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Introducing solid foods using baby-led weaning vs. spoon-feeding: A focus on oral development, nutrient intake and quality of research to bring balance to the debate

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Abstract

The World Health Organization recommends that infants be introduced to first solid foods from 6 months of age to complement milk feeds. The introduction of complementary foods is required to help infants meet their changing nutritional requirements. In recent years, baby-led weaning and spoon-feeding have been discussed as mutually exclusive approaches to introducing first solids. Baby-led weaning advocates that babies direct and control the process of weaning, deciding what they will eat, how much and how quickly. There is an emphasis on parents providing chunks of soft food that babies can pick up and chew. A traditional spoon-feeding approach involves introducing smooth runny purees as the texture for first foods and progressing to chewable solids as oral motor skills develop. Spoon-feeding provides an opportunity for infants to develop oral skills necessary for safe management of solids and may facilitate intake of iron-rich foods at weaning, whilst baby-led weaning promotes greater participation in family meals and exposure to family foods. The need to supervise infants whilst eating to avoid risk of choking on food is required for both approaches. The review highlights the need for quality, well-designed research on different approaches to the introduction of first solid foods and suggests that a combined approach to baby-led weaning should be considered.

Keywords: baby-led weaning, chewing, choking, complimentary foods, premature infants, spoon-feeding

The transition from milk feeds (breast milk or infant formula) to first solids is an important milestone for parents and their children. By around 6 months of age, exclusive reliance on breast milk or infant formula no longer provides sufficient key nutrients required for growth and development (Butte *et al.* 2002; Baker *et al.* 2010; NHMRC 2012). Although breast milk remains important from 6–12 months of age, the introduction of solid foods is required to supplement milk feeds. Infant feeding guidelines have been developed around the world to provide advice on when to introduce first solids and what format first

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solids should take (DH 2003; NHMRC 2012; American Academy of Pediatrics 2012; Moore *et al.* 2014). In 2008, 'baby-led weaning' was a term coined, advanced and advocated by Gill Rapley and is described as an approach where the baby is allowed to direct and control the process of weaning (Rapley 2011). Using this approach, parents decide what they will offer but the baby decides what they will eat, how much and how quickly. Ease of access to technology has seen many parents turn to the internet for infant development advice and the debate between spoon-feeding purees vs. baby-led weaning has at times been polarised. This mini-review seeks to address key arguments around oral development, nutrient intake, applicability to premature infants and quality of research in the field to date. It advocates, as others have, for a combined and balanced approach to the introduction of solids (Reeves 2008).

Oral development skills needed to transition from milk feeds to first solid foods

Both traditional spoon-feeding and baby-led weaning approaches are in agreement that infants require the ability to sit up (in the midline) with little or no support as a prerequisite to safe infant feeding. In addition, the ability to signal readiness for feeding is an important developmental sign. Infants signal readiness by opening their mouth, bringing their hand to their mouth and also reaching for parent's food or cutlery during meals. There is an implicit understanding that certain motor and physical milestones and developmental readiness must be in place for an infant to be ready to commence eating solid foods. In addition to the recommendation to commence solids at or around 6 months of age, signs of infant readiness should be considered by parents when first introducing solid foods, as noted in both UK infant feeding recommendation and the Australian guidelines (DH 2003; NHMRC 2012).

A key difference between spoon-feeding and baby-led weaning approaches is in the textures of foods offered. Traditional spoon-feeding begins with smooth runny puree, whereas advocates of baby-led weaning recommend chunks of fruit, soft cooked vegetable sticks, strips of meat, fingers of toast and strips of cheese in pieces large enough so the baby can pick them up with some sticking out of the baby's fist (Rapley 2011). These recommendations are based on the premise that infants at 6 months of age can chew and that in order to become proficient at chewing babies simply need experience (Rapley 2011). However, a more thorough understanding of infant oral development is needed to appreciate the complexity of safe oral manipulation of first solids.

For infants taking milk feeds, whether by breast or bottle, milk is delivered directly to the posterior of the oral cavity, the optimal spot for swallow reflex initiation. In order to successfully manage first solids, however, the infant must accept the solids into the front of the mouth and then actively use the tongue to transport the bolus to the posterior of the oral cavity for the swallow reflex to be triggered (Evans Morris & Dunn Klein 2000; Rudolph & Thompson Link 2002). For purees, once the bolus has been moved from the front of the mouth to the back, the tongue base drops down from its protective position and propels the bolus through the throat, past the airway and into the oesophagus (Rudolph & Thompson Link 2002; Durvasula *et al.* 2014).

For solids that require chewing, a more complex process is required. The food must be effectively broken down into smaller pieces, bound together by saliva and then transported to the back of the mouth for swallowing. Infants' early chewing is a primitive up-down munching pattern (Evans Morris & Dunn Klein 2000; Rudolph & Thompson Link 2002). This pattern is fine for small pieces of soft food but inadequate for hard foods or those containing fibres, such as strips of meat. Pieces of food need to be positioned onto the gum ridges by the tongue for munching (Gisel 1991; Evans Morris & Dunn Klein 2000). During this process, the tongue is not able to efficiently protect the throat and the open airway below, particularly in the early days of learning a new skill (Hiiemae & Palmer 1999; Palmer & Hiiemae 2003). This increases the risk of choking, especially if large pieces that could block the airway are in the mouth. Different textured foods require diverse amounts of chewing strength and stamina. A banana or avocado requires fewer chewing actions and less chewing time than a piece of toast, for example (Gisel 1991; Hiiemae & Palmer 1999; Mishellany *et al.* 2006). Using a spoon-feeding approach, babies are first introduced to pureed foods where the bolus is already formed and then they practice moving it to the back of the mouth for swallowing. From here the infant progresses to purees with soft lumps, then soft foods and gradually harder and more fibrous textured foods (Gisel 1991; Evans Morris & Dunn Klein 2000; Rudolph & Thompson Link 2002; Durvasula *et al.* 2014). Muscle strength and stamina and precision of movement are built up gradually over time, much like one would expect of a

tailored weights programme in a gym. A bit like a baby progresses in gross motor development from rolling, to crawling, to standing, to walking, a similar but less obvious process of development happens in the oral phase.

The eruption of teeth further improves the ability to break down hard, fibrous and chewy food. Teeth begin to rupture at the front of the mouth typically between 6 and 8 months and those at the back from 12–24 months of age. The move from the munching pattern to development of a rotary chewing pattern does not typically occur until 12 months of age or later (Rudolph & Thompson Link 2002; Durvasula *et al.* 2014). The eruption of teeth and physiological development of chewing fit well with a recommendation for smooth foods until about 8 months and more challenging textures from 12 months of age. These patterns of oral and physical development have been well documented (Gisel 1991; Evans Morris & Dunn Klein 2000; Carruth & Skinner 2002). As noted clinically, when children do not have the required chewing strength or stamina to break down foods, they often hold them in the mouth or cheeks to soften with saliva and/or attempt to swallow pieces whole, thereby increasing risk for airway obstruction (Gisel 1991; Evans Morris & Dunn Klein 2000).

Note that in cultures without ready access to pureed foods that texture modification still occurs. Adults provide pre-chewed food to infants as first foods in Papua New Guinea, Lao People's Democratic Republic of Southeast Asia, China, the US and many other parts of the world (Lepowsky 1985; Holmes *et al.* 2007; Zhou *et al.* 2009). When adults chew foods, the food is typically ground down to small particles averaging about 2 mm in size and bound together with saliva to form a soft, moist cohesive ball (Prinz & Lucas 1995; Mishellany *et al.* 2006; Foster *et al.* 2011). The practice of pre-chewing food for infant consumption reflects the anthropological importance of reducing choking risk.

Arguments that babies at 6 months of age are capable of adequately chewing hard-textured food and that choking risk relates to poor positioning shows an inadequate understanding of infant oral development (Rapley 2011). Infants are not born with an innate understanding of appropriate bite size and will often break off larger pieces than they can safely manage. It is of comfort that both traditional spoon-feeding and baby-led weaning approaches advocate strict infant supervision during all feeding to safeguard choking risk (DH 2003; Rapley 2011; NHMRC 2012). The UK Child Accident Prevention Trust (2012) provides specific advice on types of foods and sizes of foods that pose a choking risk to babies and toddlers. Fatal and non-fatal risk of choking is highest in children under the age of 3 years and particularly high for children under 12 months of age (Centre for Disease Control and Prevention 2002; Chapin *et al.* 2013; Siddel *et al.* 2013). Siddel *et al.* (2013) note that although there is substantial legislation in the US regulating non-food items that pose a choking risk (*e.g.* toys), equivalent guidelines do not exist for high-risk foods. As a general guide, the width of a child's fifth fingernail (little fingernail) can be used as a proxy measure to gauge the diameter of the child's airway (King *et al.* 1993). This simple but validated method provides a reference point for the size of food pieces that could obstruct an infant's airway.

Effect of food texture offered on type and quantity of nutrients consumed

The approach to first solids has an impact on the quantity and types of nutrients consumed. Iron is a micronutrient needed for the development of normal red blood cells, healthy immune function, cognitive development, enhanced oxygenation and hunger signalling (Baker *et al.* 2010). Eighty per cent of iron stores in newborns are accumulated during the final trimester of pregnancy, resulting in the infant having sufficient iron stores until about 6 months of age (Butte *et al.* 2002). Healthy term infants require very little iron early in life (~0.27 mg/day); however, by 6 months of age the Australia National Health and Medical Research Council recommend 11 mg/day (NHMRC 2012), with dietary reference values for iron in this age group varying between countries. The iron concentration of breast milk averages 0.35 mg/l (range 0.2–0.4 mg/l). However, this varies from mother to mother (Butte *et al.* 2002; Baker *et al.* 2010). Breast milk is considered a poor source of iron and is not improved with maternal supplementation (Butte *et al.* 2002). Thus, the need for iron-rich complimentary foods from 6 months of age is evident (Butte *et al.* 2002).

Infant feeding guidelines in Australia have recently changed to acknowledge the early need for iron-rich first foods by recommending the introduction of iron-enriched infant cereals and pureed meat, poultry and fish (sources of haem iron) or cooked tofu and legumes as first foods, followed by pureed vegetables, fruits, dairy products and other foods (NHMRC 2012). Older Australian guidelines and other guidelines from around the world recommend the introduction of pureed fruits and vegetables as first foods,

moving towards pureed meats afterwards (DH 2003). Regardless of these differences, the style of weaning has an effect on types of foods and hence type of nutrients offered. The UK *Infant Feeding Survey* (2010) found that 94% of infants studied received purees as first foods and of these 57% were rice cereal, followed by pureed fruit and vegetables (McAndrew *et al.* 2012). Studies of baby-led weaning indicate that mothers are likely to offer fruit, vegetables or carbohydrate-based foods such as bread or rusks as first foods (Brown & Lee 2011; Wright *et al.* 2011; Rowan & Harris 2012). For example, Brown & Lee (2010) reported that 78% of infants, weaned using a baby-led approach, were first introduced to fruit or vegetables, with <14% receiving baby rice cereal. In contrast, 60% of infants introduced to solids using spoon-feeding received infant rice cereal as a first food. Wright *et al.* (2011) report that bread, rusks and biscuits were introduced first in their baby-led weaning cohort, followed by fruit and vegetables (20%), confectionery (5%) and meat (2%). From a nutrient perspective, spoon-feeding affords the ability to offer iron-enriched infant cereal or pureed meats that would be more challenging to introduce using a strict baby-led weaning approach.

Some studies have indicated that baby-led weaning may prove protective against obesity, as children weaned with a baby-led approach have been found to have a lower body mass index (BMI) than those infants weaned with traditional spoon-feeding (Brown & Lee 2013). Although infants in the baby-led weaning cohort were of lighter bodyweight, 75% of the entire cohort fell within the healthy weight range, with 4% underweight and only 2% considered overweight. Specifically, 86% of infants in the baby-led weaning group were of normal weight, 8% overweight and 5% underweight. In the spoon-feeding group, 78% were considered normal weight, 19% overweight and 3% underweight (Brown & Lee 2013). However, the authors noted that it was a combination of maternal child-feeding style in tandem with weaning approach that explained their results. Mothers following a baby-led weaning approach were reported to be more relaxed about feeding, provided less pressure for the child to eat, and were less concerned over child weight gain. Baby-led weaning was also associated with increased infant participation in family meals and exposure to home-cooked family meals (Brown & Lee 2013).

There is a difference in the amount of food consumed using the two approaches. In a large longitudinal study, Wright *et al.* (2011) found that most infants at 8 months of age were having finger food once a day but only half of the cohort were having finger foods more than once per day. If no pureed/mashed food is being consumed, it is questionable whether solid finger foods offered once per day will be sufficient to meet nutritional and growth needs. Brown and Lee (2013) noted that infants weaned using a baby-led weaning approach had 5–6 milk feeds per day with 70% still receiving night milk feeds, whilst the spoon-feeding group had 4–5 milk feeds per day with 46% receiving night milk feeds. Arden and Abbott (2015) reported that mothers using the baby-led approach offered finger food, but they were not concerned whether the food was ingested because of the attitude that 'until the age of one food is for fun'. Of additional concern, the mothers reported that milk is sufficient until babies are one year old and that they would prefer their babies to have milk than take nutrition from solids. These data suggest that the volume of food consumed using the baby-led weaning approach may not be sufficient to meet the child's nutritional and growth needs.

Suitability of baby-led weaning to premature or developmentally delayed infants

Baby-led weaning is not suitable for all infants. As noted above, premature infants, particularly those born before or within the last trimester, have higher iron needs than term babies (Baker *et al.* 2010). Most premature infants also have difficulty managing lumpy solids even at 12 months of age (Hawdon *et al.* 2000). In addition, introducing solids too early to preterm infants may lead to avoidant feeding behaviours (Chung *et al.* 2014). Whilst term infants start reaching for food between 4 and 7 months, it is not usually until 8 months that infants are self-feeding, and doing so without gagging (Wright *et al.* 2011). Infants who are developmentally delayed in other gross motor milestones such as walking also show developmental delays in the age they reach for food (Wright *et al.* 2011). This congruence between gross motor development and readiness for finger foods strengthens the recommendation to look at readiness cues, as opposed to chronological age or even corrected age of premature or developmentally delayed infants, to guide safe introduction of solids.

The need for further well-designed research

Published research on baby-led weaning has methodological flaws that might bias results and interpretation of data. Studies to date rely on parental report

rather than objective impartial assessment (Wright *et al.* 2011; Rowan & Harris 2012; Brown & Lee 2013; Moore *et al.* 2014; Arden & Abbott 2015). Some studies show measurement or sampling bias. For example, in one study mothers who participated in the baby-led weaning approach responded via Internet surveys, whereas objective laboratory measures were taken for the spoon-feeding group (Townsend & Pitchford 2012), in a different study participants were exclusively drawn from online forums for baby-led weaning (Rowan & Harris 2012) and in another study infants that presented with failure to thrive or child health problems were excluded (Brown & Lee 2013). All studies reported here were observational rather than an experimental comparison of the two approaches. Demographic differences are also noted in the studies, with mothers who adopted the baby-led weaning approach having statistically significantly higher levels of education than those in traditional spoon-feeding groups who volunteer for similar studies (Brown & Lee 2011). The recommendation for a well-designed, randomised control trial is well placed (Cameron *et al.* 2012).

Summary

When introducing first solids, babies might be best suited to spoon-feeding of pureed, preferably iron-rich, first foods. This method allows development of oral skills and intake of iron essential for cognitive development. With the eruption of teeth and further development and refinement of oral motor skills, babies can progress to small pieces of soft foods. Once these are safely consumed, progression to soft pieces of mashed and finger foods, synonymous with baby-led weaning, occur naturally. The introduction of large pieces of food prior to an opportunity to develop tongue control, tongue lateralisation, and strength and stamina for chewing might increase risk of choking and decrease both volume and type of nutrients consumed (*e.g.* iron-rich). However, baby-led weaning may offer other benefits including greater participation in family meals, more exposure to family foods and reduced maternal anxiety about weaning and feeding (Brown & Lee 2013). A combined approach to first foods acknowledging the oral developmental needs of early feeding and chewing using spoon-feeding combined with a willingness to provide family foods that can be safely managed using baby-led weaning is therefore advocated. For both methods, the need for supervision at meal-times is critical to safeguard against choking risk.

Conflict of interest

The author has no conflict of interests to disclose.

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