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Bolus Enteral Nutrition: Improves Splanchnic Circulation in Critical Newborn

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SUMMARY

Objective: To demonstrate how enteral bolus nutrition increases splanchnic oxygenation in critically ill newborns.

Material and Methods: Systematic review, structured question IOP was translated into indexed language through DeCS and MeSH for a precise search the reliable documentary source consulted were Cochrane, PubMed, Epistemonikos, Trip Database, EBSCO, Ovid; UNAM Digital Library; BVS (Virtual Library in Health), SciELO and Elsevier. Boléanos and positional operators were used as a search strategy. We included 10 articles with randomized clinical trial design and observational cohort, no older than ten years of publication, excluding studies in adult population. The quality evaluation was through the Platform Critical Reading Sheets 3.0 and graded by OXFORD scale.

Results: 192 articles were identified, 145 were eliminated in the sampling for not meeting the inclusion criteria, of which 47 were eligible and underwent a critical reading process through the FLC 3.0 platform, finally 10 (100%) articles with high quality were included, whose designs were 10% (1) randomized trial and 90% (9) observational cohort studies for the hierarchy were used the OXFORD scale.

Conclusion: The reviewed evidence supported that enteral bolus nutrition allows the increase of splenic oxygenation levels favoring gastrointestinal function being effective in preventing the presence of complications and improving the prognosis of life of the preterm neonate by reducing the risk of necrotizing enterocolitis and increasing mesenteric blood flow.

Keywords: Newborn; Enteral Nutrition; Feeding Methods; Oxygenation/Metabolism; Splanchnic Circulation

Abbreviations: BVS: Biblioteca Virtual en salud (Virtual Library in Health); IOP: Intervention Question Result; DBP: Displasia Broncopulmonar (Bronchopulmonary Dysplasia); SCOR: Relación De Oxigenación Esplácnico Cerebral(Cerebral Splanchnic Oxygenation Ratio); ECN: Enterocolitis Necrosante(Necrotizing Enterocolitis); TOI: Índice de oxigenación en el tejido (TOI: Tissue Oxygenation Index); SNG: Sonda nasogástrica (Nasogastric Tube); SOG: Sonda orogástrica (Orogastric Tube); AB: Alimentación en bolo(Bolus Feeding), AGA: Adecuados para la edad gestacional (Suitable for Gestational Age); AME: Arteria Mesentérica (Mesenteric Artery); AEB: Alimentación enteral en bolo(Bolus Enteral Feeding); CEF: Continuous Enteral Feeding (ACE: Alimentación enteral continua)

Introduction

The neonatal stage is characterized as one of the stages of accelerated growth and where nutrition has the greatest impact, in this sense enteral feeding and optimal nutrition in the term and premature newborns play an important role in the prevention of complications [1,2]. The World Health Organization (WHO) defines preterm newborns as those born less than 37 weeks gestation [3]. The incidence of prematurity worldwide ranges between 5 and 10%, being considered higher in underdeveloped countries [4]. At the national level, the National Institute of Perinatology reports an incidence of 19.7% of premature babies, on the other hand, the Mexican Institute of Social Security (IMSS) specifies ranges ranging from 2.8% to 16.6% of prematurity. At the local level, there are 67,192 births belonging to preterm live births, which represents 7.2% of all births [5-7]. The main causes of morbidity and mortality of the preterm infant predominate the respiratory distress syndrome (RDS) consecutive bronchopulmonary dysplasia (DBP: Displasia Broncopulmonar) due to infections and the existence of necrotizing enterocolitis (ECN: Enterocolitis Necrosante (Necrotizing Enterocolitis)) [8-10].

Enteral feeding, according to the Clinical Practice Guidelines (CPG), should be started in the first 4 days of life, considering that premature newborns are hemodynamically and physiologically stable, different benefits are alleged when starting enteral feeding early as fewer incidences due to hyperbilirubinemia, cholestatic jaundice and osteopenia; They determine that enteral nutrition by intermittent bolus is more physiological compared to other feeding methods causing a cyclical increase in intestinal hormones, however, there is no significant evidence regarding somatic growth, incidence of enterocolitis and food tolerance [11-13]. Bolus feeding is food that is administered in equal volumes every three hours in neonates weighing less than 2500 grams and every two hours in neonates weighing less than 2 500 grams. The goals of enteral tube feeding are to provide growth similar to intrauterine growth without causing any damage to its metabolic, excretory functions, or to compete with it in a complicated state [14-16].

Among the antecedents of the present research is in a study conducted in 32 preterm infants whose objective was to test the hypothesis that tissue oxygenation in the splanchnic bed compared to tissue oxygenation in the cerebral circulation changes after feeding in preterm infants who tolerate orogastric feeding in full bolus feeding, In conclusion, this study indicates that the ratio of cerebral splanchnic oxygenation (SCOR: Relación De oxigenación Esplácnico Cerebral) and splenic tissue oxygenation index (TOI) (TOI: Índice de oxigenación en el tejido (Tissue Oxygenation Index)), but not cerebral TOI, increases significantly after feeding in stable preterm infants who tolerate complete orogastric feeding. Studies in preterm infants have shown that, after bolus feeding, there is significant vasodilation in the mesenteric circulation [17]. In line with this finding, a concomitant increase in splenic oxygenation has been described, which is related to better feeding tolerance and as a protective factor against necrotizing enterocolitis. Based on the above there is a reasonable doubt as to the benefits of bolus feeding in premature newborns for the reduction of necrotizing enterocolitis, food tolerance and growth, therefore, this paper describes the objective of demonstrating how enteral bolus nutrition increases splanchnic oxygenation in critically ill newborns.

Materials and Methods

Quantitative research, type systematic review through the phases of Evidence-Based Nursing, the research question was formulated based on the Population, Intervention and Outcome (IOP) model, the object of study was enteral bolus nutrition, the characteristics of the population included were: preterm newborns in critical condition. The answer to the question was through the stages of the bibliographic search, once the evidence was located, it underwent a screening process through the PRISMA statement [18], the internal and external evaluation of the eligible articles was carried out and finally their level of evidence and degree of recommendation was assigned.

Search Strategy

The search covered a single time period from 19 January to 07 March 2021. The process of analysis and preparation of the search began with a list of terms according to the elements of the IOP question and were translated into a language indexed through the Descriptors in Health Sciences (DeCS) [19] and the Medical Subject Headings (MeSH) [20] and was considered free terms (Table 1). The sources consulted were: Databases: EBSCO, PubMed, Cochrane, Epistemonikos, Ovid, Electronic Journal: SciELO, Publisher: Elsevier, Metabuscador: Trip Database, and virtual libraries: UNAM Digital Library, BVS: Biblioteca Virtual en salud (Virtual Library in Health); inclusion criteria were considered: articles with publication not exceeding 10 years, studies with randomized clinical trial design, observational cohort and for the precise search AND, OR and positional SAME, WITH operators were used to form search strings. We excluded those studies where the population were adult patients, patients who did not have enteral feeding treatment by means of nasogastric tube (SNG: Sonda nasogástrica (Nasogastric Tube)) or orogastric tube (SOG: Sonda orogástrica (Orogastric Tube)), who presented little validity and those who could not access the full text.

Table 1: Indexed terms of the structured question.

LANGUAGE	STRUCTURED QUESTION ELEMENTS		
	Patient/ Problem Critically ill preterm infants	**Intervention Intermittent Bolus Enteral Feeding**	**Result Splanchnic circulation**
SPANISH	Preterm Newborn* Critical Care*	Enteral nutrition* Feeding methods* Intermittent bolus feeding***	Oxygen** Splenic oxygenation*** Splanchnic Circulation**
ENGLISH	Infant, Premature* Critical Care*	Enteral Nutrition* Feeding Methods* Intermittent bolus feeding***	Oxygen** Splanchnic oxygenation*** Splanchnic Circulation**
PORTUGUESE	Premature Newborn* Critical Care*	Enteral Nutrition* Feeding Methods* Intermittent bolus power***	Oxygenation** Spanic oxygenation*** Splanplankton Circulation**

Note: Source: own elaboration Terms in *DeCS, **MeHS and ***Libres

Results

According to the PRISMA statement, a total of 192 articles were identified in various sources, in the sampling 145 were eliminated for not meeting the aforementioned criteria, of which 47 were eligible and underwent a critical reading process through the FLC 3.0 platform [21], finally 10 (100%) articles with high quality were included, whose designs were 10% [1] randomized trial and 90% [9] observational cohort studies (Figure 1). The remaining 30 were eliminated for not meeting quality criteria. The interpretation to assign level of evidence and the degree of recommendation was used by the scale of the Centre for Evidence-Based Medicine, Oxford (OCEBM) (Table 2). Evidence indicates that bolus feeding increases blood flow levels at the mesenteric level and with this splenic oxygenation [22-31].

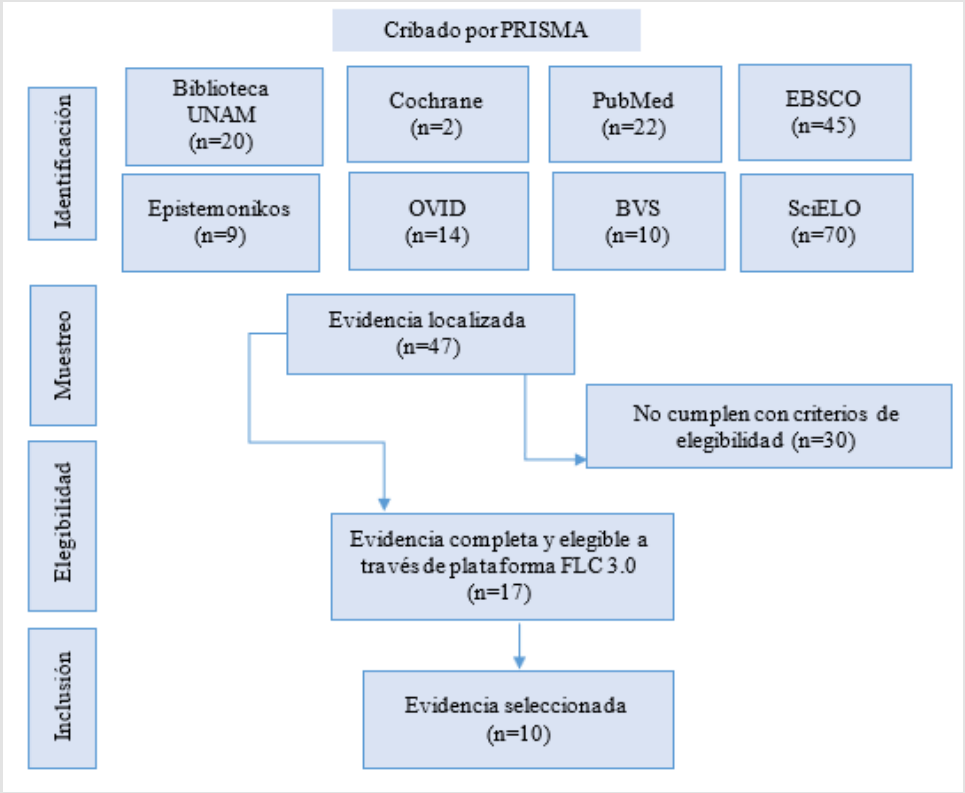

Figure 1.

Table 2: Synthesis and interpretation of evidence, year. (n=10).

Scale: OXFORD				
Evidence/year	**Design**	**Level**	**Degree**	**Conclusion**
Impact of continuous vs bolus feeding on splanchnic perfusion in very low birth weight infants: a randomized trial, 2016 [22]	Randomized Trial	A	1b	(AB: Alimentación en bolo) Bolus Feeding and continuous feeding achieve a qualitatively similar effect on splanchnic blood flow, with a more relevant effect after Bolus Feeding (AB: Alimentación en bolo).
Bolus vs. continuous feeding: effects on splanchnic and cerebral tissue oxygenation in healthy preterm infants, 2014 [23]	Prospective cohort study	A	1b	The (AB: Alimentación en bolo) Bolus Feeding is associated with an increase in oxygenation in the technique, which could reflect an increase in blood flow in the mesenteric region
Near-infrared spectroscopy measurements of splanchnic tissue oxygenation during continuous versus intermittent feeding method in preterm infants, 2013[24]	Primary study with methodological design prospective cohort and unicenter	A	1c	Splanchnic oxygenation is higher in AGA (AGA: Adecuados para la edad gestacional (Suitable for Gestational Age)) than in SGA infants during both Bolus Feeding (AB: Alimentación en bolo) and continuous. Continuous EC could help limit the risk of hypoxic-ischaemic bowel damage in critically ill preterm infants, especially AGA (AGA: Adecuados para la edad gestacional (Suitable for Gestational Age)) infants.
The effect of enteral bolus feeding on regional intestinal oxygen saturation in preterm infants are age-dependent: a longitudinal observational study, 2019 [25]	Primary study with cohort, prospective and observational design	A	1c	This study raises questions about when and why intestinal saturation increases or does not increase consequentially to AEB (AEB: Alimentación enteral en bolo (Bolus Enteral Feeding)) in the first postnatal weeks of the preterm infant and whether a decrease in intestinal perfusion after feeding may be associated with gastrointestinal complications later
Feeding interval and postprandial intestinal blood flow in premature infants, 2013[26]	Primary studio with design cohort prospective and observational	A	1c	The speed of mesenteric artery blood flow AME (AME: Arteria Mesentérica (Mesenteric Artery)) increased significantly after feeding in 2- and 3-hour fed infants. Milk volume per serving may affect postprandial increase in AME (AME: Arteria Mesentérica (Mesenteric Artery)) blood flow velocity
Splanchnic-cerebral oxygenation ratio decreases during Enteral feedings in anemic preterm infants: observations under near-infrared spectroscopy, 2019[27]	Primary study with prospective, observational cohort design in 2 centers	A	1c	RNPs with a hematocrit of 28% had a decrease in SCOR (SCOR: Relación De Oxigenación Esplácnico Cerebral (Cerebral Splanchnic Oxygenation Ratio)) from baseline and during enteral feeding, suggesting that anemic infants had less physiological capacity to adapt to moments of increased metabolic demand. This could lead to increased intestinal hypoperfusion and increased risk of food intolerance and necrotizing enterocolitis.
Association of Bolus Feeding WITH Splanchnic AND Cerebral Oxygen Utilization Efficiency Among Premature Infants WITH Anemia and After Blood Transfusion, 2020 [28]	Prospective cohort study	A	1b	Feeding was associated with a reduction in the efficiency of splanchnic oxygen utilization. There was a postprandial increase in splanchnic tissue oxygenation due to mesenteric vasodilation, mediated by the enteric nervous system.
Correlation of abdominal rSO2 with superior mesenteric artery velocities in preterm infants, 2013[29]	Primary study with prospective observational methodological design and unicenter	A	1c	In very preterm infants, the regional oxygen saturation index (A-rSO2) reflects blood flow in the mesenteric artery (AME: Arteria Mesentérica (Mesenteric Artery)) and may provide continuous noninvasive intestinal perfusion monitoring.

Effect of patent ductus arteriosus on splanchnic oxygenation at enteral feeding introduction in very preterm infants, 2019 [30]	Primary study with cohort, prospective and observational design	A	1b	The presence of patent ductus arteriosus (PDA), either with restriction or hemodynamically significant features, did not significantly affect the splenic oxygenation response to the introduction of AEB (AEB: Alimentación enteral en bolo (Bolus Enteral Feeding)) and was not associated with increased rates of intestinal complications.
Feed-related splanchnic oxygenation in preterm infants with abnormal antenatal doppler developing gut complication, 2018 [31]	Primary study of observational methodological design	A	1b	Infants who developed gastrointestinal complications showed significantly lower splenic oxygenation and increased splanchnic oxygen extraction in response to AEB (AEB: Alimentación enteral en bolo (Bolus Enteral Feeding)).

Discussion

According to the evidence, enteral nutrition has several benefits related to splenic oxygenation and depending on the method of approach, either bolus or continuous. Similarly, it is identified as another benefit the monitoring of the oxygenation of mesenteric tissue through the use of the infrared technique, which allows to provide non-invasive information on tissue perfusion, however, this practice is limited due to the deficiency of research in relation to monitoring and the low number of populations studied. Bozzetti [16] and Maruyama [22] use mesentery flow velocity monitoring and note that bolus feeding shows an increase in splenic perfusion rate; Dani, et al. [20] point out that bolus milk feeding increases splenic oxygenation in patients with an adequate gestational age, however, in premature patients continuous enteral feeding limits the risk of intestinal hypoxic-ischemic damage. Other evidence points to the similarity when using near-infrared spectroscopy (NIRS) as an instrument to evaluate splenic perfusion and oxygenation, in such a way that it continuously indicates oxygen saturation in relation to enteral feeding and the risk of developing necrotizing enterocolitis. Braski, et al. [23] evaluated for the first time the effect of enteral bolus feeding using the NIRS method in patients with low weight and a decrease in hematocrit and for which they point out that premature patients have a lower adaptation, increased risk of food intolerance and necrotizing enterocolitis and therefore suggest the use of NIRS as a tool on oxygenation in patients at high risk of develop enterocolitis.

Conclusion

Bolus enteral feeding is a clinical practice in the care of premature newborn patients, based on the evidence it is concluded that the choice of an AEB (AEB: Alimentación enteral en bolo(Bolus Enteral Feeding)) method improves splenic oxygenation, so it is associated with greater benefits such as: reducing the risk of food intolerance, reducing the time of complete nutrition, reduced risk of necrotizing enterocolitis and increased mesenteric blood flow; Similarly, it was found that a method of great help is the NIRS (Near Infrared Spectrography), which allows the monitoring of oxygenation and splenic circulation with what could be used as an additional instrument on splenic oxygenation in patients at risk of necrotizing enterocolitis, however, the results demonstrate that there is still significant data limitation as benefits of AEB(AEB: Alimentación enteral en bolo(Bolus Enteral Feeding)) since the increase in splenic oxygenation could be related to the increase of hormones and proteins in the gastrointestinal system. The two enteral feeding techniques: AEB (AEB: Alimentación enteral en bolo(Bolus Enteral Feeding)) and AEC have different effects on splenic tissue oxygenation; AEB(AEB: Alimentación enteral en bolo(Bolus Enteral Feeding)) is associated with increased oxygenation in the technique, which could reflect increased blood flow in the mesenteric region, on the other hand AEC is associated with a significant decrease in splanchnic oxygenation and for which research with larger populations and related to increased blood flow in the mesenteric region is suggested.

According to the evaluation of our results, we observed the limitation of the information published in relation to the topic in a population of RNP, for which, in relation to the review of the evidence, we recommend: The control of enteral bolus feeding over continuous enteral feeding, evaluation of adverse effects on bolus feeding as food intolerance, Ideal recognition on the monitoring of splanchnic oxygenation during enteral bolus feeding.

Conflict of Interest

The authors declare no conflict of interest in relation to this work.

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