The relationship between feeding characteristics and feeding function in children with intellectual disability

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Abstract

To develop strategies to support feeding and swallowing functions from early stage, we evaluated chief complaints regarding feeding, and assessment of the feeding function. The subjects consisted of 53 preschool children and their guardians, who participated in feeding consultation in a welfare center. In this study, we extracted chief complaints and assessment of the feeding function, and made comparisons. The primary illnesses were intellectual disability (n = 20), autism (n = 16), and Down’s syndrome (n = 17). Chief complaints regarding food selectivity, self-feeding, utensils, and chewing were common, and, particularly, the frequency of chief complaints concerning self-feeding and utensils was significantly higher in the groups with intellectual disability or autism, compared to children with Down’s syndrome. As for evaluation of the feeding function, the proportion of children classified as having a disordered self-feeding function was significantly higher in the groups with intellectual disability and autism (approximately 70%) than children with Down’s syndrome. As a result of comparing chief complaints reported by guardians and assessment of the feeding function, in the groups with intellectual disability and autism, many children with chewing as the chief complaint were classified as having a disordered self-feeding function. Regarding children with Down’s syndrome, however, a disordered food-capturing or chewing function was prevalent, even in those with self-feeding as the chief complaint. Thus, children with intellectual disability exhibited many problems regarding chewing, the self-feeding function, and cognitive function. Additionally, inconsistencies between chief complaints and functional evaluation often occurred, suggesting that there is a need for appropriate actions and support.

Key words

Developmental disorders, Feeding instruction, Preschool children, Self-feeding function

Introduction

In children with congenital diseases, feeding and swallowing functions as well as general development are commonly impaired in some way¹–³). Many reports on feeding and swallowing functions in children with developmental disorders have been published, and it has also been reported that problems regarding feeding and swallowing functions arise in 50 to 80% of crippled children¹–⁵). Such symptoms are markedly present, particularly in children with physical disabilities attributable to central nervous system disorders (e.g., cerebral palsy), progressive neuromuscular diseases (e.g., muscular dystrophy), and Down’s syndrome associated with a hypotonic state and/or macroglossia, and feeding and swallowing rehabilitation has been provided in various forms⁶–⁹). On the other hand, in recent years, problems arising in feeding situations have been major issues in children with intellectual disability¹⁰,¹¹). Problems regarding the feeding function frequently occur in such children as limitations of chewing and self-feeding functions rather than those of the swallowing function, and it is considered that problems concerning the cognition stage are also markedly

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Key words

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influential\textsuperscript{12–14}. Particularly in children with autism spectrum disorders (ASD), many problems (e.g., food selectivity related to sensory dysfunction, incorrect ways to capture food, lack of willingness to self-feed, and difficulties in participating in meals), which are different from previously reported feeding and swallowing disorders, have been described\textsuperscript{14–18}).

Feeding and swallowing rehabilitation for children with intellectual disability sometimes focuses on development of the cognitive function and reduction of sensory dysfunction, as well as training and instructions targeted for improvement in the feeding function, and so it is considered that cooperation between multiple professions plays an extremely important role\textsuperscript{9,20}. In Japan, speech-language-hearing therapists, physical therapists, occupational therapists, and clinical psychotherapists are supporting the development of disabled children in coordination at regional welfare and rehabilitation centers. On the other hand, there are few opportunities to deal with food selectivity and a lack of willingness to eat in ASD children, and reports on feeding instructions for preschool children and the details of consultation are limited\textsuperscript{21,22}).

The study objective was to aid in the development of strategies to solve problems regarding

![Fig. 1 Assessment sheet for feeding function](image-url)
feeding situations and function in children with intellectual disability. For this purpose, we investigated the main problems and the current state concerning the feeding function in children, who requested to participate in feeding consultation in a regional welfare center.

**Objectives and Methods**

The subjects were preschool children with intellectual disability, who participated in feeding-consultation business at a certain welfare center in Tokyo between April 2007 and March 2012, and their guardians. Firstly, children with multiple malformations, cleft palate, or marked motor retardation were excluded. The subjects had received developmental support and nutritional instructions in medical and rehabilitation centers, however, had not been provided with medical care or support regarding the feeding function. Then, among these children with ASD many of them were aged 3 years and older and many of children with Down’s syndrome were below the age of 2 years. Hence, 53 participants of this study were selected by stratified sampling from the whole 69 children who attended the feeding-consultation to clear off the demographics bias among the primary-illness.

Based on the subjects’ data stored in the welfare center, we summarized the chief complaints and items regarding functional evaluation, which were obtained at the time of the initial feeding consultation, and analyzed them according to their primary illnesses. Figure 1 shows the Assessment Sheet used during feeding consultation.

Also, related professions (e.g., public health nurses, clinical psychotherapists, and physical therapists) provided advice and data regarding the growth and development of the subjects during feeding consultation. After a pre-meeting based on such information, 2 dentists evaluated the feeding function, and gave instructions to guardians in actual feeding situations.

In the present study, the “Chief complaint” and items regarding “Assessment of feeding function” were extracted, and chief complaints and assessment of the feeding function were each compared according to primary illnesses. The relationship between chief complaints and the feeding function was also evaluated. The chief complaints were classified into: “Food selectivity is marked (Food selectivity)”, “Dietary intake is low (Dietary intake)”, “Feeding time is long (Feeding time)”, “The way to self-feed and handle utensils is poor (Self-feeding)”, “Chewing is insufficient or absent (Absence of chewing)”, “The form of meal is inappropriate (Form of meal)”, “The way to intake liquid is poor (Liquid intake)”, “The tongue is thrust (Tongue thrust)”, and “Drooling is frequent (Drooling)”. As for evaluation of the feeding function, the subjects were classified as showing incomplete acquisition of one of the following functions based on the 8 stages of feeding-function development: “Swallowing function”, “Food-capturing function”, “Mashing function”, “Chewing function”, and “Self-feeding function”. Also, food selectivity and sensory dysfunction in children with pervasive developmental disabilities were also evaluated.

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>Typical characteristics and findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive stage</td>
<td>Eating limited kinds of food despite no functional problem, sensitivity to certain taste and smell and having little appetite.</td>
</tr>
<tr>
<td>Swallowing function</td>
<td>Tongue protrusion or suckling-like tongue motion while swallowing and reverse swallowing motion and poor bolus formation.</td>
</tr>
<tr>
<td>Food-capturing function</td>
<td>Capturing food with incisors from utensils, tongue protrusion when capturing food and no keeping mouth voluntarily.</td>
</tr>
<tr>
<td>Mashing function</td>
<td>Whole swallowing when eating soft food, residual food on hard palate or surface of tongue and difficulty to keep soft food with no mashing motion with tongue.</td>
</tr>
<tr>
<td>Chewing function</td>
<td>Swallowing down when eating solid food, no lateral motion of tongue and difficulty to keep solid food with no jaw motion.</td>
</tr>
<tr>
<td>Self-feeding function</td>
<td>Stuffing food into mouth, poor handling with utensils, inappropriate gripping utensils, quick self-eating and putting food in mouth at one gulp.</td>
</tr>
</tbody>
</table>
disorders were evaluated and classified as being “Cognition stage” failure\(^{22}\). The evaluation of feeding function was conducted after direct observation of mealtime of the subjects by 2 dentists based on the criteria of diagnosis of feeding disorders regarding to the exist of characteristic symptoms on the feeding behavior, oral motor function, swallowing function and self-feeding motion. If multiple stages of feeding function were affected, the lower stage of function was selected as the evaluation of feeding function for the subject following the diagnostic measure in the previous studies\(^{23}\). The criteria of present study based on the previous studies about functional diagnosis were shown in Table 1. Additionally, video pictures of mealtime were used when the dentists had a different opinions regarding to the diagnosis and the disordered feeding function was discussed until reaching an agreement and deciding the primary disordered feeding function of the subjects.

For statistical analysis, Mann-Whitney’s \(U\) test was used to compare the age among the primary-illness and the chi-square test was used to compare the male-female ratio of the groups. Furthermore, the chi-square test and Tukey multiple comparison test were used to compare the following items between the primary-illness groups: chief complaints, assessment of the feeding function, and relationship of chief complaints with assessment of the feeding function. All analyses were performed using SPSS 18.0J (SPSS Japan, Tokyo), and the level of significance was set at 0.05 and 0.01.

The present study was approved in advance by the institutional review board of the School of Dentistry, Showa University (Approval number: 2011-002).

**Results**

The subjects’ primary illnesses are shown in Fig. 2. Of the subjects, 20 (37.7%) were given a diagnosis of intellectual disability, without other specific primary illnesses recorded. Children with a diagnosis of autism spectrum disorders (ASD) numbered 16 (30.2%), and children with a diagnosis of Down’s syndrome numbered 17 (32.1%).

The mean age each group at the time of the initial examination and gender are shown in Table 2. The mean age of the children was 3 years and 4 months (±8 months), the youngest child was aged 2 years and 2 months, and the oldest was aged 5 years and 2 months. Among the 3 groups, there were no significant differences in mean age, the ratio of number who were 3 years and older and gender.

![Fig. 2 Diagnosis of subjects](image)

<table>
<thead>
<tr>
<th></th>
<th>Intellectual disability (n = 20)</th>
<th>ASD (n = 16)</th>
<th>Down syndrome (n = 17)</th>
<th>(P) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age (year:month)(^{a})</td>
<td>3:3 ± 0:8</td>
<td>3:4 ± 0:6</td>
<td>2:10 ± 0:9</td>
<td>0.35 (intellectual disability vs. ASD)</td>
</tr>
<tr>
<td>Three years old and above(^{b})</td>
<td>10 (50%)</td>
<td>12 (75%)</td>
<td>9 (53%)</td>
<td>0.31 (ASD vs. Down syndrome)</td>
</tr>
<tr>
<td>Gender(^{b})</td>
<td>Male 15 (66.7%)</td>
<td>11 (68.8%)</td>
<td>9 (52.9%)</td>
<td>0.74 (intellectual disability vs. Down syndrome)</td>
</tr>
<tr>
<td></td>
<td>Female 5 (33.3%)</td>
<td>5 (31.3%)</td>
<td>8 (47.1%)</td>
<td>0.27(^{-})</td>
</tr>
</tbody>
</table>

\(^{a}\): Mean age was compared with Mann-Whitney’s \(U\) test  
\(^{b}\): Age and sex groups were compared with chi-squared test
The feeding-related chief complaints reported by guardians are shown in Fig. 3. Food selectivity was most frequently complained of in ASD (56.3%), followed by intellectual disability (35%), and Down’s syndrome (17.6%), but no significant differences were observed between any groups. The frequency of self-feeding was significantly higher in children with intellectual disability (45%) and ASD (50%).

![Graph showing frequencies of chief complaints in each group](image)

**Fig. 3**  Frequencies of chief complaints in each group

*: $P<0.05$ by chi-squared test and Tukey multiple comparison test

N.S.: not significant

![Graph showing disordered feeding functions in each group](image)

**Fig. 4**  Disordered feeding functions in each group

****: $P<0.01$ by chi-squared test between Intellectual problems and Down syndrome

***: $P<0.01$ by chi-squared test between ASD and Down syndrome
than those with Down’s syndrome (11.8%). Chewing was the most frequently reported intellectual problem (70%), followed by ASD (43.8%), and Down’s syndrome (29.4%), with a significant difference between intellectual disability and Down’s syndrome. Form of food was complained frequently in children with Down’s syndrome (29.4%), followed by ASD (18.8%) and intellectual disability (15%), however, these numbers did not show any statistical differences. Liquid intake was not complained of in intellectual disability (ASD: 12.5%, Down’s syndrome: 17.6%). As for tongue thrust, there was a significant difference between Down’s syndrome (23.5%) and intellectual disability/ASD (0%).

The developmental stages of disordered feeding functions, which were identified in feeding situations, are shown in Fig. 4. In the groups with intellectual disability and ASD, approximately 70% each showed a disordered self-feeding function. On the other hand, children with Down’s syndrome showing a disordered self-feeding function numbered only 2, and the proportion was significantly lower compared to those with intellectual disability or ASD ($P<0.01$). The number of children with a disordered chewing function was 5 in intellectual disability, 1 in ASD, and 6 in Down’s syndrome. The group with Down’s syndrome showed the disorders of all functions excluding the cognition stage. In the group with intellectual disability, a disordered mashing function was identified in only 1 child, and a disordered swallowing or food-capturing function was not noted. One child with intellectual disability and 3 children with ASD were classified as having cognition stage failure due to marked food selectivity.

The relationship between chief complaints reported by guardians and assessment of the feeding function is shown in Fig. 5. In this study, we summarized food selectivity, self-feeding, chewing, and the form of food, which were all complained of in all groups. Of the children with food selectivity...
as the chief complaint, 5/7 subjects with intellectual disability, and 6/9 subjects with ASD were classified as having a disordered self-feeding function, while no subject was classified as having such a disorder in those with Down’s syndrome, showing a significant difference between children with intellectual disability and Down’s syndrome, and between children with ASD and Down’s syndrome. Of the children with self-feeding, 7/9 subjects with intellectual disability, and all 8 ASD subjects were evaluated as having a disordered self-feeding function. In the group with Down’s syndrome, on the other hand, 1 subject was classified as having a disordered food-capturing function and 2 subjects each were classified as having disordered chewing and self-feeding functions, respectively. There was a significant relationship between children with intellectual disability and Down’s syndrome, and between children with ASD and Down’s syndrome. Of the children with chewing as the chief complaint, 11/14 subjects with intellectual disability, and all 7 subjects with ASD were classified as having a disordered self-feeding function. In the group with Down’s syndrome, 1 subject each were classified as having disordered food-capturing and mashing function respectively, and remained 3 subjects were evaluated as disorders of chewing function. This group exhibited a significant difference from the groups with intellectual disability and ASD when compared with Down’s syndrome group. Regarding the form of food, 2 subjects showed a disordered chewing function and 1 subject showed a self-feeding disorder in the group of intellectual disability. Similarly, 1 and 2 subjects each with ASD had disordered chewing and self-feeding functions, respectively. Conversely, 1 subject each with Down’s syndrome had a food-capturing disorder and a mashing disorder respectively, and other 3 subjects had chewing functions. However, there were no significant differences between the groups.

Discussion

It is known that, in children with developmental disorders, various problems regarding development of the feeding function arise over time from the initiation of weaning. Particularly, such children may develop problems regarding the feeding function and behavior, which are characteristic of the types of congenital disease (e.g., tongue thrust in children with Down’s syndrome, and sensory dysfunction in children with pervasive developmental disorders), and such problems often continue over time. With these backgrounds, in the present study, the subjects were divided into those with intellectual disability, ASD, and Down’s syndrome, in whom we analyzed chief complaints reported by guardians, and evaluation of the feeding function.

In terms of chief complaints concerning the feeding function, the proportions of food selectivity, self-feeding, and chewing were high. It has been reported that autistic children often complain of food selectivity, and approximately 50 to 80% of such children exhibit various problems, such as “Eating only specific foods.” Also, the frequencies of problems (e.g., eating/not eating depends on food properties, and only foods that are cooked in a specific way are accepted) in children with Down’s syndrome and those with developmental disorders showing intellectual disability are sometimes higher than those in neurotypical children. In the present study, the guardians of more than half of ASD children, and guardians of more than 30% of children with intellectual disability reported chief complaints regarding food selectivity, and the frequencies were similar to those described in previous studies. ASD children often exhibit problems concerning the grasping and handling of utensils, due to sensory dysfunction and underdevelopment of the fingers. The present study also showed such problems occurring more often in children with intellectual disability and ASD, compared to those with Down’s syndrome. A similar tendency was also observed for chewing, the frequency of which was significantly higher in children with intellectual disability than those with Down’s syndrome, possibly attributable to the fact that children with intellectual disability or ASD have fewer problems regarding swallowing and chewing functions, and more problems concerning self-feeding and cognition, while those with Down’s syndrome have fewer opportunities to eat foods that require self-feeding or chewing, due to the retarded development of gross-motor and/or feeding functions. On the other hand, chief complaints regarding liquid intake were not observed in children with intellectual disability, and only those with Down’s syndrome showed tongue thrust. Patients with Down’s syndrome often exhibit tongue thrust and/or spilling at the time of fluid intake, which are associated with macroglossia and/or incomplete lip closure, and problems regarding development of the tongue motor function often arise. It has
also been reported that ASD children, including those without problems concerning the oral cavity function, do not like to take fluids due to allergic symptoms of the lips and around the oral cavity, and are likely to spill liquids because they do not close their lips. It is estimated that these feeding-function-related characteristics attributable to primary illnesses were recognized as problems, and complained of by guardians.

As for classification of the feeding function, similarly to previous studies, disordered swallowing and food-capturing functions were scarcely identified in children with intellectual disability and ASD, and many of them were classified as having a disordered self-feeding function. In the group with Down’s syndrome, on the other hand, no children were evaluated as having cognition stage failure due to food selectivity and/or sensory dysfunction, and the developmental disorders of swallowing, food-capturing, mashing, chewing, and self-feeding functions were exhibited. In this study, we not only summarized the feeding function and chief complaints according to the subjects’ primary illnesses, as other researchers did in previous studies, but also evaluated the relationship between assessment of the feeding function and chief complaints reported by the guardians for all groups.

In the group with food selectivity as the chief complaint, the proportion of those with a disordered self-feeding function was significantly higher in ASD children than those with Down’s syndrome. Food selectivity in ASD children is often observed due to sensory dysfunction and/or limited interest in meals, for which the cognition stage failure is responsible. In the present study, of the 8 ASD children, only 2 were classified as having such failure, and the others did not show sensory dysfunction in and around the oral cavity, which are possibly responsible for food selectivity. The latter children were evaluated as having problems regarding self-feeding movement and the handling of utensils, suggesting that non-favorite foods may be those difficult to eat by themselves and/or capture with utensils. Therefore, it was considered that foods or their properties, which are unsuitable for the self-feeding functions of ASD children, do not attract their interest in meals, which is recognized by guardians as food selectivity. Regarding self-feeding and chewing, most children with intellectual disability, and all ASD children were evaluated as having a disordered self-feeding function, and this finding was consistent with the chief complaints reported by guardians. On the other hand, children with Down’s syndrome who were self-feeding, had disorders of food-capturing, chewing, and self-feeding functions. This suggested that, in such children, including those who are self-feeding, there is a high likelihood that development of the oral cavity function is insufficient, and problems concerning food capturing and intraoral processes arise even when guardians question the self-feeding function. Therefore, it is considered that feeding instructions need to involve professional intervention. On the contrary, many children with Down’s syndrome present with problems regarding tongue movement, especially retarded development from back-and-forth motion to upward-and-downward or lateral motion, and development of the chewing function is often difficult to be achieved, particularly in infancy. These issues can become a cause of tongue thrust, which is considered to influence the acquisition of food-capturing, mashing, and chewing functions, and children with Down’s syndrome who their guardians felt were “Not chewing” were also deemed as such by those who evaluated the feeding function. On the other hand, children with intellectual disability and ASD exhibit problems regarding self-feeding rather than the chewing function. The size of a mouthful and self-feeding pace do not remain constant in neurotypical children as well when their self-feeding function is underdeveloped, and such children sometimes take food into the mouth which is difficult to chew due to its large amount.

It is considered that, as a result, even children with an acquired mashing or chewing function may swallow food without chewing, and insufficient chewing is frequently complained of by guardians in infancy. It has also been reported that issues regarding the self-feeding function (e.g., quick eating, stuffing food into the mouth, and associated suffocation) develop in 70 to 90% of children with intellectual disability and ASD, and, while guardians pay attention to chewing manners (e.g., “Not chewing” and “Swallowing food without chewing”), the causes were possibly related to the self-feeding function, such as adjustment of the size...
of a mouthful, and self-feeding pace. In this respect, the present study showed the greatest difference between chief complaints and the feeding function, and so it is considered necessary to provide not only evaluation by feeding-function experts, but also adopt professional measures in coordination with physical and occupational therapists, who support the development of gross-motor and micro-motor functions of children. There were no significant differences in the form of food between the 3 groups, and the relationship between the complaint reported by guardians and evaluation of the feeding function was not clear. Children with a disordered chewing function were identified in all primary-illness groups, but there were also a few children with a disordered mashing or self-feeding function, suggesting that it is necessary to appropriately evaluate the feeding function regardless of the primary illness, and propose suitable forms of food.

From the results of previous studies and present study, children with a certain congenital disease often indicated characteristic feeding dysfunctions or abnormal feeding behaviors such as tongue protrusion for Down’s syndrome, limited food acceptance in for and swallowing solid food whole in intellectual disability. Additionally, the caregivers who could observe mealtime of these children may have doubt about some functional or behavioral findings. However, complaints of caregivers are not necessarily consistent with actual evaluation of the feeding function. It is also important to resolve and ease up these complaints promptly, however it is of the same importance as above correspondence to evaluate the actual feeding function and to explain the differences between the main complaints and diagnosis of feeding function.

For instance, the method how to hold a spoon or pacing method of self-feeding is provided as feeding instructions for children with developmental disorders even if these children show a chewing disorder. When the appropriate evaluation and correspondence and enough explanation to guardians the reason why self-feeding instruction is essential to improve swallowing whole, it may be occurred that the disordered feeding function and main complaints are not improved. Therefore, various early intervention including feeding consultation and evaluation actual feeding condition could be effective to improve the disordered functions and doubt of guardians regarding mealtime of children with intellectual disabilities.

Conclusion

In the present study, the following knowledge could be suggested.
1. A large proportion of children with intellectual disability and ASD had chief complaints regarding self-feeding, the handling of utensils, and chewing, whereas a small proportion of those with Down’s syndrome had such complaints.
2. The proportion of children evaluated as having a disordered self-feeding function was significantly higher in the groups with intellectual disability and ASD than the group with Down’s syndrome, with few problems regarding swallowing and food-capturing functions observed in the groups with intellectual disability and ASD.
3. Intellectual disability and ASD with a high proportion of children, whose chief complaints reported by guardians were associated with self-feeding and/or utensils, were classified as having a disordered self-feeding function, but some children with chewing as the chief complaint were also classified as so, showing a gap between chief complaints reported by guardians and evaluation of the feeding function.
4. In the group with Down’s syndrome, many children with chief complaints regarding self-feeding and/or utensils also exhibited disorders of the oral cavity function, such as food capturing and chewing, and it was frequently necessary to support development of the oral cavity function in such children.

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References