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ORIGINAL ARTICLE

Oral-motor Dysfunction at 10 Months Corrected Gestational Age in Infants Born Less Than 37 Weeks Preterm

Charlotte A. Buswell · Paula Leslie · Nicholas D. Embleton · Michael J. Drinnan

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Abstract Feeding difficulties are common in preterm infants. These may be associated with inadequate dietary intake, poor growth, and parental anxiety. Oral-motor dysfunction has been observed in preterm infants during sucking and the early stages of weaning but has not been rigorously studied in later infancy when eating a range of food consistencies. We aimed to establish if oral-motor dysfunction during feeding occurs in preterm infants in later infancy and to explore the relationships with specific neonatal risk factors: gestational age at birth, prolonged supplementary oxygen requirement, and delay in establishing full oral feeding. Infants born less than 37 weeks gestational age were evaluated once at 10 months corrected gestational age using a validated feeding assessment (Schedule for Oral Motor Assessment). Fifteen infants were enrolled (9 males, 6 females; median gestational age at birth = 33 weeks, range = 25–36 weeks; median birth weight = 1890 g, range = 710–2950 g). Oral-motor dysfunction was observed in three infants all born after 31 weeks gestation. No relationship was found with the neonatal risk factors. This study indicates that oral-motor dysfunction may occur in later infancy and is not easily predicted from specific neonatal risk factors. Further study is required to evaluate the true prevalence and the health implications of oral-motor dysfunction in this population in later infancy.

Keywords Oral-motor dysfunction · Preterm · Pediatrics · Deglutition · Deglutition disorders · Weaning

C. A. Buswell · N. D. Embleton · M. J. Drinnan
Newcastle upon Tyne Hospitals Foundation Trust (NHS), Newcastle upon Tyne, UK

C. A. Buswell (✉)
Child Development Centre, Royal Victoria Infirmary, Queen Victoria Road, Newcastle upon Tyne NE1 4LP, UK
e-mail: Charlotte.Buswell@nuth.nhs.uk

P. Leslie
Department of Communication Science and Disorders, University of Pittsburgh, Pittsburgh, PA 15260, USA

Feeding difficulties are common in preterm infants, particularly in those born at the earliest gestations or with complex health needs [1, 2]. This is likely to be multifactorial in origin and may be associated with inadequate dietary intake resulting in poor growth and parental anxiety [3, 4]. Oral-motor dysfunction (OMD) has been observed in preterm infants when sucking and in the early stages of weaning to solid foods. Oral-motor skills have not been rigorously studied in the later stages of weaning when infants have made the transition to eating a range of food consistencies [5, 6].

Healthy term infants progressively develop the oral movements to manage an increasing range of consistencies during their first two years. Chewing skills develop between 6 months and 2 years, most rapidly between 6 and 10 months [7]. By 10 months 80% of infants have progressed to eating lumpy foods [8]. OMD has been observed in preterm infants at a corrected gestational age (CGA) of term and associated with prolonged supplementary oxygen requirement and delays in establishing full oral feeding [5]. These infants' parents described persisting feeding difficulties at 12 months; however, these later reports were collected by postal questionnaire and so relied on parents' interpretation and recall.

In a further study, preterm infants born less than 30 weeks gestation had significantly more dysfunctional oral-motor behaviors at 6 months corrected gestational age (CGA) when eating weaning foods than matched full-term

control infants [6]. A validated feeding assessment was used but it is unclear whether the observers were blinded to other data on the infants. The preterm infants had birth weights less than 1000 g and were recruited from hospital nutrition and development clinics; both factors may increase their risk of feeding difficulties [9].

Anecdotal evidence and a postal questionnaire suggest that OMD remains an important yet poorly recognized health issue in preterm infants in later infancy as they make the transition to more challenging food consistencies [5]. There is no published evidence of oral-motor skills collected from direct observations during feeding in later infancy. The aims of our study were to determine, first, if OMD is present during feeding in later infancy and, second, if specific neonatal factors previously associated with feeding difficulties, i.e., gestational age at birth, prolonged requirement for supplementary oxygen, and delay in establishing full oral (breast or bottle) feeding, might predict OMD [5, 6, 10]. We planned evaluations at 10 months CGA because at this age infants have usually progressed to eating a range of food consistencies and they have not yet reached the stage where they refuse to cooperate with a standardized feeding assessment which requires them to accept new foods and to be fed by an adult [8, 11].

Method

Participants

Infants born less than 37 weeks gestation, who would be 10 months CGA during the 4-month study period (March to June 2006), were identified from the database of a tertiary-level neonatal unit (Royal Victoria Infirmary, Newcastle upon Tyne). We anticipated that this population would allow us to study infants born at a range of gestational ages. Exclusion criteria included conditions that were potential confounding factors: congenital problems (e.g., cardiac or structural gastrointestinal abnormality); significant parenchymal hemorrhage or leukomalacia identified on routine cerebral ultrasound; documented visual impairment; aspiration risk which had precluded oral feeding; or significant social concerns (e.g., fostered).

Parents of eligible infants were contacted by letter by the pediatrician (NDE). The Hartlepool and North Tees Local Research Ethics Committee granted ethical approval and parents gave informed written consent to participate in the study.

Data Collection

The lead researcher (CAB) visited each infant once at home to collect the feeding history and carry out an assessment of oral-motor skills during feeding. This visit lasted 45 minutes and was planned to take place before infants' midday meal when they would be interested in feeding.

Feeding History

A structured questionnaire was used for parents to record information on feeding history since hospital discharge, including age at commencement of weaning. This was based on clinical practice and developed for this study as there was no appropriate published alternative.

Oral-motor Assessment

The Schedule for Oral Motor Assessment (SOMA) was used to measure infants' oral-motor skills during feeding [12]. This assessment has been validated on children aged 8 months to 2 years [11, 13]. The SOMA uses standard foods of five different consistencies and a standard feeding technique to enable specific dysfunctional oral-motor behaviors seen in children with feeding difficulties to be identified. The assessment is videotaped; oral-motor behaviors during feeding are rated from the videotape as normal or dysfunctional. Infants are only scored on those consistencies they accept during the assessment. Infants with scores on or above specified thresholds for each consistency are classified as having OMD; the threshold for OMD varies depending on the consistency.

At the home visit parents identified which of five consistencies their infant usually ate. The standard food examples given to parents were purée (Petit Filous® fromage frais), semisolid (Müller® rice pudding), solid (peach from tinned fruit cocktail), biscuit (Heinz Farley's® bear biscuit), and liquid (juice or water).

The SOMA administration procedure was followed. Parents seated infants in their own usual mealtime seating. Assessments were videoed by parents using a digital video camera (Sony HC22E, Japan) mounted on a tripod (Velbon CX440, Japan). The view was of the infant's face and neck from an oblique angle. After a brief demonstration, the parent monitored the video screen ensuring that the infant's face remained within view.

The lead researcher fed infants those consistencies that their parent said they usually ate. The standard foods, a weaning spoon, and a free-flowing feeder cup (Tommee Tippee®, UK) were used. The loaded spoon was presented in a standard manner to ensure that no compensatory strategies such as scraping food off the spoon on the infant's upper lip were used. Infants were offered three spoons of purée, three spoons of rice pudding, three pieces of peach, a biscuit, and a drink. Infants who refused to be fed by the lead researcher were fed by the parent, following instruction on the standard spoon presentation.

To ensure that there was no researcher bias in rating oral-motor behaviors, the videotapes were rated by an independent observer blinded to all other infant data. To evaluate interobserver reliability, a second blinded observer rated a random selection of the videotapes. Both observers were speech-language pathologists with extensive clinical experience in infant feeding but not of the SOMA. Prior to commencing data collection, clinical experience of using the SOMA was trialed by the lead researcher and both observers. This experience was used to refine the observers' written instructions to ensure a consistent approach to rating.

Variables in Neonatal History

Data on variables in the infants' neonatal histories were recorded from their medical notes following home visits. These variables were gestational age at birth, number of days of supplementary oxygen, and number of days since birth when full oral feeding by bottle or breast was established. Birth weights were converted to standard deviation scores (z scores) in a manner consistent with recent publications [14].

Statistical Analysis

Oral-motor skills were assessed using the SOMA. For each infant we calculated a score for each consistency they ate during the assessment. For the purposes of statistical analysis we have presented SOMA scores as the percentage of oral-motor behaviors that the observer was able to rate in each infant. The data followed a non-normal distribution and so nonparametric statistics were used where appropriate.

Aim 1: Presence of oral-motor dysfunction

The scores for each consistency were summarized using appropriate descriptive statistics. For each food consistency the number of infants with scores on or above the threshold for OMD on the SOMA was established.

Aim 2: Relationship between oral-motor dysfunction and variables in neonatal history

Spearman's rank correlation coefficient was used to analyze the relationship between each infant's score and (1) gestational age at birth, (2) number of days of supplementary oxygen, and (3) number of days since birth when full oral feeding by bottle or breast was established.

Interobserver reliability

Overall agreement between the two observers' scoring of six randomly selected videotapes was analyzed. The intraclass correlation coefficient was used; this expresses agreement in relation to overall variability in SOMA ratings. Student's paired t test was used to assess the systematic errors between the two observers' scoring.

Data were analyzed using SPSS v12 for Windows (SPSS Inc, Chicago, IL).

Results

Participants

Thirty-six infants were identified who were born at less than 37 weeks gestation and who would be 10 months

Table 1 Participant characteristics

Gender	Gestational age at birth (weeks:days)	Birth weight (kg) (z score)	Supplementary oxygen required (weeks:days)	Full oral feeding established (weeks:days)
F	24:04	0.71 (−0.41)	52:06	13:04
M	28:04	0.89 (−1.48)	9:06	10:06
M	28:04	1.17 (−0.06)	8:04	10:00
M	30:04	1.66 (−0.64)	0:04	6:05
F	31:04	1.17 (−2.03)	0:03	5:03
M	32:03	1.77 (−0.17)	0:00	3:05
M	32:05	1.94 (−0.22)	0:00	5:04
F	32:06	1.96 (−0.11)	0:02	0:04
M	33:05	2.47 (−1.21)	0:00	2:05
M	34:05	2.02 (−0.90)	0:02	1:03
F	35:00	2.04 (−0.93)	0:02	0:06
F	35:01	2.36 (−0.37)	0:04	0:04
M	35:05	1.72 (−2.24)	0:00	2:04
F	36:04	1.81 (−2.48)	0:00	1:02
M	36:06	2.95 (−0.47)	0:00	0:05

Supplementary oxygen requirement and time to establish full oral feeding are presented as weeks and days since birth

CGA during the study period. Eight infants were subsequently excluded for the following reasons: neurological impairment (2), genetic abnormality (1), cardiac disorder (1), structural gastrointestinal disorder (1), maternal health (2), and not in parental care (1). Of the 28 infants whose parents were invited to participate, 15 infants were enrolled. Median gestational age at birth, birth weight, and birth weight z scores were 32 weeks and 5 days (range = 24 - weeks and 4 days to 36 weeks and 6 days), 1890 g (range = 710–2950 g), and −0.37 (range = −2.48 to 1.21) (Table 1). Median age at evaluation was 44 weeks CGA (range = 42–49 weeks). Nine infants were male and six female. One set of twins participated.

Oral-motor Assessment

Aim 1: Presence of oral-motor dysfunction SOMA scores varied widely between infants (Table 2). Three infants had SOMA scores on or above the threshold for OMD, in one infant for each consistency eaten, and for the other two for all consistencies except the semisolid. Parents of these three infants reported that none of them usually ate the solid consistency. The remaining 12 infants' SOMA scores were all within the normal range for all consistencies.

Some data were missing either because the observer was unable to observe the oral-motor behavior or because she was uncertain of her observations. Mean oral-motor behaviors that the observer was able to rate for each consistency were purée 97% (range = 78–100%), semisolid 99% (range = 88–100%), solid 95% (range = 78–100%), biscuit 97% (range = 86–100%), and liquid 92% (range = 79–100%).

Aim 2: Relationship between oral-motor dysfunction and variables in neonatal history There was no relationship between each individual infant's SOMA score and infants' gestational age at birth, number of days of supplementary oxygen, or number of days since birth when full oral feeding was established (Table 3). The three infants with OMD were born after 31 weeks gestation, required no more than 4 days of supplementary oxygen, and had established full oral feeding by 38 days after birth (37 weeks gestational age).

Interobserver Reliability

Six of the 15 infants' SOMA videotapes were selected randomly and rated by a second observer. The second observer's ratings were systematically higher than the first observer's ($p = 0.005$). However, the effect of this was small, with just 6% more positive ratings for the second rater, and complete agreement on whether individual infant's SOMA scores were on or above the threshold for OMD. Interobserver agreement as assessed by intraclass correlation coefficient (0 = agreement due to chance alone to 1 = complete agreement) was excellent (0.93).

Table 2 SOMA scores presented for each of the 15 infants for the five SOMA consistencies

	Purée (threshold for OMD = 33%)	Semisolid (threshold for OMD = 50%)	Solid (threshold for OMD = 44%)	Biscuit (threshold for OMD = 41%)	Liquid (threshold for OMD = 36%)
	0	0	0	5	R
	11	0	0	5	0
	14	0	0	5	0
	11	0	0	5	8
	11	0	0	5	8
	11	0	0	14	8
	11	13	NUE	5	0
	11	0	R	10	R
	22	0	R	5	0
	22	0	0	5	8
	22	0	0	R	15
	22	0	11	24	8
	33	29	NUE	R	**55**
	66	29	NUE	**68**	**58**
	86	**88**	NUE	R	**69**
mean ± SD	23.7 ± 23.0	10.5 ± 23.6	1.2 ± 3.7	12.7 ± 18.5	18.2 ± 24.8
median (range)	14 (0–86)	0 (0–88)	0 (0–11)	5 (5–68)	8 (0–69)

NUE = not usually eaten, R = refused

Bold indicates infants' scores that were on or above the threshold for oral-motor dysfunction

Table 3 Relationship between SOMA scores at 10 months corrected gestational age and three variables in neonatal history

Consistency	Gestational age at birth	Time on supplementary oxygen	Time to establish full oral feeding
Purée ($n = 15$)	0.42 ($p = 0.1$)	−0.18 ($p = 0.5$)	−0.39 ($p = 0.2$)
Semisolid ($n = 15$)	0.08 ($p = 0.8$)	0.13 ($p = 0.7$)	−0.24 ($p = 0.4$)
Solid ($n = 9$)	0.14 ($p = 0.7$)	−0.3 ($p = 0.4$)	−0.41 ($p = 0.3$)
Biscuit ($n = 12$)	−0.05 ($p = 0.9$)	0.13 ($p = 0.7$)	−0.18 ($p = 0.6$)
Liquid ($n = 13$)	0.09 ($p = 0.8$)	0.38 ($p = 0.2$)	−0.27 ($p = 0.4$)

Supplementary oxygen requirement and time to establish full oral feeding are calculated as days since birth. Statistics are according to Spearman's rank correlation

Discussion

This is the first study reporting direct observations of preterm infants' oral-motor skills during feeding in late infancy on a range of consistencies. We have shown that OMD is present in a small proportion (3/15, 20%) of preterm infants at 10 months CGA and is not easily predicted from previously reported risk factors. While the health implications of this require further study, it suggests that preterm birth may be associated with feeding difficulties in late infancy. Previous studies report observations of OMD in preterm infants at term and at 6 months CGA [5, 6]. Reports after this age are derived from parent questionnaires [5, 10].

We excluded infants who were likely to have a high incidence of feeding disorders, such as those with neurological impairment. Infants with a range of gestational ages at birth and diverse neonatal problems were recruited to make the study findings applicable to clinical practice. It is possible that parents with concerns about their infant's feeding were more likely to enroll than those without. Although parents of seven study infants spontaneously expressed concerns about feeding, only one of these was the parent of an infant with OMD. Parents' concerns about their preterm infants' feeding have been previously described in detail, as have oral-motor skills during feeding, but the two areas have not been compared in the same study [10].

We used a robust methodology, including a validated feeding assessment. Because the SOMA is rated from videotaped assessments, we were able to use independent observers and ensure that they were blind to all other data on infants. Agreement between the observers' scoring of infants was high, with complete agreement on whether individual infants had OMD. By timing the feeding assessments at 10 months CGA, we were able to evaluate infants eating a range of consistencies *and* to minimize the number of infants who would not cooperate with being fed; this ensured minimal consistencies refused (Table 2).

A limited number of aspects of feeding were measured in this study, the focus was on oral-motor skills [1]. We did not plan to evaluate the impact of OMD on weight gain or growth because numerous factors can confound the relationship. As each infant was evaluated only once, it is not possible to know how long OMD may persist or if and when oral-motor skills may change.

Clinical evaluations of infants with feeding and nutrition issues should include consideration of progress with food consistencies. In our study, all the infants usually ate at least four of the five consistencies. However, none of the three infants with scores above the threshold for OMD on the SOMA had progressed to eating the solid consistency (Table 2). It is possible that the parents of these three infants were sensitive to their infants' feeding skills and so did not offer consistencies that were too challenging [15]. Alternatively, offering a limited range of consistencies may have impacted on their oral-motor development.

Because influences on weaning are numerous, there may be further explanations for variable progress with food consistencies [16, 17]. A recent study of term infants describes faltering weight associated with difficulties progressing with food consistencies in later infancy [18]. Eating a limited range of consistencies and OMD are associated with poor nutrition and growth in other populations [19–23]. Progress with food consistencies should be one of the aspects of feeding further evaluated in preterm infants. A larger study of preterm infants might identify predictors of OMD; these could be used to target early intervention with those at risk of feeding difficulties.

Previously, purée has been described as the consistency most discriminative of OMD in a study of children with nonorganic failure to thrive [23]. In our study infants, purée and liquid provided the most evidence of OMD. However, no consistency showed any relationship with the three variables in infants' neonatal histories.

Recent work suggests that preterm infants' growth may benefit from an early weaning strategy which includes advising parents to introduce weaning foods as soon after 13 weeks after birth if they consider their infant ready [24]. In our study, parents introduced weaning foods considerably later, at a median of 24 weeks after birth (range = 16–30 weeks). We suggest that before recommending early weaning, health professionals should establish whether an infant has adequate oral-motor skills.

This study suggests that OMD is present in a small proportion of preterm infants at 10 months CGA. Further study is required to identify predictors and to evaluate potential health implications of OMD in preterm infants.

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Charlotte A. Buswell MSc, CertMRCSLT
Paula Leslie PhD, CertMRCSLT, CCC-SLP
Nicholas D. Embleton BSc, MBBS, MD, FRCPCH
Michael J. Drinnan PhD