеральной нагрузке, а также нуждались в проведении ИВЛ. Гестационный возраст пациентов не превышал 34 (32–35) недель. Для энтерального кормления через питательный зонд, установленный за пределы привратника, использовали смесь NAN® Антирефлюкс. Объем энтерального кормления определяли из расчета необходимой потребности 120 ккал/кг/сут. **РЕЗУЛЬТАТЫ:** В результате проведенного исследования в группе больных с транспилорическим кормлением обращает на себя внимание меньший срок пребывания в стационаре — 54 (41–67) дня по сравнению с группой ГК — 86 (64–94) дней, $p < 0,05$. Прибавка массы тела в группе ГК была значительно ниже — 89 (55–200) г по сравнению с группой транспилорического кормления — 161,5 (110–218) г. Аналогичные изменения зафиксированы и в отношении снижения уровня общего белка на 10-й день исследования в группе ГК (36,5 [32–40] г/л) по сравнению с группой транспилорического кормления (47 [42–50] г/л), $p < 0,05$. **ВЫВОДЫ:** Использование транспилорического питания у недоношенных детей на ИВЛ в сравнении с ГК является более эффективным методом. Полученные данные свидетельствуют о таких положительных эффектах, как снижение срока госпитализации, предотвращение гипопроотеинемии, большая прибавка массы тела.



KEYWORDS: neonatology intensive care, transpyloric feeding, gastroparesis

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КЛЮЧЕВЫЕ СЛОВА: интенсивная терапия в неонатологии, транспилорическое кормление, гастропарез

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Introduction

Impaired motor function of the upper gastrointestinal tract (GIT) is a prevalent issue in the neonatal intensive care unit (NICU). Delayed gastric emptying can lead to enteral nutrition intolerance and progressive nutrient deficiency. It has been estimated that gastrointestinal dysfunction affects at least 60 % of patients in the NICU [1, 2]. Additionally, approximately 30 % of patients in the NICU who attempted enteral nutrition had to discontinue it due to reduced tolerance to feeding [2]. Prolonged withholding of enteral nutrition is associated with extended stays in the NICU and increased mortality rates [3–6].

Gastroparesis, characterized by impaired gastric emptying without any mechanical obstruction, is frequently observed in newborns. The development of gastroparesis is influenced by several factors, including compromised perfusion of the gastrointestinal wall, the release of inflammatory cytokines, intestinal wall edema due to capillary leakage, hyperglycaemia, electrolyte imbalances, and hormonal dysregulation affecting motility. These factors collectively impact both the proximal and distal motility of the stomach.

Objective. The objective of this study is to assess the benefits associated with the utilization of the transpyloric feeding method in premature infants undergoing artificial ventilation as compared to gastric feeding.

Materials and methods

A prospective, longitudinal study was conducted at the Children's Hospital of Irkutsk from September 2021 to September 2022, under the supervision of Chief Physician, MD, professor Novozhilov V.A. The study received approval from the local Ethics Committee of the Russian Medical Academy of Continuous Professional Education in Irkutsk, Russia (Protocol No. 10, November 28, 2021). Informed consent was obtained voluntarily from the legal representatives of all participating children. The study included 64 patients aged between 10 and 90 days of life, with a gestational age corresponding to 29 (26–37) weeks. All patients had a confirmed diagnosis of pneumonia [6], requirement of mechanical ventilation, and exhibited low tolerance to enteral feeding through a gastric tube. Patients with congenital malformations, those who had undergone gastrointestinal tract surgery, and individuals with contraindications for enteral nutrition were excluded from the study.

Patients who required mechanical ventilation and exhibited clinical manifestations of gastroesophageal reflux (GER) while receiving gastric feeding (GF) were offered transpyloric feeding (TPF). The installation of a transpyloric tube (TPT) was guided by ultrasound imaging [7], with successful placement and confirmation of the tube's location using a portable ultrasound scanner, Mindray M7 (China). The ultrasound method for visualizing the position of the TPT was found to be effective and safe, with a success

rate of 94.1 % [7]. An anti-reflux formula was used for enteral feeding through a feeding tube placed after the pylorus. The volume of enteral feeding was determined based on the requirement of 120 kcal/kg/day. The administered volume of the nutrient formula, adjusted according to body weight, was delivered within a two-hour period. The assessed indicators were evaluated on the first and tenth days of transpyloric feeding. The duration of tube placement in the transpyloric position was limited to ten days to mitigate the risk of complications [8], and no complications related to transpyloric feeding were observed.

The severity of each patient's condition was assessed using the following scales: nSOFA-Neonatal Sequential Organ Failure Assessment (Neonatal Organ Failure Assessment scale) [9], NTISS-Neonatal Therapeutic Intervention Scoring System (neonatal treatment effectiveness scale) [10], and SNAP-Score for Neonatal Acute Physiology (Neonatal Acute Physiology Assessment Scale) [11]. Scores were calculated based on medical records upon admission to the intensive care unit, and the maximum score at admission and on the tenth day was utilized for analysis. Pneumonia therapy adhered to Russian clinical guidelines [6]. During treatment, all children underwent invasive mechanical ventilation using Maquet servo-i infant devices, employing "Pressure Controlled Ventilation" (PCV). Ventilation parameters were selected based on the severity of the condition upon admission and the acid-base state results.

Statistical analysis

Statistical analysis was performed using the STATISTICA 10.0 program for Windows. The distribution normality was assessed using the Kolmogorov-Smirnov criterion. Quantitative data are presented as medians and quartiles — Me (p24–p75). The Mann-Whitney test was employed to analyze the statistical significance of differences in quantitative characteristics between two independent groups. A significance level of $p < 0.05$ was considered statistically significant.

Results

The degree of organ dysfunction was assessed using the nSOFA, NTISS and SNAP scales. In the group receiving transpyloric feeding (TPF), the nSOFA score was estimated at 3 (3–4) points, while in the gastric feeding (GF) group, it was 3 (2–4) points. NTISS with a score of 26 (23–29) points in the GF group and 25 (23–26) points in the TPF group. SNAP resulting in a score of 92 (85–100) points in the GF group and 94 (88–99) points in the TPF group. The laboratory data over time are presented

in the table. No statistical differences were observed between the compared groups at the beginning of the study (Table 1).

During the course of the study, noticeable improvements were observed in the condition of newborns receiving transpyloric feeding (TPF). There was a more significant and sustained decrease in the concentration of oxygen in the inhaled air during mechanical ventilation. By the tenth day, this indicator decreased by 47 % in the TPF group, whereas in the gastric feeding (GF) group, it decreased by only 30 % ($p < 0.05$). However, the duration of mechanical ventilation did not show a significant change and did not reach statistical significance. In the GF group, the duration was 10.5 (9–12) days, while in the TPF group, it was 10 (8–13) days.

Throughout the intensive care period, the TPF group exhibited a two-and-a-half-fold reduction in leukocytosis, whereas the GF group only experienced a two-fold reduction. As a result of TPF treatment, the total protein level increased by 4 % in this group, whereas in the GF group, it decreased by 25 % ($p < 0.05$). Furthermore, a significant increase in body weight was observed in the TPF group, with a gain of 161.5 (110–218) g, whereas the GF group only experienced a gain of 89 (55–200) g, $p < 0.05$.

There were no statistically significant differences in the changes in severity of the condition on day 10. According to the NTISS scale, the GF group had a score of 6 (3–9) points, while the TPF group had a score of 5 (3–6) points. On the nSOFA scale, on the tenth day of treatment, the TPF group scored 2 (1–2) points, and the GF group scored 2 (1–3) points. Regarding the severity of the patient's condition on the SNAP scale on day 10, the GF group scored 22 (15–26) points, whereas the TPF group scored 19 (16–22) points.

In terms of hospital stay, the group of patients receiving TPF had a duration of 54 (41–67) days, whereas the GF group had a duration of 86 (64–94) days ($p < 0.05$).

Discussion

Newborns, particularly preterm infants, have limited nutrient reserves and higher energy and material demands, making them more susceptible to hypercatabolic processes. Therefore, it is crucial to establish a clear algorithm for nutritional support in these critically ill infants. Recognizing the need for early nutritional support initiates its implementation as soon as possible. Early transition from parenteral nutrition to enteral feeding helps prevent bacterial translocation syndrome in the undernourished intestines. However, numerous studies indicate that premature infants often struggle with tolerating gastric feeding.

Table 1. Comparative characteristics of the studied indicators between groups on the 1 and 10 days of the beginning the feeding

Test trait	GF group, <i>n</i> = 32 Me (p25–p75)		TPF group, <i>n</i> = 32 Me (p25–p75)	
	Day 1	Day 10	Day 1	Day 10
Platelets, $n \times 10^9$	91 (112–138)	101 (100–173)	89 (100–144)	110 (100–150)
Leukocytes, $n \times 10^9$	18.2 (12.8–19)	8.7 (6.7–9.9)	14.2 (10.8–16.8)	6.8 (5.5–9.5)
Leucocyte formula shift to the left, %	15 (12–22)	5 (3–7)	12 (8–17)	3.8 (2–4)
Total protein, g/l	49 (42–53)	36.5 (32–40)*	45 (37–50)	47 (42–50)*
Urea, mmol/l	3.3 (2.7–3.5)	3.2 (2.9–3.4)	4.2 (3–5.8)	4 (3.2–5.4)
Creatinine, mmol/l	37 (28–56)	38 (33–57)	38.5 (30–53)	40 (32–53)
pH	7.22 (7.16–7.24)	7.38 (7.36–7.4)	7.21 (7.16–7.24)	7.37 (7.35–7.4)
pCO ₂ , mm Hg	68.2 (63.9–71.2)	43 (38–46)	68 (62.3–71.2)	43 (38–49)
pO ₂ , mmHg	34 (29–40)	47 (41–53)	35 (29–41)	44 (36–52)
Glucose, mmol/l	4.5 (3–7)	4.7 (3.8–5.9)	5 (3–7)	5.3 (4–6)
HCO ₃ ⁻ , mmol/l	22.2 (19.4–25.5)	25.9 (24.2–27)	22.4 (19.4–25)	23.6 (21.2–26.4)
FiO ₂ , %	65 (55–75)	45 (35–55)*	67.5 (55–80)	36 (35–45)*
K ⁺ , mmol/l	4.1 (3.5–4.5)	3.9 (3.4–4.2)	3.8 (3.5–4.2)	4 (4–5)
Na ⁺ , mmol/l	137.5 (136–142)	139 (137–141)	138 (136–141)	138 (136–140)
Ca ²⁺ , mmol/l	1.1 (1–1.3)	1 (1–1.2)	1.1 (1.1–1.3)	1 (1–1.2)

* $p < 0,05$ in comparison of GF and TPF groups.

GF group — gastric feeding, TPF group — transpyloric feeding.

The scientific literature on identifying the optimal feeding method has conflicting findings. Gastroparesis is frequently observed as a manifestation of gastrointestinal dysfunction, with the etiology often unknown in children. While this condition affects 4 % of adults, there is limited data on its prevalence in children [12].

Published studies have demonstrated that transpyloric feeding (TPF) is comparable in effectiveness to surgical fundoplication. This study is the first to demonstrate the advantages of TPF over gastric feeding (GF) in premature infants with pneumonia and undergoing mechanical ventilation. The GF group showed significantly lower weight gain compared to the TPF group. Similar changes were observed in the decrease of total protein levels in the GF group. Furthermore, the duration of mechanical ventilation and length of hospital stay were significantly shorter in the TPF group. Consequently, it can be concluded that transpyloric nutrition is a more effective method compared to gastric feeding for premature infants on mechanical ventilation.

However, it is worth noting that there are studies in the scientific literature that restrict the use of TPF. A group of researchers led by E.A. Jensen from the Department of Neonatology at the Children's Hospital of Philadelphia, Pennsylvania, USA, found that TPF slightly increased the frequency of hypoxemia among study participants [13]. Additionally, there have been reported cases of spontaneous perforation when using nutrient tubes placed outside the pylorus [14].

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Conclusion

Impaired tolerance to enteral nutrition is a significant challenge in a considerable number of seriously ill patients in the neonatal intensive care unit. Addressing this issue requires active involvement from resuscitators and the implementation of practical approaches such as transpyloric feeding. The findings of a prospective study have demonstrated that transpyloric nutrition is an effective method of providing nutrition to critically ill infants. This approach enables rapid stabilization of the nutritional balance, substantial weight gain, reduction in oxygen concentration during mechanical ventilation, and ultimately, a shorter hospital stay.

Disclosure. The authors declare that they have no competing interests.

Author contribution. All authors according to the ICMJE criteria participated in the development of the concept of the article, obtaining and analyzing factual data, writing and editing the text of the article, checking and approving the text of the article.

Ethics approval. This study was approved by the local Ethical Committee of Russian medical academy of continuous professional education, Irkutsk, Russia (reference number: 10-28.11.2021).

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