The role of lactose in milk and an overview of intolerance to lactose.

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Abstract

The main sugar in both human breast milk and other animal milks is lactose. The newborn babies have a surge in lactase enzyme levels to enable adequate digestion of the lactose in milk, but over time, the enzyme level drops and a degree of lactose intolerance is very common. If the lactose is not digested, it can reach the colon where it is involved in the production of short chain fatty acids and inducing more gas production in the process, leading to flatulence, bloating, watery stools and prominent nappy rash. We review the role of lactose in milk, as well as an overview of lactose intolerance.

Keywords: Lactose, Milk sugar, Lactase, Lactose intolerance, Flatulence, Diarrhoea, Nappy rash.

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Introduction

The main sugar in both human breast milk and other animal milks is lactose [1]. The new-born babies have a surge in lactase enzyme levels to enable adequate digestion of the milk lactose, but over time, the enzyme level drops and a degree of lactose intolerance is very common. We will review some aspects of the role of lactose in milk, as well as an overview of lactose intolerance.

Lactose and lactase

Lactose is a disaccharide that is formed by glucose and galactose and is the main carbohydrate in breast milk. It is hydrolysed by the enzyme lactase which is bound to the brush border membrane of mainly the upper small intestine of the breast feeding infant [1,2]. This enzyme is up regulated in the immediate new-born period to support the digestion of milk. Human milk contains approximately 70g/L of lactose as compared to cow's milk, which has 46g/L. Lactose contributes to about 40% of the daily energy needs of a breast fed infant.

Why is lactose the milk sugar?

It requires energy for the mother to produce galactose from glucose, as well as to combine glucose and galactose to form lactose. The baby also needs to spend energy to break the lactose down to glucose and galactose. Part of the galactose is also converted back to glucose in the liver. Why has nature chosen lactose as the milk sugar? Galactose containing oligosaccharides are incorporated in glycolipids and glycoproteins which play a prominent role in early brain development including in myelin formation. It is possible that lactose as the milk sugar is a measure to avoid galactose deficiency at a crucial period in brain development [4,5]. Galactose from other sources and from endogenous synthesis can be used for the same purpose too. Studies have found similar cognitive development in children fed milk-based and lactose free infant formula [6].

The concentration of lactose in mammalian milk stays reasonably stable, and this helps to maintain osmotic pressure of the milk by regulating the water content in milk [7]. This is a factor as to why fore-milk is thin with more water, as it has more lactose. This helps to quench the thirst of the baby at the start of the feed, and if the baby feeds for thirst, they just take a quick feed of the fore-milk, but if hungry, they feed longer so they get the hind-milk as well for satiety to get the higher fat content from the hind milk. Lactose also helps the absorption of calcium and other minerals contained in milk. This could be related to the stool pH dropping due to acidic by-products [8]. Lactose is a structural component of many human milk oligosaccharides (HMOs) which are prebiotics. When the lactase enzyme levels are not adequate to digest the full lactose load, the lactose passes undigested through the gut and in this situation, it can behave as a prebiotic [9]. Though lactose has a sweetish taste, it does not stimulate the reward centre in the brain, and so, does not interfere with the baby's satiety response during breast feeding and does not promote overfeeding. Lactose is the only disaccharide that has reduced impact on dental health with a much lower caries risk compared to sucrose [10]. These could be the factors as to why lactose is the milk sugar.

Role of lactose as a prebiotic

As described above, when the lactase enzyme content is lower than required, the undigested lactose is fermented in the colon by the gut micro biota. This results in production of lactate, short-chain fatty acids (SCFAs) and gas and it functions as a prebiotic [9]. Along with the Human milk oligosaccharides (HMOs), lactose contributes to the gut micro biota composition with the lactobacilli and bifid bacterium predominance seen in breast fed infants [11]. A study comparing babies on an extensively hydrolysed lactose-free formula with babies on an infant formula containing lactose showed a positive effect of lactose on composition of gut micro biota with significant increase in bifido-bacteria and lactobacilli and reduction in bacteroides and clostridia species [12]. In addition, it was noted that the concentration of acetic and butyric acid in the stool was higher in the babies on the lactose-containing formula.

Lactose intolerance

In the new-born period and in the first 2-3 months of life, many babies present with frequent watery stools, diaper rash and colic. This could be considered as features of lactose intolerance

and could also overlap with features of cow's milk protein intolerance [13]. Neonates have a range of lactase levels at birth, and with increase in the milk volume and the resultant exposure to more lactose, the lactase enzyme up-regulates. Though it is possible that partial lactose intolerance could contribute to the above pattern, parents have to be reassured that this is expected during this period and are self-resolving. Appropriate and adequate skin care of the nappy area to avoid rash (avoiding pressure during cleaning, preventive use of barrier nappy cream) and avoiding overfeeding to avoid exposure to a high lactose load are the only measures needed in breast feeding babies. The benefits of breast milk far outweigh any transient concerns as above. It is not justified to substitute breast milk with a low lactose formula for such babies for such transient symptoms and paediatricians and midwives should educate the mothers about this important fact and help them tide over this period. If the baby is already partly on some formula feeds for any reason, a trial of low lactose infant formula could be considered, with stress on not modifying the breast feeding (on the contrary, supporting to achieve more breast feeding) at the same time.

Following an acute gastroenteritis, there may be a transient secondary lactase deficiency due to loss of the brush border cells of the small intestine. This could lead to persistent loose stools and diaper rash [14]. A brief period of low or lactose free infant formula can help in this setting. Once the stool pattern improves and the nappy rash has healed, gradually changing back to the previous feeding pattern is usually well tolerated. Supplementing Zinc and vitamin A is important in this setting as well, especially in developing countries.

In most mammals, after the initial breast feeding phase, the lactase enzyme is down-regulated as there is no further milk intake. However, as the human race evolved, we domesticated the cow and started intake of dairy products. So, lactase persistence has been noted in varying proportions. This varies between populations, largely related to the proportion of milk intake in the population group and ranges from 50-70% of lactase non persistence [14,15]. This is very rare in children below the age of 6 years and the incidence increases with age. As discussed above, when the dose of lactose ingested exceeds the ability to digest due to the reduced lactase level, symptoms like flatulence, bloating, griping and diaper rash arise. These symptoms respond simply to some reduction in the lactose intake. Most children and adults with lactase non-persistence can tolerate is the amount of lactose present in one cup of cow's milk (around 12g) in a single dose [13,15]. As the dose of intake increases, the likelihood of symptoms will increase. The nature and severity of the symptoms depend upon factors like the dose of ingested lactose, residual lactase activity, gut motility and the nature of the gut microbiota. Psychological factors regarding perception of abdominal pain and discomfort play a role as well [15].

It is important to remember that milk protein intolerance has features that are mostly different from simple lactose intolerance-it needs more specific treatment, and if that diagnosis is considered, the management approach is different (not in the scope of this article).

Summary

The composition of breast milk and the reason why nature has designed it this way is intriguing. Lactose in milk is one such factor and though many of the older kids and adults have relative lactase deficiency due to non-persistence of lactase enzyme, a simple approach to the management as dictated by common sense is adequate in most such situations. One very important message here is that breast feeding should not be disturbed for transient intolerance of lactose-supporting breast feeding and helping the mother come out of this transient phase is very important.

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